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URBAN AGRICULTURE AS A CATALYST FOR REVITALIZATION PROCESSES IN RESIDENTIAL DISTRICTS OF EUROPEAN CITIES. THE CASE OF ANDERLECHT, ROESELARE AND ROMAINVILLE

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Abstract
The article presented herein constitutes a research summary on urban, multi-purpose facilities that combine commercial, service and industrial functions with the concept of commercial urban agriculture and residential housing, which came into existence in the second decade of the 21st century as one of the forms of revitalization of neglected housing and industrial districts. It aims to support the thesis regarding the catalyzing role of urban agriculture in transforming urban tissue at the touch-point of its various functional zones and its growing role as an element of nature in transforming urban structures. The examination of the selected facilities, catalogued as belonging to the group in scope, provided a subsequent explanation of the problem of diversity and their recently relatively more excellent value in space, especially housing districts. It also allowed us to address the question of their increasing popularity following 2019. The research is based on the method of historical and interpretative mixed research combined with three case studies analysis: Abattoir BIGH in Anderlecht (Belgium), Agrotopia (Inagro) in Roeselare (Belgium) and La Cité Maraîchère in Romainville (France).

Keywords: **Urban agriculture; Revitalization; Housing; Europe; Greenhouse; Rooftop gardening.**

1. INTRODUCTION

Urban agriculture, apart from the range of benefits it provides to city dwellers, the urban environment and the broader economy [1, 2, 3], has also recently become an important element in the process of revitalizing metropolitan areas, post-industrial neighbourhoods affected by changes in the structure of industrial production, population migration and many other related factors, often affecting areas of historic importance to the architectural fabric and urban structure of the city [4, 5].

Multifunctional facilities of a new type, based on urban agriculture, are currently being developed in the vast majority as adaptations or extensions of post-industrial facilities or as additions to developments in residential neighbourhoods in post-industrial areas. The presented research aims to answer whether they are superior to other functions in solving the problems of revitalized areas and to what extent they are used in this case. What elements demonstrate their value for the modern city? What contributes to their increased popularity in the post-SARS-Cov-19 pandemic period? Especially bearing in mind that recent years have shown that indoor mixed-use complexes and facilities do not function properly in situations that differ from the norm and the conditions for which they were designed [6, 7]. Therefore, does yet another type of mixed-use development, regardless of its size, have the right to become the solution to the needs of urban dwellers? The research question posed in this study is

Table 1.
Quantitative search results on professional portals. Authors' elaboration based on dezeen.com and archdaily.com as of 20.07.2023

keyword search	www.dezeen.com	www.archdaily.com
urban agriculture	85	12.660
revitalisation	104	177
Europe	1.294	16.932
housing	725	3.686
urban agriculture, revitalisation, housing	0	221
urban agriculture, revitalisation, housing, Europe	0	4
urban farming, revitalisation, housing, Europe	0	85

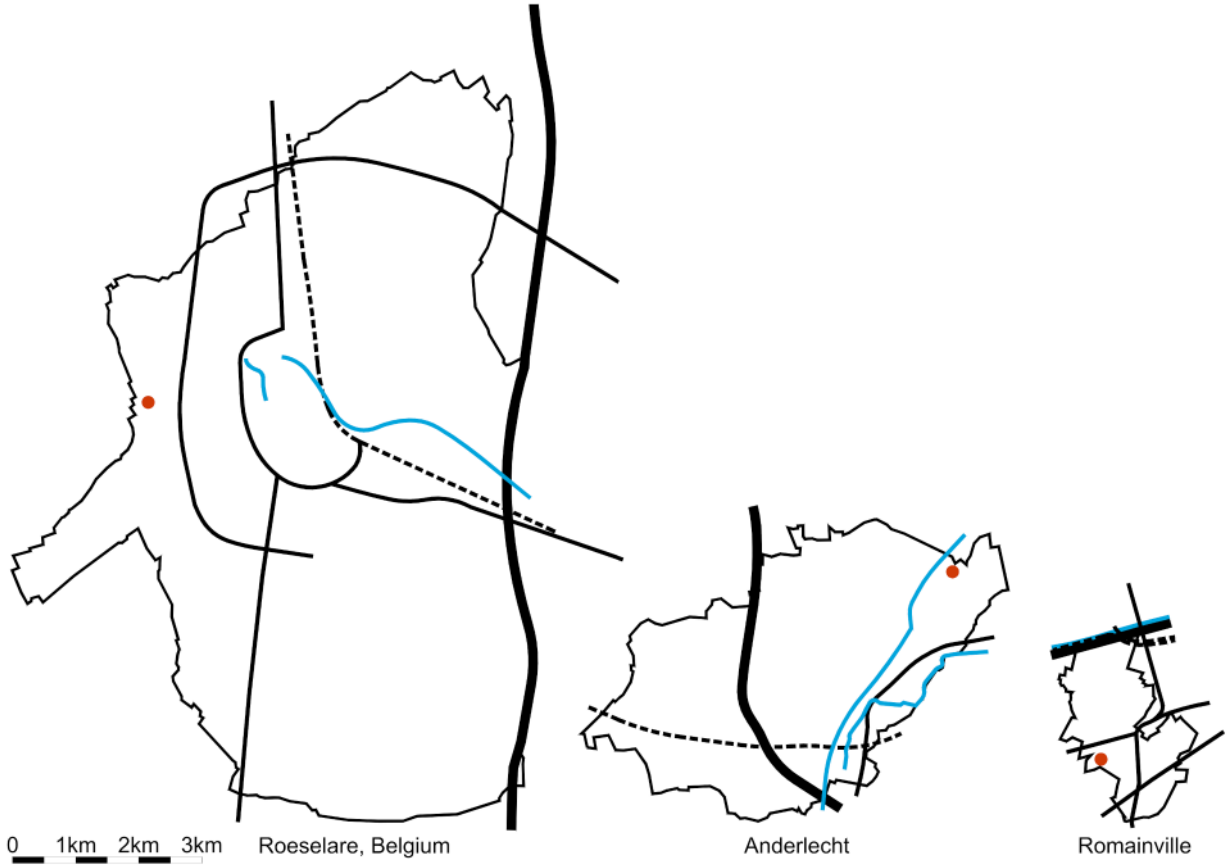

Figure 1.
Location of facilities at a city scale. Authors' elaboration

whether, and if so, to what extent, urban agriculture has the potential to be an important form of land use in the process of revitalizing residential development in European cities and achieving SDG11 (referring to creating cities and human settlements inclusive, safe, resilient, and sustainable) [8] in the nearest future.

It aims to identify the role of urban agriculture in the ongoing revitalization processes, one of the stages of which is developing a new function in an area and what forms it takes depending on the context of proximity and the degree of association with residential development throughout the process. The essence and innovation of this research is to draw attention to the possibility of using the functions of urban agriculture to achieve the goals of the revitalization process through the use of vertical expansion of facilities and areas, thus significantly expanding the research field in this area.

The three examples of revitalized areas with urban agriculture facilities at their centres were used in the analysis (see Figure 1):

- Abattoir BIGH, Anderlecht, Belgium;
- Agrotopia (Inagro), Roeselare, Belgium;
- La Cité Maraîchère, Romainville, France.

