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Multifunctionality of urban agriculture and its characteristics in Latvia

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Abstract. In the 21st century, urban agriculture renews and diversifies approaches to the practice within the context of urban regeneration, climate change risks, sustainable development and resource consumption balance problems. Influenced by the long historical evolution and intensification of various risks, food production in urban areas involves the widest multifunctionality to date. Therefore, the aim of this research is to identify the main functions of urban agriculture and to evaluate their significance in Latvia. The following tasks were set to achieve the aim: 1) to identify and classify functions of urban agriculture, 2) to analyse the performance and significance of functions in Latvia. Several methods were employed to perform tasks and achieve the aim: the monographic and descriptive methods for making a theoretical discussion; the analysis, synthesis and deduction methods for obtaining information, systematisation and classification of functions; a structured expert interview for rating and ranking functions and identifying interactions between them. The research identified 14 functions of urban agriculture, which were classified into 5 groups: political, economic, social, environmental and technological. The most significant functions of urban agriculture in Latvia are social (promotion of social cohesion and public health, education and maintaining traditions and values) and technological innovations. There are interactions between all functions, and support for urban sustainability, education, provision of ecosystem services and technological innovations have the strongest impact on other functions. Interactions of functions proved the multifunctionality of urban agriculture, which could be an important support tool to contributing to sustainable urban development.
Key words: urban agriculture, functions, sustainable development, Latvia.

Introduction

Urban agriculture receives increasing research attention, and the number of relevant research papers have increased significantly since 2010 (Dobele & Zvirbule, 2020). As the number of relevant research studies increases, not only the scope of research topics and findings but also the diversity of interpretations of various aspects expands. The definitions of urban agriculture increasingly vary, especially in the context of territorial boundaries, and the interpretations of the factors, functions and other aspects also tend to vary. In the definition of the United Nations in 1996, urban agriculture is defined very broadly as food production inside of cities (*World review. Urban...*, 1996), while in the definition of 2015, it is specified not only as agriculture inside of cities, but also near them (Game & Primus, 2015), thus creating wide interpretations in studies. Similarly, the functions of urban agriculture are often identified for a specific case and regional situation, thereby making it difficult to compare research results. This creates a necessity on the research field to identify and classify aspects for a unified and generalised approach, that is not focused specifically or narrow. Despite the fact that urban agriculture has received increased attention in academic and scientific research in recent decades, there is still a need for deeper, broader work in its theorisation (WinklerPrins, 2017). In addition, urban agriculture in Latvia has been studied very little. Although new studies are needed to cover urban agriculture experiences of a wider range of countries, it is also very important to summarise existing results by systematic theoretical reviews, creating a comprehensive identification and classification of aspects. Therefore, this research is structured by a two-step approach and results. First, a systematic theoretical review and applied research

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was done to identify and classify functions of urban agriculture, regardless of the research scale and the region, thereby identifying the most important functions that are not adapted to an analysis of a specific case. In the result, identified and classified functions are universally applicable to an analysis of urban agriculture practices in various cities, regions and countries, thereby allowing for comparison between different case studies. Second, identified and classified functions were rated by experts to analyse their implementation according to the specific situation in Latvia. In the result, the main functions of urban agriculture in Latvia have been identified and the analysis of their interaction has been carried out.

Materials and Methods

To perform the first research task (to identify and classify functions of urban agriculture), a systematic theoretical review of aspects has been done by analysing research papers from the Scopus and Web of Science databases. The keywords "urban agriculture" and "urban farming" were used for the selection of research papers published in the period 2000–2021. For analysis and achieving the aim (identification and classification of functions), 215 research papers relevant to the research aim were selected for identifying functions. The analysis, synthesis and deduction methods were used to identify and group functions. Functions are classified into 5 groups: political, economic, social, environmental and technological functions.

A structured interview was conducted to perform the second research task (to analyse the performance and significance of functions in Latvia). The method was chosen due to its suitability in case studies without previous research results and in the situation with the lack of scientific discussion of urban agriculture in Latvia. The interview consisted of two parts: 1) an assessment of the performance of functions of urban agriculture in Latvia, 2) an assessment of interactions between functions of urban agriculture. The performance of functions was analysed for the current situation and experience in Latvia; experts' assessment of the performance of functions was made on a metric scale (from 0–10 points). Experts' assessment of interactions between functions was done according to four levels of the impact: strong, medium, weak and no impact. Expert interviews were conducted in July–August 2022. The selection of experts was made with the aim of identifying opinions of representatives from various fields and with the experience from different state cities of Latvia:

- *an expert in political and legal aspects*: a senior expert from the Department of Protected Areas of the Ministry of Environmental Protection and Regional Development of the Republic of Latvia;
- *an expert in economic and business aspects*: a doctor of economics, associate professor of Rezekne Academy of Technologies, director of the Research Institute for Business and Social Processes;
- *an expert in social aspects*: a doctor of medical sciences, associate professor of Riga Stradins University, leading researcher of the Institute of Public Health;
- *an expert in environmental and technological aspects*: a doctor of architectural sciences, associate professor of Latvia University of Life Sciences and Technologies, leading researcher from the Department of Landscape Architecture and Planning.

