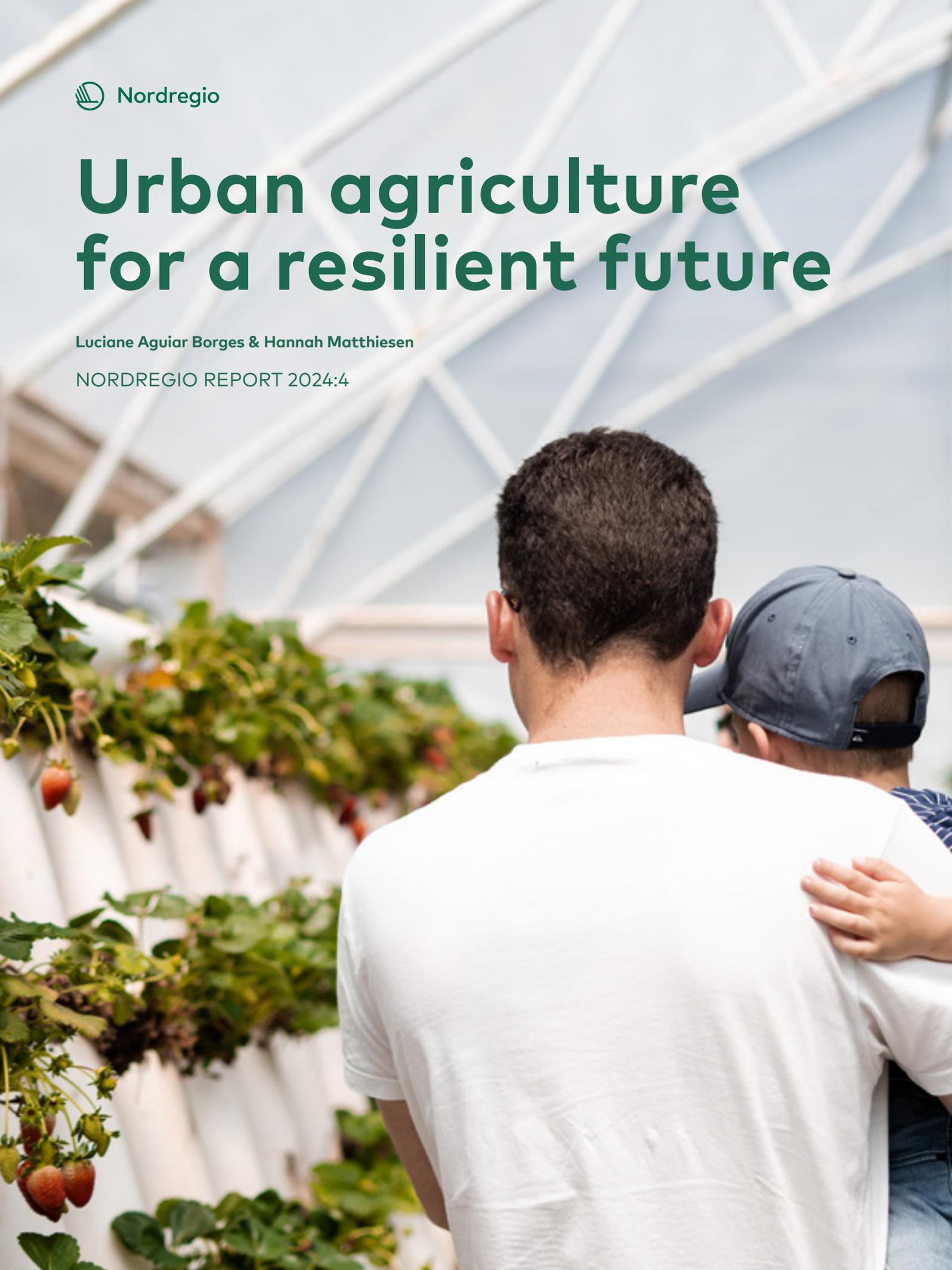


# Urban agriculture for a resilient future

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NORDREGIO REPORT 2024:4



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# Glossary

- **Aquaponics:** is technology that integrates aquaculture and hydroponics. It combines fish and plant culture technologies in a closed system in which fish excrement is used as nutrient for growing plants.
- **Blackwater:** domestic waste water from toilets (water, urine, faeces and toilet paper) (Paulo et al., 2013)
- **Ecosystem services:** consist of direct and indirect contributions of ecosystems to human well-being. Ecosystem services are commonly classified into four types: provisioning, regulating, cultural and supporting.
- **Greywater:** domestic waste water from sinks, shower, bath, kitchen and laundry activities (Paulo et al., 2013)
- **Hydroponics:** is a soil less method to grow crops. Water is the growing environment, requiring addition of nutrients to provide the proper conditions for the crop's cultivation.
- **Regenerative design:** it is a holistic approach that supports social and ecological systems to co-evolve and succeed (Brown et al., 2018). Applied to cities, this concept integrates ecology knowledge with urban design (Blanco et al., 2021)
- **Waste heat:** is the energy that is not used and is lost into the environment. Different methods and technologies can be used to recover waste heat (e.g., regenerative and recuperative burners, economisers, waste heat boilers, air preheaters, heat pipe systems) (Jouhara et al., 2018)
- **Transdisciplinary:** integrates knowledge across academic disciplines and with non-academic stakeholders to address societal challenges (Seidl et al., 2013)

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Photo: Getty Images/unsplash.com



Photo: Charlie Harris/unsplash.com

## Introduction

This report is the outcome of the project "Urban Agriculture for a Resilient Future – FUTURE UA" financed by the Nordic Council of Ministers and implemented in 2023. The partnership between the Nordic Council of Ministers Office in Latvia, Nordregio, and NordForsk enabled the creation of a forum with the participation of several stakeholders for discussing the future of urban agriculture in the Nordic-Baltic context. In this endeavour, three webinars were implemented in June 2023, and study trips to Latvia, Finland, Norway, and Sweden brought together a group of stakeholders from different sectors and interests in urban agriculture.

In this report, we discuss the future of urban agriculture across different themes, namely (1) *cultivating change* in connection with innovation and legislation, (2) *cultivating community* in connection with culture, and (3) *cultivating knowledge* in connection with education and science.

While the first theme reflects the potential of agriculture to occupy more space in cities and to be perceived as a desirable urban function through innovation and legislative support, the second theme focuses on the known benefits of urban agriculture for building community and fostering social inclusion. The third theme reflects the momentum urban agriculture is gaining in institutional education through the implementation of programmes that respond to the growing demand for systematic knowledge of urban agriculture at different qualification levels.

The selection of the cases as well as the purpose of this project was inspired by several projects that deal with urban agriculture (see Box 1).

*Box 1: Previous and current research that has inspired the FUTURE UA project*

- **SiEUGreen** – **Sino European Innovative Green and Smart Cities** (2018-2022). Financed by the European Commission Horizon 2020 Research and Innovation Programme, grant number: 774233.
- **NORDGREEN** – **Smart Planning for Healthy and Green Nordic Cities** (2020- 2023). Financed by NordForsk, grant number 95322.
- **TANGO-W** – **Transformative Capacity on the nexus of Food-Energy-Water** (2022-2025). Financed by the Swedish Energy Agency grant number 52849-1 under the European Joint Programme Initiative.
- **Nordic Climate Neutral Cities** (2023-2025). Financed by the Nordic Council of Ministers, under the Nordic Co-operation Programme for Regional Development and Planning 2021-2024, thematic group on Green and Inclusive Urban Development in the Nordics.

This report is primarily a presentation of seven urban agriculture initiatives that tell stories about how different actors have engaged with or support the practice of growing food in cities. The description of the cases was based on webinar discussions, interviews with the main stakeholders of each case, and study visits.<sup>[1]</sup> These cases provide the context to show how different actors can engage in urban agriculture and food systems, as well as to discuss their challenges and opportunities and to draw lessons from their practices.

The international exchange of experiences enabled by the different activities implemented in the project and summarised in this report has undoubtedly strengthened the Nordic-Baltic networks. Furthermore, the urban agriculture cases

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1. A study visit to Helsinki was helpful in reporting the Dodo case and the visit to Campus Ås, was informative for the reporting of the NMBU case.

convey stories that can inspire actions towards a competitive green, socially sustainable, and environmentally friendly Nordic (and Baltic) Region assisting to achieving the vision of making the Nordic Region the most sustainable and integrated region in the world by 2030 (Nordic Council of Ministers, 2020).

This report targets a broad and heterogeneous audience, including planners, entrepreneurs, academics, and the general public, who are interested and believe in the potential of urban agriculture to tackle many of the challenges we face today, such as the climate crises. After reading this report, the reader is expected to gain:

- A glimpse of the literature on the benefits and drawbacks of growing food in cities.
- An understanding of urban agriculture from different perspectives (e.g., municipalities, entrepreneurs, communities, educational institutions).
- An overview of opportunities and challenges for implementing agriculture in cities.
- Inspiration for alternative urban futures as the stories told in this report carry seeds for change that can assist transitioning our cities to more functional ecosystems.

The report proceeds as follows: Chapter 2 provides a brief overview of the benefits and challenges of growing food in cities and notes some of the policies that recognise the importance of urban agriculture. Chapter 3 consists of seven urban agriculture stories that highlight the voices of different stakeholders and their experiences with urban agriculture. Chapter 4 summarises and discusses the main opportunities and challenges identified in the stories, and Chapter 5 concludes with some reflections about the future of urban agriculture.



Photo: Kevin Dous/unsplash.com

## Agriculture in cities

We are living in an uncertain world. Over the past decades, we have been witnessing the effects of rapid environmental degradation due to unsustainable usage of natural resources and a fuel-based economy that hurts the environment even further. As a consequence of this, the climate crisis has accentuated the vulnerability of cities and rural areas with extreme weather such as droughts, heavy rains, cyclones, and hurricanes affecting fertile regions that, in the past, were able to supply our needs.

In this volatile and ambiguous future, the main certainty is a need for change. Our current situation is not sustainable and requires rethinking our economic model, reshaping our lifestyles, reorganising our institutions, challenging our cemented "ways of working" to restructure our relationship with nature. This calls for common visioning, creativity, societal awareness and commitment, and political will that challenges the antagonistic relationship between people and nature.