The selection of examples for the analysis was made

Table 2.
Quantitative results of literature searches in Web of Science and Elicit.org databases. Authors' elaboration based on databases analysis as of 20.07.2023

keyword search	Web of Science	Elicit.org
urban agriculture + revitalisation	15 [20–23]	>50
urban agriculture + revitalisation + housing	1 [24]	>50
urban agriculture + revitalisation + Europe	0	>50
urban agriculture + revitalisation + housing + Europe	0	>50 [25–33]

by keyword search in major professional portals publishing press releases on contemporary architecture and urban planning. The facilities were to be completed, including elements of indoor urban agriculture, located within the European Union, and thus – within a familiar cultural circle, legislation and climate zone. This search aimed to find the entire possible collection of examples that met the pre-set criteria for further selection. Conceptual and competition designs were excluded from the analysis. Due to the territorial coverage of the research, the most popular portals in Europe were selected: dezeen and Archdaily. A greater range of results was obtained from a search on the Archdaily website (Table 1).

This resulted in a set of 85 records, which were then analyzed for their relevance. In the end, only one facility fulfilling the above-mentioned assumptions was included in this catalogue – La Cité Maraîchère in Romainville. A few interesting concepts were found, which have not yet been completed and are part of the trend, such as MVRDV's 2017 "H-O-M-E" project for a military site in Mannheim or Transborder Studio's 2016 "New Agricultural District" housing project on the site of a former dairy in Oslo. These could be valuable subjects for future research. The remaining examples were found based on broader keyword searches in the listed databases, which may reflect either their misclassification or a lack of attention to the elements relevant to the present study up until now. As a result, three examples meeting the initial assumptions were found.

The analyzed examples have only been described so far in the professional press. Hence, the sources have mainly focused on describing the technical parameters and architectural solutions of the individual facilities rather than on a broader analysis of the phenomenon of indoor urban agriculture in Europe [9–17]. The only cross-cutting article in this field by Benoit Joly from 2022 addresses the problem of hybrid solutions in creating horticultural greenhouses and urban farms. It refers to the examples of Agrotopia and La Cité Maraîchère [10].

In the course of the research, it turned out that at the time the materials for the study were obtained, in addition to the two examples above, only one other site meeting the criteria had been built in Europe. This was Abattoir BIGH, which was included for further consideration.

2. RESEARCH MATERIALS AND METHODS

The research used a mixed method approach - a multiple case study, qualitative [18] and partly historical-interpretative research [19]. The results of the comparative analysis of the facilities conducted by the adopted set of parameters characterizing buildings on an urban and architectural scale are presented in detail further on.

The research was conducted on sites completed between 2018 and 2023 and refers to the newest trends in revitalization and urban housing architecture. The analysis was carried out taking into account the spatial, urban and architectural scales, with a 15-minute walking distance assumed as the largest.

Material for the study was obtained through field surveys, and design and operating materials of the buildings made available by the current users and owners, design offices, and press materials, also available in part on the companies' and designers' websites and professional portals, were also analyzed.

For the literature analysis, the Web of Science database supported by Artificial Intelligence Research Assistant (Elicit.org) was used. The search included the following keywords: "urban agriculture", "revitalization", "Europe", and "housing". The analysis was limited to studies published after 2005, the full text of which is available, written in English and published in peer-reviewed academic journals (Table 2).

In the end, six publications from the Web of Science database and ten publications from Elicit were extracted from the criteria groups, which factually covered the thematic scope determined in the study. Their detailed analysis is presented in the next chapter.

3. STATE OF RESEARCH

Urban agriculture, besides several benefits to city dwellers, its environment and broadly understood urban economy [2], has also become an increasingly important element of the revitalization process of urban areas. It can, therefore, be an element that arrests unfavourable social and spatial phenomena affecting areas of historical importance to the city's architectural tissue and urban structure [4, 5].

3.1. Revitalization and urban agriculture

The need to implement urban agriculture as a tool for transforming existing cities, rather than just designing the cities of the future, is emphatically written about by Vikram Bhatt, Leila Farah, Nik Luka and Jeanne M. Wolfe in the earliest of the publications analyzed [20], discussing that the revitalization of the urban fabric through introducing urban agriculture is not about ploughing up everything that is not buildings and introducing waving patches of grain. It is about finding under-invested sites that do not fully exploit the potential of existing structures and enriching them through the implementation of a policy of greater social and spatial coherence [20]. Although this example concerns the area of Montreal and McGill University's downtown campus, it nevertheless demonstrates the potential of experimental actions for the revitalization process of an area of education, research and housing through incorporating participatory processes, the simplicity, replicability and reproducibility of the proposed solutions, while at the same time their variability (modularity and seasonality) [20].

European research in the past few years has focused on revitalizing transitional areas, particularly peri-urban agriculture [21]. Studies have looked at traditional agriculture in areas affected by urban sprawl from 1970 to 2015 [22]. Similar studies in Portugal examined conditions for local food production systems. There is a link between urban agriculture in Europe and urban regeneration efforts to combat social issues like depopulation and integrating historical agricultural landscapes into urban structures [23, 24]. The studies focus not on modern urban agriculture but on traditional forms found in urbanized areas or transition zones. The main factor examined has been the landscape and its changes due to urban agriculture development, emphasizing the need to protect rural landscapes in transition zones [25, 26].

The use of the food-water-energy nexus in the process of revitalization of cities is described as a great potential and a useful tool in most of the proposed strategies for Europe [27] by maintaining local character and a unique sense of place, creating inclusive mixed-used urban living and high-quality architectural design and public space as a catalyst for a better city. Thus, the combination of sustainable development strategies and urban residential regeneration in Europe has already been recognized and linked to elements of fresh food production. It has already been described that urban farming can provide an element of the metropolitan revitalization program and a component of integrating greenery and buildings into the urban landscape [28].

3.2. Business model of the farms under study

The analyzed facilities adopt a business model referred to in the literature as low-cost specialization, characteristic of crops with high added value due to transport and storage costs, freshness and perishability, all of which make them still profitable despite the increased costs of cultivation [29]. This type of cultivation – performed on a relatively small area of expensive land and thus requiring greater efficiency, such as greenhouse cultivation, to increase profitability – has been diagnosed as profitable for many European agglomerations, including Paris [30], Copenhagen [31] and The Hague [32]. Using the flowchart of the low-cost specialized urban farms analysis, the study was repeated for the reviewed examples to confirm which of the detailed models urban farms gravitate to [29] (Table 3).

3.3. Directions for the development of urban agriculture

In 2015, research summarising future directions and global trends in urban agriculture development suggested that vertical indoor agriculture designed for this purpose or re-purposed will mainly serve intensive horticultural production or only the building envelope will be used as a form of bioreactor for algae production [33].

The value of proposed technical solutions was questioned, but now the focus is on adjusting urban-fringe relationships, using wasteland, peri-urban agriculture, and planning strategies [33]. Nigel Curry identified multifunctional agriculture and sustainable land use as key criteria [33]. Housing's role in sustainable urban development was recognized even earlier, but its connection to urban agriculture as a policy element in settlement revitalization is more recent [34].

