Journal of Agriculture, Food Systems, and Community Development
ISSN: 2152-0801 online
https://foodsystemsjournal.org

Urban farming as a form of the future food security in the Czech Republic

Jan Szturc,[a] * Tomáš Mašíček,[b] Adéla Navrátilová,[c] and Jana Kozlovsky-Dufková [d]
Mendel University in Brno

Submitted September 11, 2024 / Revised December 16, 2024, and February 14, 2025 / Accepted February 17, 2025 / Published online May 31, 2025

Citation: Szturc, J., Mašíček, T., Navrátilová, A., & Kozlovsky-Dufková, J. (2025). Urban farming as a form of the future food security in the Czech Republic. *Journal of Agriculture, Food Systems, and Community Development*, *14*(3), 109–122. https://doi.org/10.5304/jafscd.2025.143.009

Abstract
The article explores alternative ways of utilizing urban spaces for agricultural production, in contrast with permanent land occupation. The primary goal is to highlight the process of urban farming in the Czech Republic, where it is not yet widely practiced. The research component of the study assesses the production potential of newly identified suitable spaces that could partially meet the demand for food. Specifically, the urban farming production potential for vegetables in the city of Olomouc was determined based on currently available data and spatial analysis using ArcGIS Pro software. The results indicate that 408.04 hectares of land currently not used for agricultural activities in Olomouc could be repurposed for urban farming. This total area has a production potential of 7,099.9 tons, which would meet 42.68% of the total demand for vegetables. Given that current knowledge suggests it is not possible to generalize which locations will have high or low production potential, it is always necessary to conduct a detailed analysis of the specific area.

Keywords
brownfields, urban food production, potential areas, production potential, rooftop growing, vegetable production, climate adaptation

[a] * *Corresponding author:* Jan Szturc, Department of Applied and Landscape Ecology, Faculty of AgriSciences, Mendel University in Brno; Zemědělská 1; 613 00 Brno; Czech Republic; jan.szturc@mendelu.cz;
https://orcid.org/0000-0002-5290-9166

[b] Tomáš Mašíček, Department of Applied and Landscape Ecology, Faculty of AgriSciences, Mendel University in Brno; Zemědělská 1; 613 00 Brno, Czech Republic; tomas.masicek@mendelu.cz;
https://orcid.org/0000-0001-8134-1373

[c] Adéla Navrátilová, Department of Applied and Landscape Ecology; Faculty of AgriSciences, Mendel University in Brno; Zemědělská 1; 613 00 Brno; Czech Republic; adele.navratilova@gmail.com

[d] Jana Kozlovsky-Dufková, Department of Applied and Landscape Ecology; Faculty of AgriSciences, Mendel University in Brno; Zemědělská 1; 613 00 Brno; Czech Republic; jana.dufkova@mendelu.cz;
https://orcid.org/0000-0002-4603-6936

Conflict of Interest Disclosure
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding Disclosure
The article was prepared as part of an unspecified research project of the Institute of Applied and Landscape Ecology of the Faculty of AgriSciences of the Mendel University in Brno.

Introduction

The article aims to highlight alternative ways of utilizing urban spaces for agricultural production, contrasting with permanent land occupation. The primary goal is to showcase the process of urban farming in the Czech Republic, where it is not yet widely practiced. Additionally, the article seeks to demonstrate the potential for effective use of urban spaces based on the results of other studies (e.g. Ackermann et al. (2013), Altmann et al. (2018), Mougeot (2000)) and to apply these findings to the conditions of the Czech environment. The research component aims to determine the production potential of newly identified suitable spaces that could partially satisfy the food demand in the city of Olomouc. Although current knowledge suggests that it is not possible to generalize which locations will have high or low production potential, it is always necessary to conduct a detailed analysis of the specific area.

Literature Review

The development of human settlements and society is changing the structure of the landscape and the functional use of the territory. The expansion of cities and villages, including other infrastructure, has resulted in a dramatic loss of agricultural land, including the most fertile land (Van der Heijde, 2012). Urban expansion is the result not only of population growth but also of lifestyles that use more space (European Environment Agency [EEA], 2016). Suburbanization is a serious problem globally for a number of environmental and socioeconomic reasons. Approximately 56% of the world population now lives in cities, and this is projected to increase to 75% by 2050 (United Nations [UN], 2018). The global human population is likely to continue to grow rapidly, leading to a continued shift of population from rural to urban areas and significant further land development for urban expansion (Gerland et al., 2014; Montgomery, 2008; United Nations Department of Economic and Social Affairs [UNDESA], 2018). The UNDESA (2022) reports that more than half of the projected global population growth by 2050 will be concentrated in just eight countries (Democratic Republic of Congo, Egypt, Ethiopia, India, Nigeria, Pakistan, the Philippines, and the United Republic of Tanzania).

Urban sprawl is associated with a range of environmental, economic, and social impacts, but these are harmful and long-lasting. For example, it contributes significantly to the loss of fertile agricultural land land cover, and its ecological functions. The increase in built-up areas reduces the size of natural habitats and increases landscape fragmentation and the spread of invasive species (Piorr et al., 2011; Szturc et al., 2017). Urban sprawl leads to higher greenhouse gas emissions, higher infrastructure costs for transport, water, and electricity, loss of open landscapes, and degradation of various ecosystem services (EEA, 2016). These adverse impacts can lead to an overall reduction in production potential and the disruption of national food security. Van der Ploeg (2020) and Ragasa and Lambrecht (2020) note that the COVID-19 pandemic highlighted the weaknesses of trends in urban sprawl in the last three or four years. This argument is confirmed by the Food and Agriculture Organization of the United Nations (FAO) et al. (2022), which states that despite hopes that the world would emerge from COVID-19 in 2021 and that food security would start to improve, world hunger has further increased. It is estimated that between 702 and 828 million people were affected by hunger in 2021 (FAO et al., 2022). Since the outbreak of COVID-19, the number of hungry people has increased by about 150 million (FAO et al., 2022). Kinnunen et al. (2020) state that the dominance of the global food system has resulted in up to 80% of the world's population being dependent on food imports. European Union countries alone import up to 93 million tons of non-EU food annually (Eurostat, 2017). These facts suggest the occurrence of systematic inequalities between different regions of the world, which may be further exacerbated by the ongoing conflict in Ukraine. The World Food Programme (WFP; 2022) states that the main expected impact of this conflict on global food security is on global grain and energy markets. When the effects ~~impacts~~ of climate change and biodiversity loss are factored in, the result is a very fragile system that is unable to respond flexibly to an ever-changing and unstable environment. This dire situation is compounded by the findings of a study on the food requirements of the global population, which suggests that by 2050, current production will need to be increased by up to 60% (Alexandratos & Bruinsma, 2012; Ray et al., 2013).

