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Towards more resilient, community-driven urban food systems: design and implementation of case studies in European cities

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Abstract

Increasing urbanization rates, loss of natural resources and the effects of climate change are challenging the sustainability of European cities. Therefore, ensuring resilient urban food systems is crucial to achieve food and nutrition security. Conventional systems are increasingly vulnerable to present and future disruptions, which urges us to change the way we produce, consume, and think about food. The development of local or regional food systems can play an important role because of the multifunctional services that are offered to the inhabitants of the city and its surroundings. The EU Project "Food systems in European Cities – FoodE" (H2020-862663) aims to encourage the development of such systems across the city-regional context by supporting their design, implementation and evaluation. Within the FoodE framework, 15 pilot case studies are being set up in 11 EU cities and serve as demonstration and first application of innovative solutions in market and social contexts, co-designed with citizens and relevant stakeholders. These local initiatives range from small-scale fisheries and low-tech market gardens to agricultural parks, semi-industrial high-tech greenhouses and vertical farms, in rural, coastal and urban agglomerations. This study reports and analyses the results of the community-based design approach of the pilot initiatives in the definition of priorities and optimal features to be implemented.

Keywords: urban agriculture, short chain, sustainable production, co-creation process, community gardens

INTRODUCTION

Today's society is facing a range of socio-ecological challenges connected with urbanization, such as social segregation, public health concerns, depletion of natural resources and consequences of climate change (Artmann et al., 2021; Sanyé-Mengual et al., 2018). Conventional food systems are increasingly vulnerable to present and future disruptions, prompting us to change the way we produce, consume, and think about food. In recent years, systemic solutions that offer multifunctional benefits, such as urban agriculture (UA), have been increasingly considered as sustainable practices that help address the complexity of societal challenges and urban food systems. Research and implementation of innovative, citizen-driven food initiatives has shown how they can fulfill multiple functions and produce a range of market and non-market goods and services, positively impacting the city-region environment in the social, economic and environmental dimensions of sustainability. Impacts include for example: increases in the availability of fresh, nutritious food, contribution to urban renewal, social inclusion, job creation, environmental and food education, and promotion of local economies. According to the City-Region Food System approach, the concept of "city-region" is intended as a flexible space that includes urban

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centers, the surrounding peri-urban and rural territories and encompasses "all the actors, processes and relationships that are involved in the production, processing, distribution and consumption of food" (Forster and Escudero, 2014; Ruaf, 2015). City-regions are composed of mixed patterns between commercial food systems, based on market and profit interests (e.g., commercial urban farms) as well as non-commercial initiatives, driven by other beneficial dimensions such as self-sufficiency (e.g., individuals produce and consume at the micro level) and socio-cultural interests (e.g., community gardens) (Krikser et al., 2016). Furthermore, such local food systems may integrate different degree of technologies to actively control the production systems or may adopt more passive, low-input solutions.

The diversity of European cities and regions creates barriers to the demonstration of systemic food-related innovative approaches valuable in such a variable range of contexts. While numerous innovative urban agriculture projects are found in the different corners of Europe, their replicability and adaptability to the different contexts is hampered by the lack of critical mass of studies and business cases. Failures in UA projects are often associated with inadequate technological sizing or inappropriate business models, and influenced by other factors such as impeding regulatory frameworks, access to land and its potential contamination, local climatic conditions and resource availability (Orsini et al., 2020b). In addition, the adoption of top-down policies has often limited widespread implementation of sustainable UA initiatives, restricting the possibility for citizens and communities to choose their own strategies for the local environment, whereas grassroots initiatives may have a positive impact on the long-term viability of UA projects (Seyfang and Haxeltine, 2012; Seyfang and Smith, 2007). In recent years, several cities have promoted policies for active citizen participation in the co-design of innovative UA initiatives (e.g., "Parisculteur" in Paris, "Bilancio Partecipativo" in Bologna, or "Sprouting Oslo" in Oslo). However, these projects were only local in reach, limited to few UA typologies, and often poorly accompanied by effective dissemination measures for wider adoption by other European cities.

The EU Project "Food systems in European Cities – FoodE" (H2020-862663) aims to encourage the development of UA initiatives that integrate into the city-regional context by supporting their design, implementation and evaluation. This paper describes how 15 pilot case studies were selected in 11 EU cities to serve as living labs, piloting innovative social and market solutions that were co-designed with citizens and relevant stakeholders.