Siv Skar and her team noted the importance of urban

Table 3.
Summary of elements of the low-cost specialisation business model of the analysed farms. The author's elaboration is based on [29]

	Agrotopia	La Cité Maraîchère	Abattoir BIGH
Customer segments	People from the area requesting fresh vegetables	People from the area requesting fresh vegetables	People from the area requesting fresh vegetables
	Agro-food industries	Families willing to cultivate plants	People from the area requesting leisure activities/enjoyment
	-	-	Families willing to cultivate plants
Value proposition	Courses/Education	Courses/Education	Courses/Education
	Low cost: economies of scale, partly also direct marketing	Low cost: economies of scale, partly also direct marketing	Rent-a-field (social fund)
	Specialities (niches)	-	Low cost: economies of scale, partly also direct marketing
	-	-	Specialities (niches)
Channels	On-farm	On-farm	On-farm
	Agro-food industries	Agro business	Agro-food industries
Customer relationships	Personal to agro-food industries	Dedicated personal assistance	Personal to agro-food industries
Revenue streams	Short supply chains	Short supply chains	Short supply chains
	Product sales	Product sales	Product sales
	High turnover per farmland unit		High turnover per farmland unit
Key resources	Farm location	Farm location	Farm location
	Machinery/ Equipment	Machinery/ Equipment	Machinery/ Equipment
	Irrigation infrastructure	Irrigation infrastructure	Irrigation infrastructure
	Labour	Land	Labour
	-	Labour	-
Key activities	Production and long supply chain marketing	Direct sale	Direct sale
	Standardised activities: fresh vegetables	Standardised activities: fresh vegetables	Production and long supply chain marketing
	-	-	Standardised activities: fresh vegetables and fish
Key partnerships	Associations	Associations	Associations
	Agro-food industries	Thematic Networks	Thematic Networks
Cost structure	Wages	Wages	Wages
	Water and electricity	Water and electricity	Water and electricity
	Running costs	Running costs	Running costs
	Equipment and machinery	Training	Equipment and machinery
	Cost reduction via specialisation	Equipment and machinery	Cost reduction via specialisation
	Certification	-	Certification
Key conclusion	Focusing on very few products; often this product is used to broaden income sources.	Focusing on very few products; often this product is used to broaden income sources.	Focusing on very few products; often this product is used to broaden income sources.
	Agribusiness	Good accessibility	Agribusiness
	Good accessibility	-	Good accessibility

agriculture in mitigating the effects of climate change in cities [35], thus reinforcing the effect of people's shift back towards living in green city centres also through the potential to increase the availability of fresh, unprocessed food in central areas. At the same time, despite the recognition of the urban agriculture element in Europe as part of a sustainability policy, unlike other elements of urban infrastructure, agriculture remains an undervalued, underestimated, and under-invested element [35]. Besides, in the typology of urban agriculture presented in the same study, primary attention was paid to the elements of

agriculture considered typically found in cities [35]. The glasshouse element has emerged here potentially as one for use on façades or roofs. Despite this potential, sustainable food systems are still overlooked in European policy [36], and their potential to initiate the process of urban renewal is also lacking. An example of this can be found in the new European Union strategy document "The Common Agricultural Policy: 2023-27" (CAP), which still does not take into account the specificities of urban agriculture in the Union's planned strategy for the development of sustainable agriculture [37].

3.4. Urban agriculture in Europe

The steps taken up to 2017 in Europe, socially focused and attempting to individualize planning policies towards moving away from solutions with limited influence zone, are summarised in a study by Barbora Duží, Bohumil Frantál and Marian Simon Rojo [38]. Other European achievements, such as those of COST Urban Agriculture Europe [39], have been continued in the form of the Online Atlas of Urban Agriculture, available on the COST website [40]. A study of farm business models in Spain, Italy, and Germany reveals the shift from traditional collective urban farms to new commercial models impacting urban areas [29].

None of the directions of urban agriculture in Europe currently address the issue of the superstructure of existing facilities. Studies conducted recently on the development of vertical extensions, in most cases only of residential buildings, include an analysis of strategies and technical solutions only for urban-service functions and increasing the intensity of residential development in the centres of European cities [41–43]. They do not deal with allocating such extensions for urban indoor agriculture and other agricultural greenery. This remains the domain of practical, commercial action in urban space.

4. MODELLING OF URBAN FARMS

4.1. Is greenhouse a systemic tool or a systemic problem?

Studies carried out in the Netherlands and Belgium show that greenhouse horticulture, although functionally linked to agriculture, is often found in suburban areas, blending in with typically urban developments [32]. Hence, the conviction of some researchers, even before the appearance of the first large-scale implementation of urban rooftop gardening, is that this is the form most likely to link the rural and urban character of urban space [31]. Greenhouses appear to be a promising form of urban agriculture implementation [44]. The last decade has shown that they were right. This has been evidenced by the form of the buildings being examined in this study. So far, the greenhouses found in the city have also been a symptom of the urban sprawl phenomenon since, as a method of increasing food production and extending growing times, they have appeared on the fringes of cities in well-communicated areas [32]. However, the same researchers point out that, with the implementation of sustainable development principles and the change in greenhouse production technology, they have become a method for significantly reducing agricultural water demand, as observed in areas with unfavourable climates, such as in Israel and Almeria [45].

Studies in Almeria have also shown a local trend of a 0.3°C reduction in temperature per decade due to a significant number of greenhouses in the area [46, 47]. Although there are no studies confirming the same phenomenon for rooftop greenhouse solutions, the possibility seems so interesting that the first facilities have already been set up to experimentally test integrated rooftop greenhouses (iRTG) in the process of regular operation [48]. Studies show that in the future, greenhouses are willing to shift from being energy consumers to becoming one of the leading electricity producers, at least in the case of those surveyed from Denmark [32, 49].

Previous research has revealed another important problem in the presence of greenhouses in urban and peri-urban areas. Research by Elke Rogge has shown that greenhouses have a significant visual impact on the landscape, perceived as unfavourable [50, 51] and that their location adjacent to urban areas creates functional and social conflicts [51, 52]. The typical large-scale greenhouse form, higher, more extensive and much more dominant than the surrounding buildings, is perceived as not fitting seamlessly into the landscape. In his research, Van den Berg describes the area between Rotterdam, The Hague, Zoetermeer and Delft as "a rural-urban no-mans land" [52], echoing the residents' general dislike of this form of development, resulting in the considerable anonymity of the space and the depopulation of relatively large areas (with a large cultivated area, the number of workers is minimal and access for the public is significantly limited).

Hence, in some countries, such as Denmark and the Netherlands, there has been conscious governmental

support in converting peri-urban greenhouse areas into housing estates and, at the same time, "clearing" the landscape [32], which, however, required not only legislative but above all financial support. Experiences from the last 50 years show that having greenhouses in urban areas is beneficial despite risks. Recent studies focus on minimizing the impact of large greenhouses in cities by considering technological advancements and urban functionality [51].

Therefore, from a combination of benefits – the reduction in water demand, the introduction of renewable energy sources as a method of power supply, and technological advances in production methods – the only problem to be solved is the demand for peri-urban land that might otherwise not be developed at all or used for more strategic functions. The solution to this problem is to use the rooftops of buildings, mainly industrial, for building greenhouses, which already have their road infrastructure, access to utilities, etc., and therefore whose further use does not result in the development of unfavourable spatial and social phenomena.

4.2. Urban farming in the process of revitalization

Studies have been published for more than a decade now, confirming the positive economic, socio-cultural, and ecological impact of urban agriculture on space, especially in former industrial areas [36, 53]. So far, however, the architectural and spatial dimension of the activities conducted in this way has not yet been analyzed, most likely mainly due to the lack of permanent, rather than merely seasonal, developed spatial forms. The research that was conducted focused on the United States [54], although references to Italy (Catania) can also be found [55]. An analysis of the activities (mainly developed as bottom-up community initiatives) undertaken in the "Querbeet Hörde – Harvest your City!" programme as part of the process of revitalizing the post-industrial district of Dortmund Hörde in the Ruhr area revealed several specific objectives, which in this case were intended to act as a catalyst for the process [36].

