Carrot City: the impact of food security on the design of cities and buildings

Dr Mark Gorgolewski

Professor & Director of
the graduate program
in building science

Department of
Architectural Science
Ryerson University,

Toronto, Canada

1 Abstract

Growing food within an urban or near urban environment can reduce the need for industrialized production, packaging and transportation of foodstuffs leading to environmental and social benefits. It can act as a focus for urban community participation and engagement and can increase awareness of the health benefits of local fruits and vegetables that do not require artificial preservation and ripening and the desire for more natural methods of food production. Movements such as community agriculture, farmers' markets, the 100-mile diet and Slow Food put local food supply at the heart of urban sustainability. Reconnecting cities to their food systems is now emerging as one of the core components of more sustainable urban settlements.

In the past, when transport options were limited and the technology of preserving food was less developed, there existed a very close link between the forms of cities and their regional food supply. The invention of agriculture supported the development of cities and a dramatic increase in human population. The design of buildings was also influenced by the needs of processing, preserving and storing food. However, since the industrial revolution, growing fruit and vegetables within or close to urban areas has been largely eroded, particularly in western nations. Large-scale industrialized agriculture has become a specialized rural activity, and the distances to market have become long and reliant on cheap transport and preservation techniques.

Recent trends towards convenience food leads to increased carbon emissions due to production and processing which is often energy intensive, as well as the necessary packaging and transport which is often from far away destinations. Cooking from basic ingredients is likely to be less carbon intensive – some estimates suggest that returning to food intake patterns of the 1990s would reduce European carbon emissions by 100 million tonnes of carbon dioxide.

Cities such as London, New York, Rotterdam and Toronto, are beginning to consider the impact of food on their future, and developing strategies required to develop food access and production in a sustainable way. These initiatives usually stress the need for urban agriculture to be economically viable, spatially integrated into the city, and to be woven into the social fabric of the city. This may include both opportunistic interventions such as the use of niches and overlooked spaces such as roofs, and planned interventions such as new building integrated food production and urban farms. Cities also offer opportunities to make connections between the requirements of various plants and the available resources such as waste heat, water, nutrients available in waste, etc. At the same time there are opportunities to address issues such as health, community engagement, and education.

This paper discusses how urban agriculture is having an impact on the types of buildings and urban spaces that are being proposed and built. Three different strategies are considered: use of underused infrastructure spaces, vertical farms, and farming subdivisions.

1.1 Wasted urban spaces

The use of these undervalued or waste spaces in the city is a potentially fruitful area for expansion of urban food production, and an opportunity to improve the quality of spaces. Spaces such as abandoned industrial zones, riverbanks, ravines, rail corridors, even residential backyards can be seen as idle sites that are ready to be transformed into spaces for food production, to the benefit of the community. Increasingly designers are looking at the potential for such spaces to become an asset and a catalyst for community-based food production.

1.2 Vertical farms

Producing food in high-rise farms has attracted considerable attention in recent years particularly following the pioneering work of Dickson Despommier. The vertical farm concept has grown out of the realization that as the world population grows there may be a shortage of suitable horizontal surfaces available close to urban areas to produce the quantities of food needed to feed cities. Despommier used data from NASA to estimate that each person could be fed from the produce of about $30m^2$ of intensively farmed land using current technologies and he speculated that this could be reduced with innovation. His team proposed that an urban farm the size of a city block rising 30 storeys high, and providing about $300{,}000m^2$ of agricultural space could supply the nutritional needs of 10,000 people. Despommier claims that benefits would include zero need for food transportation, on site waste recycling, year round food supply with reduced reliance on weather, and urban renewal providing economic benefits to the city.

Nevertheless critics claim that even if vertical farming were feasible on a large scale, it would merely extend the dependence of food production on industrial inputs, chemical processes, and fossil fuels. Even with all-glass walls, insufficient daylight will penetrate between the floors. Calculations suggest that to produce significant amounts of food in such buildings would be a huge drain on electricity supply, making them impractical, and the food would have a very high energy input per calorie of useful food energy.

1.3 Farming Subdivisions

Farming Subdivisions have evolved in recent years where residential uses are mixed with working agricultural land used for orchards, vineyards, annual and perennial crops, and livestock. Typically such subdivisions are protected through a conservation easement or land donation which limit what type of development is allowed, but do not always ensure the land will continue to be farmed. Usually long-term agreements with farmers in the community encourage adoption of organic and small scale farming practices to minimize impacts on the residents and provide jobs within the community.

Although such communities may reduce “food miles” travelled if the food which they produce is consumed locally, this has to be balanced by the potential of additional car transport and other environmental damage they generate. Farm subdivisions continue to fuel the development of exurbia, bringing people to the edge of cities, and exacerbating sprawl. Many of these developments have limited community diversity, and consist of large family houses located in places which are poorly served by public transport and require the residents to rely on cars for transport.