Results and Discussion

1. Functions of urban agriculture and their classification

The historical development of urban agriculture represents its role in urban planning principles at the beginning of the emergence of cities, the significance of its functions in crisis periods and its new, 21st century's functionality, that incorporates sustainable development principles and lifestyle trends (Dobele & Zvirbule, 2020). A combination of several processes, such as public and research interest, change in social values and technological innovations, interacting with the challenges of and barriers to agricultural practices in the urban environment, has determined that urban agriculture develops not only in different ways, influenced by the availability of resources, but also as a multifunctional practice. Even though initially agricultural practice in urban areas involved functions such as food security and autonomy (Dobele & Zvirbule, 2020), in the 21st century it has economic, social and political potential, including functions such as food production and security, creation of a place for socialisation and social inclusion, promotion of public health, emancipation from city life, contact with nature, rest and recreation, educational opportunities (both ways: teaching and learning), diversification of the urban landscape, recycling of organic waste, mitigation of the impact of extremely negative sustainability scenarios, reuse of water and parts of wastewater, preservation of biodiversity, positive impacts on the climate, better air quality (Ferreira *et al*., 2018; Pourias, Aubry & Duchemin, 2016), improvement in the visual image of the city as well as creation of inspiration and positive emotions (Bourque, 1999). The research identified 14 functions of urban agriculture and classified them into five groups: political, economic, social, environmental and technological functions.

Table 1

Functions of urban agriculture

Classification	Characteristics	Function	Function code
Political functions	role of and opportunities for urban agriculture in policy making and development strategies	support for urban sustainability	P1
		improvement in urban organic waste management	P2
Economic functions	economic benefits of various scales, including the supply of both food and financial resources	food security	E1
		reduction of expenses on food	E2
		income generation	E3
		poverty reduction	E4
Social functions	promotion of physical and psychological health, lifestyle, social trends, values and other social aspects at both the public and individual level	social cohesion development	S1
		promotion of public health	S2
		education	S3
		maintenance of values and traditions	S4
Environmental functions	creation of a sustainable urban environment by mitigating risks of urbanisation	provision of ecosystem services	En1
		preservation of and improvement in the environment, including landscape	En2
Technological functions	potential of urban agriculture practices for promoting technological innovations and solutions	technological innovations	T1
		increasing the energy efficiency of buildings	T2

Source: authors' construction.

1.1. *Political functions of urban agriculture*

Political functions of urban agriculture relate to the *role of and opportunities for urban agriculture in policy making and development strategies*. In implementing political functions, urban agriculture has the potential to support sustainable development, circular economy and waste management strategies and plans. Already in the 1990s, research on urban agriculture found that even a lack of availability of land resources in urban areas only partially limited the use and usefulness of urban agriculture as a policy and planning tool (Maxwell, 1995). The multifunctionality of urban agriculture is one of the most significant prerequisites and drivers for considering and incorporating agricultural practice into local policies and planning. The concept of multifunctionality is widely used in research on sustainable agriculture and policy making with the aim of emphasising additional functions of agriculture beyond food production (Pourias, Aubry & Duchemin, 2016). Therefore, after summarising findings on political functions of urban agriculture published in research papers, in this research they are grouped into two functions:

- **support for urban sustainability**,
- **improvement in urban organic waste management**.

Urban sustainability is one of the UN sustainable development goals, and the concept of green cities includes balancing consumed and produced resources, incl. food, improving environmental quality and developing public urban green areas (*Goal 11: Make..*, n.d.). The desire to create a greener, more sustainable environment is an important motivator for urban dwellers to implement agricultural practice (Dobele, Zvirbule & Dobele, 2021). Urban agriculture, depending on the region, country, availability of resources and socioeconomic situation, also has potential for achieving other UN goals, e.g. "no poverty" (No. 1), "zero hunger" (No. 2), "good health and well-being" (No. 3), "gender equality" (No. 5), "responsible consumption and production" (No. 12) and "climate action" (No. 13). Even though urban agriculture is not a basic solution to or tool for achieving the sustainable development goals, its functionality in supporting urban sustainability is significant socially, environmentally and politically.

International and national sustainable development strategies relate to the implementation of circular economy principles, which are prescribed by the action plan for the transition to a circular economy in the European Union (*Par Rīcības plānu..*, 2020). Developing a circular economy closely relates to

waste management plans and principles. Urban agriculture most directly relates to ***urban organic waste management***, as its functionality is noteworthy both for international and national policy makers and urban planners (Holmer & Drescher, 2005; Vazquez *et al*., 2002). Waste management plans envisage both reducing the amount of waste produced and promoting the reuse of current waste, and the development of urban agriculture practice can both reduce the amount of food waste and create an opportunity to use organic waste for the compost. Even though the implementation of political functions of urban agriculture is affected by risks related to its status and a lack of it in both sustainable development strategies and the legal framework governing agriculture and food trade, and therefore also in support programmes, the findings of a research published in 2015 have shown that urban agriculture needs to be given more attention as a positive social and economic activity in urban areas, and ways should be found to integrate it into overall urban land use planning and policy making (*Foodmetres..,* 2015).

1.2. *Economic functions of urban agriculture*

Economic functions of urban agriculture are associated with *economic benefits of various scales, including the supply of food and financial resources*. Even though urban agriculture is difficult to assess in terms of direct financial benefits due to limited resources and high costs, it provides economic benefits in several ways. On a larger scale, urban agriculture reduces poverty and food insecurity caused by urbanisation, while also improving the health of urban dwellers and the urban environment (*Twelve Organizations Promoting*.., 2016). An important aspect is also opportunities for business expansion and promotion, especially in the segment of small and medium enterprises, performing the function of income generation. The function of income generation, depending on the size of agricultural activity, could be significant at both the business and the household level. At the household level, economic functions of urban agriculture can be classified into three categories: food production, additional or basic income generation and reduction of expenses on food (Poulsen *et al*., 2015). Economic functions of urban agriculture identified in this research are as follows:

- **food security**,
- **reduction of expenses on food**,
- **income generation**,
- **poverty reduction**.