Producing food in cities may be one viable pathway towards resilience. In fact, extensive research shows that urban agriculture can positively contribute to urban sustainability in multiple ways (Menconi et al., 2020; Russo & Cirella, 2019). Besides providing ecosystem services, urban agriculture contributes to increasing biodiversity in cities as the occupation of vacant or idle land provides habitats for wildlife (Clucas et al., 2018) and the variation in vegetation cover and crop diversity delivers higher levels of biodiversity than other types of green areas (Lin et al., 2015). Furthermore, urban agriculture facilitates water infiltration (Hallett et al., 2016), contributes to regulating noise and temperatures ameliorating heat island effects (Nicholls et al., 2020a), and supports healthy soils (Beniston & Lal, 2012), waste recycling (Dalla Marta et al., 2019; Pollard et al., 2018), and air and water purification (Cortinovis & Geneletti, 2019)

Examples of the potential of urban agriculture to increase food security worldwide, particularly in the global south, are also found in the literature (Edmondson et al., 2020; Nicholls et al., 2020b; Sanyé-Mengual et al., 2018). Despite limited research on the financial dimension, some studies emphasise urban agriculture's ability to generate income, particularly for low-income households (Clucas et al., 2018; CoDyre et al., 2015; Victor et al., 2018). Regardless of profitability, community gardening may contribute to satisfying dietary requirements and may also induce economic activity in sectors that supply urban farmers with the necessary production means. Diversification beyond food production, such as floriculture (Manikas et al., 2020), and the exploitation of amenities and provision of training and other services (Gregory et al., 2016; Holland, 2004) are examples of complementary UA activities that can generate direct and indirect jobs in community gardens, generating positive externalities for other sectors.

Urban agriculture is often considered an enabler of new forms of social engagement, providing an arena for challenging stereotypes, exchanging knowledge, and dismantling social barriers (Corcoran & Kettle, 2015). Previous research provides evidence for the development of both bonding and bridging social capital through urban agriculture activities (Audate et al., 2019; Christensen et al., 2019; Shostak & Guscott, 2017). Beginning with a shared enjoyment of gardening, some social bonds have also been found to deepen over time, with fellow gardeners becoming a source of social support (Teig et al., 2009; Veen et al., 2016). Svendsen (2009) found that, while gardening often started out as a common activity among a small group of friends or neighbours, it often expanded to include rich social

networks both within neighbourhoods and beyond.

The **well-being benefits** associated with urban agriculture include improved physical and mental health through decreased risk factors (e.g., obesity), increased life satisfaction, reduced loneliness, increased happiness, decreased stress, connection to culture, and healthy ageing (Audate et al., 2019; Genter et al., 2015; Mourão et al., 2019; Van Den Berg et al., 2010). Hawkins et al. (2011) and Vanden Berg et al. (2010) found participation in allotment gardening to be more effective for well-being than other forms of exercise in reducing stress, even when the exercise was conducted outdoors. The connection to culture is largely concerned with the degree to which urban agriculture supports people to maintain their cultural identity and share aspects of their culture with others. For some immigrant populations, the cultivation of particular herbs or vegetables enables communities to sustain cultural values and knowledge from their countries of origin (Shostak & Guscott, 2017; Taylor & Lovell, 2015). Urban agriculture activities may also provide well-being benefits by enabling individuals or communities to engage with and feel ownership over urban space in what may be called environmental stewardship (Romolini et al., 2012).

Another co-benefit of urban agriculture is related to its contribution for urban **regeneration** by increasing the vitality and liveability of public spaces (Panerai et al., 2004). Urban agriculture can positively influence the social performance of public spaces (Marcus, 2007) as it invites interpersonal interactions, creating safer cities. In addition, urban agriculture may deliver mixed uses to the neighbourhood (Poulsen et al., 2017) and provide opportunities for recreation for those who do not readily access green areas (Eggermont et al., 2015).

Alongside these benefits, however, some **undesirable effects of urban agriculture** have also been documented. These primarily relate to potential environmental impacts and risks, for example, excessive water consumption (Dalla Marta et al., 2019), potential contamination of aquatic ecosystems and water quality (Harada et al., 2018), and maintenance concerns for irrigation practices, fertilising, weeding, pest control, pruning, and harvesting (Lee et al., 2019). The literature has seldom addressed social externalities, albeit some studies have pointed out problems such as vandalism (Lee et al., 2019) and green gentrification (Sbicca, 2019). Horst et al., (2017) also pinpoint that the associated benefits for health, skill-building and jobs, community development, and food security should be considered with caution. In fact, urban agriculture may reinforce and deepen societal inequities by benefitting more privileged communities and resourced organisations, as well as contributing to marginalisation and even displacement of socioeconomically disadvantaged households. If not consciously planned, urban agriculture can further exacerbate the processes of gentrification, as urban agriculture projects can make affordable neighbourhoods more attractive to economically advantaged groups (Horst et al., 2017; Safransky, 2014).

In light of these benefits, and despite of drawbacks reported in some studies, urban agriculture is acquiring growing recognition as a pathway for fostering sustainability in cities. In policy, the 2001 FAO initiative Food for the Cities (FAO, 2023c) was the first tangible step in recognising cities as drivers of change in food policies. A stepping stone for the activation of municipal authorities and city councils in this debate was the Milan Urban Food Policy Pact in 2015 (Milan Municipality, 2015). This programme has brought together several mayors to develop holistic strategies integrating food, social economy, environment, and health, and it currently includes the participation of more than 200 cities and towns worldwide. More recently, other European documents such as the Farm to Fork Strategy (European Commission, 2020b), the Biodiversity strategy (European Commission, 2020a), and the Food2030 policy framework (European Commission, 2016) also emphasise the importance of city governments in developing short food supply chains that deliver co-benefits for all. In addition, urban agriculture is mentioned in roadmaps to strive for climate neutrality in cities, as a mitigation strategy that can deliver several co-benefits to urban populations (Lwasa et al., 2022).

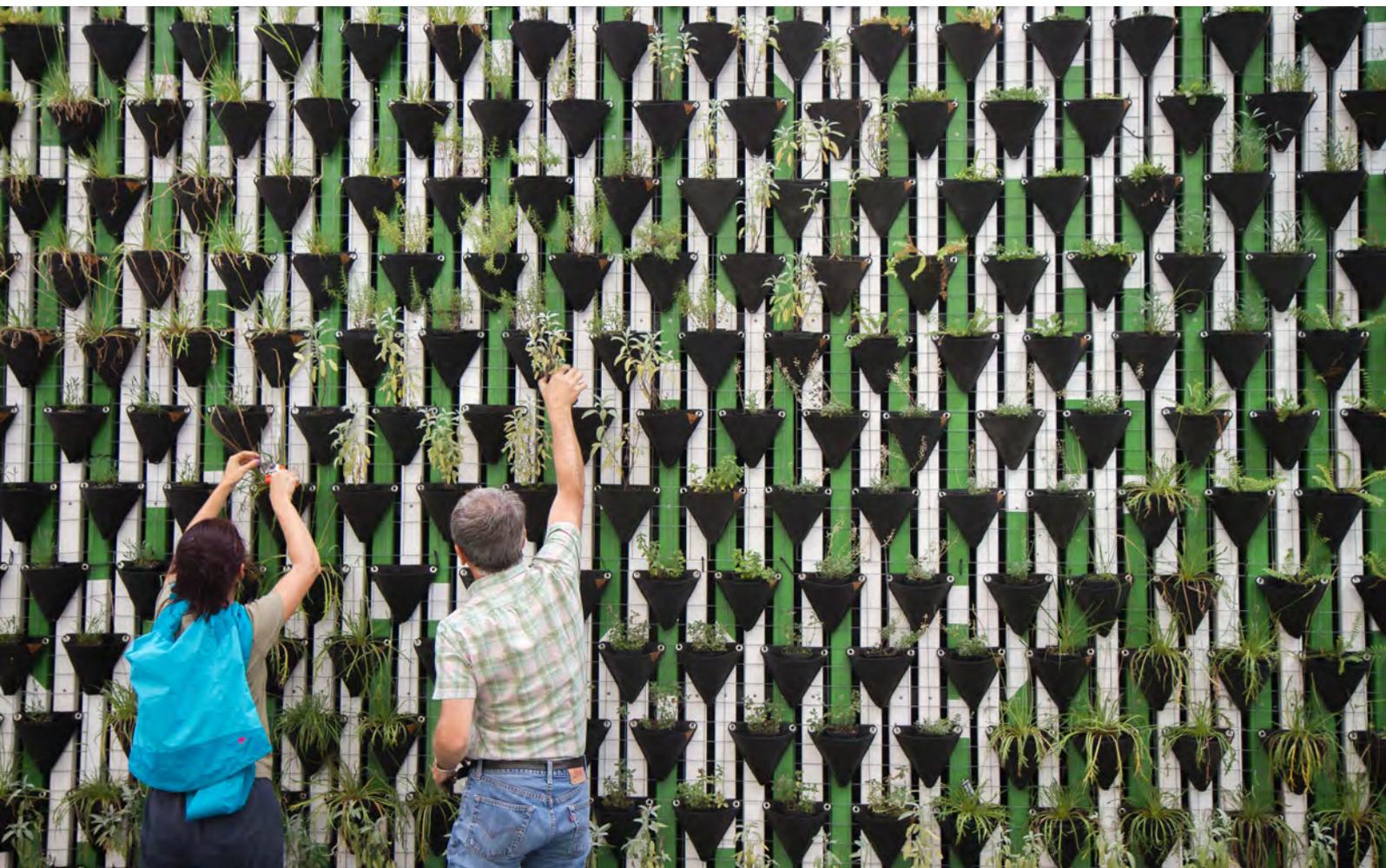


Photo: Daniel Funes/unsplash.com

## Urban agriculture stories

This section presents seven stories about urban agriculture in the Nordic-Baltic context. The opportunities and challenges described by the stakeholders involved in these initiatives provide the main takeaways to further discuss the future of urban agriculture.

*Cultivating change* in connection with innovation and legislation.

