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Peri-Urban Food Production and Its Relation to Urban Resilience

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Abstract: Food production on the urban–rural fringe is under pressure due to competing land uses. We discuss the potential to improve resilience for urban–rural regions by enhancing food production as part of multifunctional land use. Through studies of peri-urban land in the regions of Gothenburg (Sweden), Copenhagen (Denmark) and Gent (Belgium), recent developments are analysed. Arable farming has been declining since 2000 in all three areas due to urban expansion and recreational land use changes. In city plans, networks of protected areas and green spaces and their importance for human wellbeing have been acknowledged. Policies for farmland preservation in peri-urban settings exist, but strategies for local food production are not expressed in present planning documents. Among the diversity of peri-urban agricultural activities, peri-urban food production is a developing issue. However, the competing forms of land use and the continuing high dependence of urban food on global food systems and related resource flows reduces peri-urban food production and improvements in urban food security. The positive effects of local food production need to be supported by governance aiming to improve the urban–rural relationship. The paper discusses the resilience potential of connecting urban–rural regions and re-coupling agriculture to regional food production.

Keywords: peri-urban agriculture; multifunctionality; urban food security; urban resilience; food policy; governance

1. Introduction

Currently more than 50% of the global population lives in cities and urban areas and this share is continuing to increase [1]. This trend makes it difficult to achieve resilience and sustainability in rural-urban areas and complicated processes of changes and transformation in resource use and food production are required. Land in peri-urban regions is under severe pressure from a number of different and contradicting uses and land use changes here are swift [2]. The emerging pattern of peri-urban (the definition of “peri-urban area” varies depending on the perspectives from which these areas are analysed; in this paper, we use the definition of [3] in which the peri-urban area encompasses the fringe of the city and the urban periphery and is characterized by discontinuous built development with an average density of at least 40 people per ha) land use is comparable among many European countries, where the demand for land can be classified into the following four, sometimes slightly

overlapping, categories: (1) built-up areas (housing, commerce, industry, etc.) and infrastructure; (2) land for food production; (3) protected nature and cultural heritage areas; and (4) areas for recreation (diverse sports activities, e.g., golf courses, horse riding, etc.). Urban planning and the achievement of resilient livelihoods require compromises to be made between the competing land uses since they all include needs for human wellbeing. Land use policies and strategies exist for housing areas and other building activities, recreational activities and their land needs as well as for the conservation of biodiversity and cultural values in designated areas. However, there is often no specific policy for food production in peri-urban and urban regions and strategies seldom balance the multiple interests of land use which intersect at these locations. Without effective policies for food production, other land uses, e.g., for recreation such as horse riding, may receive higher priority than food production, which is connected with urban food security and human wellbeing [4].

European food production is integrated into the global food system and its consequences for food security is the subject of much current discussion [5–8]. The dependence on global systems with long food chains and a number of links related to production, transport, delivery, etc. implies that opportunities to influence the food chain locally are limited.

The functioning of this system demands continuous access to resources and transport and communication systems without disturbances. At the same time, we are aware of the increasing uncertainty for all livelihoods as a result of, e.g., global environmental change including climate change with increased risk of droughts and floods in different parts of the world [9]. This implies direct effects on agriculture, food production and infrastructure.

Agricultural policies, on the other hand, both national and European in the form of the Common Agricultural Policy (CAP), have undergone several changes. Furthermore, the current deregulation of national agricultural policy in several EU countries has also influenced peri-urban agriculture. This has opened the door to other forms of land use on agricultural land such as horse farms and riding schools and “adventure farms” as tourist attractions, etc.

Local food production from peri-urban regions reduces dependence on the global food system, which also lessens vulnerability to a region’s food provision [4]. Concurrently, in general, interest in, and demand for, locally produced food is increasing among urban citizens. Another dimension of local food production is the strong educational element that fosters sustainability and holistic insights by allowing urban people to reconnect with the place of origin of the food, the ecological and social links in the food processes and the limits of the ecosystem involved in food production. Against this background, it is motivating to look into the state of art of peri-urban agriculture and food production for urban consumers in highly developed EU countries that have high scores on the United Nations Human Development Index (HDI) [10] which may infer a high level of human well-being and urban resilience.

The aim of this paper is to analyse peri-urban land use changes in relation to food production and food security. Furthermore, the paper aims to clarify the connections between food production, urban resilience and multifunctional land use in an urban context.

In order to meet the overriding aim, we pose the following research questions:

- (1) What land use changes are occurring on agricultural land in peri-urban areas?
- (2) What is the state-of-the-art regarding peri-urban food production?
- (3) To what extent is multifunctional peri-urban food production occurring?
- (4) What kinds of governance mechanisms are being used to support peri-urban food production as a part of multifunctionality?
- (5) How can peri-urban agriculture link urban and rural regions and increase their resilience?

2. Resilience and Food Security in an Urban Context

2.1. Urban Resilience

The concept of resilience has been used in different contexts and interpreted in different ways [11]. A general interpretation of resilience is that it refers to the capacity of a system to react to

disturbances by restructuring in such a way that its capacity for maintaining key functional processes is upheld [12–14]. Resilience implies transformative capacity and active capacity building [15,16]. *Urban resilience* was recently elaborated in an extensive literature review [17]. They draw attention to various inconsistencies and contradictions in the existing definitions of *Urban resilience* and propose the following new definition:

“Urban resilience refers to the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales—to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity”. [17]

Cities are connected to other cities in a global network and are linked to rural regions at the regional and global levels to provide and manage global resource chains [18]. Food production in most parts of the world is heavily involved in and interconnected in the global food system [7].

2.2. Food Security

Urban food security [4] means that citizens should “have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” [19]. Today food that is consumed in urban and rural regions is, to a large extent, imported from other, often distant, parts of the world. Similarly, with regards to staple food products that are produced closer to the consumers, such as dairy products, the inputs to production, such as high-protein soya, are imported from distant locations, e.g., Brazil, to feed dairy cows in Sweden [20]. The inclusion of food production in the globalized food production systems has disadvantages and threats. A lack of local control, disturbance of long-distance transportation and delivery systems, a changing geo-political situation, and the consequences of climate change are some of the changes that are threatening food security [21]. Local food production in peri-urban areas could help to reduce dependence on the global food system, which is vulnerable to disturbances. Delivering locally produced food and maintaining land areas so that they are suited to food cultivation in peri-urban areas have potential effects that need to be studied empirically, e.g., to what extent does it increase urban resilience [22]?

However, besides playing a role in food security, peri-urban food production may contribute to rural resilience in other ways. For example, it can create increased landscape and species diversity, recreational opportunities, attractive living environments, and it may play a role in adapting to climate change and reconnecting urban regions to food production. These soft location-based factors have become more relevant due to international competition between urban regions [23,24].