The primary function of agriculture is the supply of food. Therefore, one of the basic functions of urban agriculture is also the ***food security***. An analysis of economic performance has found that urban agriculture can play a significant role in households that have access to land resources and the necessary time to provide self-sufficiency in food, especially vegetables (Glavan *et al*., 2016). Urban agriculture can make a positive impact on food security in several ways: first, home-produced food provides freer access to fresh, nutritious food; second, the household is provided with a more stable source of food, including storage, which is not affected by changes and fluctuations in wages or food prices; third, the variety, quantity and quality of food with a short shelf-life increases (Poulsen *et al*., 2015). In addition, one of the main motivations for practicing food production in urban areas is social satisfaction of consuming home-produced vegetables and crops for the household (Dobele, Zvirbule & Dobele, 2021; Trendov, 2018). However, the most significant risk to the function of food security is specifics of urban agriculture practice – the variety of crops suitable for urban areas is limited, as mostly vegetables and herbs are grown there, and their calorie content is low. Therefore, the production grown in urban areas represents mostly a supplementary food, not a staple food (Azunre *et al*., 2019).

Food production interacts with the ***cost reduction*** function, which is both a practice motivator (Dobele, Zvirbule & Dobele, 2021) and an economic benefit (Azunre *et al*., 2019). Even though most of the food produced by urban agriculture is intended for the household or the immediate family members, it is the opportunity to exchange and give away the food produced that is mentioned in research studies as one of the most frequent motivations for practicing farming (Pourias, Aubry & Duchemin, 2016). Urban agriculture is profitable for the household if considering food prices in shops and, especially, organic food prices. But if the average labour cost in the respective region is considered, the economic benefit could also be negative (Glavan *et al*., 2016). An economic calculation of expenses is essential for an assessment of financial profitability not only in relation to the function of reducing food expenses but also in relation to the function of income generation.

The ***function of income generation*** involves significant differences regarding whether the commercial goal is to generate basic or additional income and whether farming is practiced by a household or an enterprise. If pursuing the commercial goal, it is important that food is produced for the local, not the regional, national or global markets. Therefore, the competitiveness of urban agriculture involves the supply of food for the immediate neighbourhood, incurring no additional expenses on packaging, marketing, distribution and transportation (*World Review. Urban*.., 1996), which interacts with

political functions regarding sustainable development. Shortening food supply chains is also an objective of several European Union strategies, including the Farm to Fork Strategy (European Commission, 2020). In relation to food quality, the advantage of urban agriculture is the ability to ensure transparency of how the food is produced, and factors of the quality are not only size, shape, adherence to production process standards but also freshness and shortness of the supply chain (Opitz *et al*., 2016). Therefore, urban agriculture has a potential regarding the function of income generation at both the household and the enterprise level.

The ***poverty reduction*** is one of the sustainable development goals set by the UN, and urban agriculture can at least partially reduce food insufficiency caused by urbanisation (*Twelve Organizations Promoting..*, 2016), especially in the Global South, where it is considered as a critical tool in providing food to the poorest populations (Ferreira *et al*., 2018). The function of the poverty reduction is affected by a number of factors, therefore, the role of urban agriculture in poverty reduction should also be critically viewed, especially because urban agriculture is mainly able to provide households with only a small part of the necessary food (Dobele, Zvirbule & Dobele, 2021; Parece & Campbell, 2017).

There are several risks to economic functions of urban agriculture, and the most important ones are the availability and high prices of resources compared with those in rural regions, and relatively small quantities of food produced. Even though the quantities produced are influenced by several factors such as land fertility, processing techniques and restrictions on the use of pesticides, one of the social factors characteristic of urban agriculture is a lack of agricultural knowledge and experience among practitioners, as most of them practice farming based on own experience, the use of family members' recommendations, information obtained from neighbours and other gardeners (Dobele, Zvirbule & Dobele, 2021; Glavan *et al*., 2016). Urban agriculture has the potential to develop economic, social and environmental sustainability. However, by focusing only on economic benefits, urban agriculture loses its meaning – it is impossible to compare the profitability of land used for industrial and commercial purposes with the land for agriculture purpose. Nevertheless, it is the social and environmental functions of urban agriculture that can mitigate the ever-increasing risks of urbanisation and globalisation (Azunre *et al.,* 2019).

1.3. *Social functions of urban agriculture*

Social functions of urban agriculture are related to the *promotion of physical and psychological health, lifestyle, social trends, values and other social aspects at both the public and the individual level*. It is social functions, equivalent to environmental functions, that are among the dominant ones in relation to characteristics of urban agriculture in the 21st century (Dobele & Zvirbule, 2020). Urban agriculture contributes to such social aspects as education, civic participation and engagement, gender equality and social equity, health improvement and recreation (Azunre *et al*., 2019). Urban agriculture, especially in the Global North, is perceived by the population more as a social value than a food production practice (Dobele, Zvirbule & Dobele, 2021; Sanye-Mengual *et al*., 2016), with the main motivators being the production of healthy food and relaxation, social interaction, rest and recreation, the acquisition of new knowledge and keeping traditions alive, which cannot be offset by produced food or economic benefits and financial income (Dobele, Zvirbule & Dobele, 2021; Glavan *et al*., 2016). This research classifies the wide range of social functions into four:

- **development of social cohesion**,
- **promotion of public health**,
- **education**,
- **maintenance of values and traditions**.

A modern society is characterised by social alienation, especially a lack of face-to-face communication, which creates conditions when people in cities often no longer know their neighbours, and the society is characterised by a lack of unity. Urbanisation has replaced traditional community ties with anonymity and individualism. The pressures of the information age, the global economics and competition-oriented social policies have led Western society to a crisis of social cohesion (Veen *et al*., 2016). Urban agriculture is recognised as one of the most important pillars for sustainable social development in urban areas, which contributes to ***social cohesion*** by creating an alternative social network that affects social growth and common wellbeing (Glavan *et al*., 2016). Social cohesion is developed if people in society feel and are connected to each other, there is a desire and readiness to get involved in community activities, in identifying and solving regional problems and in national policy-making, thereby strengthening civic participation, which in urban agriculture is most successfully implemented through community gardens (Veen *et al*., 2016). The engagement of residents in urban agriculture and collective territorial management creates new ways of public inclusion and participation – the development of new approaches by using eco-innovation systemic thinking, which is based on circular economy and nature-oriented solutions and environmental services provided by the urban ecosystem (Ferreira *et al*., 2018). To

achieve the maximum positive impact of urban agriculture, it is important that gardens are accessible to as many people as possible, including those who are not gardeners (Schram-Bijerk *et al*., 2018). The interest and involvement of local governments is also necessary for achieving success.