Even though cities are often separated from the surrounding landscape and are primarily intended to serve economic and social functions, it is estimated, as Karanja and Njenga (2011) state, that about 15-20% of global food production comes from urban areas and supplies about 800 million urban dwellers, equivalent to about a quarter of the global urban population. With rapid urbanization threatening the sustainability of rural agriculture in the face of climate change, natural resource depletion, and limited land resources, the question arises at the same time whether there is a need to start placing more emphasis on the environmental aspect of cities. Urban agriculture could be just one of the important elements of this aspect (Abdulkadir et al., 2012). In fact, the intensification of urbanization around the world presents many challenges for cities' ability to support the needs of their inhabitants. The long-term impacts are particularly relevant for future generations and the surrounding landscape from which they draw their resources. In this regard, this research posits that urban agriculture can increase the food security of local communities and reduce dependence on industrially produced food and fossil fuels. Urban production strategies exist at many levels, from large commercial farms to small community gardens and gardening colonies (Krop, 2015). Dubbeling and de Zeeuw (2011) state that urban agriculture could play a major role in increasing food security in conjunction with climate change mitigation measures, particularly through its ability to reduce the urban heat island effect, its ability to sequester CO_2 in plant life cycles, and by reducing CO_2 emissions from transportation by shortening the supply chain.

According to Mougeot (2000), urban agriculture can partially substitute for import demand from rural agriculture and overseas food supply to cities. Urban farmers create an environment that suits their specific needs for urban farming activities. Examples include Brookly Grange farm in New York, which operates three rooftop farms totalling 2.27 ha with an annual production of around 45 tons (Brooklyn Grange, n.d.); Agripolis Organics farm in Vaugirard, Paris, which encompasses 1.4 ha and strives to feed 5–10% of the borough's population each year (Agripolis, n.d.); and Lufa Farms in Montreal, Canada, which operates year-round via heated greenhouses (Lufa Farms, n.d.). Some urban farmers use abandoned or underused paved areas, transforming them into spaces of production. For example, in Dallas, Texas, U.S., a farm was created on a 0.8 ha unused parking lot (Farming Veterans, n.d.), while in Melbourne, Australia, an experimental farm was established on two parking lots, producing 365 kg of food for vulnerable populations in eight months (Noone, 2019). Alker et al. (2000) report that brownfields are often discussed as sites for which meaningful uses are sought in urban areas. Brownfields are land that has undergone development but is not currently being used. However, they are accompanied by a potential risk of contamination from earlier activity, such as industrial production or commercial activities. One example is the use of an old military bunker in Clapham, London, where artificial light is used for underground production (Growing underground, n.d.).

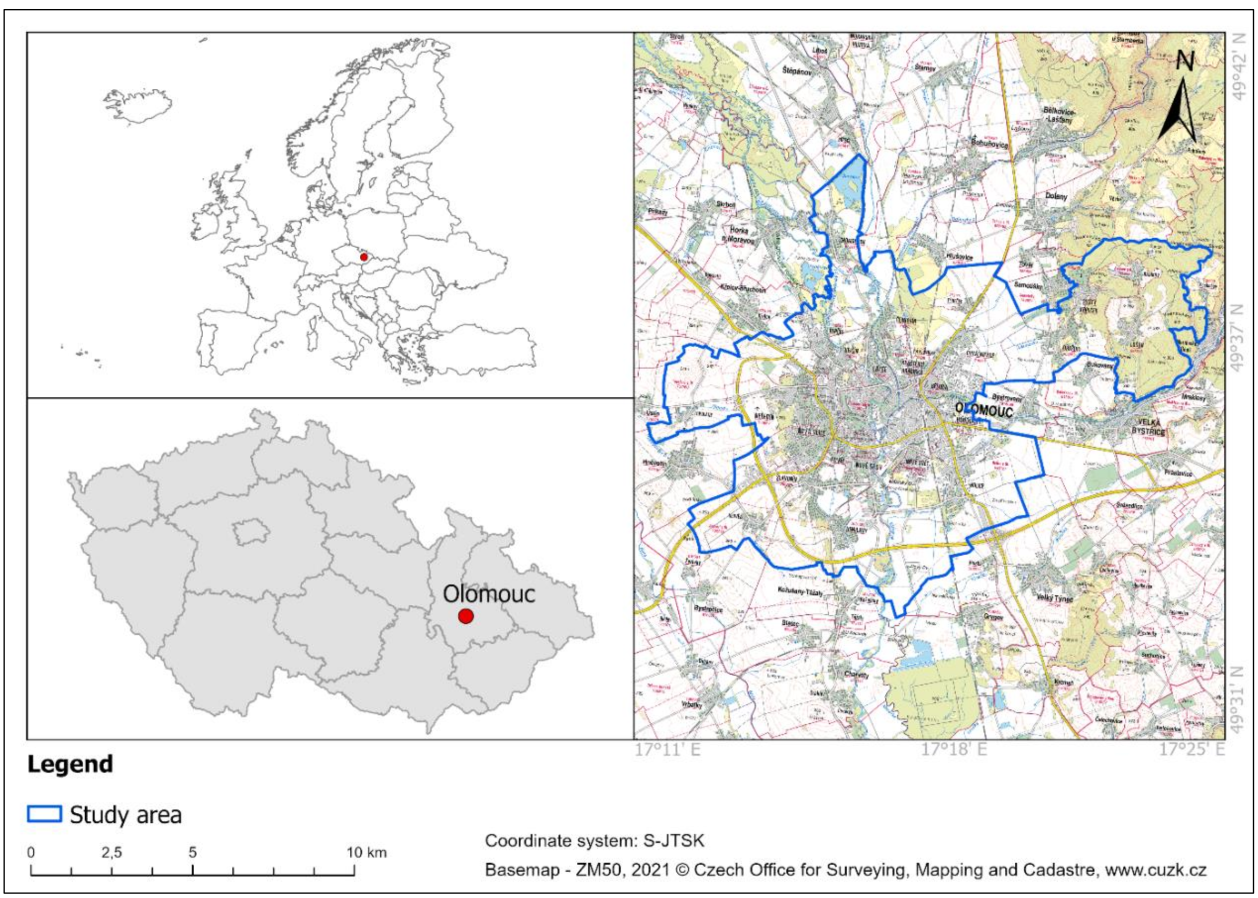
The perception of urban farming in the Czech Republic is still considered to be a rather marginal matter for a few enthusiasts and gardeners. Therefore this research highlights the potential for urban farming among citizens. An example of this is the newly launched mini-garden project in Frýdek-Místek, located in the eastern part of the Czech Republic, in the form of raised beds in a housing estate (Matějíková, 2021). Kalista (2021) further states that in the Czech Republic, only rooftop farms using hydroponic systems (e.g., ForestBit) are currently known, but the use of rooftops for beekeeping is quite popular (Klub Střešních Včelařů, n.d.). Community gardens are another type of urban farming in the Czech Republic, and they are experiencing a major boom. Mapko (n.d.) reports that there are about 138 community gardens in the Czech Republic. In contrast to the relatively new concept of community gardens, there is a long tradition of gardening colonies (a community garden is a shared space for growing plants together, while a garden colony is divided into individual gardens for personal use) in the Czech Republic, but they are disappearing as a result of development activities (ČZS, n.d.). In the Czech Republic, the trend of community subsistence gardening rather than the trend of localized commercial production can be seen on land blocks in cities.