2.3. Multifunctional Food Production and Resilience

The concept of *multifunctional food production* is often used as alternative to the specialized production according to the productivist paradigm in agriculture [25], combining agricultural activities with the maintenance of biodiversity, cultural ecosystem services, recreation, social cohesion, etc. [23,26]. There is also a climate dimension to farmlands which have a diversity of habitats and crops; arable land with annual and perennial crops, and woody species, such as fruit trees, and grasslands (pastures)—all are relevant for carbon sequestration and complement the added value of multifunctional food production.

The value of agricultural land that produces different ecosystem services—and not just food—is directly related to the agricultural practices and methods applied. Multifunctional food production can be achieved under organic agriculture or with methods based on the circulation of nutrients within the ecosystem and independence from continuous external inputs, agro-ecological methods [27,28]. Such methods often involve a combination of different types of crop—annual, perennial and woody species—such as agroforestry and agro-silvicultural systems with a combination of crops and fruit-trees, such as alley cropping or home gardens [29]. Biological diversity is promoted and enhanced by

the crop diversity and by production methods that will increase biodiversity of different organism groups, e.g., pollinators [30]. Further, such production systems promote a diverse landscape structure, which facilitates the maintenance and production of a number of other ecosystem services, not least recreation by attracting visitors (cf. agricultural monocultures). Agro-ecological methods are often labour-intensive, but they have prolonged harvest seasons [28] and high yield output per area yields [31,32] and, therefore, they are applied in the different forms of urban agriculture that are currently developing around the world [22]. Such methods are also well-suited to peri-urban food production as they facilitate the co-production of a number of ecosystem services including recreation, which responds to the demands of the urban population.

Another dimension of multifunctional food production is its potential for knowledge generation and cultural exchange in the food production activities with positive implications for the integration of different cultures, social cohesion and social sustainability [33]. New research states that access to nature and diverse ecosystems, e.g., cultural landscapes with a high diversity of habitats and species, has positive and enhancing effect on human health including both physical and psychological dimensions [34,35].

How does multifunctionality in peri-urban food production relate to urban resilience? The provision of food that is less dependent on the global food system and with a diversity of crops produced in systems that allow the co-production of habitats and landscapes will produce more than food, e.g., promote recreation and a number of other ecosystem services. Such peri-urban agriculture and food production will enhance flexibility and contribute to urban food security and, thus, urban resilience.

3. Material and Methods

3.1. Study Sites

We selected the following three European urban regions for the study of peri-urban agricultural landscapes: Gothenburg in Sweden; Copenhagen in Denmark; and Gent in Belgium (Figure 1). The scale and level of resolution are different for the three cases. The three case study areas are all “peri-urban” according to the definition in Loibl et al. [3], but the national share of total peri-urban land varies significantly between the three countries in question, approximately 2% in Sweden, 5% in Denmark and 40% in Belgium [36]. The Gothenburg and Gent studies are outlined in detail in the RETHINK project (www.rethink-net.eu) [37,38].



Figure 1. The location of the three study areas, Gothenburg, Copenhagen and Gent.

3.2. Data Collection

We used a mixed method methodology and a multi-scale approach which was informed by the five research questions formulated above. For the Hisingen part of Gothenburg, the Swedish case study area, the information on agricultural land use changes on the periphery of the city was collected via the Swedish land parcel system [39] to identify changes during the last 15 years [40]. Information on current land use and production was collected from qualitative interviews with farmers, city planners, and officials responsible for municipality owned land and the management of protected areas. Document analysis (municipal planning documents, maps, etc.) was performed to gather information on the planning situation. For the Copenhagen case, we used data collected from interviews carried out in peri-urban areas in different parts of Greater Copenhagen in 1984, 1994, 2004 and 2014 [41–43]. For the Gent region, data are based on a multi-stakeholder process which was performed in the case area in 2014. In the first step, GIS-data, statistical data, policy data and interview-data were gathered. Data on changes in the number of farms, farmland area, farm type and crops grown were based on national agricultural statistics and the Flemish version of the European land parcel identification system. After analysing these data, they were used as the starting point for a group discussion with the stakeholders [24].

3.3. Data Analysis and Presentation of Results

We acknowledge the context dependence of each case study and, therefore, the results are first presented for each case study and then combined in a table to facilitate a comparative analysis and discussion.

4. Peri-Urban Agricultural Development in Three European Regions

In this section, we present the results from the three cases separately, while a comparative analysis is presented in the end of Section 4, and further discussed in Section 5.

4.1. The Swedish Case—Gothenburg

The city of Gothenburg on the west coast of Sweden is the second largest in the country with 548,190 inhabitants [44]. The urban region comprises 13 municipalities (GR-region) with a population of approximately 1 million citizens. The Hisingen region is located in the north of Gothenburg and is the case study area for this paper. Hisingen has 155,000 inhabitants and is peri-urban, comprising residential, industrial and commercial areas as well as agricultural land. Hisingen was considered to be the kitchen garden of the city and the region was famous for its good quality vegetables [45]. The region included mixed forms of agriculture with livestock, dairy and cereal production, which resulted in a cultural landscape with a large number of habitats and high biological diversity.

4.1.1. Development of Agriculture in Hisingen

Up until the 1960s, farmers from Hisingen took a variety of locally produced foods to the markets in Gothenburg. A considerable proportion of Hisingen (approximately 15%) is protected in the form of nature reserves and Natura 2000 sites and all those areas belong to the coastal cultural landscape.

The general development trend for this peri-urban area is a transformation from a rural agricultural landscape with mixed farming systems, into a peri-urban landscape with strong imprints of urbanisation. During the period 1951–1975, the total area of arable land declined by 53% [46]. Today, a significant amount of agricultural land is used for recreational activities, of which horse riding activities are the most popular [37]. A very important step in the transformation process took place in 1967 when the city of Gothenburg purchased most of the agricultural properties with the intention of using the land for urban expansion. However, urban growth was slower than anticipated and today much of the agricultural land is in the hands of lease holders, some of whom are former landowners. The most evident land use change over the past three decades has been the transformation from

arable land into leys and permanent pastures for the expanding horse businesses and thus shaping the “horsificated” landscape [37,46] (Figure 2).