Public health involves a set of different aspects, including both physical and mental health. Urban agriculture has functionality in promoting public health in several ways – practicing it reduces stress, provides recreation, healthy food, physical activity and social contact and cohesion, thereby reducing feelings of alienation and loneliness (Angotti, 2015; Schram-Bijerk *et al*., 2018). In the context of public health promotion, urban agriculture plays an important role in providing healthy nutrition in several ways: 1) income is generated, thus providing the household with additional income that can be used to improve health, 2) community gardens provide fresh products to those who need it, 3) those who grow food at home eat fruits and vegetables more often, thus improving their diet (Azunre *et al*., 2019).

The second important aspect regarding the function of public health is the rejuvenating effect of contact with nature on psychological health: 1) the contact with nature can have a positive effect on those having a high level of stress, thereby creating a more relaxed, positive emotional state, 2) attention devoted to nature helps to restore and improve cognitive performance (Schram-Bijerk *et al*., 2018). Various research studies have interviewed urban dwellers who have admitted that gardening helps them to relax and recover from the stress and tension of everyday life, and it also contributes to two stress-relieving factors: physical activity and contact with nature (Dobele, Zvirbule & Dobele, 2021; Van den Berg & Custers, 2011; Veen *et al*., 2016).

One of the most important factors contributing to sustainable development, an understanding of risks and resources, social cohesion and co-responsibility is ***education***. Urban agriculture can perform the educational function at several levels: 1) the individual and household level – it gives an opportunity to learn new skills, as well as self-develop; 2) the school and education system level – by including school gardens and their management as a part of school activities and curricula; 3) the community level – sharing knowledge, skills and experience between urban gardeners in the neighbourhood and community. An opportunity to learn something new is also one of the motivators for dwellers to engage in urban agriculture in their households (Dobele, Zvirbule & Dobele, 2021). The incorporation of horticulture practices into school activities and curricula would promote the understanding of food supply systems and functions and values of nature, which are part of the goals and objectives of sustainable development at both the national and the international level. However, farming based on the principle of cooperation in community and public gardens, even though it is difficult, gives an opportunity to learn together and from each other about food production, agriculture, as well as urban planning and administrative institutions, thereby creating the need to cooperate and inform others about the opportunities created by urban agriculture for producing food in the urban environment (Angotti, 2015). Urban agriculture's educational function has the potential to create an innovative learning approach, which, contrary to the top-down model as a knowledge transfer scheme, creates a non-linear learning process, thereby contributing to the integration of different fields and territories. It involves the integration of knowledge of products (market impact, quality, safety), processes (transport and infrastructure, supply and service, technology), social aspects (behaviour/ habit change, new relationships, cultural inclusion) and governance (food planning, subsidies and taxes, labels and certificates) (*Foodmetres*.., 2015). In addition, the educational function can interact with the functions of urban sustainability, social inclusion and cohesion (Ferreira *et al*., 2018).

Aspects of motivation for practicing and functions of urban agriculture are diverse – from the availability of fresh and better-tasting food to the enjoyment of nature, a healthy lifestyle, an opportunity to socialise, the preservation of the urban landscape and the greening of the neighbourhood. However, a no less important function is to preserve local culture and traditions through involving urban dwellers in agricultural practice as well (Pourias, Aubry & Duchemin, 2016; Trendov, 2018). Therefore, the social function of urban agriculture – ***maintenance of values and traditions*** – is contextually different. Although historically agricultural activities have been traditional not only in rural areas but also in urban areas, influenced by various factors, they have significantly decreased in terms of quantity in urban areas, although their functional diversity has increased (Dobele & Zvirbule, 2020). However, urban agriculture involves several aspects of traditional values related to both contact with nature and food production practices. It provides and promotes a renewed connection with nature, agricultural practice and the production of one's own food for self-consumption. Urban agriculture, especially in the Global North, most often attracts individuals who like gardening, healthy food, making social contacts, contact with nature etc. (Schram-Bijerk *et al*., 2018). These are the most important motivators for the urban residents (Dobele, Zvirbule & Dobele, 2021).

All kinds of urban agriculture (food produced for self-consumption in individual households, community and public gardens, commercial practices) make a highly positive social impact in terms of food safety and security, quality, health and traditions and culture (*Foodmetres*.., 2015). However, the most significant risks to the social functions of urban agriculture are a lack of awareness of agricultural practice and related opportunities and a low interest from governing and administrative institutions (school administrations, local governments etc.) in the functions and possibilities of urban agriculture.

1.4. *Environmental functions of urban agriculture*

Both the promotion of urban sustainability and the restoration of traditions and values as well as other functions directly interact with environmental functions of urban agriculture – *creation of a sustainable urban environment and reduction of risks of urbanisation.* They also involve interaction between the environment and society – urban agriculture creates a link between public health and ecosystem health through producing healthy and sustainable food (Schram-Bijerk *et al*., 2018). The development of various functions is relatively broad in scope under such interaction conditions – urban agriculture contributes to the preservation of the environment and biodiversity, increases the ecological (environmental) awareness of local residents by using their free time in a healthy way that promotes a healthier lifestyle, while at the same time develops cooperation between urban gardens and the city (Trendov, 2018). In addition, the impact of urban agriculture on hydrological systems, biodiversity and air quality can replace part of that which is destroyed by urban systems (*World Review. Urban*.., 1996). After identifying and analysing environmental functions of urban agricultural, the research grouped them into two functional categories:

- **provision of ecosystem services**,
- **preservation of and improvement in the environment, including landscape**.