- **Stockholm Royal Seaport** (Sweden) is an eco-district with the ambition to transform grey infrastructure into edible green spaces by growing food on rooftops, facades, and underground spaces. The ambition of growing food in the built environment is a strategy for improving sustainability in the district through the provision of productive ecosystem services.

- **Växthuset på Berga** in Stockholm (Sweden) discloses the experience of an entrepreneur who grows bananas and papayas in a greenhouse in Southern Stockholm, challenging the norm that tropical fruits cannot be grown in cold climates.

*Cultivating community* in connection with culture.

- **Dodo** (Finland) is a non-governmental organisation for urban gardening and environmental activism in Finland. With branches in Helsinki, Oulu, Tampere and Turku, Dodo is sowing seeds of urban sustainability in the Finnish context.
- **Longyearbyen**, Svalbard (Norway) showcases how the Arctic community is striving for the circular use of resource by employing the waste of a brewery as input for producing local food more sustainably.

*Cultivating knowledge* in connection with education and science.

- **Campus Roslagen** in Norrtälje (Sweden) is a frontrunner in aquaponics education in the Nordic-Baltic Region, performing an essential role in the qualification and development of new skills for urban farmers.
- **Norwegian University of Life Science - NMBU**, in Ås (Norway) employs an innovative pedagogical approach to qualify professionals in urban agriculture in the first master's programme in urban agriculture in the Nordic Region.
- **Roof2Fork** in Riga (Latvia) is a research project that investigates the potential of growing food on rooftops and provides essential knowledge on the quality of food produced in urban areas.



*Växthuset på Berga, Stockholm, Sweden; Dodo, Helsinki, Finland; Roof2Fork, Riga, Latvia*



Photo: ThisIsEngineering RAEng/unsplash.com

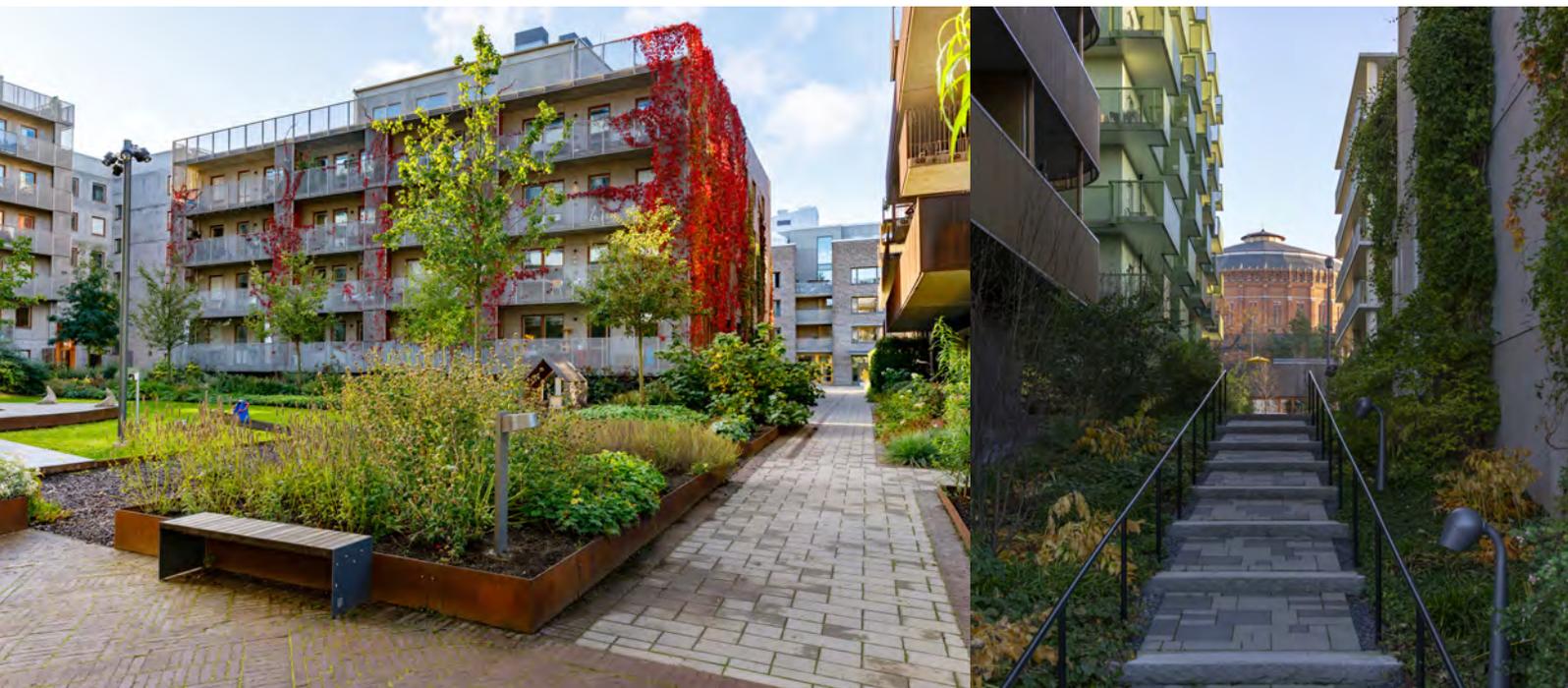
# Cultivating change in connection with innovation and legislation

## **Growing food in the built environment: A strategy for improving sustainability in Stockholm Royal Seaport**

Stockholm Royal Seaport has the ambition of transforming grey infrastructure into edible green spaces by growing food on rooftops, facades, and underground spaces. With this and other actions, the district is paving the way towards a sustainable future.

Stockholm Royal Seaport is a former industrial area that has been transformed into one of the largest urban developments in Europe. With the provision of 12,000 new homes and 35,000 working places, significant densification is accompanied by high sustainability ambitions such as achieving carbon neutrality by 2030. The district was appointed by Stockholm City Council as a “sustainability-profiled area” with the mission of testing and developing innovative solutions and governance processes. The ultimate goal is for the district to act as a forerunner for sustainable urban development. As a test-bed district, it is possible to enforce sustainability targets and requirements to construction companies and employ monitoring tools to track the performance of the development. These mechanisms resulted into high compliance in energy performance, mobility, urban greenery, and waste management.

In 2019, a report explored the question: “if we were to produce 10% of food consumed in cities, what spaces could be used for that?” The report identified potential areas, surfaces, and dark spaces in the city that could be used for urban farming (Stockholms Stad, 2019). This inspired the policy target of creating conditions for productive ecosystem services in the district (Stockholms Stad, 2021) and highlighted the need to assess the potential of urban agriculture to address sustainability concerns. Maria Lennartsson, who is R&D Coordinator in Stockholm Royal Seaport and Project Manager for the Stockholm pilot on urban agriculture, says:



*Green walls in Stockholm Royal Sea Port, Stockholm, Sweden*  
Photos: Jansin & Hammarling/flickr.com; Eric Cung-Dinh/flickr.com

”

*We did a study a few years ago that challenged our way of thinking. It was about mobility, and we began by asking ourselves: if we forget everything else and focus on how to plan a city with the best mobility solutions, what would that look like? What we got out of this study was planning principles that can be applied. And that is precisely what we do here. If we think about urban agriculture and the potential of growing food in cities, what would that look like and what planning principles can we develop?*

In 2022, with the support of the European Joint Program Initiative,<sup>[2]</sup> an in-depth study began which explores the viability of including food production as a requirement for developing a particular area of the district. The process includes visionary workshops to discuss the barriers and opportunities to grow food in cities and how to embrace it as “urban infrastructure.” One key element of growing food in the district is the ambition to go beyond the cultivation of green leaves to include the growing of caloric food, which is paramount for increasing the resilience of cities regarding food security.

To this end, a working group and several workshops have taken place to discuss the possibility of farming in cities through the implementation of green roofs, greenhouses on the tops of buildings, agri-walls on the facades, and growing mushrooms and cultivating fish in dark spaces. Regenerative design has been a leading concept in these discussions. This concept mimics natural ecosystem processes and builds on a systemic and integrative approach to meet societal needs while preserving nature’s integrity. These workshops include the participation of civil servants from different departments (e.g., water, energy, waste, land management, parks, public health) and private sector actors (e.g., developers) as well as civil society. Together these actors share their ideas about the potentials and challenges of effectively introducing farming in urban spaces. From Maria’s perspective:

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2. Transformative Capacities in Energy, Food and Water – TANGO-W project. Financed by the Swedish Energy Agency grant number 52849-1

”

*Conceiving urban agriculture from the perspective of productive ecosystem services and regenerative design offers a means to return to the environment a little bit of what we take.*

There are several opportunities to implement such an ambitious project in the district. From a legislative perspective, the sustainability policy safeguards the work of testing innovative sustainable solutions in Stockholm Royal Seaport. The implementation of such piloting activities over the last 12 years has been characterised by cooperation across different municipality sectors. Beyond this, great connection with large and heterogeneous networks including NGOs, businesses, researchers, and developers provides a rich environment to debate alternative means to grow food in cities. The strong power of the municipality is an advantage as there is the possibility to influence the allocation of land process to developers, for example, by introducing strict requirements in the land sale contracts. In addition to these aspects, Stockholm has a long history of urban farming with several allotment gardens located across the city, but still not enough to fulfil the high demand from people to grow food in cities. As Maria Lennartsson says:

”

*Reimagining allotment gardens in dense urban areas can create ways of having modern social recreative possibilities including recreative gardening and food production.*

Furthermore, the growing global awareness about the importance of establishing short-supply food chains fostering resilience and self-sufficiency, especially in tandem with climate change, COVID-19, and the war in Ukraine, is reflected in the market, which has experienced an increased number of small and medium-sized enterprises and startups focusing on producing food in cities (Butturini and Marcelis, 2020).

Among the barriers, the novelty of growing food in the built environment can be perceived as a risk for some stakeholders, as the dissociation between agriculture and cities is still present in the minds of some residents as well as policymakers and developers. This poses some challenges in raising interest within the planning administration to enable the incorporation of a strategy for food production in the upcoming land allocation processes, as well as to anchor the idea of growing food in buildings among the developers who may focus on the risks rather than the benefits of urban agriculture.