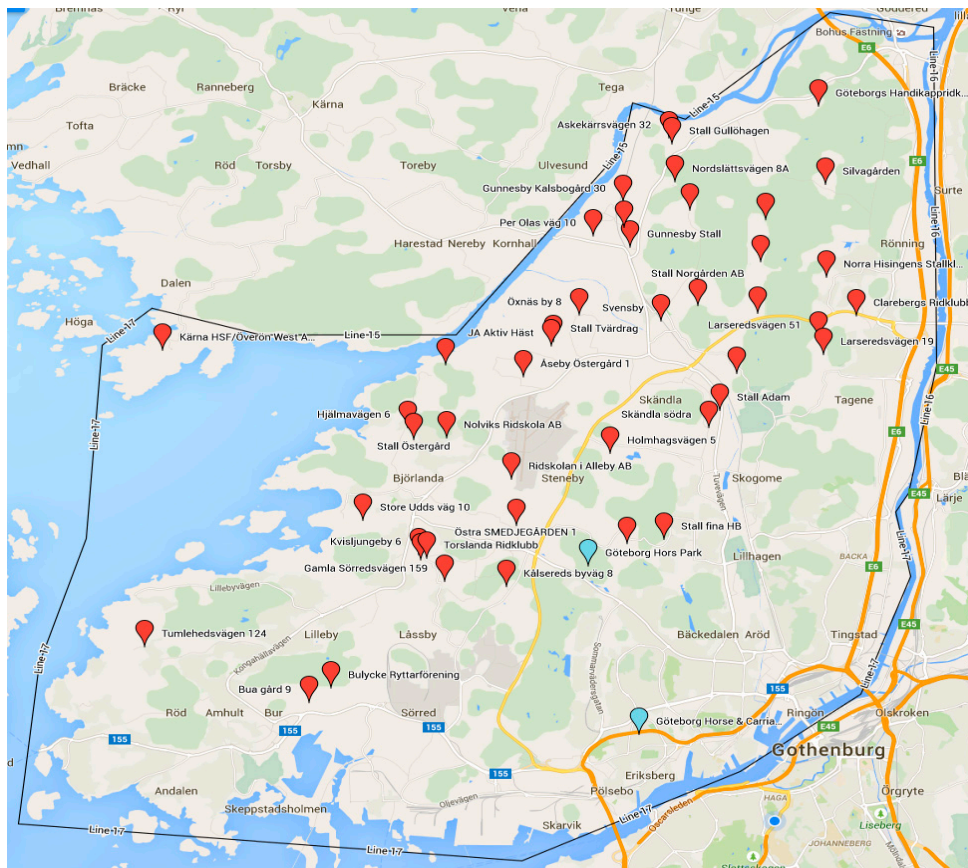


Figure 2. Horse farms and stables with own home page, red and blue drops, Hisingen 2015. The actual number of horse farms is greater than indicated on this map (see [46]). Source: own data collection on Google map.

During the most recent period, 2001–2013, the cultivated arable area in Hisingen decreased by 5% compared to the average of 3% for Sweden for the same period [47]. Today, three farms produce food for local consumption in the region. Of these, two produce meat with grass-fed nearly organic production including grazing on unfertilized grasslands. This is a combination of a management agreement for protected areas, where livestock grazing is part of the management measures, and the need to produce fodder for the meat-producing livestock. Hence, these activities demonstrate a high degree of multifunctionality by producing and maintaining landscape values with biodiversity and cultural values parallel to meat production [48]. One of the farmers sells his meat in his local shop where customer demand is much larger than the current supply [37]. Another farmer produces a diversity of vegetables and berries which he sells on the farm. Once again, demand is greater than the current supply. In total, 15% of the arable land in Hisingen is used for local food production of which vegetable production currently only accounts for 1 per cent.

4.1.2. Strategies for Preserving Peri-Urban Agricultural Land and Aspirations towards Urban Food Policy

There is pressure to use the agricultural land in Hisingen for private housing as well as infrastructure and recreational development. The city recently (2014) launched a new zoning plan for the Hisingen area (Figure 3). The intention is to safeguard some of the agricultural land for local food production. Now, approximately 50% of the agricultural land is used for horse-related activities

(recreational riding, riding schools, summer grazing and winter fodder production), but the city intends to encourage food production on its farmland to increase urban food security and resilience. However, other parts of the agricultural land do not have long-term protection and are maintained as reserves for urban expansion (the yellow areas in Figure 3). The city of Gothenburg is currently working on a policy instrument for local food production and is also actively supporting the establishment of Community Supported Agricultural enterprises [49]. An important ambition of the food production activities is to fight urban segregation and to increase social coherence and sustainability by engaging and mixing different cultural groups [50].

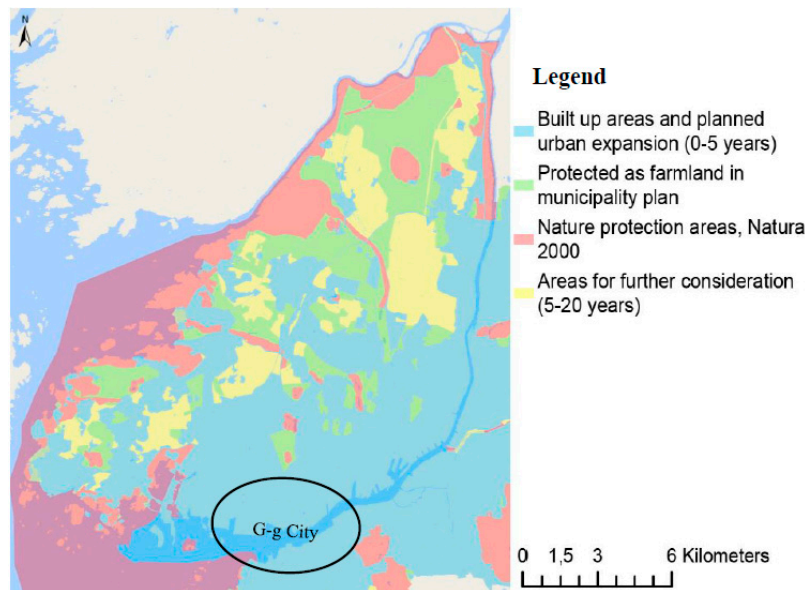


Figure 3. Zoning of land use and planning perspectives in 2014 for Hisingen, peri-urban Gothenburg. G-g is Gothenburg. Source: adapted from Municipality of Gothenburg, 2014.

4.2. The Danish Case: Farming in Greater Copenhagen

Copenhagen is the capital of Denmark and the Copenhagen metropolitan area covers 320 km² and has a population of 770,000 (2016). Greater Copenhagen (GC), which includes the Copenhagen metropolitan area and the surrounding municipalities (a total of 34 municipalities), covers 3020 km² and has 2,020,000 (2016) inhabitants. From an urban perspective, GC is considered to be a functionally coherent metropolitan area with 32% of the peri-urban inhabitants working in the central urban area of Copenhagen. The region includes extensive open spaces including nature reserves and areas used for agricultural purposes [51].