This paper considers the implications of these three strategies on food supply and the design of the built environment. The implications and limitations of these strategies are considered and projects are used to illustrate these ideas.

Keywords: urban agriculture, resilient city, food security, vertical farms, farming subdivisions

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Summary

Growing food within an urban or near urban environment can reduce the need for industrialized production, packaging and transportation of foodstuffs. It can act as a focus for urban community participation and engagement. There is also an increasing awareness of the health benefits of local fruits and vegetables that do not require artificial preservation and ripening and the desire for more natural methods of food production. Movements such as community agriculture, farmers' markets, the 100-mile diet and Slow Food put local food supply at the heart of urban sustainability. Reconnecting cities to their food systems is now emerging as one of the core components of more sustainable urban settlements.

This paper discusses how urban agriculture is having an impact on the types of buildings and urban spaces that are being proposed and built. Three different strategies are considered: use of underused infrastructure spaces, vertical farms, and farming subdivisions. The implications and limitations of these strategies are considered and projects are used to illustrate these ideas. In particular, Toronto in Canada is used as a model to show ways to tackle agriculture and food issues as design challenges in urban locations. These examples of the connections between food issues, increased density and built form have the potential to transform not only food systems; they can also underpin basic assumptions about the spaces and functions required in the design of buildings and urban spaces, and our understanding of the sustainable city.

Keywords: urban agriculture, resilient city, food security, vertical farms, farming subdivisions

1. Introduction

In the past, when transport options were limited and the technology of preserving food was less developed, there existed a very close link between the forms of cities and their regional food supply. The invention of agriculture supported the development of cities and a dramatic increase in human population. The design of buildings was also influenced by the needs of processing, preserving and storing food. However, since the industrial revolution, growing fruit and vegetables within or close to urban areas has been largely eroded, particularly in western nations. Large-scale industrialized agriculture has become a specialized rural activity, and the distances to market have become long and reliant on cheap transport and preservation techniques.

The physical footprint of most cities is steadily growing, but the ecological footprint which measures the impact of the city by the amount of land that is needed to provide for all of its resource and waste disposal needs is far bigger, extending to many times the physical size of the city, and it is also growing rapidly. Resilient cities are cities that can effectively operate and provide services under conditions of distress, such as when global supply chains begin to break down due to oil shortages. Resilient cities can better absorb various shocks and stresses to which they may

be exposed, including world food supply problems.

Urban agriculture is an essential part of a resilient city. Growing food in cities reduces the dependency on distant food supplies, which can easily be affected by disrupted transport, armed conflicts, droughts or flooding and increasing food prices. Apart from enhancing food security and reducing the urban ecological footprint, urban agriculture can also play a role in city greening, air quality, water management, and social cohesion.

Furthermore, food supply is deeply implicated in the problems of climate change. The WWF estimates that the food chain contributes about 30% of total UK greenhouse gas emissions [1]. Other estimates have suggested even higher figures in some countries. With a world population approaching 7 billion and predicted to grow to 9 billion by 2050, food production becomes a key factor in the battle with climate change, requiring changes in what we eat, how we produce it and where it comes from.

Recent trends towards convenience food leads to increased carbon emissions due to production and processing which is often energy intensive, as well as the necessary packaging and transport which is often from far away destinations. Cooking from basic ingredients is likely to be less carbon intensive – some estimates suggest that returning to food intake patterns of the 1990s would reduce European carbon emissions by 100 million tonnes of carbon dioxide [2]. In the UK it has been suggested that carbon dioxide emissions could be reduced by about 22% if food were produced organically, consumed locally, and only when in season.

Urban regions are the primary consumers of food, energy, water and other resources, and they produce huge volumes of waste that need to be disposed. Increasingly, communities around the world are considering how to transition to a post-carbon economy and reduce other environmental impacts and deal with these resource needs in a more holistic way. A key factor is to integrate food, energy and water into closed loop systems and this opens up many opportunities for alternative ways to provide the basic needs of the community. In most existing urban areas there is a lack of closed-loop thinking where wastes from one process are used as a resource elsewhere. Integration of urban agriculture at the scale of a community allows a variety of synergies and closed-loop systems to be explored. Many opportunities exist for developing systems based on ecological principles that consider cyclical approaches and feedbacks.

Mougeot [3] imagines a city as an ecosystem, and lists several key aspects of resilience: 1) urban agriculture integrated into urban management (requiring governmental recognition), 2) self-reliance through local food systems (local markets and food security through cooperation of local producers), 3) available green spaces that provides ecological and social benefits to both the rich and the poor, and 4) well-established resource recovery, in which waste is reused as bio-compost.

1.1 Cities and food

Not surprisingly, cities are beginning to consider the impact of food on their future. For example, the London Mayor's Food Strategy Implementation Plan considers the strategies required to develop London's food access and production in a sustainable way. In New York City, FoodWorks is a plan spearheaded by the City Council Speaker to "use New York City's food system to create jobs, improve public health and protect the environment." The program seeks to create a greener, healthier New York by improving the food cycle of "production, processing, transport, retail, consumption, and post-consumption [4].