Applied Research Methods

The study area (Figure 1) is in an intensively farmed part of the Czech Republic, which is characterized by high fertility and large soil blocks; the structure of the crop mix corresponds to market requirements (e.g., maize, barley, rape, sugar beet). The city of Olomouc can be classified as a medium-sized city in European terms, and as a large city in the Czech context in terms of population (Šilhánková, 2020); the population as of 2021 was 99,496 (ČSÚ, n.d.-b, 2023).

This research determined the production potential of selected economically profitable areas in Olomouc to meet the food demand of the entire city. To answer the research question and objective, the methodology included quantitative analysis using statistical data. Food demand was derived from food consumption (per capita) and limited to the vegetable category, which constitutes a high share of the consumer basket, as shown in the Czech Statistical Office's data series "Consumption of food and non-alcoholic beverages (per capita per year) for the period 2012 to 2021" (ČSÚ, n.d.-a). After considering the population of Olomouc in 2021, the consumption) of vegetables from the total food consumption (87,278 tons) in that year represents a share of 19.44% (in absolute value, i.e., 16,964 tons of vegetables). For a clearer expression of potential production, individual types of vegetables were divided into seven production groups: fruiting vegetables (cucumbers, salad cucumbers, tomatoes, peppers, melons), root/tuber vegetables

Figure 1. Spatial Location of the Area of Interest



Maps by authors Szturc and Mašíček.

(carrots, parsley, celery, potatoes), leafy greens (lettuce, spinach), legumes (green peas, green beans, kidney beans, peas, lentils), bulbs (onions, garlic), brassicas (cabbage, kale, cauliflower, kohlrabi) and other vegetables (unspecified).

The total food demand for vegetables for the inhabitants of Olomouc was then used to determine the total production area required to satisfy it. The calculation of this area is based on the required production area per capita, which is on average 100 m^2 per year, as shown in previously published studies by Kastner et al. (2012) and Viljoen et al. (2005).

The farm ZE-ZA-HRÁTKY was chosen mainly because of the higher species diversity of the crops grown per size of production area than in conventional farming, and because of its socio-economic overlap with local character. This farm was also chosen as a model because it is the only company that manages agricultural land located within the city of Olomouc. The statistical data on production provided by the ZE-ZA-HRÁTKY farm (in digital form) in the municipality of Olomouc were used to calculate the average yield per one m^2 and subsequently to determine the total production potential for urban agriculture. These data are from the period of 2019–2021 from an area of 3,500 m^2, including the cultivation area, which includes areas for the necessary infrastructure between the individual beds. The average yield was calculated, as well as the food demand for each of the seven production groups. The calculations included determining the average yield in kg per production group for each year, the average per production group in kg for the whole three-year period, expressing the average yield in kg for each year.m^{-2}, and calculating the average yields for the whole three-year period in kg.m^{-2} from a total area of 3,500 m^2.

The selection of potentially suitable areas in Olomouc was made based on an evaluation of their potential for agricultural activities. The spatial analysis was based on four types of production areas that are not currently used for agricultural activities, including rooftops, concrete-covered areas, brownfields, and green areas. The analysis was conducted using ArcGIS Pro software, which was also used to produce map outputs depicting potential production areas broken down by the above types. Criteria for each type of acreage were established based on the methodology for researching potential production areas in New York City by a research team from Columbia University (Ackerman et al., 2013). This was then translated into the Czech context and the specific area of interest. In order to specify whether the analyzed parcels correspond to the established criteria, we used data on the cadastral areas concerned (Czech Office for Surveying, Mapping and Cadastre,[1] 2021), orthophotos via WMS viewing service (Czech Office for Surveying, Mapping and Cadastre, 2021b), mapy.cz server, Google Maps server, and a field survey method. The criteria set for individual plots are based on the ability of effectively managed areas to be economically viable, that is, capable of yielding a commercial return.

The criteria for potentially suitable buildings' roofs for urban agriculture follow from the Land Registry (LR):

- Must be buildings,
- roofs must be flat,
- the continuous area must be at least 950 m^2 (the economically viable value for roofs),
- a maximum of 10 floors, and
- can not be used for heavy industry.

For concrete-covered areas, brownfields, and green areas, the literature does not specify a minimum area size that would meet the condition of economic viability. For the purposes of the present analysis, a minimum size criterion for these types of areas was set at 500 m^2. This value was estimated on the assumption that ground-level areas offer more production opportunities than rooftop areas. Other criteria for concrete-covered areas are their registration in the cadastre as "other areas," which may include underused car parks and unused playgrounds. In the case of brownfields, these are areas that are defined as brownfields in the

[1] A cadastre is "an official register of the quantity, value, and ownership of real estate used in apportioning taxes" (Merriam-Webster, n.d.).

National Catalogue of Open Data on the Open Data Portal (n.d.). According to the cadastre, other areas and grass areas that do not fulfill an important function according to their use code are considered green areas. This means that in the case of other areas, these must not be roads, grass strips near roads, garages, cemeteries, gardening colonies, recreational areas and public spaces (parks, squares, zoos or currently used playgrounds); in the case of grass areas, they must not be areas currently used for agriculture, areas with tree cover over 25% of their area, greenery in courtyards or near housing estates, or areas used for development purposes. Areas that are part of small-scale special protected areas of national and local importance are excluded.

In addition to the areas identified above, the calculation of the commercial production potential of vegetables in Olomouc included areas currently used as arable land with a predominantly conventional type of agriculture and part of which is publicly owned. Only areas larger than 500 m² were included in the calculation, as smaller areas are generally considered to be inefficient for commercial use. For the calculation of the production potential of arable land in public ownership, the dataset provided by the Property Law Department of the Olomouc City Council was used, which included the distribution of land according to ownership certificate. The production potential of each type of land (expressed in terms of its area and average yield per 1 ha) was derived on the basis of spatial analyes, datasets publicly available from the website (Land Parcel Identification System of the Ministry of Agriculture of the Czech Republic), data provided by public institutions (e.g., The State Agricultural Intervention Fund), and the aforementioned example farm ZE-ZA-HRÁTKY.

Results and Discussion

Food Demand for Vegetables

The food demand was determined based on data from the Czech Statistical Office Consumption (ČSÚ) of food and non-alcoholic beverages, per capita per year, for the Czech Republic in 2021 (ČSÚ, n.d.-a). The highest demand can be observed, as shown in Table 1, for the root/tuber vegetable group, which is dominated by potatoes, and the fruit vegetable group, with the highest demand for tomatoes. The other major groups are brassica crops and other vegetables without further specification. From the total per-capita consumption of vegetables in the country in 2021, which was 167.20 kg, the total food demand for vegetables per population of the area of interest was then determined. In 2021, the population was 99,496. After considering the population of the area of interest, the total food demand for vegetables is estimated to be 16,635.73 tons.

The question remains whether the current demand for vegetables in the Czech Republic corresponds to a nutritionally balanced diet. For example, according to the Healthy Eating Plate scheme published by Harvard Medical School, vegetables (excluding potatoes) should make up approximately 50% of our diet (Willett & Skerrett, 2017). However, if we look at the country's current consumption, vegetables (including potatoes) make up only 19.44% of Czech diets; when potatoes are excluded, the total vegetable consumption is 12.44%. Therefore, it can be expected that if the food demand for vegetables is recalculated to correspond to a nutritionally balanced diet (excluding potatoes), the total demand for vegetables would nearly quadruple.