Despite the technical, legislative, and governance barriers that need to be addressed to effectively grow calories in cities, there is a crucial need to discuss and demonstrate urban agriculture as a desirable urban function that can shorten food supply chains, improve biodiversity, enhance social inclusion, and improve community life. These are key components in the political debate about how to transform our cities from dysfunctional to functional ecosystems that work towards sustainable and resilient urban futures. Visions are seeds of change; thus, they need to be cultivated, as we need to change current mindsets to be able to meet global environmental goals and live more in harmony with nature. As Maria Lennartsson says:

”

*I hope that urban agriculture will be an integral part of the upcoming developments and that we also influence the policy paper or the urban agriculture plan that the city is currently developing.*

### *Box 2: Stockholm Royal Seaport: Summary of opportunities*

- The global awareness on the importance of establishing short food supply chains supports urban agriculture as a mean to strengthen urban resilience and self-sufficiency
- The district employs an innovative governance model characterised by experimentation of sustainable solutions and co-creation with a broad and heterogeneous network (e.g., NGOs, businesses, researchers, developers)
- The vision of including food production in cities follows Stockholm's tradition in urban farming with urban allotment gardens.
- Gardening has become a meditative practice for urban dwellers during COVID-19 as a mean to reconnect with nature.

### *Box 3: Stockholm Royal Seaport: Summary of challenges*

- It takes time and effort to raise interest within the planning administration to enable incorporating urban agriculture in forthcoming land allocation processes.
- Urban agriculture initiatives may be met with resistance or indifference from political leaders.
- Developers and other stakeholders may focus on risks rather than benefits, making it difficult to implement food production into the urban environment.
- High land costs threaten the implementation of agriculture in cities.

## Växthuset på Berga: Growing tropical fruits in Stockholm

Yes, it is possible to grow tropical fruits in the Stockholm Region. Björn Oliviusson is an entrepreneur who grows bananas and papayas in Southern Stockholm challenging the norm that tropical fruits cannot be grown in cold climate.

Växthuset på Berga is a greenhouse built in 2012 as part of Björn Oliuvissson's PhD. The greenhouse is 80 m<sup>2</sup> and takes the shape of a dome with a height of 4.5 m at the highest point. It is built with five layers of polycarbonate—two thick layers in the external part of the greenhouse and three thin layers inside—that create four different channels of air, providing excellent insulation. Inside the greenhouse, an aquaponic system enables the cultivation of tropical fruits (e.g., bananas, papayas, vanilla, sugar cane). The greenhouse has been attracting the attention of many people, and since its opening has hosted approximately 18,000 visitors from around the world. Its proximity to energy sources from a local school allows for the system's functionality which shows high productivity compared to soil-based production. The record productivity of 17 kg/m<sup>2</sup> of bananas contrasts with the average output of 5 kg/m<sup>2</sup> of bananas cultivated with traditional soil-based technologies. As Björn says:



*Björn Oliviusson, owner of Växthuset på Berga, Stockholm, Sweden*

”

*(...) If we were to start some sort of production indoors in an urban setting, it's likely that we reach production volumes that are at least close to those commercial quantities.*

The products are well-received in the market; local shops acquire most of the fruits which are slightly processed (peeled, cut, and frozen) before being sold. Fish are a fundamental part of the aquaponic system as they provide nutrients to the plants through their waste; however, the fish are not commercialised as this would demand larger investments and infrastructure to comply with rules and legislation to slaughter them. Therefore, only the small fish are sold for aquariums. Nevertheless, the potential of growing fish should not go unnoticed. As Björn says:

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*In aquaponic systems, it is possible to farm many different species of fish, even in the same tank. By creating multispecies production, we will be able to utilise many left-over products as feed, or to convert them into feed (insects, mushrooms), creating food webs within the tank. This will enable us to close the nutrient loop even more.*

The high temperature achieved in the greenhouse has affected the choice of crops to be cultivated. Rather than investing in technologies for regulating the temperature, which would enable growing vegetables (e.g., cucumbers, tomatoes, green leaves), Björn opted for tropical fruits that grow well in the greenhouse environment. Besides having high tolerance for shifting temperatures, these species also easily adapt to changes in air humidity and light, and the workload is lower as one person can easily manage the tasks needed to maintain the greenhouse. Compared with cultivating vegetables, farming tropical fruits is less demanding, and the running costs (maintenance and pest control) are much lower. The disadvantage is that these fruits need to grow longer, between three and five years, before providing economic returns.

Capitalising on the advantage of flexible working conditions, Björn also dedicates his time to teaching and consultancy. He is a mentor in a professional course on aquaponics and a consultant providing several customers with advice on how to grow food with aquaponics. In addition, he participates in several events spreading the knowledge about aquaponics and the urgent need to embrace this technology considering the negative effects of climate change on highly productive areas. For example, places such as Almeria in the southeastern part of Spain used to produce a large amount of the vegetables consumed in Europe, but food production in the area has suffered due to severe drought.

Closed aquaponic systems require one-tenth of the amount of water of soil-based production, and they use no pesticides as beneficial insects are used to naturally counteract eventual pests. Nevertheless, it has been a slow process to raise awareness of enabling short food supply chains and influencing the market to embrace aquaponics in food production. The European legislation is an obstacle as food grown in aquaponic systems is not granted organic labels, exacerbating the competition of the products with extremely cheap imports. Introducing aquaponic systems would require a change in the different systems for growing food, but Björn sees the resistance to change as a concern:

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*Just a few weeks ago it was in the news about the drought in the High Plains in the United States. But it was known that the need to water these giant fields would come for at least 20 years. The only thing that changed was that it happened earlier than predicted. So that is a problem. If people were aware and more effort, more money would be invested to find alternative solutions for urban food production it would be much easier (...). As we say in Sweden “you need to have a knife on your throat” to realise the need for change; otherwise, people do not react.*

Another mental barrier to overcome is accepting that new systems such as aquaponics may not offer maximum profitability immediately, but they create several benefits in the long run. As the example above shows, traditional means of growing food are becoming more expensive with the rising need for water for irrigation and increasing labour and fertiliser prices. This trend suggests that the prices of imports will increase, and food shortages may soon become a reality. This dark future may be the entry point for the success and acceptability of aquaponics.

One future vision is to embrace food production with greenhouses and aquaponics in cities. These technologies have the potential to create a fully closed-loop system that can be placed anywhere (e.g., between buildings). In addition, the greenhouses do not demand soil and can function with waste heat, and available water from the buildings, so they fit nicely into urban environments. Nevertheless, there is a need to demonstrate in a convincing manner that this system is a viable solution for improving the sustainability of our food systems. As Björn suggests, showcasing a highly productive and economically viable greenhouse using aquaponics in a city centre could be an eye-opener for politicians, urban planners, and entrepreneurs on the advantages of supporting short food supply chains. In addition Björn says:

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*The benefits for society would be huge if it were to be implemented on a large scale. It will easily gain acceptability because plants, fishes, flowers are things that most people consider positive, and they would have increased self-sufficiency when it comes to food. So, I think it will increase. I just hope it will increase quickly enough.*

#### *Box 4: Växthuset på Berga: Summary of opportunities*

- Aquaponics systems deliver higher yields compared with traditional soil-based technologies for growing food.
- Greenhouses and aquaponic systems can be easily implemented in cities, as they can be built in between existing buildings, use heat waste and available water, and also provide food and pleasant environments for people.
- Aquaponic systems do not make use of pesticides and use only 10% of the amount of water compared to soil-based technologies.

#### *Box 5: Växthuset på Berga: Summary of challenges*

- The market has been slow in uptaking aquaponics technology.
- European legislation does not grant ecological, organic labels to food grown with aquaponics, thus hurting its competitiveness.
- New skills and competencies are needed to enable the implementation and management of aquaponic systems in the built environment.
- Growing fruits in aquaponic systems is a long-term investment as many years are required before the production can be commercialised.



Photo: Filip Urban/unsplash.com

## Cultivating community in connection with culture

### **Sowing seeds of urban sustainability: Dodo's journey in urban gardening and environmental activism in Finland**

Back in 1995, a group of students who wished to find alternative ways to live more sustainably in cities initiated a non-governmental organisation called Dodo. Since then, Dodo has been implementing grassroots experiments to enhance urban sustainability and resilience while exploring what people can do to improve the environment and minimise the footprint of urban life.

Currently, urban agriculture, climate change, and urban planning are the three fields in which Dodo focuses to engage urban communities and nurture a sustainable culture. In 2009, with Dodo's thematic focus on "Food and the City", urban gardening became an area of interest, and they began identifying suitable places for growing food. The interest in urban agriculture follows the tradition of allotment gardens from the early 20th century that persists today in the context of many Finnish cities. For Dodo, making small-scale urban gardening accessible to all, from individual initiatives to large-scale community projects, is a great pathway to inform and engage urban communities in a healthy coexistence of humans and the environment. Today, Dodo's urban gardening activities in Helsinki are centred at an urban gardening centre and at the garden in Jätkäsaari.

Dodo's efficient management group includes a head of organisational development, project coordinators, an active board, and interns. Together, the team sustains a democratic structure that thrives on the commitment of university students and other volunteers. Dodo's office is located next to Turntable, which is the urban farming and event centre where several activities are offered to the community, such as workshops and social gatherings. For example, the organisation hosts bi-monthly Urban Dinners where people prepare and eat a meal together using food waste from local stores.



*Dodo's Office and hydroponic system demo, Helsinki, Finland*

To sustain the organisation, Dodo has several potential revenue streams. The renting of Turntable centre for private and public events, as well as Dodo's large network, create beneficial conditions for seeking external funding. In addition, the smart management of resources through investments in different hedge funds helps cover administrative expenses. Though, these sources are not always reliable. As Malm Nordlund, who is head of Dodo's organisational development, says:

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*It is a year-by-year basis, we need to apply for different funds for different projects or even events each year and sometimes we get funding and sometimes we don't.*

Amidst these opportunities, Dodo grapples with a multitude of challenges. Student volunteers are often managing busy schedules, and these time constraints impact the organisation. Additionally, the NGO experiences difficulties in attracting committed members, as individuals often opt for financially compensated jobs instead. This also applies to engagement in activities, as people may be interested in joining the event but do not necessarily have the capacity to be involved in the planning process. The balance between short-term and long-term planning poses a persistent issue, impacting the organisation's ability to secure new members and transfer knowledge effectively. While the year-by-year planning opens up possibilities to include input from motivated members who are committed for a short period of time, this is accompanied by an overall uncertainty that negatively impacts the organisation's stability.