Urban regeneration is associated in research with the concept of urban vacant land, especially in those areas in Europe where the intensity of development and the amount of historic fabric is most significant and significantly exceeds the potential availability of undeveloped sites [56]. However, the authors of the 2016 study mainly point to the role of temporary development versus agricultural function as a stage between the absence of function and the permanent development of spaces or facilities. Since then, the approach to the role of urban agriculture in urban space transformation has changed considerably. It is worth mentioning, however, that this research has, for the first time, highlighted the potential of areas defined as abandoned neighbourhoods, i.e. areas associated with the decline of an industry in a mainly suburban area, which is challenging to adapt and susceptible to a process of re-urbanization, drawing attention to the example of Detroit and the grassroots initiatives already described in the literature [57].

Recent research points to the importance of adapting wasteland spaces on rooftops for urban agriculture [58], although in the case of Kyle Adrade's research, this aspect was only described theoretically. Contemporary research is already clearly referring to the need for integrated action in urban space regeneration processes by integrating with urban agriculture to create "sustainable, equitable, and resilient communities, which will be critical as we face the climate challenges ahead" [59], but not as a method of mechanically fixing broken space, but a process of transformation designed for each situation.

5. CASE STUDIES

The case study analysis shows the diversity of the functional and spatial structure of the facilities under study (see Figure 2) (Table 4).

Table 4.
Functional analysis of selected cases. Author's elaboration

area [sqm]	Agrotopia (Inagro)	La Cité Maraîchère	Abattoir BIGH
floor area /non-agricultural/	170	98	1.051
communication	221	305	568
indoor agriculture	5.307	1.213	1.321
agriculture/communication	379	234	1.654
technical area	2.338	473	46
publicly-opened area	2.443	333	337
SIMPLIFIED TOTAL AREA (including construction)	**10.858**	**2.656**	**4.977**

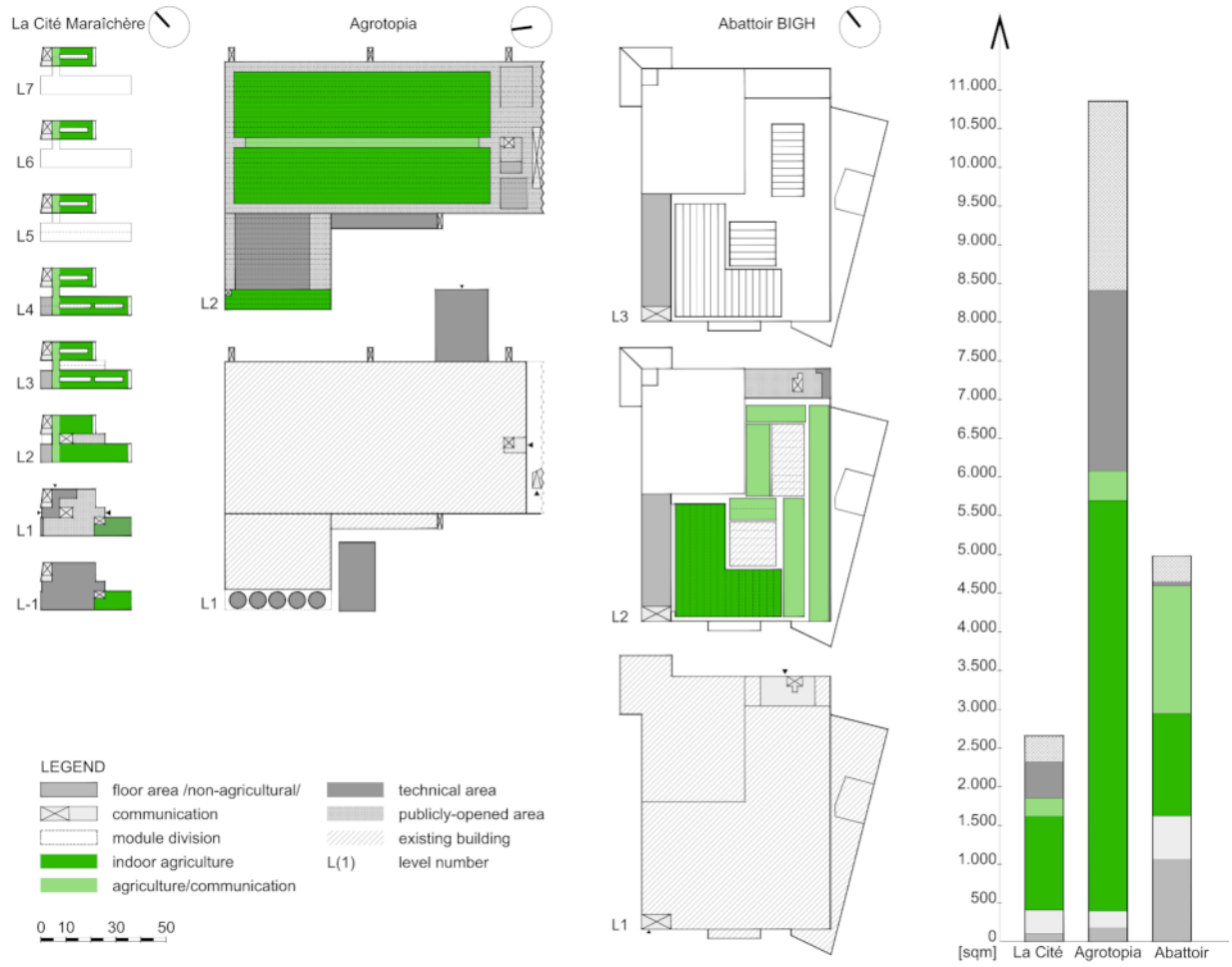

Figure 2.
Functional analysis of selected cases. Functional distribution on different levels (left) and a chart showing the distribution of floor area by functional groups. Authors' elaboration based on [10, 60, 61]

5.1. Abattoir BIGH, Anderlecht, Belgium

The first of the analyzed cases was developed as part of a complex process of revitalization of the Cureghem district in Anderlecht. Its focal point is transforming a closed area of the still partially functioning municipal slaughterhouse into a multifunctional complex of residential and commercial developments linked to agricultural production and trade [11].

5.1.1. Urban structure

NV Abattoirs et Marchés d'Anderlecht-Cureghem was a complex of peri-urban slaughterhouses combined with a meat and cattle market. The choice of this area was influenced primarily by its location, enabling it to reduce the nuisance of transporting cattle through the city streets. The navigable canal and the Western Railway Station, built in 1872 in Cureghem, allowed for efficient and relatively unobtrusive transport of animals to the area. It was not until 1888 that the city of Anderlecht permitted the construction of a new slaughterhouse and cattle market. The complex was designed by Adolphe and Guillaume Charlet, Emile Pierret, Emile Tiron and Henri Chevalier. The main entrance was built in the years 1901-2, according to a design by Henri Rieck.

The entire site originally covered an area of 20 ha (it has now been reduced to around 10 ha). The main preserved cattle market building took the form of a roofed hall measuring 100x100m, constructed in an arched cast-iron structure in the middle of the complex [11]. The slaughterhouse building was erected directly behind the market, along with the railway station and animal housing area. The complex administration was housed in a representative

building on the side of the entrance square. The complex has survived despite plans to demolish most of the industrial buildings in Cureghem and replace them with social housing as early as the 1950s due to its considerable profitability. As a result, however, it was gradually surrounded by quartered buildings with an irregular grid.

The demand to modernize the premise, which with increasing urbanization was surrounded by residential and commercial developments, often chaotic, was mainly driven by the need to transform a foreclosed area, providing the opportunity to implement a range of social activities in an emblematic place for the neighbourhood. Within the framework of the FEDER-EFRO programme, the decision was made to build a new public market hall that would provide retail trade by 2013 without removing the slaughterhouse function. The Abbatoir 2020 masterplan envisaged a gradual transformation of the site from an industrial, enclosed area to an open area that serves the local community and is an important part of the urban tissue of Cureghem [12].