Table 1. Current Demand for Vegetables in Interest

Groups of vegetable	Demand/groups (tons)	Demand/inhabit (kg)
Fruit	3,591.81	36.10
Root	8,178.57	82.20
Leafy	358.19	3.60
Legumes	477.58	4.80
Bulbs	1,313.35	13.20
Brassica	1,273.55	12.80
Other	1,442.69	14.50
Total	**16,635.73**	**167.20**

Source: ČSÚ, n.d.-a

Average Yield per Square Meter

The data from the example farm ZE-ZA-HRÁTKY for the period 2019–2021—from a total growing area of 3,500 m² including infrastructure (M. Dobrá & L. Dobrý, personal communication, December 3, 2021)—were used to determine the amount of vegetables produced in the city of Olomouc per unit area. The results indicate that the highest yields on average are achieved for the root/tuber vegetable and fruit vegetable groups (Table 2).

The average yield per area of 3,500 m² over the three-year period was around 6,104.50 kg; the average yield per m² was 1.74 kg. Rabin et al. (2012) report that a similar type of farm in the U.S. achieves an average yield of around 2.44 kg/m².

Table 2. Average Yield of Vegetables

Groups of vegetable	ø yield (kg)	ø yield/m²
Fruit	1,529.01	0.44
Root	1,865.26	0.53
Leafy	728.90	0.21
Legumes	182.92	0.05
Bulbs	503.56	0.14
Brassica	1,285.23	0.37
Other	9.62	0.003
Total	**6,104.50**	**1.74**

Source: M. Dobrá & L. Dobrý, personal communication, December 3, 2021.

Table 3. Area of All Potential Production Areas

Type of area	Area (ha)
Rooftops	138.65
Other potential areas	269.39
Total	408.04

Table 4. Area of Potential Production Roofs

Type of roofs	Area (ha)
Flat roofs	95.39
Mixed roofs	43.26
Total	138.65

The observed yield per m² is therefore lower compared to U.S. urban farms. The same applies to the comparison with the average yield of vegetables from conventional farming for the Czech Republic in 2021, which is around 2 kg/m² (Němcová & Buchtová, 2021). If we estimate from the above data that the average area required to meet the per-capita demand for vegetables is 100 m², and the average per capita demand is 167.20 kg, then an example farm with a yield of 1.74 kg/m² and a total area of 1 ha should be able to meet the year-round food demand for vegetables for almost 104 people.

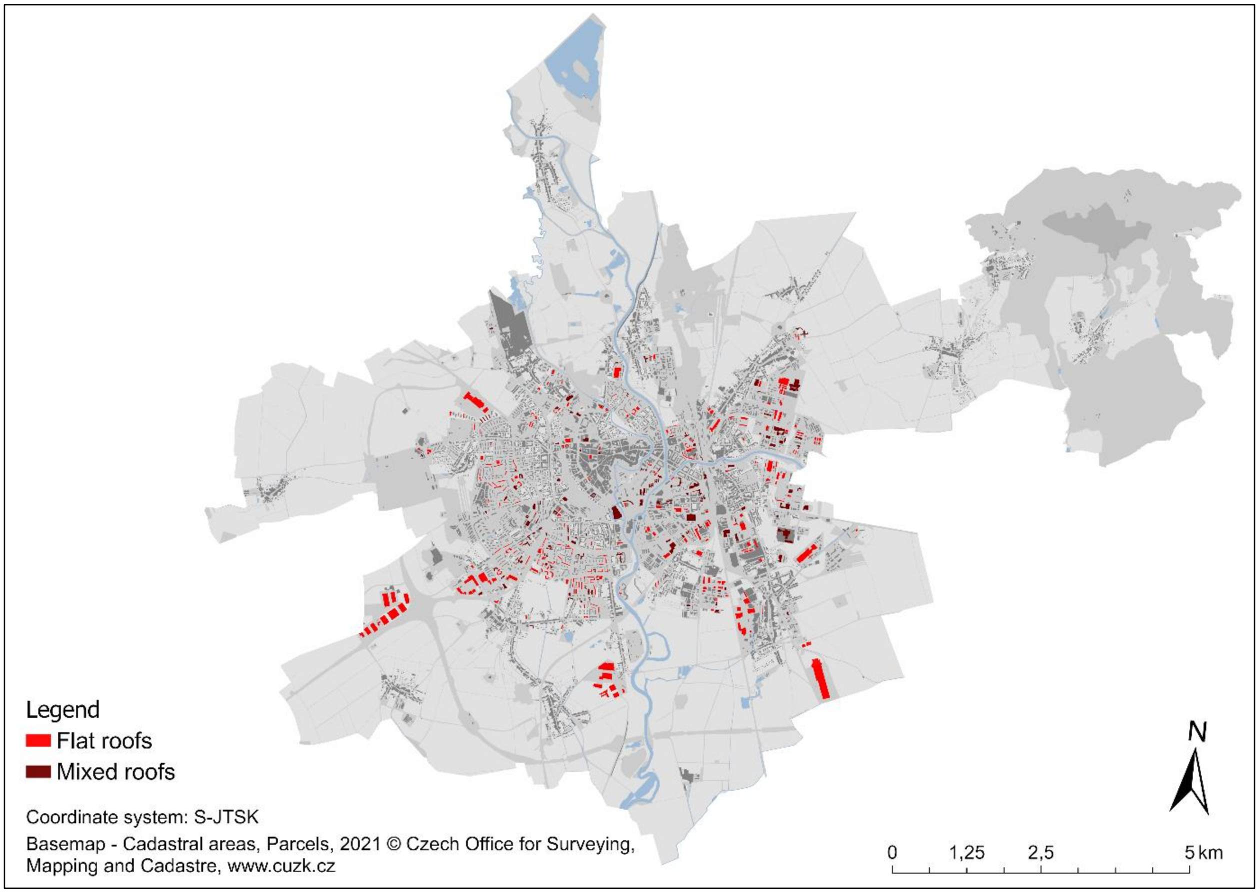
Spatial Analysis of Potential Production Areas

Spatial analysis in ArcGIS Pro software was selected as the most appropriate way to identify potential production areas in Olomouc. The four types of production areas suitable for urban agriculture were divided into two groups according to structural differences. The first group consists of rooftops and the second group consists of concrete-covered areas, brownfields, and green areas, designated in this study as "other potential areas." Subsequently, the total area of all potential production areas in the city was found to be 408.04 ha (Table 3). The area size values resulting from the spatial analysis were then used to calculate the production potential of each area type.

Rooftops are often cited as suitable areas for urban agriculture (Islam et al. 2023; Whittinghill & Starry, 2016), primarily because they are unused areas and therefore do not create pressure for further land taking. This statement comports with the observation of Li et al. (2015), who state that the permanent loss of agricultural land can cause threats, to some extent, to the food security of a region. The total area of potentially suitable rooftops larger than 950 m² reaches 138.65 ha in Olomouc (Table 4). In general, however, flat roofs are considered the most suitable, with an area of 95.39 ha in the city. Of these, four roofs are larger than 2.5 ha and account for 19.32 ha of the total potential roof area. Mixed roofs with structural anomalies account for 43.26 ha of the total area. The distribution of the several types of potential roofs for production in Olomouc can be found in the map in Figure 2.