MATERIALS AND METHODS

Identification of 15 UA pilot projects

Fifteen urban agriculture initiatives were identified in 11 European cities to serve as pilot case studies within the FoodE project (https://foode.eu/project-pilots/) (Table 1). The projects are located in urban, peri-urban or rural areas in Mediterranean (Italy, Spain), eastern (Slovenia, Romania), central (Germany, the Netherlands, France) and northern (Norway) Europe. They include large- and small-scale food system initiatives that aim to perform multiple functions, providing market or non-market goods and services, and incorporating varying degrees of technology and control of food production systems. Host cities were intended to be representative of the socio-cultural and geographical diversity of European regions and were identified based on both the availability of space and equipment and the level of technological readiness. Four of the 11 projects were designed from scratch, while the remaining initiatives were already existing (in different stages of progress) and underwent improvements and integrations. The organizations leading the projects are local authorities (e.g., municipalities), higher education institutions (e.g., universities, research centers), non-profit organizations (NGOs), small and mid-size enterprises (SMEs), cooperatives and producers' organizations.

Table 1. Overview of the 15 UA pilot initiatives implemented in 11 European cities (location, name of the projects, main growing systems and food products).

City (country)	Pilot project name	Production system	Food products
Amsterdam (NL)	Open source aquaponic farm	Soilless greenhouse with active climate control and aquaponic system	Leafy and fruity vegetables, aromatics, edible flowers, fish
Berlin (DE)	Urban farm with hydroponic greenhouse and greywater pilot plant	Soilless greenhouses with passive climate control	Leafy vegetables
Bologna (IT)	"AlmaVFarm": an indoor vertical farm for growing food, competences and innovation	Plant factory with artificial lighting (soilless)	Leafy vegetables, aromatics
Bologna (IT)	"Serra Madre": a food hub for education, leisure and urban farming innovation	Greenhouses with soilless cultivation and an aquaponic system; open-air, soil-based gardens	Vegetables, fish
Bologna (IT)	Urban Farming at "Salus Space"	Open-air garden (rooftop); Open air, soil-based community garden; indoor farming containers	Vegetables,microgreens, mushrooms
Iasi (RO)	"CUIB": restaurant with local products	Open-air, soil-based garden (with raised beds)	Vegetables, aromatics
Lansingerland (NL)	Plant factory for demonstrational purposes	Plant factory with artificial lighting (soilless)	Leafy and fruity vegetables, aromatics
Ljubljana (SI)	"Prison Honey": urban beekeeping for rehabilitation and social inclusion	Beekeeping	Honey, propolis
Naples (IT)	Urban agricultural park with farmers and fishery market	Open-air, soil-based gardens; soilless greenhouses with passive climate control	Leafy vegetables, potted aromatic plants
Oslo (NO)	Educational hydroponic garden prototype	Plant factory with artificial lighting (soilless)	Microgreens, aromatics
Oslo (NO)	Educational rooftop farm for school pupils	Beekeeping; open-air garden (rooftop)	Honey, vegetables
Oslo (NO)	Plant factory for social inclusion	Plant factory with artificial lighting (soilless)	Microgreens, aromatics
Romainville (FR)	The "Cité Maraîchère": sunlight-based vertical farm, educational gardens, sustainable and social food, market gardening and mushrooms production, circular innovation and short food chain	Multistorey greenhouse with passive climate control and planter boxes (soilless); open-air garden with planter boxes (soilless)	Vegetables, fruits, aromatics, mushrooms
Sabadell (ES)	Urban agricultural park for participatory agricultural test spaces	Open-air, soil-based garden; open field farms; fruit orchard	Vegetables, fruits aromatics, field crops
Tenerife (ES)	Sustainable small-scale fishery for school canteens	-	Fish

Community-designed UA pilot projects

The pre-identified UA pilot initiatives required comprehensive design or improvement through integrating technological solutions, environmental innovations, business models, products, services, and societal infrastructures. To this end, the study adopted a community-designed approach that considers the needs and desires of the end-users and UA stakeholders as well as local needs and available resources. In literature, this process is usually described as a framework of activities such as storytelling, convivial events, mind mapping, co-design

and prototyping workshops, while providing the appropriate tools and support to facilitate the implementation of the proposed solutions (Ballantyne-Brodie and Telalbasic, 2017; Seyfang and Haxeltine, 2012; Turetta et al., 2021). In this study, each UA practitioner (and working team) was asked to define the following aspects: a) feature(s) of the project to be the focus of co-design activities; b) type(s) of participatory activity that best fit the project objectives; c) representative group of stakeholders to involve for co-design and co-creation purposes; and d) the available budget. In accordance with this, each UA pilot organized participatory processes (over a period of 10 months) involving civil society and food chain stakeholders in defining priorities and optimal features to be implemented. Activities were disseminated locally and internationally, through the extended network of UA partners and promoted through web pages, press releases and social media.

All information on the pilot initiatives was collected through questionnaires completed by each of the 15UA pilots. Each pilot project is run by 1 or 2 institutions, has one contact person ("CRFS practitioner") and a team of 3 to 10 people (depending on the pilot) working on the project.