The main hall has been transformed into a multifunctional retail and exhibition space that is publicly accessible and suitable for temporary cultural and commercial events. The open-plan form of the historic building itself facilitates this. The general plan was to establish a public zone here by introducing complementary buildings and by intentionally creating a new function based on the existing one. The designed urban interior encloses and completes the 4 quarters separated by a public zone in its north-western part, on the side of the historical main entrance. The three market hall buildings in the design form the square's northern wall. The plan also includes the construction of the so-called North Market as a new development on the canal side.

What stands out in this concept is, for the first time, the conscious approach to the planned introduction of the agricultural function in the revitalization process and its association with commerce and human habitation. Already today, despite the implementation of only the first stages of the whole project, the quality of the living space has been significantly improved, if only because of the progressive aestheticization. The introduction of cultivated green space, both indoor and outdoor, in and on buildings that are lower than the surrounding ones makes it visible from the existing development. It adds value to a site that was previously just a paved square.

The concept for the site's revitalization included phasing, allowing the area to function permanently and uninterruptedly as an urban slaughterhouse and market area, with a gradual transformation into a multifunctional complex and a transition from an enclosed area towards a public space. The binding element of the whole concept was the need to run a new model of communication support for the area by constructing a new metro station to handle the increasing number of inhabitants. Within the analyzed area, elements that are not only historically but also functionally valuable were recognized, creating a core element of the identity of the place, while the rest was progressively demolished (see Figure 3).

5.1.2. Function

The Foodmet hall, now a symbol of the ensemble's revitalization process, has become an important element of the concept and is used as a host facility in the development of the farm. Its modern yet simple form is intended to relate to the multicultural character of the district [60]. It was erected on a site that had long served to host an open market (informally and formally).

The Foodmet Hall was created as an extension of the existing market hall that was part of the original layout of the urban slaughterhouse complex. Also designed and realized between 2009 and 2015 by the design team of ORG Permanent Modernity, it became an important part of the task of completing and constituting a temporary form of arrangement adapted to the needs of the multicultural immigrant community that made up the majority of the inhabitants of this part of Anderlecht [17] in the form of a multifunctional covered market hall and constituted the next stage in the planned revitalization process after the transformation of the neighbouring market hall building.

The Abattoir BIGH urban farm, also by ORG Architects, was built on the roof of the Foodmet market hall. Construction of the farm started in 2016, the outdoor garden was established in 2017 and the greenhouse was completed in 2018. The specific location of the building allowed the introduction of small-scale fish and herb processing and simultaneous on-site sales [17, 62]. The scope of the facility's impact, defined by the scale of agricultural production sales, covers the Brussels metropolitan area, not exceeding a range of 12–15 km from the production site.

Unlike the other two cases, the public entrance to the farm is located on the northeast side and connects to the entrance to the market hall. This is due to the

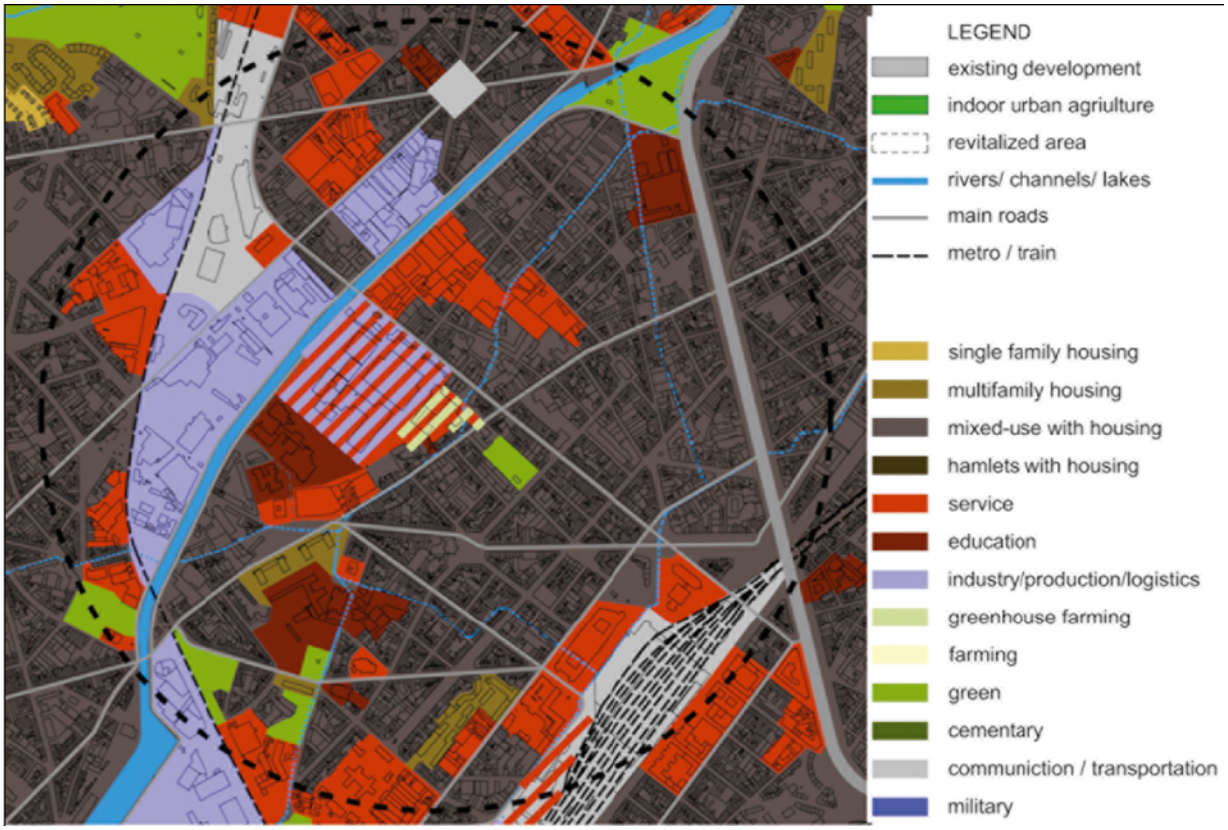

Figure 3.
Functional analysis of the area of the Anderlecht district, Cureghem within 1km of the Abattoir BIGH farm. Authors' elaboration based on site research and [63]

building's location in the urban complex. The entrance to the administration, office and technology area has been separated and is located on the south side, neighbouring the extended delivery area of the facility. These parts completed the space designated for the purpose in the original design of the hall. The office zone on the east is connected to the cultivation zone via a sanitary corridor along the entire length of the block. The overall space is complemented by rooftop soil and container cultivation to the east. Once the entire building was completed, the office space was supplemented with a superstructure made of stacked containers placed at the expense of the open cultivation section.

5.2. Agrotopia (Inagro), Roeselare, Belgium

5.2.1. Urban structure

Agrotopia was built on the roof of the Food Exchange building – the headquarters and logistics centre of REO Veiling. The facility was designed and constructed between 2015 and 2022 in the area bounded by the R32 expressway on the west side, Diksmuidsesteenweg on the north-east side and Oostnieuwkerksesteenweg on the south side in the industrial belt between the historic centre and the satellite settlements, on the route connecting the city with the village of Oostnieuwkerke on the west. The wedge of development forms a transitional section between the boundary of the industrial zone located along the expressway and the residential and service areas developing towards the centre to the east. The area is thus located in a mixed development belt, taking on a more industrial and commercial or residential character, depending on the more specific local conditions (including its setting along the historic routes linking Roeselare with neighbouring towns). This has made it possible to connect the area as a whole into a semi-closed circuit, where agricultural production is used simultaneously for retail, processing (REO Neerzetloods) and catering.