The results can be compared to some extent

Figure 2. Location of Potentially Suitable Roofs



Map by author Navrátilová.

with the city of Berlin, which is approximately eight times larger than Olomouc in terms of area but has a similar ratio of potential roofs to the total area of the city. The ratio corresponds to a value of 100 ha of potential roofs per 10,000 ha of city area. Berlin has a total area of 89,180 ha, where 888.7 ha constitutes the area of potentially suitable roofs (Altmann et al., 2018). In contrast, New York City, with a total area of 78,380 ha, has approximately 1,246 ha of such potential areas (Ackerman et al., 2013). The ratio of potential roofs is therefore higher in New York City than in European cities and can be explained by the structural difference of American cities, which are characterized by denser development and a higher proportion of buildings with flat roofs.

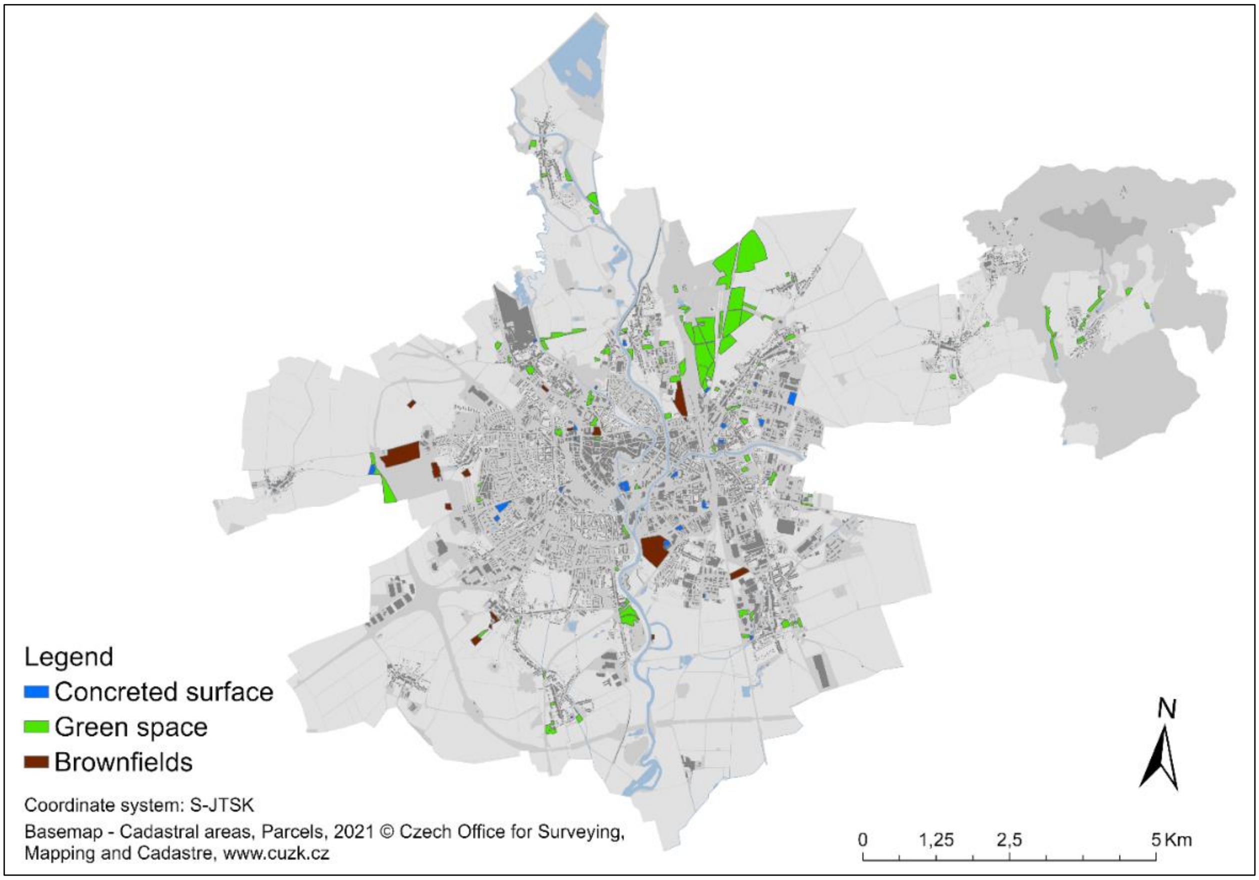
Other potential areas in Olomouc are represented by concrete areas (i.e., unused parking lots, old playgrounds), brownfields, and green areas—where no agricultural activity is currently taking place—and occupy an area of 269.39 ha (Table 5). The spatial location of the types of other potential production areas is shown in the map in Figure 3.

Table 5. Other Potential Production Areas

Type of area	Area (ha)
Concrete-covered surface	17.36
Green space	189.99
Brownfields	62.04
Total	269.39

These results show that approximately 30% (79.4 ha) of the potential areas in the study area are covered by an impermeable layer of concrete, which may represent a key resource for urban agriculture. Szopinska-Mularz and Lehmann (2019) state that with the development of transport infra-

Figure 3. Location of Other Potentially Suitable Areas



Map by author Navrátilová.

structure toward low-emission modes of transport (i.e., a shift away from car transport), the need for parking spaces in city centers is expected to decrease. To increase local food resilience, with this research we argue that these newly available areas could then be used for the development of urban agriculture. For example, a case study analyzing the potential use of car parks in the UK indicates that up to 1,293 parking spaces could be used for urban agriculture (Szopinska-Mularz & Lehmann, 2019). In this context, as Mohareb et al. (2017) emphasize, the focus of municipal policymakers and urban planners should be on linking urban agriculture to urban resources through urban planning and industrial ecology.

Calculation of Production Potential

The production potential in vegetable cultivation in the city of Olomouc was determined based on the results of the acreage of individual areas in the spatial analysis, data obtained from the Public LPIS database of the Ministry of Agriculture, and data provided by the property management department of the Olomouc City Council. The total production potential in the area under consideration was determined from the total area of potential areas, which included rooftops, other potential areas (concrete-covered areas, green areas, and brownfields), and currently used arable land, amounting to 4,897.92 ha, with a production potential of 85,223.81 tons of vegetables (Table 6). If 100% of the potential area (4,897.92 ha) for vegetable cultivation were used, Olomouc would be able exceed the food demand for vegetables by approximately 512.29% (sufficient for 509,712 residents). According to the study's projections, using 19.52% of the potential area would be sufficient to meet the food demand for 100% of residents (99,496). The highest production potential for vegetable cultivation in terms of total area is shown by the currently used arable land in Olomouc. Nevertheless, it cannot be said that the production potential of rooftops and other potential areas of 408.04 ha is somehow negligible. If vegetables were grown on all these areas, 42.68% of the food demand would be met.