RESULTS AND DISCUSSION

Based on the pilot project goals as well as the outcomes of the participatory co-design activities, the 15 FoodE pilot projects were implemented in the 11 EU cities. In total, 1290 participants were involved in the projects' co-design and co-creation processes. The participants included different types of stakeholders and representatives: students, academics, citizens, private companies and entrepreneurs, associations (e.g., parents', producers', citizens' associations), chefs, UA employees, public authorities, schools, NGOs, media and financial investors. All participants were actively engaged by the pilot practitioners through their network of contacts, digital channels, organization of events, and dissemination of material. Scientists' main role was to facilitate and provide methods for the co-design process as well as translate the outcomes in a more systematic way. Co-design and co-creation processes occurred within the framework of several initiatives (already existing or purposely organized): student competitions (e.g., hackathons, "UrbanFarm2021" described by Orsini et al., 2020a), student projects or assignments in collaboration with high schools and universities, surveys (e.g., questionnaires, interviews), workshops, and focus groups (Figure 1). In particular, the participants were asked to define priorities and optimal features to be implemented in the UA initiatives, to contribute to the ideation and conceptualization phases and/or to submit executive projects. Different outputs were created according to the types of activities such as project proposals, small-scale prototypes, digital tools, and reports through material gathered from focus group discussions, open events, workshops, survey results and interviews. Overall, the main co-design targets are summarized and displayed in Table 2. The resulting solutions were evaluated and implemented based on: a) relevance to the project objectives, b) novelty, and c) feasibility within the given budget.

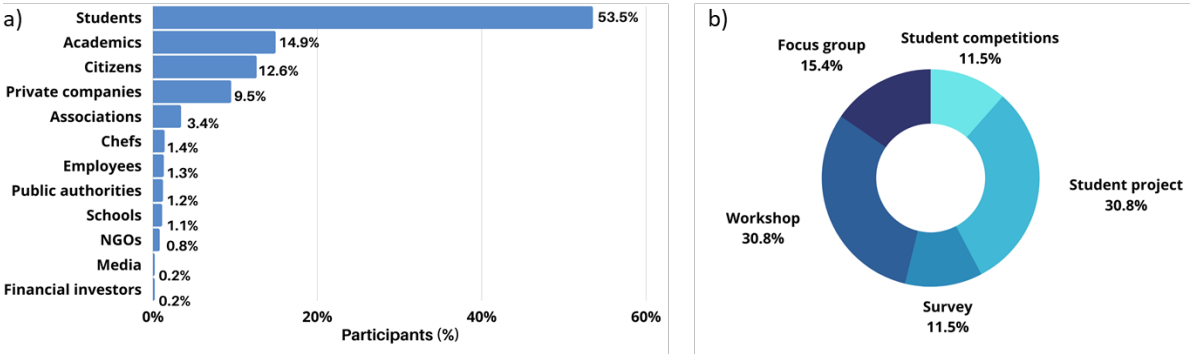

Figure 1. Types and percentages of participants (a) and co-design activities organized (b).

Table 2. Main aspects subject to co-design in the 15 UA pilot initiatives.

Design target	Examples in UA pilots
Design of sustainable solutions for growing systems	Investigate the perception of participants regarding the sustainability of growing systems and co-generate solutions to improve systems' resource use efficiency
Design of digital solutions	Develop user-friendly interfaces for visualizing pilot performance data, make data and their interpretation accessible to non-expert users such as citizens, students or other UA stakeholders
Identification of the biggest challenges with business models in UA projects	Identify factors hindering the growth and diffusion of UA initiatives and co-generate solutions towards the creation of business models that are tailored to the community needs and customers' desires
Identification of activities to engage and empower local stakeholders	Test several types of actives (e.g., hands-on and "do-it-yourself" workshops, raising awareness activities) to bring local stakeholders close to the UA initiatives, analyse them and identify their needs in order to adjust and fine tune future activities and services offered at the pilot site
Optimize beekeeping systems and equipment	Co-generate technical and practical solutions for beehives and beekeeping equipment following different criteria (e.g., functionality) and in accordance with good practice of landscape architecture
Identification of solutions towards zero-waste UA initiatives	Investigate strategies and solutions to generate less waste and/or upcycle waste
Identification of sustainability indicators for the UA initiatives	Investigate end-users' perception of the different dimensions of sustainability; test which measurement indicators are most effective in showing the benefits of sustainable strategies and actions implemented within the pilot initiative
Regeneration of multi-functional urban space	Co-design agricultural, economic, social and architectural aspects of the UA pilot project. This includes: re-development of the current space in an urban and peri-urban setting, design the production systems and its management, outline a production plan, include technological and social innovations, ensure circular resource and material flows, integrate recycle and upcycle strategies, where possible, propose innovative business models encompassing food production, environmental issues and social inclusion that can be applicable and scalable in similar contexts
Selection of agricultural products	Investigate the community's preferences in terms of agricultural products, including vegetable species, fish species, develop methodologies for the selection of these products and the corresponding production plan