The quarter has fruit and vegetable wholesalers, car showrooms, and multi-storey car parks on the western side. The eastern corner has diverse single- and multi-family housing and commercial develop-

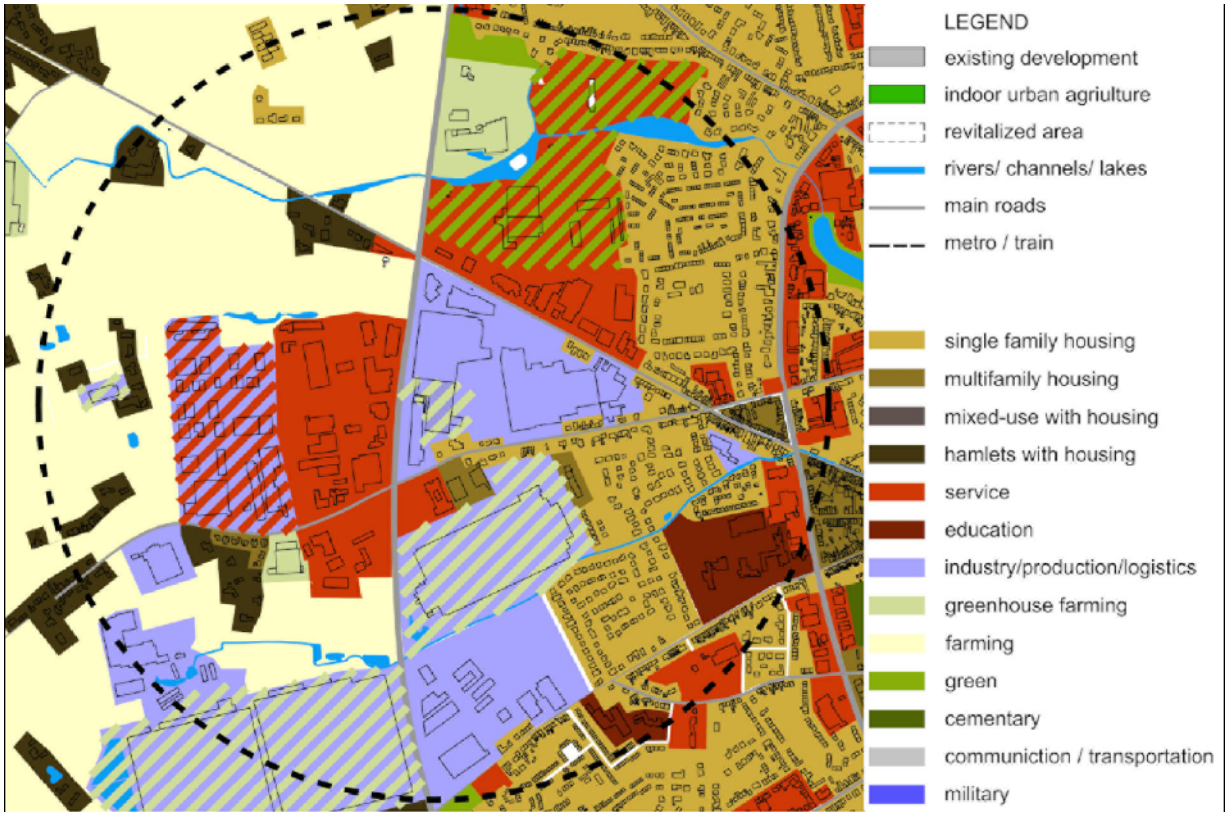

Figure 4.
Functional analysis of the area of Roeselare within 1km of the Agrotopia farm. Authors' elaboration based on site research and [65]

ments, changing the area significantly. Due to the rank of the roads in the urban network, access to the site is only possible from the south. The base building and the extension in question form a logically shaped link between the historic hinterland to the north and the withdrawn building line of the car showroom range.

The apparent affiliation with the linear settlement pattern associated with the development along the route towards the Oostnieuwkerke has resulted in the area under consideration being a boundary point between the industrial and logistics development and the residential and residential-service development of increasing intensity towards the historic centre. Concerning the low building heights in the area as a whole, the withdrawal of the much higher buildings (especially the elevated vertical farming block) into the quarter has resulted in it fitting in much better with the context of the site and in no disruption to the coherence of the structure.

The importance of this facility to the transformation of the urban fabric of the belt between Roeselare and Oostnieuwkerke is all the greater as it represents the first food production facility on the side of the compact development. On the western side, at the edge of the urban area, a significant amount of ground-level greenhouse development appears for intensive cultivation in a relatively small area. This form has developed into a belt where the fragmentation of the built environment and its mixed function result in the impossibility of separating typical agricultural fields and the right quality of land (see Figure 4).

5.2.2. Function

The greenhouse and research centre on urban agriculture in Roeselare, Belgium, was designed by the team of META architectuurbureau and van Bergen Kolpa architects in 2021 [62, 64]. The facility was created by extending the existing REO Veiling agricultural auction market. The Flemish Government Architect's Pilot Projects for a Productive Landscape (PPPL) funded the facility. Therefore, it is not formally linked to revitalization processes, although the Productive Landscapes Programme was established to protect suburban landscapes. It, therefore, indirectly relates to the foundations of the revitalization process itself.