Table 6. Production Potential by Type of Area

Type of area	Area (ha)	Production potential (tons)
Arable land	4,489.88	78,123.91
Roofs	138.65	2,412.51
Other potential areas	269.39	4,687.39
Total	4,897.92	85,223.81

The results can be compared with research on the self-sufficiency of large cities, which shows, for example, that if the cities of London and Berlin used more remote peri-urban areas for their food supply, they could be 100% self-sufficient in food. In comparison, the cities of Milan and Rotterdam show a maximum self-sufficiency rate of around 25% (Zasada et al., 2019). Filippini (2015) notes that some research also focuses on peri-urban areas where agricultural production already occurs but that are not primarily used to meet food demand. Tornaghi (2013) states that it is always necessary to analyze the critical geography of urban agriculture. The body of literature on critical urban studies, therefore, suggests that it is not possible to generalize about which city will have high or low production potential; it is always necessary to conduct a detailed analysis of the area of interest. This argument is supported by Clinton et al. (2018), who describe how the potential of urban agriculture indicates the possible volume of food production in unused urban areas, in both built and undeveloped areas. This statement is also supported by McClintock et al. (2013), who argue that when calculating the potential productivity of vacant land, it is important to factor in both the geographic adaptability of a particular crop to the local agroecosystem and its seasonality.

The present study attempted to quantify the potential productivity of the main types of suitable urban spaces in the city of Olomouc. The production potential for vegetable cultivation in Olomouc, according to the spatial analysis we carried out, is 2,412.51 tons, assuming cultivation on substrate. The total area of potential roof areas is then 138.65 ha. If all the potentially designed rooftops were used, then approximately 14.50% of the food demand would be fulfilled.

The research on potential rooftops for vegetable cultivation in Berlin indicates that if all suitable rooftops with a minimum size of 1,000 m² were used, then there would be an excess of production needed to meet food demand (Altmann et al., 2018). An analysis in Bologna, Italy, found that up to 12,000 tons of vegetables could be grown in a substrate-free way on 82 ha of flat roofs and terraces, equivalent to 77% of the food demand of the population (Orsini et al., 2014). Therefore, it is possible that if the average yield for substrate-free systems were determined in Olomouc, the production potential of roofs would reach higher values.

The other areas offer one of the other potential types of areas for urban agriculture development. The total area of potential other areas for vegetable cultivation is 269.39 ha. The production potential of these areas amounts to 4,687.39 tons. If all the potentially proposed areas of this type were used, 28.18% of the food demand for vegetables would be met.

A study examining the potential of vacant land for urban agriculture suggests that if up to 80% of Cleveland's vacant land were converted into production areas, the city could meet:

- up to 50% of its demand for fruits and vegetables,
- up to 25% of its demand for poultry and eggs, or
- 100% of its demand for honey,

depending on the scenario selected (Grewal & Grewal, 2012). The production potential values calculated for the city of Olomouc do not differ significantly from those in the Cleveland study, although only vegetable production was assessed. In Detroit, the potential for outdoor vegetation production could reach 31% of the total available area (approximately 1,618 ha), and up to 75% if greenhouses were used to extend the growing season (Colasanti et al., 2010). In Olomouc, the estimated production potential is as follows:

- Concrete-covered areas (17.36 ha): Up to 302.06 tons, covering 1.82% of vegetable demand.
- Brownfields (62.04 ha): Up to 1,079.50 tons, covering 6.49% of demand.
- Green areas (189.99 ha): Up to 3,305.83 tons, covering 19.87% of demand.

The total arable land in Olomouc is 4,489.88 ha, of which only 0.3% is currently used for vegetable cultivation. If the entire area were used exclusively for growing vegetables, the production potential would be 78,123.91 tons, which could meet the city's vegetable demand nearly five times over (469.62%).

Publicly owned arable land presents a direct opportunity for municipal involvement in urban agriculture. Only plots larger than 500 m² were included in the analysis. These total approximately 376.49 ha, with a production potential of 6,550.93 tons, which could fulfil around 39.38% of the city's vegetable demand.

For comparison, in New York City, between 66,000 and 94,000 ha would be needed to meet the demand for fruits and vegetables, yet only 2,000 ha are available. However, if the entire metropolitan and peri-urban areas are considered, 58% to 89% of the demand could be met, assuming local market distribution (Ackerman et al., 2013).

This highlights that, as in Olomouc, peri-urban areas with existing arable land offer the highest production potential. Structurally, however, these cities differ significantly, with contrasting characteristics in their peri-urban zones.

Conclusion

The aim of the paper is to determine the production potential of vegetables for urban agriculture in the city of Olomouc, Czech Republic, based on currently available data and spatial analysis in ArcGIS Pro software. The issue of food security is increasingly discussed in the public space, especially in the context of the worldwide occupation of quality arable land and the impacts of climate change.

The results show that 408.04 ha currently not used for agricultural activities in Olomouc could be repurposed for urban agriculture. This total area has a production potential of 7,099.9 tons, which would provide 42.68% of the total vegetable demand. If the city's total arable land (4,489.88 ha) were also considered for vegetable production, using less than 20% of all these areas could meet the food demand for vegetables of the city's inhabitants.

Urban agriculture, as a way of meeting part of the demand for food, offers the possibility of increasing the natural capital of cities in addition to food production, the impact of which has many other social and environmental benefits. If urban agriculture contributes even a fraction to more sustainable and stable cities, then this is a direction that should be considered in urban planning. On the other hand, it is important to bear in mind certain risks associated with food production in cities, such as the effects of air pollution and increased concentrations of heavy metals on plant health, high investments (e.g., irrigation, substrate, compost), or the technological performance and structural integrity of buildings. Although urban farming faces several limitations, it can still contribute to climate adaptation and food security. This research thus serves as an overview of alternative ways of utilizing urban spaces for agricultural production, contrasting with permanent land occupation. The primary goal was to highlight the process of urban farming in the Czech Republic, which it is not yet widely practiced. The results of this study could also motivate of municipal policymakers and urban planners to implement more urban farming and involve more local people in the activity in the Czech Republic.

References

Abdulkadir, A., Dossa, L. H., Lompo, D. J. P., Abdu, N., & Van Keulen, H. (2012). Characterization of urban and peri-urban agroecosystems in three West African cities. *International Journal of Agricultural Sustainability*, *10*(4), 289–314. https://doi.org/10.1080/14735903.2012.663559

Ackerman, K., Dahlgren, E., & Xu, X. (2013). *Sustainable urban agriculture: Confirming viable scenarios for production: Final report* (NYSERDA Report No. 13-07). New York State Energy Research and Development Authority (NYSERDA). http://urbandesignlab.columbia.edu/files/2015/04/2_Sustainable-Urban-Agriculture_NYSERDA.pdf

Agripolis. (n.d.). *About us*. Retrieved May 2023 from https://agripolis.eu

Alexandratos, N., & Bruinsma, J. (2012). *World agriculture towards 2030/2050: The 2012 revision* (ESA Working Paper, No. 12-03). FAO Agricultural Development Economics Division. https://www.fao.org/3/ap106e/ap106e.pdf

Alker, S., Joy, V., Roberts, P., & Smith, N. (2000). The definition of brownfield. *Journal of Environmental Planning and Management*, *43*(1), 49–69. https://doi.org/10.1080/09640560010766