4.2.1. Development of Agriculture in Greater Copenhagen

Due to changes to the administrative boundaries of GC as part of a structural reform in 2006, it is difficult to produce long-term continuous statistics for agricultural development in the region. However, data for the period 1982–2006 show that the total area of agricultural land has declined by 6.5% in GC compared to 5.3% for Denmark as a whole, and that the number of farm units in the same period has declined by 39% in GC compared to 53.5% for the whole of Denmark in total [52].

A case study in GC, which includes eight case areas covering different urban fringe areas in GC for the period 1984–2014 with surveys taking place every ten years, provides interesting and detailed insights into the development of agriculture in the area [42,53] region. The cases studies include the Danish case study for this paper. Figure 4 shows the location of the eight case studies within the differentiated countryside of Greater Copenhagen: the fertile and mostly flat land in the south, and the hillier and less fertile land in the north.

The GC study indicates that the loss of agricultural land to urban development increased markedly after 2004 with all cases losing land to urban development. Likewise, for the six cases that were part of the study for the entire period, the study shows that the number of full-time farmers declined from 14% to 3% in the north and from 38% to 8% in the south. Looking at the land use (for the six cases), arable land in the north and south declined by about 19%, whereas permanent grassland and uncultivated areas increased. Forest increased slightly in both regions, while horticulture (glasshouses) disappeared (see Table 1 for the aggregated land use for the six cases). Concerning livestock, all types declined except horses and sheep. Dairy cows and pigs have completely vanished from the northern case-study areas. Looking at all eight cases, the study shows that, in 2014, only 40% of the farmers produced products that were sold on the market. The remaining 60% only produced products for domestic use or had no agricultural production. In contrast to the declining traditional farming activities, non-farming businesses on the farm increased in the period 1994–2014 in all case study areas, with the largest increase being in the south, 120%, followed by the north, 90%, and the centre 55% (areas closest to Copenhagen City). Non-farming businesses include small crafts, offices, storage, contractors, etc. In answer to the question whether non-farming businesses were a motive for purchasing the farm, 35% of the farm owners answered “yes”. These figures indicate that agriculture for food production is decreasing in GC in favour of hobby farms and non-agricultural activities. The farmers who are still producing (full- and part-time farmers) are mainly arable farmers, some of whom have labour-intensive niche-production (vegetables).

Table 1. The change in agricultural land use in (GCS) in the period 1984–2014 (the six cases that were included in the study for the entire period).

Land Use	1984	1994	2004	2014
Arable land (short term rotation)	84%	78%	74%	67%
Permanent grassland	6%	9%	12%	13%
Horticulture	3%	2%	0%	0%
Christmas trees/greenery	0%	1%	2%	2%
Forest	2%	1%	3%	4%
Other areas incl. buildings, roads, nature etc.	6%	8%	8%	14%

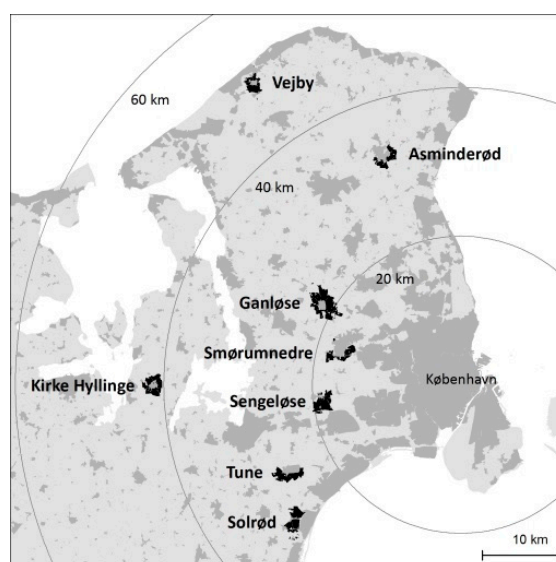


Figure 4. The location of the case study areas in the Greater Copenhagen Survey (GCS) 1984–2014, which includes the Danish case study from this paper. The three northern cases, Vejby, Asminderød and Ganløse, as well as the three southwestern cases, Solrød, Tune and Kirke Hylling, were part of the study for the entire period from 1984 to 2014. The two cases located in the centre closest to Copenhagen, Sengeløse and Smørumnedre, were included in 1994.

4.2.2. Farmland Conservation Strategies

In Denmark, planning for agriculture is a part of the mandatory comprehensive planning system introduced in the beginning of the 1970s. The main idea of the planning system is that the countryside should be a zone where all activities or changes, except those necessary for agriculture (and other primary sectors), need permission. The objective of this system is two-fold: to reserve land for primary production and to prevent urban sprawl and unplanned development in order to protect the landscape and habitats. To complement the rural zoning system, all municipalities also prepare a comprehensive land use plan for the whole countryside including designation and planning rules for agriculture, nature and other interests in the countryside. In addition to planning legislation, agricultural property is regulated by the Agricultural Holdings Act including rules about ownership, leaseholds, education, farm size, etc. During the last 30 years, the rules of the Agricultural Holdings Act as well as the planning legislation have been liberalized, which implies that everybody, regardless of whether they have a farm education or not, can purchase a farm property and that activities other than farming, such as handicrafts, small industry and office businesses, within some predefined frames, can take place on a farm holding without planning permission. The liberalization of the rules related to the type of activities which can take place on a farm have had a huge impact on peri-urban agricultural areas, which is also indicated in the GC study. Moreover, the two-fold objective of the planning legislation: to protect prime agricultural land and nature and landscape of high values from urban development, shows that nature and landscape interests are mostly protected at the expense of prime agricultural land [54,55].

The latest comprehensive regional plan for GC was produced in 2005. Here planning for agricultural land is mentioned, although rather vaguely: *prime agricultural area shall (intentionally) be maintained, if withdrawn for urban and recreational development, respect should be given to the agricultural production condition*. A screening of the municipality plans for 2013, including all municipalities in Greater Copenhagen with a reasonable amount of agricultural land (16 municipal plans), shows that none has an explicit strategy for food production/food security in their municipality. In several of the studied plan documents, agriculture is highlighted as being important for the municipality, but mainly because agriculture keeps the landscape open, contributes to nature conservation or produces energy. One municipality has an explicit strategy to increase organic production and uses this strategy as a way of branding itself.

To summarize the Danish case-study: Governance mechanism with the intention of preserving agricultural land use interests exist, but they are not very effective because the land is not specifically preserved for food production, but for all types of "green production" including nature (uncultivated land). In municipality plans, agriculture is highlighted as being important, but mainly due to its role in landscape maintenance, which indicates that little attention is given to food production or food security.