Urban agriculture can perform the function of ***ecosystem services*** that involves several aspects: 1) microclimate conditions reducing the urban heat island effect, which can reduce air conditioning costs; 2) potential to absorb dust, clean the air and control noise; 3) preservation of biodiversity by using plants specific to the region; 4) reuse of water resources for irrigation (Ferreira *et al*., 2018; Lydecker & Drechsel, 2010). Urban agriculture does not generate new water resources, yet the implementation of wastewater recycling systems would allow optimising the production of agricultural products and complying with the principles of the circular economy. Urban agriculture has the potential to reduce indirect CO_2 emissions by reducing the length of food supply chains for urban residents, as well as the amount of packaging and food losses due to short transportation time (Llorach-Massana *et al*., 2017). In addition, the functionality of urban agriculture is shaped by the interaction with urban pollution, as high air pollution in cities is mostly caused by industrial production and transport emissions. Moreover, in densely populated city districts it is difficult to find a successful solution to planting trees, which is one of the main environmental solutions that reduces pollution. Urban agriculture approaches, such as roof and vertical gardens, small greenery in boxes etc., can contribute to at least partial mitigation of ecosystem risks (Azunre *et al*., 2019).

The ***preservation of and improvement in the environment***, greening of the urban environment and expansion of green areas are among the criteria of urban sustainability (*Goal 11: Make..*, n.d.). The air temperature in cities is significantly higher than in peri-urban or rural areas, and a 10% increase in urban greening can reduce urban temperatures by even 4 degrees Celsius (Azunre *et al*., 2019). Urban agriculture is one of the ways of greening the urban environment, which also performs several social functions even without significant innovative technological solutions. Additional investment in rooftop and vertical gardens can reduce the amount of energy needed to heat or cool a building. However, the greening of one's surrounding is one of the strongest motivators for urban dwellers to practice urban agriculture (Dobele, Zvirbule & Dobele, 2021), and in the 21st century urban agriculture makes an important part of cities' green infrastructure (Goździewicz-Biechońska & Brezińska-Rawa, 2022). Urban agriculture is not a universal or basic solution to the environmental risks of urbanisation, yet it can significantly influence and contribute to various solutions.

In the context of environmental functions, however, there are risks associated with agricultural practices themselves. Urban farming is often practiced by urban dwellers having no knowledge of or experience in agriculture, which increases the risk of incorrect use of plant protection products (Azunre *et al*., 2019). Urban agriculture also creates risks for the development of invasive plant species in the urban environment and the risk of parasite concentration in urban gardens and farms (Azunre *et al*., 2019; Ferreira *et al*., 2018; Glavan *et al*., 2016), which in turn reduces the potential of environmental functions. Mentioned risks emphasise the need for urban agriculture to focus on responsible and sustainable practices, which in turn points to the need for legal regulation and access to education and training, as the benefits of regulated, proper urban agriculture practice and its functions are significant for contributing to urban sustainability and a qualitative environment.

1.5. *Technological functions of urban agriculture*

Technological functions of urban agriculture are related to its potential for promoting technological innovations and solutions. Considering the cost and limited availability of land in urban areas, in the 21st century urban agriculture is characterised by the need for considerable adaptation, seeking innovative and non-traditional approaches to producing agricultural products (Dobele & Zvirbule, 2020). As a result of innovation and adaptation in the global experience, urban agriculture has also proved its potential for increasing the energy efficiency of buildings. Therefore, this research identifies two technological functions of urban agriculture:

- **technological innovations**,
- **increasing the energy efficiency of buildings**.

Technological innovations involve several aspects: urban agriculture promotes both the creation of innovative approaches and ways of agricultural production, adapting to factors in the urban environment, and technological innovations in the adaptation of sites and spaces to agricultural production. Under the circumstances where there is not enough land available for producing food, innovative techniques which are especially specific to urban agriculture: boxes, bags, hanging pots, vertical structures etc., are sought (*Foodmetres*.., 2015). However, new techniques are not the only kind of innovation in urban agriculture, as the adaptation of sites and spaces creates necessity for broader solutions through analysing and researching hydroponics, aquaponics, LED lighting and other technological solutions in agriculture. In the agro-food system, technological innovations are considered to be the main prerequisite for creating a competitive advantage, focusing on social, economic and environmental sustainability (*Foodmetres*.., 2015).

An important aspect of the technological functions of urban agriculture is also the use of agricultural practices to ***increase energy efficiency*** by means of thermal insulation of building walls and roofs, as well as thermal energy storage and use of technologies (Hortus, n.d.). Even though the mentioned technological solutions can rarely bring commercial benefit, not being able to achieve profitable production volumes, energy efficiency is proved by energy savings on cooling and, especially, heating of a building (Uk-Hyeon *et al*., 2022).

The largest risks to performing the technological functions of urban agriculture are the financial investment as well as knowledge and experience required. It is possible to implement technological innovations already at the household level to meet self-consumption needs. However, increasing the energy efficiency of buildings requires a large investment, which could be attracted at the level of municipalities and companies and often requires international cooperation.