Altmann, S., Sanz Alcàntara, M., Suhl, J., Ulrichs, C., Raquel, S. M., Fitz-Rodríguez, E., Lopez-Cruz, I., Rojano-Aguilar, A., Navas-Gomez, G., Schmidt, U., & Dannehl, D. (2018, March). *Potential of urban rooftop farming in Berlin* [Poster presentation]. DGG Tagung, BHGL Tagungsband, Berlin, Germany. https://www.researchgate.net/profile/DennisDannehl/publication/323801529_Potential_of_urban_rooftop_farming_in_Berlin/links/5aabb1d245851521c848667d/Potential-of-urban-rooftop-farming-in-Berlin.pdf

Brooklyn Grange. (n.d.). *Brooklyn Grange*. Retrieved May 2023 from https://www.brooklyngrangefarm.com

Český statistický úřad [ČSÚ]. (n.d.-a). Spotřeba potravin – 2021 [Food consumption – 2021]. In *Spotřeba potravin a nealkoholických nápojů (na obyvatele za rok)* [*Consumption of food and non-alcoholic beverages (per capita per year)*]. Retrieved May 2023 from https://www.czso.cz/csu/czso/spotreba-potravin

ČSÚ. (n.d.-b). Veřejná databáze [Public database]. In Vše o území, Olomouc (okres Olomouc) [All about the area, Olomouc (Olomouc district)]. Retrieved May 2023 from https://vdb.czso.cz/

Český zahradkářský svaz [ČZS]. (n.d.). Zpravodaj Českého zahrádkářského svazu [Newsletter of the Czech Gardening Association]. Retrieved May 2023 from https://www.zahradkari.cz/

Clinton, N., Stuhlmacher, M., Miles, A., Uludere Aragon, N., Wagner, M., Georgescu, M., Herwig, C., & Gong, P. (2018). A global geospatial ecosystem services estimate of urban agriculture. *Earth's Future*, *6*(1), 40–60.https://doi.org/10.1002/2017EF000536

Colasanti, K., Litjens, C., & Hamm, M. (2010). Growing food in the city: The production potential of Detroit's vacant land. The C. S. Mott Group for Sustainable Food Systems, Michigan State University. https://www.canr.msu.edu/foodsystems/uploads/files/Growing_Food_in_the_City_-_Colasanti_Litjens_Hamm.pdf

Czech Office for Surveying, Mapping and Cadastre. (2021). *Base map - Cadastral areas, Parcels*. https://geoportal.cuzk.cz/(S(z2uvaw4qaz04ckb53oiylzmv))/Default.aspx?menu=223&mode=TextMeta&side=mapy10&text=dsady_mapy10

Dubbeling, M., & de Zeeuw, H. (2011). Urban agriculture and climate change adaptation: Ensuring food security through adaptation. In K. Otto-Zimmermann (Ed.), *Resilient cities: Cities and Adaptation to Climate Change—Proceedings of the Global Forum 2010* (pp. 441–449). Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0785-6_44

European Environment Agency (EEA). (2016). *Urban sprawl in Europe: Joint EEA-FOEN report* (EEA Report 11/2016). https://www.eea.europa.eu/publications/urban-sprawl-in-europe

Eurostat. (2017, October 16). *EU trade in food*. https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/edn-20171016-1

Farming Veterans. (n.d.). *Home*. Retrieved May 2023 from http://www.farmingveterans.org

Filippini, R. (2015). *Food production potential of periurban agriculture: Contribution of periurban farms to local food systems* [Doctoral dissertation, Scuola superiore Sant'Anna di studi universitari e di perfezionamento, Pisa, Italy]. https://hal.science/tel-01285728

Food and Agriculture Organization of the United Nations [FAO], International Fund for Agricultural Development [IFAD], UNICEF, World Food Programme [WFP], & World Health Organization [WHO]. (2022). *The state of food security and nutrition in the world 2022*. https://doi.org/10.4060/cc0639en

Gerland, P., Raftery, A. E., Ševčiková, H., Li, N., Gu, D., Spoorenberg, T., Alkema, L., Fosdick, B. K., Chunn, J., Lalic, N., Bay, G., Buettner, T., Heilig, G. K., & Wilmoth, J. (2014). World population stabilization unlikely this century. *Science*, *346*(6206), 234–237. https://doi.org/10.1126/science.1257469

Grewal, S. S., & Grewal, P. S. (2012). Can cities become self-reliant in food? *Cities*, *29*(1), 1–11. https://doi.org/10.1016/j.cities.2011.06.003

Growing Underground. (n.d.). *Zero Carbon Farms Ltd*. Retrieved May 2023 from https://web.archive.org/web/20230508035042/https://growing-underground.com/

Islam, S., Alam, M. R., & Rashid, K. J. (2023). Identification of potential rooftops for gardening and contributions of RTGs to improve the socio-economic condition and promote a sustainable urban environment in the changing climatic condition of Bangladesh. In U. Chatterjee, N. Bandyopadhyay, M. D. Setiawati, & S. Sarkar (Eds.), *Urban commons, future smart cities and sustainability* (pp. 511–532). Springer, Cham. https://doi.org/10.1007/978-3-031-24767-5_22

Kalista, M. (2021). *Ozelenit Prahu a farmařit v centru města. Na střeše obchoďáku se otevírá studentská ekofarma s bylinkami a zeleninou* [*Greening Prague and farming in the city center. A student eco-farm with herbs and vegetables opens on the roof of a shopping mall*]. https://www.startupjobs.cz/newsroom/ozelenit-prahu-pomoci-proti-horku-nastreseobchodaku-vznikla-ekofarma

Karanja, N., & Njenga, M. (2011). *Feeding the cities*. In Worldwatch Institute (Ed.), *State of the world 2011* (pp. 109–120). Routledge. https://doi.org/10.4324/9781849776745-10

Kastner, T., Ibarrola Rivas, M. J., Koch, W., & Nonhebel, S. (2012). Global changes in diets and the consequences for land requirements for food. *Proceedings of the National Academy of Sciences*, *109*(18), 6868–6872. https://doi.org/10.1073/pnas.1117054109

Kinnunen, P., Guillaume, J., H., A., Taka, M., D'Odorico, P., Siebert, S., Puma, M., J., Jalava, M. & Kummu, M. (2020). Local food crop production can fulfil demand for less than one-third of the population. *Nature Food*, *1*(4), 229–237. https://doi.org/10.1038/s43016-020-0060-7

Klub Střešních Včelařů. (n.d.). *Střešní včelí stanoviště: Praha* [*Rooftop bee habitat: Prague*]. Retrieved May 2022 from https://klub-stresnich-vcelaru.webnode.cz/stresni-vceli-stanoviste/praha/

Krop, A. (2015). *Articulating ecology: Brownfield remediation, urban agriculture and prospects for community revitalization* [Doctoral dissertation, Dalhousie University]. Faculty of Graduate Studies Online Theses. http://hdl.handle.net/10222/58977

Li, J., Deng, J., Gu, Q., Wang, K., Ye, F., Xu, Z., & Jin, S. (2015). The accelerated urbanization process: A threat to soil resources in eastern China. *Sustainability*, *7*(1), 7137–7155. https://doi.org/10.3390/su7067137