4.3. The Belgian Case—Gent

Gent is one of the larger cities in Belgium with 248,242 inhabitants [56] and a total area of approximately 157 km² [57]. The total agricultural area in Gent is 3309 ha [58]. This peri-urban farmland has a diverse production and the most common crops are ley and maize, both of which are used for animal production. Other crops grown are corn, potatoes, vegetables, flowers and fruit. Several farms have broadened their activities with on-farm sale of, e.g., milk, potatoes, and strawberries. Both conventional and alternative farmers complain about the high pressure on farmland, which has resulted in a loss of farmland, high land prices and difficulties when buying or leasing farmland.

4.3.1. Development of Agriculture Since 2000

Between 2000 and 2012, the number of farms in Gent decreased from 282 to 154 farms—a decrease of 45%. The average decrease in the number of farms is comparable to the decrease in farms in

Flanders (around 40% during the same period) [59]. Meanwhile, the average *farm size* in peri-urban Gent increased from 10.6 ha in 2000 to 17.7 ha in 2012. The amount of farmland in Gent decreased by almost 10% between 2005 and 2010 [56–60]. The greater decrease in farmland in the case of Gent can be explained by the high pressure from urbanisation, the expansion of the harbour in the north of the city and the active development of nature reserves and woodlots as “green lungs” for the city dwellers.

4.3.2. Farmland Preservation Strategy

Currently, the main farmland preservation strategy in Gent is the “*land allocation plan*” (Figure 5). According to this plan, 2927 ha of land is allocated for agricultural use. Of this land, approximately 2240 ha or 77% is effectively used for agricultural production while an area of 23% is not registered as being in agricultural use (EPR, 2013). This anomaly can partly be explained by shortcomings of the database and the inclusion of roads, small landscape elements etc. in the agricultural zone. However, part of this land is used for non-agricultural activities such as houses, gardens, hobby farming, non-agricultural enterprises. Figures for Flanders show that gardens and non-agricultural enterprises account for 7% of the agricultural land [61], and grasslands with horses accounts for an additional 7% of the agricultural land [62]. Consequently, the effectiveness of the land allocation plan to preserve land for agricultural use in Gent may be questioned [63].

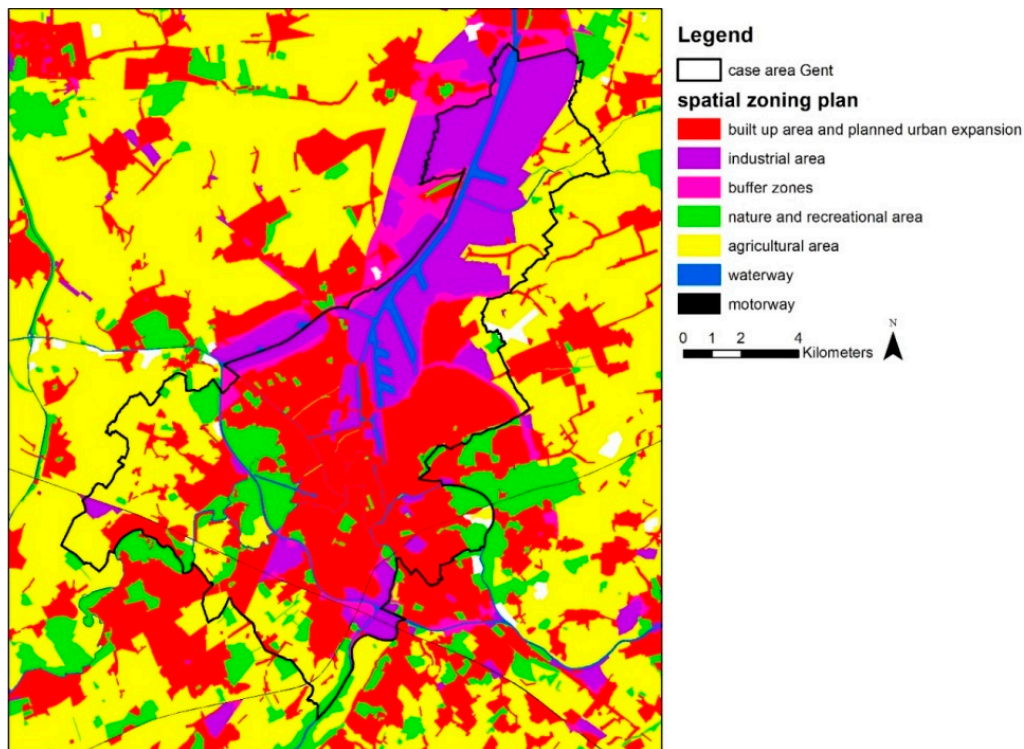


Figure 5. The land allocation plan for Gent in 2013. Source: own data collection, using digital layers from [64].

Recently, the city of Gent recognized the importance of agriculture for coping with climate change. Local food production is considered valuable because it reduces food miles and helps to tackle the urban heat island effect. Moreover, several bottom-up initiatives from city dwellers, such as Community Supported Agriculture (CSA) farms, food production on roofs or on temporary wastelands, indicated a renewed interest in food production. Furthermore, agriculture is considered valuable due to its contribution to attractive living environments and to recreational opportunities in and around the city. Hence, the city established a “food council”, initiated the development of a “*local food strategy*” and started to investigate how these bottom-up initiatives can be supported. Moreover,

the city of Gent wants to implement instruments to maintain sustainable agricultural production in the new “*Spatial Vision*” of the city. The connection between the local food strategy and the spatial vision/plan is, however, not yet clear. Developing a truly integrated policy that can build bridges between agricultural and food policy will be a challenge.

4.4. Comparative Analysis of the Cases

In order to facilitate a comparative analysis, the results from the three cases are summarized in Table 2 below.

Table 2. Status of peri-urban land use changes in the three studied areas. G-g is Gothenburg.