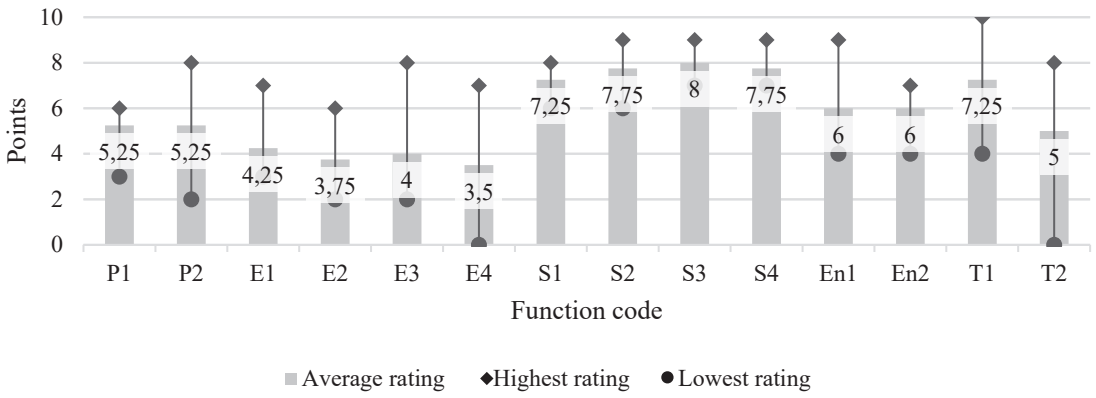
2. Functions of urban agriculture in Latvia

In Latvia, urban agriculture is mainly practiced in the form of micro-agriculture for household self-consumption (Dobele, Zvirbule & Dobele, 2021). Since 2019, community gardens have quickly developed in major cities. However, they are based on individual initiatives, with no or very limited involvement and support from municipalities and national institutions. Although the practice of producing food is common in Latvia, it is mostly associated with the rural holdings of the family or relatives. In addition, the association of agricultural practice with rural areas is not only a social but also a political factor, given that in Latvia agricultural activity in urban areas is not governed separately, and the institutional framework for urban agriculture is the same as for agriculture, which is mostly applicable and adapted only to agricultural practices in rural areas (Dobele, Zvirbule & Dobele, 2022). Urban agriculture has proved its functionality in various regions and countries of the world, and depending on the socio-economic situation and the amount of investment available, it can also provide an economically beneficial production process. In Latvia, however, it is still a very little-researched practice, which is why there is a lack of discussion both among the public and the scientific community. For this reason, in this research, experts from various fields are interviewed to identify and assess the performance of functions of urban agriculture in Latvia.

2.1. Assessment of the performance of functions

By creating a universal list of functions that could be adapted to any case, results of an analysis of a specific case might be significantly different but, most importantly, comparable. An assessment of functions of urban agriculture in Latvia is primarily influenced by the development of the practice and factors affecting it, from the cultural and historical customs and traditions of the society to the population density of cities and the availability of agricultural land and the scope and trends of agricultural practices.

On a 10-point metric scale, experts give the highest ratings to social functions of urban agriculture in Latvia (average in the group: 7.69). Technological functions (average in the group: 6.13), especially the function of technological innovations, and environmental functions (average in the group: 6.00) were rated quite high. The relatively lowest ratings were given to political functions (average in the group: 5.25) and economic functions (average in the group: 3.88).



Source: authors' construction based on expert interviews

Figure 1. Ratings of the performance of functions of urban agriculture in Latvia.

All social functions of urban agriculture were rated with high performance. In addition, they also had the lowest dispersion, which indicated that the performance of functions was equally rated by experts who represent different fields. The experts rated the function of ***education*** in urban agriculture the highest, and the dispersion in the evaluation was the lowest (average rating: 8). Primarily, the performance of this function relates to family traditions in Latvia (the transfer of food production knowledge and skills between generations), as well as the complexity of the knowledge framework of urban agriculture – food production not only increases knowledge about agriculture, but also an understanding and appreciation of natural and food resources. The function of ***maintenance of values and traditions*** has an equally low dispersion of experts' ratings (average rating: 7.75). All experts emphasised that the agricultural traditions are characteristic of the population of Latvia in a cultural and historical aspect, which has been preserved by passing down traditions of food production and an understanding of the value of nature between generations. Therefore, bringing, returning and preserving the practice of food production in urban areas represent traditional customs in Latvia. Experts also pointed out that this function is essential for the development of urban agriculture in general.

The ***promotion of public health*** is a successfully implemented function in Latvia (average rating: 7.75), primarily in the context of psychological health. Although urban agriculture could improve physical health by increasing physical activities daily and providing fresh and healthy food, in the situation of Latvia, according to experts, the supply of healthy and high-quality food is sufficient, and current urban agriculture practices only rarely create a sufficient amount of physical activities that could significantly improve physical health. Experts rated the promotion of psychological health as high, regardless of the size of the agricultural activity. The function of ***social cohesion*** development is also successfully implemented and performed well (average rating: 7.25), primarily in allotments and community gardens.

Experts rated the function of ***technological innovations*** in urban agriculture as high (average rating: 7.25), but it also has a high dispersion (4 to 10 points). Agricultural activities in urban areas are not widespread in Latvia. Therefore, the need for adaptation of spaces and resources contributes to the performance of the function. However, the high dispersion of expert ratings was determined by different ratings of necessary resources, with some experts emphasising that the implementation of successful innovations requires a large amount of investment, which is not or is rarely available.

In Latvia, urban agriculture also performs environmental functions (experts rated functions of ***ecosystem services*** and ***environmental preservation and improvement*** with 6 points), but the extent and quality of the performance of functions are affected by the small volumes of practice. Micro-agricultural activities practiced by households, such as producing food on balconies and windowsills, have little effect on the performance of environmental functions. However, larger urban agriculture projects currently, although developed rapidly, are still few in Latvia, thereby the potential of environmental functions is still incompletely implemented.