Lufa Farms. (n.d.). About us. Retrieved May 2023 from https://montreal.lufa.com/

Mapko. (n.d.). *Komunitní zahrada* [*Community garden*]. Retrieved May 2022 from https://www.mapko.cz/page/komunitni-zahrady

Matějíková, J. (2021). *Minizahrádky na sídlišti? Proč ne* [*Mini gardens on a housing estate? Why not*]. https://www.frydekmistek.cz/minizahradky-na-sidlisti-proc-ne/

McClintock, N., Cooper, J., & Khandeshi, S. (2013). Assessing the potential contribution of vacant land to urban vegetable production and consumption in Oakland, California. *Landscape and Urban Planning*. *111*(1), 46–58. https://doi.org/10.1016/j.landurbplan.2012.12.009

Merriam-Webster. (n.d.). Cadastre. In *Merriam-Webster.com dictionary*. Retrieved May 5, 2025, from https://www.merriam-webster.com/dictionary/cadastre

Mohareb, E., Heller, M., Novak, P., Goldstein, B., Fonoll, X., & Raskin, L. (2017). Considerations for reducing food system energy demand while scaling up urban agriculture. *Environmental Research Letters*, *12*(12), Article 125004. https://doi.org/10.1088/1748-9326/aa889b

Montgomery, M. R. (2008). The urban transformation of the developing world. *Science*, *319*(5864), 761–764. https://doi.org/10.1126/science.1153012

Mougeot, L. J. A. (2000). *Urban agriculture: definition, presence, potentials, and risks*. In R. van Veenhuizen (Ed.), *Cities farming for the future: Urban agriculture for green and productive cities* (pp. 1–42). RUAF Foundation, IDRC and IIRR.

Němcová, V., & Buchtová, I. (2021). *Situační a výhledové zprávy: Zelenina* [*Situation and outlook report: Vegetables*]. Ministerstvo Zemědělství [MZe]. https://eagri.cz/public/web/file/692977/Zelenina_2021_web.pdf

Noone, Y. (2019). *This car park turned urban farm has grown 300kg of produce for people in need*. SBS Food. https://www.sbs.com.au/food/article/this-car-park-turned-urban-farm-has-grown-300kg-of-produce-for-people-in-need/q1xnbg5ii

Open Data Portal. (n.d.). *Portál o datech* [*Data portal*]. Retrieved May 2023 from https://data.gov.cz/

Orsini, F., Gasperi, D., Marchetti, L., Piovene, C., Draghetti, S., Ramazzotti, S., Bazzocchi, G., & Gianquinto, G. (2014). Exploring the production capacity of rooftop gardens (RTGs) in urban agriculture: The potential impact on food and nutrition security, biodiversity and other ecosystem services in the city of Bologna. *Food Security*, *6*(6), 781–792. https://doi.org/10.1007/s12571-014-0389-6

Piorr, A., Ravetz, J., & Tosics, I. (Eds.). (2011). *Peri-urbanisation in Europe: Towards European policies to sustain urban-rural futures: Synthesis report*. PLUREL. https://www.openspace.eca.ed.ac.uk/wp-content/uploads/2015/12/Peri_Urbanisation_in_Europe_printversion.pdf

Rabin, J., Zinati, G., & Nitzsche, P. (2012). Yield expectations for mixed stand, small-scale agriculture. *Sustaining Farming on the Urban Fringe*, *7*(1), 1–13. Rutgers New Jersey Agricultural Experiment Station. http://www.urban.agroeco.org/wp-content/uploads/2015/12/Calculating-Expected-Yield-Charts.pdf

Ragasa, C., & Lambrecht, I. (2020). COVID-19 and the food system: Setback or opportunity for gender equality? *Food Security*, *12*(4), 877–880. https://doi.org/10.1007/s12571-020-01089-w

Ray, D. K., Mueller, N. D., West, P. C., & Foley, J. A. (2013). Yield trends are insufficient to double global crop production by 2050. *PLoS ONE*, *8*(6), Article e66428. https://doi.org/10.1371/journal.pone.0066428

Šilhánková, V. (2020). *Urbanistická typologie: Úvod do urbanismu a základní typologie sídel* [*Urban typology: Introduction to urban planning and basic typologies of settlements*]. Civitas per Populi. https://www.researchgate.net/profile/Vladimira-Silhankova-2/publication/349339436_Urbanisticka_typologie/links/602ba43d4585158939a992b1/Urbanisticka-typologie.pdf

Szopinska-Mularz, M., & Lehmann, S. (2019). Urban farming in inner-city multi-storey car-parking structures—Adaptive reuse potential. *Future Cities and Environment*, *5*(1), Article 4. https://doi.org/10.5334/fce.50

Szturc, J., Karásek, P., & Podhrázská, J. (2017). Historical changes in the land use connected with appropriation of agricultural land – Case study of Cadastral Areas Dolní Věstonice and Modřice (Czech Republic). *European Countryside*, *9*(4), 658–678. https://doi.org/10.1515/euco-2017-0038

Tornaghi, C. (2013). Critical geography of urban agriculture. *Human Geography*, *38*(4), 551–567. https://doi.org/10.1177/0309132513512542

United Nations Department of Economic and Social Affairs [UNDESA]. (2018, May 16). *68% of the world population projected to live in urban areas by 2050, says UN*. https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

UNDESA. (2022). *World population prospects 2022: Summary of results* (Report No. UN DESA/POP/2022/TR/NO. 3). https://www.un.org/development/desa/pd/content/World-Population-Prospects-2022

van der Heijde, P. (2012). New urban centers in the Netherlands. *Tijdschrift voor Economische en Sociale Geografie*, *103*(3), 362–373. https://doi.org/10.1111/j.1467-9663.2012.00725.x

van der Ploeg, J. D. (2020). From biomedical to politico-economic crisis: The food system in times of Covid-19. *The Journal of Peasant Studies*, *47*(5), 944–972. https://doi.org/10.1080/03066150.2020.1794843

Viljoen, A., Bohn, K., & Howe, J. (2005). *Continuous productive urban landscapes: Designing urban agriculture for sustainable cities*. Architectural Press–Elsevier.

Whittinghill, L., & Starry, O. (2016). Up on the roof: Considerations for food production on rooftops. In S. Brown, K. McIvor, & E. Hodges Snyder (Eds.), *Sowing seeds in the city: Ecosystem and municipal services* (pp. 325–338). Springer. https://doi.org/10.1007/978-94-017-7453-6_23

Willett, W., & Skerrett, P. J. (2017). *Eat, drink, and be healthy: The Harvard Medical School guide to healthy eating*. Free Press. https://archive.org/details/eatdrinkbehealth0000will/page/n1/mode/2up

World Food Programme [WFP]. (2022, March). *Food security implications of Ukraine conflict*. https://www.wfp.org/publications/food-security-implications-ukraine-conflict

Zasada, I., Schmutz, U., Wascher, D., Kneafsey, M., Corsi, S., Mazzocchi, C., Monaco, F., Boyce, P., Doernberg, A., Sali, G. & Piorr, A. (2019). Food beyond the city—Analysing foodsheds and self-sufficiency for different food system scenarios in European metropolitan regions. *City, Culture and Society*, *16*, 25–35. https://doi.org/10.1016/j.ccs.2017.06.002