A detailed overview of recently implemented UA projects with an indication of the main production systems and food products is given in Table 1. Within the UA initiatives, food constitutes the central dimension of urban and rural linkages in the aspects of ecology, socio-economy and governance. The majority of the pilot initiatives (67%) have food production as their primary function (e.g., vegetables, fruits, mushrooms, fish, insect products). In particular, the horticultural production is the most substantial among the pilot initiatives and takes place in a variety of growing systems characterized by different level of integration with buildings and climate conditioning of the growing space (following the classification proposed by Goldstein et al. (2016); O'Sullivan et al. (2019)). This includes the following system typologies: ground-based, unconditioned (e.g., open-air gardens, peri-urban field farms, fruit orchards), ground-based, conditioned (e.g., greenhouses, plastic tunnels or netting allowing for the modification of the growing environment), building integrated, unconditioned (e.g., open-air rooftop gardens), and building integrated, conditioned (e.g., rooftop greenhouses, fully indoor plant factories with artificial lighting). The systems host either soil-based or soilless cultures and integrate different degrees of technologies. In addition to food production, the pilot initiatives can fulfill multiple functions along the food chain. Of these, food distribution is covered by the majority of the pilot initiatives (67%). For example, the pilot in Tenerife (ES) distributes local fish to school canteens, while the plant factory in Oslo (NO) produces and distributes pre-cut microgreens, baby leaves and lettuce to restaurants and supermarkets in the city. More than half of the initiatives (53%) provide food-related services as one of their primary functions. These include a series of capitalized (or not capitalized) services such as

food and environmental education, research, consultancy, beekeeping, rehabilitation of specific societal groups (e.g., inmates), and public awareness raising. A smaller number of projects (27%) are involved in the prevention, redistribution or valorization of food waste. For example, the bistro' in Iasi (RO), collects "misfit-market" food from local supermarkets (e.g., food of low-quality class or close to the expiration date) and redirects over 95% to vulnerable groups and integrates the rest into the restaurant's menu. In 2021, the pilot collected over 19 t of food with a value of over 78,000 RON (about 15,000 euro) (Asociatia Mai Bine, pers. commun.). Few UA pilot projects (20%) are involved in food processing and other activities. For example, the "Water house" project in Berlin (DE) collects and treats grey water from a residential unit (with 250 inhabitants) and resells it to irrigate a small-scale greenhouse lettuce cultivation, outdoor green areas and to flush toilets; the UA project "Salus Space" in Bologna (IT) hosts co-housing buildings and offers hostel services whereas the "Cité Maraîchère" in Romainville (FR) rents out spaces for events and activities.

CONCLUSIONS

The implementation phase of the FoodE pilots is underway at the time of writing, so it is early for a comprehensive evaluation. It can be concluded, however, that involving key actors in the start-up, research, testing and implementation phases of UA projects has helped address the complexity and specificity of initiatives, for which a design based on standard and abstract models would be complicated (as already reported by Ballantyne-Brodie and Telalbasic, 2017). Firstly, participatory processes lead to direct benefits for both the individual actors and the whole UA community by creating occasions for raising awareness on several food-related topics, for promoting more environmental-friendly attitudes, for learning and making hands-on experiences, as well as for networking and community building. Secondly, a bottom-up process, centred on a community-designed approach, may have a positive impact on the long-term viability of UA projects. In addition, the early involvement of local market actors and local governments has allowed for a smoother integration of UA initiatives objectives and bottom-up solutions in the final implementation phase of the initiatives. The latter aspect seems to be crucial as the inclusive process often proves unsuccessful due to a gap in coordination and agreement between designers' and local authorities' plans and priorities (Hebinck and Page, 2017). While the co-design and living lab approaches lead to numerous benefits and increase the chances of meeting the real needs of communities, they also come with challenges. From the FoodE's experience, we can state that the involvement and awareness-raising of multiple actors, as well as the negotiations between the different entities, can be time-consuming, mainly depending on the nature and complexity of the design's goals, the local availability of resources, and management skills of the project coordinators. The development of methodological frameworks for UA co-design that have already proved effective in specific urban contexts can serve as a support for other cases (with possible adaptations), thus making the process more streamlined and easier to adopt.

The pilot projects presented in this study can be considered as living labs of UA initiatives and as such constitute the basis for future research activities envisaged by the Foode project (H2020-862663). This research includes sustainability assessments in the environmental, social and economic dimensions, identification of innovative business models, and analysis of barriers and policies that favour/impede the durability of these initiatives and their replicability in other contexts.

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