Financial instability, lack of media visibility, and the responsibility for individual actions further compound the challenges faced by Dodo. The NGO faces financial hurdles due to changes in the eligibility criteria for state funding of the Ministry of Education and Culture, rendering them ineligible for government support as a national NGO. There are possibilities to collaborate with the city to set up urban gardening initiatives, but the organisational procedure is not optimal and is relatively short-lived. Private people can rent gardening areas through Dodo, which involves a long-term rental agreement with the city. However, if these individuals are unreliable, there is a lack of accountability and resources to follow-up and react to unforeseen changes, leaving Dodo in a challenging situation. Consequently, Dodo incurs costs for space rental and fixed employee wages and other costs. Moreover, the organisation struggles to maintain a stable income, heavily relying on successful events funded by external sources, as local funding remains limited.

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*We used to apply to the Helsinki Days event organised by the city, and for many years we got a bit of funding for this event, but this year we didn't get the funding. We still wanted to do it with our own money, but it was smaller and challenging if you want to pay somebody to arrange and coordinate it all.*

Looking at the bigger picture, the success of the NGO must be recognised. After all, to maintain such an organisation for almost three decades and contribute to leveraging the city's openness to urban gardening initiatives, Dodo recognises the potential to capitalise on this support. Their "Growing Change" project for the under-30 demographic aims to delve into various aspects of the food system and related activism. The success of Dodo activities is not confined only to Helsinki; the organisation also supports activities in other cities such as Oulu, Tampere, and Turku. Nevertheless, Malm shares some risks associated with this.

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*We also have activities in Oulu, but it is a bit problematic for them to act in Oulu as an NGO registered in Helsinki. So, the activists in Oulu are thinking about registering their own NGO there, like a sister organisation so that they could apply for funds that are for NGOs based in Oulu. We are kind of too small to be national, but then there are limits on these local funds too.*

Looking ahead, Dodo aims to refine its strategies. The organisation plans to leverage short-term involvement effectively, creating a core strategy that defines its unique characteristics and evaluates the scalability of its initiatives. The vision

includes engaging the municipality more deeply in urban gardening, emphasising social inclusion, and reducing barriers for communities to access urban gardens. The focus will shift towards the positive social impact of urban gardening, fostering a more inclusive and sustainable community. Malm emphasises that their mission goes beyond merely urban gardening but also towards fostering social sustainability and connecting neighbourhoods. Dodo will focus on strengthening the established community by, for instance hosting Urban Dinners, emphasising both the social and gardening aspects of urban agriculture:

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*Stressing more these social aspects of urban gardening, especially when it comes to this kind of hobby gardening—it is something that you do more for the social interaction than for the production of food.*

After all, Dodo’s long-term impact is to get inspired by active citizens and, in return, continue striving to inspire others.



*Dodo's office outdoor area, Helsinki, Finland*

#### *Box 6: Dodo: Summary of opportunities*

- The NGO explores opportunities for growing food in urban areas while promoting social inclusion and education through the implementation of several projects and initiatives (e.g., Urban Dinners, Growing Change Project).
- The organisation runs on a creative and smart management (e.g., investments in hedge funds, cooperation with small-scale initiatives, renting out premisses for public and private events).
- Longevity and national recognition with branches in different Finnish cities strengthen of the organisation.

#### *Box 7: Dodo: Summary of challenges*

- The organisation faces difficulties to engage volunteers in the long term.
- Reliability on savings and external funding poses financial uncertainties to the organisation.
- The organisation misses a strong media platform which jeopardises the reach and establishment of stronger connections with local and higher authorities.

## Brewing sustainability on Svalbard: How a local brewery took the initiative to promote local resource production and circulation through indoor urban farming

Regardless of the extreme Arctic conditions, a pioneering project is brewing in Longyearbyen, Svalbard. Robert Johansen the owner of a local brewery, alongside Hege Giske, who moved to Svalbard in 2018, created an innovative concept of creating circularity between brewing beer and urban farming. After overcoming several obstacles, Robert established a local brewery, which has been a symbol of pride for the local community since 2014. Robert and Hege aim to use the existing infrastructure and turn biological waste generated throughout the brewing process into energy. This process will transform the waste into a natural fuel for heating a greenhouse that will grow local and fresh food. The overarching goal is to boost self-sufficiency, reduce the dependency on distant supply chains, and provide quality food to the community, thereby creating a more sustainable future for the Longyearbyen community.



*Robert Johansen, owner of Svalbard Brewery and Hege Giske, Longyearbyen, Svalbard*

Svalbard is a remote archipelago situated between the northern tip of Norway and the North Pole. Its location corresponds with exceptional climate conditions putting the landscape into darkness for 110 days a year and, in contrast, under constant light exposure for at least four months a year.

The harsh Arctic climate and tangible effects of the climate crisis pose significant obstacles to Svalbard's inhabitants and local agriculture. For instance, the poor water quality, laden with minerals and heavy metals, must be thoroughly treated before it can nourish crops. Consequently, citizens of Svalbard depend heavily on importing fresh goods via boat or plane transportation. Shipped food often decreases in quality and is low on vitamins and other nutrients. In the long run, this is not a sustainable practice, socially, economically, or environmentally. In addition to these challenges, the local community urgently needs to transition away from a coal-based economy and align with urgent decarbonisation methods to minimise climate change risks.

At the core of this project are local demand and available resources that hold potential now and require swift action. Despite its remote location, Svalbard is experiencing a rise in incoming visitors, approximately 170,000 yearly, which is a positive driver for the local economy, namely through restaurants and hotels. There is therefore an opportunity for the urban agriculture project to connect customers to locally grown products. If this succeeds, there is potential to further involve and educate the community on agricultural practices, particularly polar permaculture, which would enable the long-term vision of expanding to several greenhouses and providing a more diverse range of crops. Beyond this, the farmers can make use of the extreme climate conditions by for instance using the sun and wind exposure to store renewable energy. Another form of sustainable energy usage is transforming the brewery's byproducts into valuable bioenergy for the greenhouse, which requires a lot of energy to maintain a stable temperature and light source for the crops. As Hege says:

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*That will be a really important part of the project to see how we can use waste to create energy. There is also the possibility to cover the whole roof of the brewery building with solar panels so that we can capture the energy during the light months and store and use it during the dark period.*

However, in order for the business to develop, the project needs land to build on and financial resources to cover immediate costs. Acquiring suitable land for the enterprise is complex as the land is owned by the Norwegian government, resulting in high barriers of entry linked to costs and regulations. According to Hege Giske, there is an available area by the airport, but the location is not ideal. The legal application process as well as the transformation of the land would be too time-consuming. The area currently lacks connection to running water and electricity and is polluted from previous coal mining activities which makes it unsuitable for an agricultural base. From a legislative perspective, many areas are either predestined for housing projects or environmentally protected. Hege and Robert have been trying to raise funds to build up the greenhouse by applying for government support, both nationally and on an EU level, but so far, it has been unsuccessful, and they continuously face institutional barriers. Even though the farming project promises long-term sustainable benefits, there are limited opportunities for it to evolve now and grow into a self-sustaining business. Nevertheless, Hege remains optimistic with a clear future vision:

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*Of course, we can use the brewery as it is today, and establish one or two freight farm containers, but to get to the next level to take it further, to build a new building, it will cost a lot of investments. But we need to think that taking this high cost is better for everyone. It's better for the local community, it's better for the food systems and it's better for the environment. To become sustainable, it has and will never be cheap.*

In the upcoming months, Hege and Robert plan to identify local restaurants' needs for fresh food, starting with leafy greens that can be grown sustainably while maintaining a high quality compared to imported goods. They aim to commence a round of test products in the spring. In the long term, the project aspires to settle on a new production site for both the brewery and the farming operations. They hope to be successful in acquiring funding and support, either from the government or external investors. Overall, Hege is willing to invest in the sustainable future of

their environment, to eventually enhance self-sufficiency and circularity in this remote region while also setting an example for potential urban farmers. With enthusiasm and optimism, Hege sees a bright future for the Longyearbyen community that can flourish powered by nature.

*Box 8: Longyearbyen: Summary of opportunities*

- There is a great demand and need for fresh food in Longyearbyen.
- The vision of turning waste into resources and to use renewable energy to grow food locally aligns with goals of transitioning to a green and circular economy.
- The local community is willing and committed to the sustainable development of the region.

*Box 9: Longyearbyen: Summary of challenges*

- The strict legislation and regulatory frameworks for the implementation of new activities (e.g., access to land) trouble the implementation of the project.
- The Arctic climate poses many constraints to local food production (e.g., lack of sunlight, limited warm months) and requires greater investments.
- Limited access to infrastructure (e.g., access to running water, electricity) and pollution from coal mining activities harms the implementation of the project.
- The project implementation lacks financial backing and governmental support.



*Longyearbyen landscape, Svalbard*



Photo: Getty Images/unsplash.com

## **Cultivating knowledge in connection with education and science**

### **Campus Roslagen delivers professional aquaponics education**

Campus Roslagen has been a frontrunner in aquaponics education in the Nordic-Baltic Region, performing an essential role in the qualification and development of new skills for urban farmers.

Campus Roslagen offers several courses for professional education (e.g., nurses, solar energy designer, wind farm technicians). Since 2021, they have filled a gap in the education of urban farmers by providing technical education on aquaponics. The course has attracted a broad, diversified public showing the growing popularity of aquaponics has and its potential to produce food regardless of climate conditions.