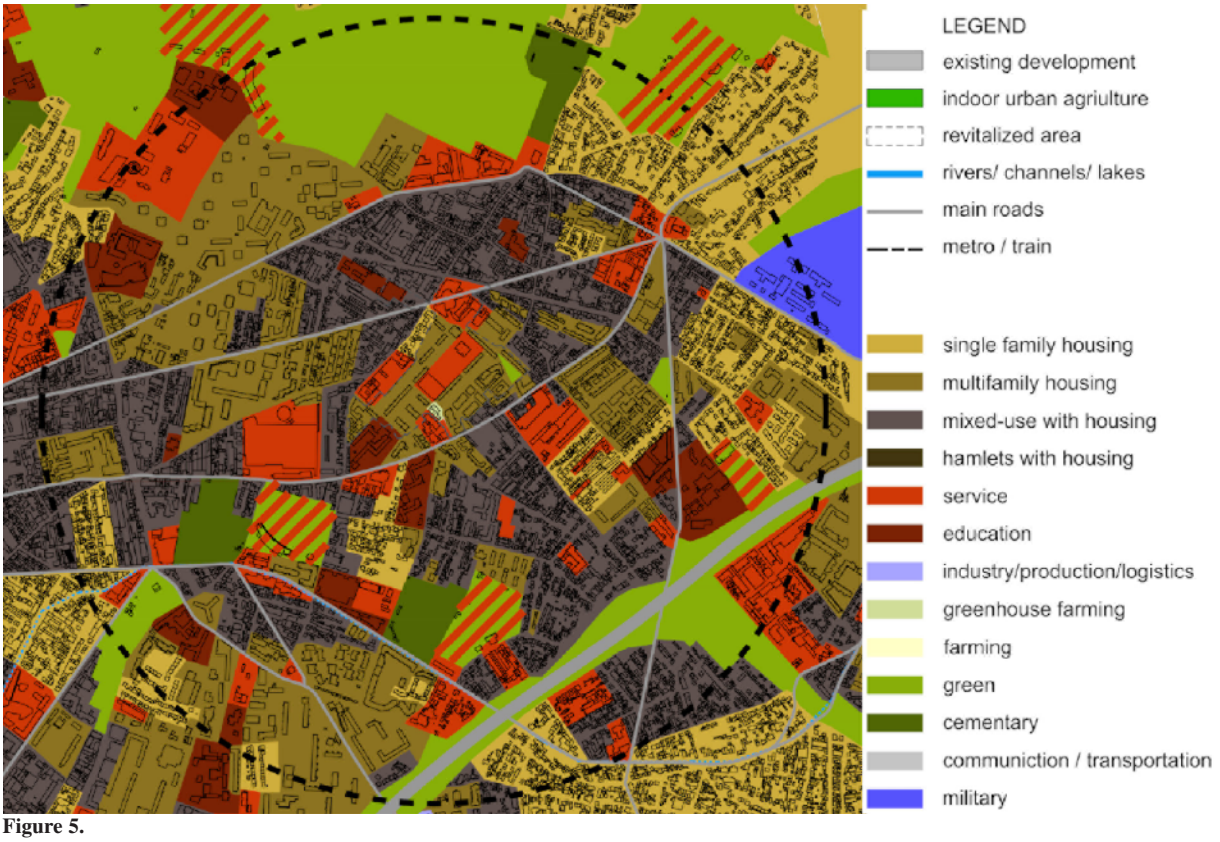

Figure 5.
Functional analysis of the area of Romainville near Paris within 1km of the La Cité Maraîchère farm. Authors' elaboration based on on-site research and [68]

The use of the existing food exchange hall facility necessitated only minimal intervention in the plan of the host building. The changes made to the ground floor involved adding technical spaces to the west and a large delivery area to the east. Evacuation staircases were also added on both sides, which were not required in the original single-storey exchange building [9, 10, 13, 14, 15, 16]. The primary public entrance area was located on the south side. It serves as an entrance area for both employees and visitors. It accommodates modules for seminar rooms, offices and an extensive sanitary facility. It represents an extension of the form of the greenhouse, in a way "flowing down" from the superstructure and veiling the overhanging hall, which is inserted beyond the line of the existing building, with a monumental open staircase on the south side. The cultivation area does not rely on daylight through the walls. The roof area is much more important in this case. Therefore, it was possible to use a box-in-box solution, i.e. to place the cultivation area in the centre of the building, separated by a technical corridor and surrounded by a public space – a corridor separating the cultivation from the façade, but allowing a full view from the outside of the plant growth process while maintaining the required sanitary regime. The technical and technological area is located in the northwest of the building, in the space between the greenhouses. It is protected from the adverse effects of direct southern light by being separated from the south by an exposure space.

The single-storey extension was divided into two blocks – the central part covered by a standard greenhouse with a shed roof and, to the west, a narrow greenhouse block representing a different technology – the vertical greenhouse.

5.3. La Cité Maraîchère, Romainville, France

5.3.1. Urban structure

The area under study was included in the urban revitalization (renovation) project (PRU) of the Île-de-France area developed by the national l'Agence Nationale pour le Renouvellement Urbain. As part of plans to revitalize and implement the self-sufficiency of selected zones of the Paris metropolitan area, a plan to revitalize a section of Romainville

called the Marcel Cachin quarter (no. 93) was adopted in 2007, planned for completion in 2014 and finally completed in 2022 with the construction of the Cité Maraîchère building. It is worth noting that this element was introduced secondarily into the revitalization plan in 2013 [61, 66, 67]. The original plan called for a small green space at this location. Similar changes also had to take place in the local planning documents (Plan Local d'Urbanisme / PLU), allowing the construction of agricultural buildings within the area of Romainville.

The area itself covered by the revitalization plan included mainly HLM (habitation à loyer modéré – low-rent housing) social housing developments dating from the 1960s, occupying a large area and initially referring to the modernist idea of creating living spaces in the city, which due to the progressive urbanization of the Paris metropolitan area-for all intents and purposes except for the administrative connection-had become one of the eastern districts of Paris.

The original complex was comprised of 16 buildings with predominantly residential functions. It was located on more than 8 hectares and had 1127 flats for around 3,000 residents. The Cité Maraîchère revitalization project included improving communication infrastructure and its better connection with the centre, adding underground parking, creating retail and service spaces with barrier-free access, and relocating key urban functions like a mediatheque, children's centre, senior centre, and cultural centre called Espace de Proximité Marcel-Cachin. (see Figure 5)

5.3.2. Function

The culmination and, at the same time, the final step in the revitalization of the estate was the construction of an urban farm as a green social space. Built, as it were, to replace a small square, it has a public space on the ground floor with a reception area, sanitary facilities, an education room, exhibition space and a café. Directly adjacent to the entrance, a small public cultivation space was also located, serving as the building's advertising space. It was extended at the first-floor level as a view into the cultivation area. As in other cases, sanitary considerations and the need for a strict separation between the cultivation area, where only selected employees have access, and the public space was an important design factor. Above the ground floor, the floors have been dedicated to cultivation, located on the south, east, and west sides. The northern part of the building was allocated for communication, offices and handy spaces related to the facility's technology, while the ground floor was also used for a small covered delivery area and staff entrance. The leading utility and technology space was located underground, with room for mushroom cultivation.

The body of the building has been designed to fit in with its surroundings despite its significantly different function. Accordingly, an additive arrangement of solids of variable height was used, which refers to the traditional form of a greenhouse with a gabled, symmetrical roof. The two wings, created by extending the greenhouse, have variable length and height. Between them is a two-storey building, also covered by a gable roof, and a public space ending (which is in the middle of the plan) with a public, open staircase of a representational character. At storeys 1 to 3, the wings are connected to the north by a technical corridor, also intended for cultivation.

As a result of this division of the body and functions, the main public entrance was located to the south, while the entrance and technical entrance were located to the north.

The dividing function into seven storeys above – and one below ground has resulted in a piling up of the cultivation and a much greater influence of the façade design on the cultivation area than in the other examples. In this case, daylighting access through the walls is much more important and relatively less through the roof, although narrow openings running along the cultivation areas have been introduced in both cultivation wings outside the public area to improve user comfort.

6. DISCUSSION

With this analysis, the examples under discussion provide an implementation of a number of the premises of green urbanism. According to Steffen Lehmann's research [69], each project achieves almost all of the basic objectives of this policy (Table 5).

The analyzed examples demonstrate the intensely experimental nature of the created architecture and its orientation towards social elements in terms of functional programme formulation. In addition to the infrastructural and technological elements necessary for its functioning, an important element of each of the analyzed examples is the diversity in the implementation of functions in public spaces.