In Latvia, political functions of urban agriculture are performed moderately well (average rating: 5.25). Although experts rated ***support for sustainable development*** more equally, their opinions differed about the functionality of urban agriculture in different fields of sustainable development. Experts emphasise urban agriculture in Latvia as a support tool for promoting social unity and political participation, but rated the current size of agricultural activity as insufficient for the implementation of a full-fledged

concept of "green cities". In relation to improvement in ***urban organic waste management***, the experts' ratings vary from 2 to 8 points, indicating the ambiguous implementation of the function. Experts admit that urban agriculture is a way to reduce the amount of managed organic waste, but the successful implementation of the function requires more support from the urban planning system. Expert opinions also differ significantly on the performance of the function of increasing the ***energy efficiency of buildings***. Currently, neither vertical nor roof gardens have been created for this purpose in Latvia, which is the most widely applied approach to building thermal regulation on a global scale. Given the high dispersion of expert ratings, the research received a comment from the Department for Energy Financial Instruments of the Ministry of Economics, which explained that, although there are several examples of such practices in the world, in Latvia such solutions to increasing the energy efficiency of buildings are used that can be specifically measured and energy savings could be identified very precisely; yet in the case of the impact of roofs and vertical gardens, there were still insufficient research studies and analyses in Latvia.

The lowest ratings of the situation in Latvia are given to economic functions of urban agriculture. ***Food security*** has sufficiently high potential, considering that it is also the basic function of agricultural activity. However, the performance of the function in Latvia is affected by the current small quantities produced and the seasonality of the climate, which limits the production of most products grown in urban agriculture. ***Income generation*** is possible and is implemented, but only in a few cases. Land and labour resources in Latvia, if comparing urban and rural areas, are significantly different, which reduces financial profitability and the possibility of generating income. However, the implementation of the function is possible in case of successful business planning and development. ***Reducing expenses on food*** is a relatively little-implemented function in Latvia because the reduction of expenses is relative if considering prices of food in shops and prices of resources needed for producing food, including alternative costs such as labour. However, depending on food production practices and an analysis of specific product groups, the function is feasible. In Latvia, the function of ***poverty reduction*** shows the weakest performance. Although in 2020 (latest available data) the index of material deprivation of the population was 16.3% of the population of Latvia, compared with 2005 it has a decrease for 40.5 percentage points (*Iedzīvotāju materiālās..*, n.d.), which indicates a significant reduction in the poverty level. Therefore, the relevance of the poverty reduction function of urban agriculture in Latvia decreases. Although several social and financial support instruments are available to the poorest residents in Latvia, the local governments of cities do not provide local or other support for producing food for self-consumption.

Impacted function

Impacting function	P1	P2	E1	E2	E3	E4	S1	S2	S3	S4	En1	En2	T1	T2
P1	x	2.3	1.3	0.5	1.3	1.3	2.5	2.5	2.5	2.8	2.3	2.5	2.3	2.3
P2	2.0	x	1.3	1.3	0.8	0.8	1.3	1.3	1.8	1.8	1.5	1.3	2.3	0.5
E1	1.3	2.5	x	1.5	1.3	1.0	2.0	1.8	2.0	2.5	1.8	1.5	2.3	0.5
E2	1.0	1.0	1.3	x	1.0	1.8	1.5	1.5	1.8	2.0	1.0	1.0	1.3	0.3
E3	1.3	1.5	2.0	1.3	x	2.0	1.5	1.8	2.0	2.5	1.3	0.8	1.5	0.5
E4	2.0	0.8	2.3	1.0	1.5	x	1.3	1.5	2.3	1.8	1.3	1.5	1.3	0.5
S1	2.5	1.8	1.3	1.0	1.5	1.5	x	2.0	1.8	2.0	1.5	1.8	2.3	1.3
S2	2.3	2.0	1.5	1.3	1.3	1.8	2.0	x	1.8	2.3	1.5	1.5	2.0	0.8
S3	2.3	2.0	1.5	1.3	1.5	1.8	2.5	2.3	x	2.5	2.3	2.3	2.8	1.5
S4	2.0	2.0	1.5	1.5	1.5	1.3	2.5	2.3	2.8	x	1.8	2.0	1.5	1.3
En1	2.5	2.3	1.5	1.5	2.0	1.0	2.3	2.3	2.5	2.3	x	2.5	2.5	1.8
En1	2.3	2.0	1.5	1.3	1.5	1.3	2.0	2.3	2.3	2.3	2.3	x	2.5	2.0
T1	2.5	2.3	1.8	1.8	1.5	1.5	2.3	2.3	2.5	2.3	2.5	2.8	x	2.3
T2	1.8	1.5	1.0	1.0	0.8	1.0	2.0	1.5	1.8	1.3	1.8	2.0	2.5	x

0 – no impact *3 – strong impact*

Source: authors' construction based on experts' interviews

Figure 2. Matrix of interactions between functions of urban agriculture.

Due to the relatively low need and a lack of local government support, the performance of the function in Latvia is weak.

2.2. Interaction and development of functions

Functions of urban agriculture could be assessed separately by comparing and analysing the performance of functions in different cities, countries and regions. However, analysing them separately from one another does not allow for a complete analysis of them. A low value of the performance of economic functions does not generate a direct financial benefit, but its prioritisation does not allow a full assessment of other functions. Therefore, to assess the multifunctionality of urban agriculture, the research carried out an assessment of interactions between functions – results are shown in a matrix (Figure 2).

According to experts, all functions make impacts and interactions. Functions having relatively stronger impacts are:

- *support for urban sustainability*, which, in case the of the implementation, can significantly strengthen social and environmental functions;
- *technological innovations* that strongly and moderately impact functions of all groups;
- *education*, which makes the strongest impact on social cohesion, the maintenance of values and traditions and especially technological innovations, which make a relatively strong impact on the other functions of urban agriculture;
- *provision of ecosystem services* considerably strengthens functions of urban agriculture such as support for urban sustainability, education, preservation and improvement in the environment and the promotion of technological innovations.

The matrix of interactions between functions of urban agriculture indicates the need to primarily promote these functions, considering their impacts on most of the other functions, thereby creating cumulative and positive multifunctionality of urban agriculture.