The seed idea of developing an educational programme on aquaponics began with the involvement of Campus Roslagen in a project financed by LEADER (a programme for rural development of the Stockholm Region). This project focused on raising awareness, informing the general public about aquaponics technology, and investigating the hindrances in uptake since, despite being developed in the early 1970s, the technology has not yet found its niche in the market. The lack of proper education to handle both plants and fish in a closed system was one of the main outcomes of this investigation. As Donatella Acquaviva, who is a project manager at Campus Roslagen, says:

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***(...) One of the results of our LEADER project was the mapping of education in Europe. There are short courses on aquaponics around Europe as well as PhD courses, but these are at a higher level. Even the master level lacks courses on aquaponics. Maybe there are a few seminars, but systematic education does not exist. That is why Campus Roslagen applied for vocational training in aquaponics.***

The two-year aquaponics educational programme is free of charge, and candidates who provide evidence of low income or are outside the labour market can get a scholarship to support their studies. Students earn 120 ECTS points through the curriculum, which is structured in four parts: (1) plants; (2) fish; (3) aquaponic system components, and (4) project management and entrepreneurship. This structure was formulated to equip students with technical knowledge to design, operate, and understand the functioning of an aquaponic system, including dealing with technical problem-solving. The curriculum also includes a 10-week internship where students gain experience in different sectors of the market (e.g., a school and a company that aimed at installing the system to feed students/employees).

The application process is quite simple: applicants must have a high school degree and basic knowledge of chemistry and mathematics for admission. The hybrid class format, with most parts of the course conducted online and quarterly meetings onsite, has attracted students from different parts of Sweden. A wide range of people have participated in the programme, with ages varying between 18 and 63 years old students coming from diverse educational backgrounds (e.g., lawyers, journalists, teachers, IT workers). This heterogeneity is an asset as different perspectives contribute to an exciting academic environment.



*Aquaponic education at Campus Roslagen, Norrtälje, Sweden*

The teachers are mostly consultants with backgrounds in agricultural or veterinarian sciences. They offer insights into applied perspectives on aquaponic systems rather than through a general approach. The division of competencies among the teachers can be a bit challenging as there is a prejudice towards the importance of one field over another. While this aspect unveils challenges in working transdisciplinary, it also reinforces the need to bridge different sciences to consolidate education and foster consensus on the potential of aquaponics. Another aspect that raises concerns about the longevity of the programme is the short-term public financing that ends in 2024. Nevertheless, the great success in attracting 200 applicants in 2021, despite being influenced by the pandemic's effects on the economy, was followed by a high competition of 100 applicants in 2023 to fill the 20 places the programme offers bi-annually.

Regarding opportunities, the program creates an added value in offering education that can bring innovation to food systems. Indoor farming is climate independent and can thus strengthen food security and sovereignty, as higher productivity is achieved with a yield of approximately five times more crops per square metre than traditional soil-based methods (FAO, 2014). The contribution this system can have to social inclusion should not go unnoticed as people with physical disabilities can easily engage in agriculture. Besides not requiring much physical effort, the heights and distances between the growing beds can be designed to allow the operation and maintenance of the system by someone in a wheelchair. In addition, the environmental performance with low water usage (around 90% water savings compared to soil-based traditional methods) and the possibility to use heat waste while producing food without pesticides, regardless of the weather conditions, are significant advantages given all the uncertainties brought by the changing climate. Donatella also adds:

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*(...) Besides being a great technology to grow food in cities, it also helps to foster entrepreneurship in rural areas. Farmers can diversify their activities, and still work with agriculture, with fish farming. It is something innovative. It also indirectly contributes to biodiversity conservation because it curbs nutrients run-off in the environment and does not use antibiotics nor pesticides.*

Another advantage is the qualification of the students to work not only with aquaponics but also in hydroponics and/or in aquaculture. This is an important aspect considering that, otherwise, the aquaponics slow-growing market would soon be saturated. Donatella views this with some frustration:

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*(...) I still don't understand when I find people that say immediately, no (to aquaponics) while other emerging fields are already so advanced. I mean, if we think of Artificial Intelligence, the progress made in this field are incredible. The same with transplants or genetically modified food. These are very complex fields (systems). So why do people say aquaponics is too difficult to handle? (...) Yeah, maybe it's just a question of competition, for economic reasons.*

With regards to the future, Donatella believes that there is momentum for aquaponics technology to thrive. Despite the high initial investments, the opportunity of using abandoned buildings or underutilised spaces in existing buildings is an alternative to reduce costs. In addition, she sees the qualification in aquaponics as an avenue that opens several opportunities for making a profit that goes beyond food production, including teaching and consultancy. In her words:

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*Who is the farmer of nowadays? Maybe he doesn't work on a farm, but perhaps he works in architecture firms or municipalities.*

*Box 10: Campus Roslagen aquaponics education: Summary of opportunities*

- The programme responds to a knowledge gap and offers education that can bring innovation to food systems, which urgently need to change to cope with environmental crises and the increasing demand to feed a growing population.
- Students gain flexible skills through different opportunities to work with plants, fish, or with aquaponics.
- Growing food with aquaponic systems allows engaging people with disabilities in the agricultural labour market.

*Box 11: Campus Roslagen aquaponics education: Summary of challenges*

- Funding for the programme beyond 2024 remains uncertain.
- It is difficult to overcome prejudices against aquaponics systems.
- Developing business models can be challenging due to the slow-growing market.
- Managing aquaponic systems can be tricky as it involves balancing a whole ecosystem.

## NMBU offers the first master's programme in urban agriculture of the Nordic Region

NMBU employs an innovative pedagogical approach to qualify professionals in urban agriculture. Back in 2018, the vision of developing a master's programme where different disciplines could work together began to turn into reality with the creation of the National Centre for Urban Agriculture. The centre was one of the outcomes of the NMBU leadership in a Horizon 2020 project called Sino-European Innovative Green and Smart Cities (SiEUGreen) that focused on the production of food in cities using waste streams.

With this background, the master's programme in urban agriculture was implemented 2021. The programme is unique not only regarding the theme of urban agriculture but also in the pedagogical method that includes a student-active learning approach. This is an open method that gives students independence and flexibility to tailor their education according to their interests. Despite challenges, as courses across seven different faculties (veterinary, business, biotechnology, technology, environmental studies, biosciences, landscape and society) are eligible to be part of the curriculum, this approach actively engages students in their own learning process while attracting a heterogeneous group of students.



*Urban Agriculture in Campus Ås; Ås, Norway*

As Trine Hvoslef-Eide, researcher in bioscience and director of the master's programme explains:

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*(...) We have a very broad disciplinary approach in our university. We have seven faculties, (...) so it's possible for students to find a topic they're interested in, and to be qualified. This format is attractive not only for plant sciences or biology candidates but also for people with other educational backgrounds. We have students with bachelor's degrees in fine arts, business, nursing, geography, landscape engineering, economics amongst others.*

The broad scope of urban agriculture includes everything from kitchen benches and balconies to rooftop gardens, community gardens, and professional large scale urban agriculture. This results in a diverse collection of master's theses including "Food security and urban agriculture: How can private, small-scale, non-commercial cultivation in the city contribute to increased self-sufficiency?" (Pettersen, 2023) and "How a resource center for urban agriculture can provide multidimensional tools for social inclusion" (Trettvik, 2023). In addition, the transdisciplinary approach goes beyond the collaboration across different disciplines by including a partnership with the external network group Pådriv. Pådriv matches the competencies of the students with real challenges faced by municipalities, communities, or private companies, giving students the opportunities to work with tools and skills to address real-world problems.

The problem-solving approach also benefits municipalities, communities, and private entities facing challenges that can be tackled through urban agriculture. The case studies are not restricted to Norway and have included Svalbard and Mauritius, both of which face enormous challenges in accessing food due to their remote geographies. The recent development of the Norwegian Strategy for Urban Agriculture (Norwegian Ministries, 2021) has strengthened the importance of the programme while also awakening the interest of different municipalities that find in the students an opportunity to get assistance to implement the strategy at the local level. In this strategy, municipalities have been given the responsibility to facilitate for urban agriculture.

The students work in heterogeneous groups to find alternative solutions for the cases, which are central for their qualification as they provide the empirical basis for the students to reflect on which competencies they lack to address the challenges they need to tackle. The absence of knowledge becomes the parameter for suggesting lectures or for choosing different courses that will be part of their education in the following term. The heterogeneous background of the students is an opportunity for them to realise how their competencies match or diverge. But this is seen as a strength. As Trine says:

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*(...) Everybody has something they can bring to the table and please respect both yourself and the others (...) and learn how to collaborate and teach each other. Nevertheless, there are disciplinary terms, what I call the tribal language of a discipline. It's something that they need to get acquainted with (...) to be able to work together. And then they have us as teachers to ask for advice, to help find suitable literature and so on.*

This educational approach is challenging, however, as the students become responsible for their own curriculum while demanding great administrative efficiency and collaboration to coordinate the supply of courses across different faculties. Another barrier is the perception that urban agriculture is just a hobby. As Trine puts it:

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*(..) That's one barrier we need to tear down. This can actually be a hobby, but it's important for people's health and well-being. But it's so much more.*

Another challenge to urban agriculture is that it should be conceptualised within circular thinking to better fit the sustainability agenda. This implies growing food by using urban waste streams (e.g., recovering nutrients from black and grey water or organic waste). Nevertheless, it is necessary to do research to ensure safety, to dismantle social resistance, and to adjust the legislation to make this a reality.

Despite these challenges, Trine sees the future of the master's programme with optimism. One of the aims for the future is to change the name to programme to Circular Urban Agriculture and offer it in English (from 2024) to attract international students that will contribute even more with the diversification of perspectives. As Trine adds:

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*Look at nutrients, we need to recycle sewage because this is the sustainable way of treating our resources. Because it is not waste, it's resources astray. In Oslo for instance, they started with water closets a bit more than 100 years ago. Before that, this was an important resource that was used by the farmers (...). So, we look at the recycling of resources, both the nutrients and the water and how we can clean and save water using vacuum toilets and making biogas from the black water. And if we look at energy, both recycling energy and green energy that we can obtain from the sun and storing energy, using energy from the summer in the winter (...). We look at the whole sustainable society and urban agriculture in our view as the whole. That's why we would like to change it to circular urban agriculture. So urban agriculture is much more than growing carrots.*

*Box 12: NMBU master's programme: Summary of opportunities*

- The programme employs a unique pedagogical perspective that combines transdisciplinary, student-active learning, and problem-solving approaches.
- Circularity of resources is one of the strengths of the programme which emphasizes technologies to grow food using waste streams (e.g., black, and grey water, organic waste).
- The students' projects and theses respond to the needs of municipalities to include urban agriculture in their agendas and to implement the Norwegian Strategy for Urban Agriculture.