Table 5.
Implementation of the principles of Green Urbanism. The author's elaboration is based on [27]

	Agrotopia	La Cité Maraîchère	Abattoir BIGH
Energy and materials			
Local Food	•	•	•
Zero Waste Concept	•	•	•
Local Materials	○	○	○
Renewable Energy	•	•	•
Socio-cultural features			
Special strategies for developing cities	○	○	○
Liveability, health and mixed-use	•	•	•
Cultural heritage		•	•
Governance and leadership	•	•	•
Education and research	•	•	•
Urban planning and transport			
Transport and public space	○	•	•
Climate and context	•	•	•
Density and retrofitting	•	•	•
Green buildings and districts	•	•	•
Water and biodiversity			
Landscape, gardens and biodiversity	•	•	•
Water management	•	•	•

Table 6.
Average greenhouse sizes in France, Belgium and the Netherlands around 2012 and the related studied example. The author's elaboration is based on [51, 69–72]

	Belgium	**France**	**the Netherlands**
Surface (out of which vegetable)	1.27 (0.6) ha	8.30 (3.14) ha	(3.81) ha
Covered surface	no data provided	2,60 ha	3,1 ha
source	(Rogge, Nevens and Gulinck 2008; Greenhouse Horticulture 2016)	(The Agricultural Counsellor 2021)	(Average utilized agricultural area n.d.; cbs Statistics Netherlands n.d.)
	Agrotopia	La Cité Maraîchère	Abattoir BIGH
Surface	1.08 ha	0.21 ha	1.43 ha
(out of which vegetable)	(0.53) ha	(0.12) ha	(0.13) ha

6.1. Size

In countries such as the Netherlands, France, Spain or the UK, the average surface of grown crops in a single greenhouse exceeds 3 ha. Due to the lack of average statistics about rooftop and indoor urban agriculture implementations presenting an average size of the cultivation area, only statistics relating to traditional intensive greenhouse agriculture can be referred to. Newly built, commercial greenhouses erected on the ground in suburban areas generally always have a surface area that exceeds the average and often exceeds ten times this value [51]. Meanwhile, only the Agrotopia greenhouse reaches a size close to the average in the country of creation. The rest of the facilities remain significantly smaller than the average size of commercial greenhouses (Table 6).

This demonstrates the experimental nature of the solutions currently being developed. The higher construction and adaptation costs concerning solutions not relevant to existing buildings make it necessary to reduce the overall construction costs, Which may cause the need to build a smaller farm.

The analysis of the aforementioned parameters also demonstrates the smaller size of existing roofs than the actual technological possibilities of creating farming greenhouses in cities. In each of the analyzed cases, one can also see the necessity to exclude part of the roof area for technical or technological reasons, which is not the case for greenhouses on the

Figure 6.
Accessibility analysis for selected cases. Authors' elaboration

ground. The analyzed cases show a complementary, rather than a superior, agricultural function concerning the surrounding area, where the size of the cultivated area is conditioned by the demand of the settlement in question, and any surplus area or higher than implementable demand for crop production is achieved in a form other than a greenhouse.

In this case, the farm's function is complementary to the revitalization process. There are no examples yet of an attempt to base the whole process directly on urban agriculture facilities, although this analysis has shown a vast potential for this, particularly in the European area.

6.2. Surrounding

Elevating the greenhouse element will allow the building's ground floors to be opened for more socially accessible purposes. Requiring strict adherence to a technological and sanitary regime, horticultural or aquaponic production is elevated above the level of everyday use, causing the whole area to be opened up to local needs or to fulfil a primary production or distribution function.

The shift towards local distribution, i.e. the conversion of hubs of national importance to those serving the local community and available within walking or cycling distance, results in this function also

becoming a social one, integrating the local community. The socially poorly perceived form of the greenhouse, being associated with an inaccessible space, is elevated above ground level and so is not as visible. It is surrounded by other functions (housing, services, retail) to domesticate it. At the same time, the raised greenhouse is perceived as greenery and so takes over, at least in part, the social and psychological role of traditional urban greenery. Building positive associations with the new function is also aimed at dispersing greenhouses in the city, which is facilitated by building them on top of existing roofs with an already set area.

Due to the assumed technological and sanitary requirements, the zone of public access in each of the analyzed cases is strictly defined and limited. The lack of direct access to the enclosed cultivation area is counterbalanced by providing a visual connection. In the case of Abattoir BIGH, it is a visual connection and access to a part of the growing containers, which are open and intended mainly for a community garden, and therefore, with access partially restricted. In the case of La Cité Maraîchère, a view limited to one storey is provided, and an area is set aside as an extension of the entrance zone intended for a local restaurant, which is therefore excluded from the regular use of the farm. The whole insight into the entire process of plant growth in a closed environment is provided in Agrotopia, with corridors surrounding the entire cultivation area and only the technical rooms partially excluded (see Figure 6).

The new function is not better than other solutions, as each has its limitations, but this one ultimately realizes current needs, referring to renewal purposes. It makes it possible to achieve a multi-level space, elevating complementary functions beyond the utilitarian level. At the same time, this function plays an additional role, influencing the perception of the transformed area as more human-friendly, more accessible and more aesthetically pleasing, introducing a closed, orderly form of greenery visible from the level of the upper floors of the surrounding buildings. It is thus visible from the residential spaces that surround each point.

Its value to the modern city is represented in being an example of the integration of greenery and buildings in revitalization processes as part of the community revitalization efforts and a visible element of a vertical extension trend as one of the housing strategies of European cities. It can also become an element of the vertical extension trend – the most current idea for solving the density problem during revitalization processes in European cities.

Therefore, urban agriculture built both as a vertical extension of indoor farming created as a mixed-use development, has the potential to become the solution to the needs of urban dwellers shortly.

The analyzed examples show the growing potential of commercial or semi-commercial introduction of urban agriculture as a component of revitalization processes in European cities. They provide evidence of the possibility of using commercial-intensive urban agriculture in the programming of this process for problem areas with specific locations on the edge of the transitional zones of different urban functions. In

Table 7.
The goals of revitalisation were achieved in selected implementations. Authors' elaboration

The goals of revitalisation	Agrotopia	La Cité Maraîchère	Abattoir BIGH
urban and architectural			
renovation/modernisation	•	○	•
conscious development of the cultural landscape	○	•	•
technical			
improving the quality of road infrastructure	○	•	•
improving the quality of technical infrastructure	•	•	•
social			
stopping the development of negative social trends	○	•	•
counteracting pathologies and social exclusion	•	•	•
improving the state of security	○	•	•
economical			
promotion of entrepreneurship	•	•	•
development of tourism	○	○	○
implementation of commercial projects	•	•	•
environmental			
improvement of the state of the natural environment	•	•	•
elimination of pollution and emissions	•	•	•

this case, the main line of contact is the boundary between industrial and residential areas, which, over time, have begun to surround the former. It is also a method for complementing the primary functions in existing settlements, as shown by the example of La Cité Maraîchère (Table 7).

7. CONCLUSIONS

The analysis of the revitalization goals achieved in the analyzed processes shows a significant impact of the introduction of urban agriculture on the economic and environmental sphere. Therefore, an interesting future research area would be the determination of optimal surface values for newly established urban rooftop farms, allowing the optimization of their construction and exploitation costs, taking into account the support systems for the assumed technological processes, climate zone and local regulations. In this way, environmental goals can be achieved by balancing the costs incurred by generating environmental values in the redevelopment area.

Another element relevant to future research on the use of urban indoor agriculture in the revitalization process of European cities in the light of this research will be the reduction of construction costs by developing mechanisms for the adaptation of existing facilities or conducting mechanisms to encourage/force the inclusion of the possibility of introducing rooftop greenhouses in the future in newly designed facilities in selected areas of the city through, for example, designed increased roof loading. In this case, the possibility of using the tools of cost participation and the entire development process by government and local municipality institutions, as well as the role of public-private partnerships in this process, should be investigated.

An element that has become apparent in the research is the need to introduce a tool into urban planning policy to identify the most favourable areas for the development of rooftop urban agriculture due to several predefined factors, such as transport accessibility of deliveries and pedestrian/bicycle access for residents, the presence of an overshadowing problem, the availability of utilities, including renewable energy, the possibility of grey water storage, composting, the social role of the farms created and their associated functions, and many others.

Finally, implementation of the results of these activities in local planning policy (including local spatial planning) in the form of local laws or mandatory design guidelines should become an element of further analysis.

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