	Gothenburg, S	Gent, Be	Copenhagen, Dk
Loss of Agricultural land (% change 2000–2014, Trends)	Loss of agricultural land: –5% (G-g: On total cultivated area irrespective of crop. Contains permanent leys for horse feed, etc. Calculated on the basis of land parcel data 2001–2013); Decline in arable land; increase in feed production for animals (permanent grasslands); 50% of agricultural land used for recreation, horse riding	Loss of agricultural land: –10%; Decline in arable land; 24% of agricultural land used for recreation, nature protection, etc.	Loss of agricultural land 1982–2014: decrease 6.5% (Copenhagen—see Table 1); Decline in arable land; increase in feed production for animals (permanent grasslands); increase in green spaces for recreation and nature and wood lots
Land use changes on remaining agricultural land	(G-g: calculated on land parcel data 2001–2013.) Cereals: –18% Permanent pasture: +14%	No data	Arable: –20% Permanent pastures: +117% Uncultivated land: +133%
Peri-urban horse farms (Horse farm: horse activities are the main activities; fodder production for the horses is sometimes included. Horse farms use arable land for feed production and horse grazing.)	Hisingen: 45 of total 62 farms are horse farms using approximately 50% of agricultural land Ley/Sown pasture (mainly for horses) increased 14% in 2001–2013	Flanders: An average of 7% of the agricultural land	In the GC case areas, 35 of total 157 farms have horses on the farm (22%) Permanent pasture has increased 8% in 2004–2014
Protected areas (PA) and other green spaces; Trend	5 protected areas (All protected areas in G-g belong to agricultural landscape and include semi-natural grasslands and arable fields), approximately 15% of the Hisingen area; Trend: PAs increasing since 2000	Trend: 4 large protected areas since 2000 for nature conservation and for recreation	Trend GC case study 1984–2014: more land for recreation
Farm land preservation strategy	Yes	Yes	Yes

Although the three cases differ in spatial extent and land cover, some trends are visible.

- First of all, although at different rates, agricultural land decreased in all three cases (Table 2). The first obvious reason is urban expansion including infrastructure. Farmland decreased considerably in all three regions, with a maximum in the Gent region with a decrease of 10% in a timespan of only five years (2005–2010).
- On the remaining agricultural land, there have also been significant changes in agricultural production in all three regions. Generally, there was a decrease in food production and an increase in animal feed production, mainly for horses. In Gothenburg, the case with the strongest horsification trend, horse farms account for 50% of the farmland. In fact, this transformation may be even greater since much of the cereals grown are used for livestock feed. A similar horsification trend is

seen in both the Copenhagen and Gent regions, although here exact figures are difficult to obtain, since the horse farms are considered non-agricultural activities and, thus, data are not available from agricultural statistics. The horsification trend can be interpreted as an expression of the strong interest in recreation, which also includes other activities, such as golfing, sports, etc., close to the urban periphery.

- Parallel to the above described horsification trend in all three cases we also see increase in scale. There was a re-structuring of peri-urban farmland with the amalgamation of smaller farm units into fewer larger units producing mainly for an external market. These farms reflect the general development in agriculture in Western Europe during recent decades [37].
- A fourth visible trend among the studied regions is the increase in protected areas and green spaces (Figures 3 and 5, Table 2). In both the Copenhagen and Gothenburg regions, the maintenance of these protected areas requires agricultural activities such as livestock grazing. As such these protected areas directly invite multifunctional agricultural activities. In addition, in the Gent region, nature areas are actively being developed. Thus far, however, they are not dependent on agricultural activities for their maintenance. In all three cases these green areas attract a lot of recreational activities.

5. The Prospects for Peri-Urban Food Production and Urban Resilience

5.1. Governance Mechanisms for the Preservation of Farmland

All three regions developed governance mechanisms to cope with the above-described trends and the pressure on peri-urban agricultural land (Table 2).

- The purchase of agricultural land in Hisingen by the Gothenburg municipality in 1967 was accompanied by a double strategy so that farmland for agriculture was given lower rent than the horse farms. At the same time, investments in land and buildings were low, which indirectly favoured the horse farms as they use farmland less intensively, often combined with other economic activities. This can be interpreted as a strategy for maintaining land in a waiting stage prior to conversion to other land uses [40] and/or giving priority to recreation over local food production. Since 2014, there has been a political will in the city to promote local food production on the city's own agricultural land. This has led to an intensive discussion in Gothenburg about how this can be achieved, renewed interest in agricultural land and a number of collaborative activities, also including the horse farms. There is a direct link to the on-going efforts to formulate a local food strategy for Gothenburg. In spite of the on-going and very promising developments in local food production in Gothenburg, it should be noted that there is an impending threat as a proportion of the agricultural land in Hisingen, the yellow areas in Figure 3, is only reserved for agricultural use until 2020. Thereafter, the fate of this land is unknown and open to different interpretations regarding which land use should be promoted to achieve sustainable development in urban planning.
- In Greater Copenhagen, it is obligatory for all municipalities to plan for and protect agricultural land. However, this planning has not prevented a kind of sub-urbanisation of the peri-urban areas, which implies that a large proportion of the farm properties are inhabited by people with only a minor interest in food production. Although these municipal plans are made and in several of these plans agriculture is highlighted as being important for the municipality, the main motivations are nature conservation, energy production and maintaining an open landscape. This indicates that little attention is given to food production or food security within the existing governance mechanism.
- In the Gent region farmland preservation is organized through spatial planning and the land allocation plan. However, as only 77% of the land allocated for agriculture is affectively in agricultural use the effectiveness of the plan to preserve land for agricultural use may be questioned. The last decade however interest in food production has risen in the Gent region.

In recent years the city has taken a lot of policy initiatives in this direction and has established a “food council”, initiated the development of a “*local food strategy*”. These initiatives might indirectly benefit the farmland preservation policy. However, for this to be effective, there needs to be a real policy integration of spatial and food policy.

Although all three regions have a governance mechanism for farmland preservation in place, their effectiveness in maintaining food production may be questioned.

The development of the agricultural land use in peri-urban locations in the three countries reflects the EU Common Agricultural Policy, which is linked to and enhances the general globalization of agricultural markets. This has a direct effect on especially the larger farms with agricultural production for an external market at the expense of the local market [65]. The expansion in horse keeping in peri-urban regions apparent in our study is also observable in many other wealthy urban regions [66] and is an expression of the recreational priorities of urban citizens. Further, the land use by the horse farms has positive implications for the potential transformation back to food production. The capacity of the agricultural land to be re-used for arable food production is preserved compared to other land uses which involve construction.

5.2. The Current Peri-Urban Food Production for Local Consumption

The amount of peri-urban food production for local consumption is very modest (Table 3). The data on this production are also very elusive and difficult to attribute to specific regions. In all three regions however there is evidence of farming initiatives that are trying to take advantages of the vicinity of large urban markets. In Gent over the last couple of years we saw a variety of small-scaled short food supply initiatives emerge such as a couple CSA farms, roof food production, the local production of gin etc. On the other hand, the more traditional farmers are also trying to sell their products in on-farm shops. In the Hisingen case there are a couple of farms producing grass-fed nearly organic meat and some farms are producing and selling berries and vegetables directly to consumers. Based on the survey in Copenhagen [53], it is evident that some local sales take place through direct sale and the Internet, and that some new large organic food producers have been established during recent decades. Further, it was obvious from the survey (ibid.) that the decline in full-time farmers has been less profound in the last decade, which indicates that the food producing farmers who have remained in the area of Greater Copenhagen have been able to adapt their production to the peri-urban conditions (ibid.)