*Box 13: NMBU master's programme: Summary of challenges*

- The implementation of the flexible and open curriculum requires a lot of coordination and efficiency among the seven faculties.
- It is difficult to overcome the misconception that urban agriculture is merely a hobby.
- It will take a long time to defeat social resistance towards the consumption of food produced with waste streams.

## Roof2Fork: Latvian research on urban agriculture

Roof2Fork is a research project that investigates the potential of growing food on rooftops.

In 2023, two research institutions—the Institute of Agricultural Resources and Economics (AREI) and the Institute of Horticulture—joined forces to study the possibilities and challenges of growing food on rooftops. With financial support from the Latvian Fundamental and Applied Research Programme financing research from diverse fields of knowledge, the project was granted a budget of 300,000 EUR to respond to the lack of knowledge about urban agriculture in the Latvian context.

Until 2025, when the project ends, a series of research activities will be implemented to provide knowledge to several issues such as a comparison of the quality of food grown in urban and rural environments and testing the effectiveness of light-weight substrates for cultivating food on rooftops, as well as their impact on the yield and quality of food. The project will also deliver guidelines for professionals and practitioners on growing food in the urban environment.



*Farming at the rooftop of AREI building, Riga, Latvia*

As Linda Ievina, an environmental researcher involved in Roof2Fork, says:

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*We see a great potential of this research area as both AREI and the Institute of Horticulture complement each other in their expertise and will be able to deliver relevant, and currently unavailable, information on how to grow food on rooftops.*

AREI has long-standing scientific experience in agriculture, with expertise in sustainable technologies for food production and bioeconomy. The Institute of Horticulture is one of the best research centres in Latvia with proficiency in agrotechnological trials and food quality analysis. With this interdisciplinary team that includes researchers from agronomy, environmental science, chemistry, and spatial planning, Roof2Fork aims to have a great impact on bridging knowledge and strengthening the potential of urban gardening in Latvia.

The comparison of food produced in urban and rural settings is a stronghold of the project. The rooftop of the AREI building located near the centre of Riga is transformed into an urban farm. Currently, the project team has equipped this space with the infrastructure and equipment such as pallets for growing food, soil sensors for monitoring moisture and temperature, a weather station for collecting meteorological data, and water supply with a rainwater collection system.

The chemical and biological analysis of the food and soils take a large part of the budget. As Līga Lepse, leading researcher in vegetable production, says:

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*A range of different vegetable crops are included in the project to represent leafy vegetables (lettuce), herbs (basil), root vegetables (radish), fruit-yielding vegetables (tomato), and legumes (sugar pea) to clarify their growing peculiarities in the urban gardening approach. The nutritional value of vegetables must be analysed to determine urban-grown food quality in comparison to rural-grown. Besides main nutritional elements (N, P, K, Ca, Mg, S) functional components (phenols, antioxidant activity, carotenes, vitamins and sugars) and undesired heavy metals will be detected in the vegetables.*

Most of the challenges of growing food on rooftops are associated with the weather, a short growing season, strong winds, and dry periods, all of which pose some uncertainties to achieving an efficient yield. Pests and birds are also of concern as they can jeopardise the development of the crops. Nevertheless, Roof2Fork will provide alternative solutions for overcoming/coping with late spring frosts when the crops are germinating and with drought periods. For example, the collection of rainwater in tanks is an important part of irrigation, as this system will minimise the use of tap water. Furthermore, the protection of the pallets with different covers will assure the safety of the crops against birds, low temperatures, and strong winds.

Since the researchers involved in the project are responsible for maintaining the rooftop farm, governance and management is not a major challenge; however, this could be an issue for maintaining rooftop gardens in residential or commercial buildings. Community rooftop gardens require a strong commitment from the building association or proper business models that grant the use of the space to entrepreneurs who can exploit it commercially. In addition, building code restrictions, infiltrations, and structural problems may also arise and lead to resistance from the tenants to implement rooftop gardens.

Despite these challenges, growing on rooftops can bring several opportunities including the use of underutilised spaces. Besides delivering fresh food and contributing to shortening food supply chains, rooftop gardens can lower the costs otherwise associated with food transportation and contribute to temperature and noise regulation while increasing biodiversity in urban areas. Rooftops can also reduce the environmental impact of buildings, lowering energy consumption while minimising storm runoff. In addition, rooftop farms can become pleasant spaces, providing urban dwellers with the opportunity to enjoy nature in crowded cities.

The project will deliver guidelines that aim to significantly impact the uptake of rooftop gardening practices in Latvia. Such guidelines will inform practitioners about the resources (knowledge, time, finances), possibilities (types of farming practices) and challenges (management, irrigation, etc.) of growing food on rooftops. As the leading researcher Pēteris Lakovskis says:

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***We have a great potential to develop green infrastructure of the cities, with a great number of buildings with a flat roof that seem to have the structural capacity to host and develop urban farms.***

In the long term, the knowledge gained through Roof2Fork is expected to strengthen the research capacity of both institutions while also raising awareness about the feasibility and importance of growing food in cities. As Līga Lepse mentions:

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*Everyone who has a suitable place can develop a rooftop farm. It is also a great opportunity for educational institutions (kindergartens and schools) to show children how vegetables are produced in a sustainable and circular approach and teach them to care for plants. In this case, financing bodies, educational institutions, and other stakeholders are invited to consider urban gardening when planning the budget.*

The researchers are also optimistic about the incorporation of agriculture in cities, with the growing attention it gathers from public and private stakeholders and civil society and how it has been showcased as a pathway for more resilient cities which can provide means to feed the growing urban population. As Linda levina says:

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*In recent years, urban gardening has been rapidly developing and spreading in Latvia. We are happy about this and willing to foster its development. Thus, we look forward to participating in the research projects in future related to this topic.*

*Box 14: Roof2Fork: Summary of opportunities*

- Besides transforming underutilised spaces into spaces of production, the use of rooftops to grow food also contributes to shorter food supply chains.
- Growing food in dense urban environments contributes to temperature and noise reduction while increasing biodiversity in cities.
- Rooftop farms contribute to lowering buildings' energy consumption and minimising urban storm run-off.
- Farming in rooftops increases the opportunity for people to enjoy nature in cities and facilitates the education of children and the public about the origin of the food we consume.

*Box 15: Roof2Fork: Summary of challenges*

- The implementation of rooftop farms is dependent on the structural capacity of buildings and legislation (e.g., building codes permits).
- Farming on rooftops may be seen as risky for residents due to infiltrations.
- Food grown on the tops of buildings are more exposed to adverse weather conditions (e.g., strong winds, droughts).



Photo: Getty Images/unsplash.com

## Lessons learned from the urban agriculture stories

This section brings the different urban agriculture stories into conversation with each other. To introduce this dialogue, Table 1 summarises the opportunities and challenges of each case.

Table 1: Summary of opportunities and challenges identified in the urban agriculture stories.

Study case	Opportunities	Challenges
Stockholm Royal Seaport	<p>The global awareness on the importance of establishing short food supply chains supports urban agriculture as a mean to strengthen urban resilience and self-sufficiency.</p> <p>The district employs an innovative governance model characterised by experimentation of sustainable solutions and co-creation with a broad and heterogeneous network (e.g., NGOs, businesses, researchers, developers).</p> <p>The vision of including food production in cities follows Stockholm's tradition in urban farming with urban allotment gardens.</p> <p>Gardening has become a meditative practice for urban dwellers during COVID-19 as a mean to reconnect with nature.</p>	<p>It takes time and effort to raise interest within the planning administration to enable incorporating urban agriculture in forthcoming land allocation processes.</p> <p>Urban agriculture initiatives may be met with resistance or indifference from political leaders.</p> <p>Developers and other stakeholders may focus on risks rather than benefits, making it difficult to implement food production into the urban environment.</p> <p>High land costs threaten the implementation of agriculture in cities.</p>
Växthuset på Berga	<p>Aquaponics systems deliver higher yields compared with traditional soil-based technologies for growing food.</p> <p>Greenhouses and aquaponic systems can be easily implemented in cities, as they can be built in between existing buildings, use heat waste and available water, and also provide food and pleasant environments for people.</p> <p>Aquaponic systems do not make use of pesticides and use only 10% of the amount of water compared to soil-based technologies.</p>	<p>The market has been slow in uptaking aquaponics technology.</p> <p>European legislation does not grant ecological, organic labels to food grown with aquaponics, thus hurting its competitiveness.</p> <p>New skills and competencies are needed to enable the implementation and management of aquaponic systems in the built environment.</p> <p>Growing fruits in aquaponic systems is a long-term investment as many years are required before the production can be commercialised.</p>

<p>Dodo</p>	<p>The NGO explores opportunities for growing food in urban areas while promoting social inclusion and education through the implementation of several projects and initiatives (e.g., Urban Dinners, Growing Change Project).</p> <p>The organisation runs on a creative and smart management (e.g., investments in hedge funds, cooperation with small-scale initiatives, renting out premisses for public and private events).</p> <p>Longevity and national recognition with branches in different Finnish cities strengthen of the organisation</p>	<p>The organisation faces difficulties to engage volunteers in the long term.</p> <p>Reliability on savings and external funding poses financial uncertainties to the organisation.</p> <p>The organisation misses a strong media platform which jeopardises the reach and establishment of stronger connections with local and higher authorities.</p>
<p>Longyearbyen, Svalbard</p>	<p>There is a great demand and need for fresh food in Longyearbyen.</p> <p>The vision of turning waste into resources and to use renewable energy to grow food locally aligns with goals of transitioning to a green and circular economy.</p> <p>The local community is willing and committed to the sustainable development of the region.</p>	<p>The strict legislation and regulatory frameworks for the implementation of new activities (e.g., access to land) trouble the implementation of the project.</p> <p>The Arctic climate poses many constraints to local food production (e.g., lack of sunlight, limited warm months) and requires greater investments.</p> <p>Limited access to infrastructure (e.g., access to running water, electricity) and pollution from coal mining activities harms the implementation of the project.</p> <p>The project implementation lacks financial backing and governmental support.</p>