In the interaction from other functions, the strongest and most extensive development is made for the following functions: education, maintenance of values and traditions, technological innovations and support for urban sustainability. This indicates that regardless of what the primary and most successfully implemented functions of urban agriculture are, they also make a reinforcing impact on urban sustainability, innovation, education etc.

Interactions between functions prove the multi-functionality of urban agriculture – functions are comparable, but cannot be assessed separately or within just a certain group. Political and economic, social, environmental and technological functions impact the other groups of functions and can be

Table 2

Advantages and risks to the development of urban agriculture in Latvia

Advantages		Risks	
aspects	*SC**	*aspects*	*SC**
the fast-paced, stress-filled lifestyle increases the need for recreation	3	high costs of resources necessary for urban agriculture	3
the topicality of the belonging between human and nature, public interest in the value of nature and its resources	3	no unified system-approach to food production practices in urban areas, no municipal planning or tax relief	3
raising food costs and consumption increases the need to produce food for self-consumption	2	insufficiently educated society (about resources, risks, food), insufficient environmental education and awareness	3
residents' past experience in producing food, traditions and cultural history	2	negative impact on the environment due to the lack of knowledge about the use of chemicals	2
demand for agricultural areas is greater than the supply – alternatives, new approaches are needed	1	currently small quantities of food produced by urban agriculture (including for commercial purposes) reduce the potential of functions	2
topicality of the green structure development	1	public disinterest, a lack of awareness	1

** SC – significance coefficient*

Source: authors' calculations based on the expert interviews

analysed within common trends, considering their mutually reinforcing impacts.

However, several factors impact the development of urban agriculture in Latvia. Table 2 shows the advantages and risks to the development of urban agriculture in Latvia identified based on the structured expert interviews. An assessment of aspects is based on the frequency of reference in the expert interviews, with each expert's opinion being assigned with a coefficient of 1.

The most important advantages of the development of urban agriculture and its functions in Latvia are related to the lifestyle and social trends characteristic to the 21st century society. The fast-paced urban lifestyle highlights the *need for recreation*, which was mentioned by 3 experts as a significant advantage for the necessity of agricultural practices. This aspect also relates to another advantage of urban agriculture, which was most often mentioned by the experts – the social trend and public interest in *interconnection and interaction between nature and human*, the role of nature and its resources in people's lives, including in the urban environment, tend to increase. At the same time, there is still a risk, although it is relatively insignificant – a *lack of public awareness* of the possibilities of agriculture in urban areas, especially in the form of community gardens and for commercial purposes.

The *cultural and historical experience* of the population of Latvia *in food production* is also an advantage. However, despite this fact, *environmental education and an understanding* of risks and available resources in Latvia are currently viewed as insufficient; family traditions and interest in nature are contributory factors, yet the general education of the public in environmental issues is a risk factor to the development of urban agriculture. Two experts also pointed to risks created by a lack of knowledge of and experience in agriculture, including the use of plant protection products among urban food producers, which can increase the negative impact of urban agriculture practices on the environment.

A significant hindering factor in urban agriculture is the *cost of necessary resources*, which results in high production costs. However, two experts projected a potential reduction in the impact of this factor, considering the growing trend in both *food consumption* and food prices. The current *small quantities produced* are a shortcoming of urban agriculture in Latvia, which also reduce the potential for commercial agricultural practices. However, a balancing and positively influencing factor is the current situation regarding the *availability and amount of agricultural land*; currently in Latvia, the demand exceeds the supply, which increases the need to seek new approaches to agricultural practices, which could at least partially be implemented in urban agriculture.

Although the relevance of *green structure development* in the urban environment tends to increase, a significant hindering factor in the development of urban agriculture in Latvia is a lack of a single systems approach to it, considering that currently in Latvia, the practice of producing food in urban areas has no legal status, financial or informational support at either the national or the local government level. Therefore, although urban agriculture in Latvia has several (especially social) significant advantages, political and economic risks are the main hindering factors to its growth.

Conclusions

1. The number of research studies and papers on urban agriculture increases rapidly, expanding and diversifying interpretations of the definition, functions, factors and other aspects of urban agriculture. The selection of functions adapted to a particular situation and case makes it difficult to compare results of different research studies. This research identifies and classifies universal functions of urban agriculture, which can be used in research of urban agriculture regardless of specifics of the practice, case and region.
2. Urban agriculture performs political (support for urban sustainability, improvement in urban organic waste management), economic (food security, reduction of expenses on food, income generation, poverty reduction), social (social cohesion development, promotion of public health, education, maintenance of values and traditions), environmental (provision of ecosystem services, environmental preservation and improvement) and technological (technological innovations, increasing the energy efficiency of buildings) functions.
3. The performance of functions varies depending on factors specific to the city, country and region examined. In Latvia, social functions of urban agriculture and technological innovations shows the highest performance, whereas the economic functions have the lowest performance. This indicates that urban agriculture in Latvia is dominated by social aspects, primarily performing functions that contribute to the development of the society.
4. Functions of urban agriculture in Latvia are influenced by several advantages of and risks to the development of urban agriculture. Advantages are mostly based on social factors, such as the need for recreation, interest in interconnection and interaction between nature and humans, and the cultural and historical experience and traditions of the population in producing food. However, the main obstacles to the implementation of functions of urban agriculture

are economic (costs of agricultural production, small quantities produced) and political (lack of awareness, common system-approach and support).

5. All functions of urban agriculture interact with each other, positively reinforcing the overall multifunctionality of urban agriculture. A matrix of interactions between functions of urban agriculture designed by the research indicates that the strongest impact is made by functions such as support for urban sustainability, technological innovations, education and provision of ecosystem services.

6. Interactions between functions of urban agriculture prove the multifunctionality of urban agriculture practices, that justifies that functions are mutually comparable but cannot be assessed separately and within only a certain group. All functions interact with each other, therefore, they could be analysed within common trends, considering their cumulative positive impacts on the multifunctionality of urban agriculture practices.

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