Despite this evidence, however, the number of farms with production for local consumption is still fairly limited. At the same time, we also see many non-agriculture related activities taking place on farm estates, which indicates that food production for local consumption is being increasingly displaced by other interests.

Several factors influence the current decline of food production of peri-urban areas including low levels of production for local consumption found in this study.

- First, increased competition for land among farmers, incoming hobby farmers and horse farms has increased land prices (compared to the rural hinterland) and has reduced the land available for full time farmers and thus land used for production. In Gent, farmers indicate that the (low) availability of land is one of the main obstacles to peri-urban food production
- Second, productive peri-urban agricultural land is converted into urban land use (despite farmland preservation policies are in place in all three case areas (Table 2)), nature conservation and recreational areas.
- Third, the growth and centralization of food retailing chains has changed the overall urban food shopping and consumption patterns and has undermined the *traditional* pattern of food provisioning from peri-urban producers. New consumption patterns linked to direct purchase at the farm gate are evolving in all three case studies but these new trends have (so far) had limited overall effects.

- Fourth, farmers need specific skills and competences to exploit the proximity of the city. Besides agronomic knowledge, they also need good marketing and management skills to set up a business models that fully exploits the vicinity of the city. Contradictions in legislation are complicating the development of such multifunctional farming activities (see [24]).
- Fifth, a lack of institutional infrastructure to link peri-urban food production more directly with local consumption is without doubt also playing a role. Although food policies are present within all three urban regions studied no specific initiatives to promote local production and to bring peri-urban farmers in closer contact with nearby urban consumers have been found. On the contrary, increased restrictions imposed on farmers in relation to food safety and CAP payments have supported centralized networks.

Table 3. Status of peri-urban food production and related policies in the three studied areas. G-g is Gothenburg. GR-region is Gothenburg region.

	Gothenburg, S	Gent, Be	Copenhagen, Dk
Peri-urban food production for local sale today	Vegetables, 1 farm, 1% of arable Meat production, 2 farms, 14% of arable	Local sale of potatoes, vegetables, fruit, milk, ice cream, cheese, meat (on farm, farmers' markets, vegetable box schemes), 2 CSA farms	No official data on this issue although increasing interest from urban citizens. The current local sale is estimated to a very small part of the total food production in the PU region
Multifunctional food production for local consumption today	<i>Livestock grazing in protected areas:</i> Meat; Landscape values; Biodiversity; Cultural heritage; Recreation	<i>Sheep grazing on banks of watercourses in the city:</i> Meat; Landscape values; Biodiversity; Cultural heritage <i>Parks with fruit trees and vegetable production:</i> Fruit; Vegetables; Recreation; Social cohesion of neighbourhoods	<i>Some farmers combine food production with other land use activities:</i> e.g., social farming, farm tourism
Governance supporting multifunctional and local food production	No specific governance instrument	Local food strategy and food council initiated by local stakeholders and the city; several bottom-up initiatives such as citizens' groups who start/support local food production initiatives	No specific governance mechanism that supports multifunctional food production—on the farm However, land use planning legislation allows multi-functionality at the farm level
Local food strategy	Yes—in progress to be issued 2017	Yes	No
Peri-Urban Agriculture linking urban—rural regions	CSA enterprises supported by GR-region and G-g municipality	CSA farms	No

5.3. Peri-Urban Multifunctionality and Food Production

Peri-urban regions are particularly well-suited to multifunctional diversification activities due to their proximity to population centres, the fact that they often comprise fragmented agricultural land and because they have the potential for multifunctional transitional pathways [25]. This is apparent in our study as the peri-urban region of all three cities display a number of multifunctional activities on agricultural land, such as hobby farming and part-time farming in combination with other jobs, nurseries for garden plants, adventure farms, golf courses and horse-riding activities [36,37,61,67].

However, so far, few examples of *multifunctional food production for local consumption* have been observed in our case study areas. In Hisingen, Gothenburg, two farms are involved in livestock grazing in protected areas and, accordingly, meat production. The livestock grazing on coastal grasslands and other semi-natural grassland is instrumental in preventing shrubs from overgrowing and in maintaining and promoting biodiversity at the species, habitat and landscape scales [68]. A number of other ecosystem services are also produced, not least cultural services such as maintaining the

attractiveness of the landscape, which is important for recreational and health dimensions [34,35]. The Hisingen farm with diverse vegetable crop production for self-harvest [37] contributes to seasonal crop diversity and to landscape variation and encourages customers to engage in outdoor activities so that it represents another example of multifunctional food production. Examples from Gent are sheep grazing on the banks of watercourses, some parks are planted with fruit trees and vegetables, which are managed and harvested by the local inhabitants and the development of a CSA farm is developed [38].

Previous research, however, stresses that transforming a traditional farming business into a multifunctional enterprise is not as straightforward as it seems [24]. Significant investment in terms of time and money and a range of specific skills are necessary to achieve multifunctional agriculture. Approaching multifunctionality as a territorial concept instead of a farm-level concept might offer opportunities for the future development of peri-urban areas [24,69]. This would, however, require a shift from individual actions to collective and coordinated actions in order to organize the entire set of functions in an efficient way. Furthermore, the complex and dynamic nature of peri-urban areas should also be taken into account [70] as this is often overlooked in zoning approaches.

In order to come to truly multifunctional models we also have to approach the relations between rural actors differently. Is competition for land occurring and does the keeping of horses exclude human food production? The answer is context dependent; in urban regions where most land is suitable for arable cultivation, such as in Gent and Copenhagen, there are obvious land use conflicts. In urban regions as in Gothenburg, the situation is different with relatively small and medium-scale landscape topography and extensive rocky outcrops which provides excellent conditions for horse-keeping. However it might also be possible to combine this with human food production by reorganizing land use and using the outlands for horse grazing in this way freeing much of the arable land for food production. Such a combination of land use would provide a number of ecosystem services, including the production of food for people, and would represent a good model for multifunctional food production. Another step in the direction of the co-production of ecosystem services is the arrangement for utilizing horse manure, previously a problematic waste, as valuable nutrients in the peri-urban cultivation. The search for these kinds of collaborative partnerships between a variety of rural actors might provide opportunities for multifunctional land use in the future.