<p>Campus Roslagen</p>	<p>The programme responds to a knowledge gap and offers education that can bring innovation to food systems, which urgently need to change to cope with environmental crises and the increasing demand to feed a growing population.</p> <p>Students gain flexible skills through different opportunities to work with plants, fish, or with aquaponics.</p> <p>Growing food with aquaponic systems allows engaging people with disabilities in the agricultural labour market.</p>	<p>Funding for the programme beyond 2024 remains uncertain.</p> <p>It is difficult to overcome prejudices against aquaponics systems.</p> <p>Developing business models can be challenging due to the slow-growing market.</p> <p>Managing aquaponic systems can be tricky as it involves balancing a whole ecosystem.</p>
<p>NMBU master's programme in urban agriculture</p>	<p>The programme employs a unique pedagogical perspective that combines transdisciplinary, student-active learning, and problem-solving approaches.</p> <p>Circularity of resources is one of the strengths of the programme which emphasizes technologies to grow food using waste streams (e.g., black, and grey water, organic waste).</p> <p>The students' projects and theses respond to the needs of municipalities to include urban agriculture in their agendas and to implement the Norwegian Strategy for Urban Agriculture.</p>	<p>The implementation of the flexible and open curriculum requires a lot of coordination and efficiency among the seven faculties.</p> <p>It is difficult to overcome the misconception that urban agriculture is merely a hobby.</p> <p>It will take a long time to defeat social resistance towards the consumption of food produced with waste streams.</p>

<p>Roof2Fork</p>	<p>Besides transforming underutilised spaces into spaces of production, the use of rooftops to grow food also contributes to shorter food supply chains.</p> <p>Growing food in dense urban environments contributes to temperature and noise reduction while increasing biodiversity in cities.</p> <p>Rooftop farms contribute to lowering buildings' energy consumption and minimising urban storm run-off.</p> <p>Farming in rooftops increases the opportunity for people to enjoy nature in cities and facilitates the education of children and the public about the origin of the food we consume.</p>	<p>The implementation of rooftop farms is dependent on the structural capacity of buildings and legislation (e.g., building codes permits).</p> <p>Farming on rooftops may be seen as risky for residents due to infiltrations.</p> <p>Food grown on the tops of buildings are more exposed to adverse weather conditions (e.g., strong winds, droughts).</p>
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## Cultivating change in connection with legislation and innovation

The two stories under this theme were told from the perspective of a civil servant, who is on a mission to include urban agriculture as part of the development of the Stockholm Royal Seaport, and an entrepreneur who grows tropical fruits in the Stockholm region. Here, the public and private perspectives meet and complement each other as the entrepreneur showcases the possibility of growing nutritious food in cold climates and sustains the vision that the built environment offers the best conditions for this, which aligns with the arguments of the civil servant.

Changing the future of food production to urban areas seems feasible with the connection between technology and legislation. While the market tests the feasibility of technologies suitable for growing food in cities, such as aquaponics, the public sector strives for the implementation of legislation that encourages agriculture in cities. Nevertheless, as the stories revealed, several challenges must be overcome at different levels. At the European level, granting ecological labels to food produced with aquaponics can help the technology to thrive and become attractive, firstly to new entrepreneurs who may see better opportunities to profit but also to consumers who may enjoy fresh and easily accessible food.

At the local level, politicians must overcome the conception that food is a matter only for rural areas and realise its great potential to address several challenges (e.g., climate regulation, increase biodiversity, food security, social inclusion) while making urban environments more pleasant and resilient. The story of Stockholm Royal Seaport, unfortunately, is rare, as the district is a test bed for sustainable solutions, enjoying public support and funding for testing novel solutions. The role it plays as a frontrunner for urban sustainability is an asset that provides the opportunity to raise awareness among politicians and civil servants from different departments about embracing agriculture in urban areas. Political bravery and food production innovation are the seeds necessary to cultivate change, and the work of the civil servant and the entrepreneur is, without a doubt, paving the way for a future in which agriculture is a desirable urban function.

## **Cultivating community in connection with culture**

The story of Dodo shows the persistence of an NGO initiated by enthusiastic students and driven by the mission of finding ways of living more sustainably in urban environments. Meanwhile Svalbard tells the story of two residents from an Arctic town that dream of overcoming the struggles of accessing fresh and healthy food. For both cases, urban agriculture provides the means to respond to their wishes and needs. Dodo showcases the power of civil society to voice wishes for an urban life that better aligns with sustainability using food as a theme to nurture communities. The Svalbard case displays the determination of community members who fight with innovation difficulties of living in a remote and climate vulnerable region.

Cultivating community in both cases is about the empowerment of people through urban agriculture. The story of Dodo highlights the role of civil society in the city. The NGO mediates urban agriculture interventions in public spaces, welcomes knowledge exchange, and celebrates sustainable urban living through various events among community members. In doing so, the NGO raises awareness about enjoyable ways to consume more sustainably and enables social learning opportunities. In Svalbard, two residents combine the visions of enabling resource circularity and encouraging local food production to form a pathway for sustainability in the local community. Besides increasing the access to local food, which is a challenge in the remote and vulnerable region, urban agriculture will support the local market and the hospitality industry, thereby creating local value as the town transitions from a coal-based economy to a green economy and requires new industries and jobs. The vision of establishing this circular system also bridges the local community with scientists beyond the borders of Svalbard, showing that small and susceptible communities have the power to connect with stakeholders that can offer solutions to their problems. Nevertheless, both Dodo and Longyearbyen face several hurdles that need to be addressed to enable their cases to thrive in the future.

Economic barriers are common to both cases. Despite the creativity and entrepreneurship applied by Dodo's board to run the organisation, the future is uncertain as accessing funding is not easy. Challenges are due to eligibility criteria for competing for financial support and engagement of new volunteers as people struggle to find time to commit within their demanding urban lifestyles. Similarly, Longyearbyen wrestles with financing to implement their circular system, as the long-term economic return and the novelty of this systems are likely to be a risk for private investors. In this case, the strict legislation that rules the development of the island is also an obstacle. In a world increasingly facing resource scarcity, legislation needs to be reviewed to support rather than hinder sustainability solutions.

## **Cultivating knowledge in connection with education and science**

The three stories included in this theme convey the message that urban agriculture is being recognised by academic institutions at different levels (technical qualification, master's degrees, and research). These educational opportunities are providing new skills and competencies and thus responding to the growing demand in the food systems' labour markets. Campus Roslagen reacts to the increasing awareness about the need to embrace aquaponics technology to feed a growing population in an uncertain climate future. This is, in fact, an urgent issue considering that we already witness disruptions in large food supply chains that rely on food production using traditional soil-based methods. This programme is attracting a heterogeneous group of students who see the economic and environmental potential of aquaponics technology. NMBU pioneered the first master's programme in urban agriculture in the Nordic Region. Responding to higher educational demand for knowledge in urban agriculture, this programme is also supporting municipalities in Norway and other regions to include urban agriculture in their local agendas. The all-encompassing view on urban agriculture goes beyond producing food to include waste streams as a resource to produce nutrients for growing food in cities. Roof2Fork showcases the significance of Latvian research institutes who are deepening knowledge on growing food in cities using rooftops. The comparison between the quality of food produced in urban and rural areas will be a valuable outcome to shed light on the argument that it is risky to produce food in cities due to pollution.

Cultivating knowledge and innovating within education and science is paramount to unlocking the potential of food systems to become more sustainable through urban agriculture. While research focusing on urban agriculture has been increasingly supported in Europe (e.g., through the Horizon Europe funding programme and other national funds), the future of education in urban agriculture faces several challenges. Campus Roslagen works to build a cohesive understanding

of aquaponics by bringing together experts from agronomy and veterinarian sciences into a systematic educational program that qualifies professionals to work not only in the aquaponics market but also with plants and/or fish. NMBU encounters some difficulties in bridging seven science faculties that are relevant for urban agriculture. The programme also struggles to change the misconception that growing food in cities is merely a hobby. In the Roof2Fork project, even if researchers gather positive results concerning the quality of food production in urban areas, growing food on urban rooftops will likely take a long time to gain traction. There remains a lack of proper business and management models that appeal to investors to effectively embrace the production of food in cities.

In order for urban agriculture to be a success, it needs to have acceptance from the market and from society with regards to new technologies, food quality, profitability, and resourcefulness.



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## The future of urban agriculture – final considerations

Evidence shows that our current agricultural practices and food supply chains are unsustainable, especially as we need to find solutions for feeding growing urban populations. The agricultural sector makes use of 72% of freshwater (FAO, 2023a), accounts for one-third of greenhouse emissions (FAO, 2023b), and has damaged biodiversity and caused soil depletion (FAO, 2022). In addition, 79% of all food produced is consumed in cities (FAO et al., 2022). Therefore, alternative futures are necessary, especially in the Nordic and Baltic countries which are vulnerable due to their high dependency on exports for feeding their populations.

The stories presented in this report are seeds for change towards sustainable and resilient futures. Each of the stories reimagine the urban environment as a productive ecosystem, demand rethinking legal frameworks, claim for innovation in food production, and create transformative knowledge and social learning.

Different actors have voiced the challenges and opportunities of initiating and implementing urban agriculture in these stories. They represent a mix of top-down (e.g., Stockholm Royal Seaport, NMBU) and bottom-up (e.g., Dodo, Växthuset på Berga) initiatives to promote the production of food in cities while asserting that urban agriculture is able to respond to different purposes and fulfill several objectives relevant for urban sustainability.

While urban agriculture suffers from the stigma of being a leisurely activity, different actors in cities need to effectively embrace and sustain the longevity of urban agriculture, which requires the recognition of it as a transformative practice. After all, urban agriculture seems to offer pathways to achieving broader environmental, social, and economic outcomes that our cities urgently require.



Photo: Raychan/unsplash.com

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