5.4. What Is Needed to Support Peri-Urban Food Production in Terms of Governance?

More efficient spatial planning measures are needed—although not sufficient—for maintaining a vital peri-urban food production. A possible pathway here could be to give commercial farmers—farmers who mainly live of their food production—priority either in relation to purchase rights (as in the former national agricultural policies) or in terms on tax benefits or through public land ownership and long term leasing contracts. A focus also on urban food security and not only food safety using instruments as those mentioned above could have positive effects.

A second pathway—or combined with the tone above—could be to integrate peri-urban food production more with public open space and outdoor recreation. Cultivated fields with different crops intermingled by grazing lands should be seen as contribution to the recreational landscapes offered to urban people and also contributing to biological diversity at species and landscape levels. This calls for making the peri-urban food production more accessible (in a broad sense) for visitors and outdoor recreation through walking and biking trails and through information on the food production to be experienced. A varied cultural landscape with arable fields, hay meadows offers a multitude of qualities for visitors, or put differently, it produces numerous important ecosystem services—more than food [68].

Thirdly, public–private partnerships between municipal councils and peri-urban farmer represent an institutional way forward to promote a local food policy. Such partnerships could deal with supply of food to public institutions (schools, kindergartens, elderly homes, etc.), with establishment of local

food markets, with leasing of agricultural land, and with educational activities targeted schools and the general public as well.

In Gent, the diversity of bottom-up initiatives for local food production has proved to be a driver for change. The city has been confronted by many requests for space to establish local food production. Combined with the growing concern about climate change, this has stimulated the city to search for a strategy to encourage sustainable peri-urban food production and to develop a local food strategy. In terms of farmland preservation, new creative ways of allocating and combining functions seem crucial. The power of change as a result of local cooperation between various stakeholders is illustrated in a Belgian case study [38] as well as studies from Spain [71], France and Italy [72]. How public debate can lead to greater attention for local food production and the adaptation of spatial plans in favour of local food production was observed by Perrin [72].

The on-going efforts in Gothenburg to develop a local food strategy are very interesting since the specific ownership situation of agricultural land here offers the city a unique opportunity to shape new models for urban-peri-urban relations and urban food security. The city is attempting to establish cooperation between food production, horse riding activities and other recreational needs for the urban population [46]. The city could play a facilitating role in encouraging this multifunctionality [24] by creating networks of farmers and other rural entrepreneurs. There are a number of examples of strategies to include food production in urban planning with the aim of facilitating local food production for the urban population and increasing food security in other cities in Europe (e.g., Paris, London, Plymouth, and Birmingham), North America (e.g., New York, Detroit, Montreal, Toronto, and Vancouver) and Cuba. This mostly has been achieved through the implementation of food charters [73], which is a set of intentions regarding collaboration to increase local food production and food security (ibid.). A food charter brings together local community authorities, entrepreneurs and non-governmental organizations and it provides opportunities to overcome the above-mentioned difficulties in the peri-urban regions.

5.5. How Can Peri-Urban Agriculture Link Urban and Rural Regions and Increase Their Resilience?

In the present study, we have seen that the area for food production is declining in peri-urban regions and that the existing food production is often only to a small extent directed towards local consumption. Yet, parallel to this trend, there are a number of new, small-scale food production activities for local urban consumers [74,75].

These kinds of new forms of food production are needed in the context of sustainability strategies and to achieve the Sustainable Development Goals by 2030 [76]. This implies that food producers in the Global North must not only aim to produce at the lowest cost, but should also consider the environmental footprints in long-distance locations from where resources are withdrawn [18]. A sustainable food production aims at high nutritional value in food products, producing environmental qualities and benefits, e.g., to mitigate climate effects by avoiding long-distance transports and to provide a number of additional ecosystem services by using methods that allow water and nutrient efficiency and enhancing biodiversity at different levels including landscapes. In addition, animal welfare dimensions are included in sustainable food production. Such food production might have good possibilities to develop in the urban/peri-urban context under the restrictions and limitations of available space. Urban and peri-urban food system activities may be the start of a paradigm shift for food production. Paül and McKenzie [71] found that farmers' positive and innovative behaviour in response to urban competition facilitated their transition from conventional farming to alternative practices such as organic farming [77], direct selling and regional branding. In this way, food production—again—becomes directly linked to social and environmental sustainability and public health work [5,78].

Can the mutual dependence between urban and rural areas create synergies and contribute to the shaping of new landscapes with *closer links between the urban and rural landscapes*? A prerequisite for such a development would be *cooperation between spatial planning and urban–rural development agencies*.

The linking of urban–rural regions would increase food security in the urban regions by offering alternatives to products from the global food chains and a less disturbance-sensitive food production in shorter food supply chains.

6. Conclusions

This study shows that these three European urban regions are influenced by significant urbanisation processes and they reflect a similar land use and agricultural development that has developed during the late 20th century up till now.

This study has highlighted the following three developmental trends: (1) Peri-urban arable land was transferred into land for recreational purposes; (2) Remaining peri-urban farms show increase in scale along with the general European development. The food production in such farms is not specifically intended for the urban consumption—commodities are sold on an external market; (3) The development of new forms of niche production that take advantage of the peri-urban location and control labour costs in new ways is occurring in all three areas (e.g., self-harvesting by consumers of vegetables and on-farm sale).

Interest in local food production is increasing in the urban regions (although mainly among the urban middle class). The diversity of urban agriculture activities is increasing and connections to peri-urban food production are developing, particularly in Gothenburg and Gent. However, a number of challenges to extending the interest in urban agriculture to peri-urban food production remain. Such challenges are, among others: the high price of peri-urban land creating a land competition; dominance of large food-chains with comparable lower prices on imported food items; and the peri-urban location for food production demands more than farming skills but also marketing and other entrepreneurial skills.

The studied urban regions have a network of protected areas, green spaces, included in their spatial urban plans. The ecological value and importance for human wellbeing are acknowledged in the city plans. The importance of peri-urban farmlands for strengthening urban food security and a strategy and implementable plan for local food production for urban consumption are not yet apparent in current planning documents. A sustainable future including urban food security requires the re-coupling of urban and rural areas. To strengthen the link between urban and peri-urban regions in terms of food production for urban consumption, the following governance measures need to be implemented:

- Secure incentives/regulations for access to farmland for food production at a reasonable level of land rent decoupled from the huge peri-urban land prices.
- Facilitate the establishment of local markets for locally produced food.
- Encourage and promote the production of Food Charters that link consumers, authorities, entrepreneurs and producers in urban–rural regions.
- Facilitate the creation of networks of farmers and other rural entrepreneurs who have an interest in food production and establish new partnerships around multifunctional agriculture and local food production.
- The linking and integration of spatial planning and urban–rural development agencies.

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