The work in Rotterdam to develop a food strategy stresses the need for urban agriculture to be economically viable, spatially integrated into the city, and to be woven into the social fabric of the city. De Graff [5] has proposed that urban agriculture should be incorporated into the city spatially, technically and socially. Spatial integration addresses the need to find appropriate locations within the city for food production. This may include opportunistic interventions such as the use of niches and overlooked spaces such as roofs, and planned interventions such as new building integrated food production. Technical integration addresses opportunities to make connections between the

requirements of various plants and the available resources such as waste heat, water, nutrients available in waste, etc. Social integration addresses the organisation needs of urban agriculture, and the opportunities to address issues such as health, community engagement, and education.

Food issues can often be a point of departure for addressing a range of design challenges including social inclusion, cultural context, community design and sustainable building practices. Research suggests that food-related initiatives can lower water treatment costs, reduce the heat island effect in cities, and cut health costs through better nutrition. This can all help politically to enable funding initiatives for such projects.

2. The potential for growing food in urban areas

Despite Ebenezer Howard's proposals at the start of the Twentieth Century for towns integrated with agricultural lands, traditionally planners have frowned upon mixing agricultural uses with housing. Modern agriculture is regarded as an industrial process, generating noise, odours, pollution, manure and other wastes, and using heavy machinery that should be kept away from homes. Conversely trespass and vandalism can be a problem to farmers. But can small-scale agriculture, designed to feed local people, successfully combine with residential land uses? Recent interest in alternatives to industrial agriculture have led to smaller scale, organic approaches to food production, less reliant on chemical fertilisers, insecticides and herbicides, that may be more suitably integrated with urban and suburban environments. It is now important for the urban design community to consider the implications of such food production on the design of buildings and urban spaces.

Below three approaches to urban food production are discussed in more detail, illustrated with examples of project or proposals for Toronto in Canada.

2.1 Wasted urban spaces

Contemporary cities are full of abandoned or overlooked spaces often abused and regarded as contributing little to the urban fabric. The flight of heavy industries from many North American cities have created landscapes that are often left unused due to complex social and economic pressures that make the land undesirable for any use. Such spaces, described as "junk spaces" [6] or "drosscapes" [7], are often condemned as urban scars and lead to localized social and economic poverty. Similar phenomena occur on land that is adjacent to, or under, major arterial infrastructure such as elevated highways and transit lines. A Brookings Foundation study reported that 70 major American cities averaged 15% vacant land area, with higher vacancy rates in the south [8].

In many cities around the world there is an ongoing debate about what is an appropriate response to such junk spaces and specifically how to reduce the impact of essential infrastructure on local neighbourhoods, particularly as the environmental justice movement has highlighted that the worst land uses tend to occur in the most impoverished parts of town. The use of these undervalued or waste spaces in the city is a potentially fruitful area for expansion of urban food production, and an opportunity to improve the quality of spaces. Spaces such as abandoned industrial zones, riverbanks, ravines, rail corridors, even residential backyards can be seen as idle sites that are ready to be transformed into spaces for food production, to the benefit of the community. Increasingly designers are looking at the potential for such spaces to become an asset and a catalyst for community-based food production. For example, BK Farmyards' Stacey Murphy saw an opportunity in expanding the use of suburban shopping centers with large underused parking lots. The proposal "Park N Farm – Terraforming the Strip Mall Parking Lot" is a strategy to transform oversized strip mall parking lots into food producing areas. The UK architectural consultancy What If has mapped neglected spaces that surround the inner city housing estates in Shoreditch, London, UK. They have identified, as Jane Jacobs in North America has suggested, that gaps within the urban fabric can detach and isolate communities. They have been developing a strategy for how such unloved spaces could be appropriated to accommodate the needs of the local population, including for growing food. In Toronto, the Tower Renewal initiative initiated by the previous Mayor links the potential for local food production with a neighbourhood's social and physical renewal.

These project show that undervalued infrastructure spaces in the city have considerable potential for community food production. The Gardiner Expressway, a highway overpass that slices through Toronto separating the city from Lake Ontario, includes a raised section. This provides the location for a proposal by Toronto student Andy Guiry, which investigates the possibility of situating productive greenhouse spaces below a raised highway, utilizing the side facing south to capture sunlight and the heavyweight structure of the highway for thermal mass to store the captured heat. Other features of the project include the reuse of wasteland adjacent to the highway for additional productive land, and the integration of educational facilities and a commercial space that sells garden supplies in addition to food and plants produced in the large greenhouse. Adding to the sustainable agenda for this project, materials proposed for the building were to be reused components from nearby wherever possible. This concept has the potential to be implemented below many raised highway structures with unused, or underused land below.

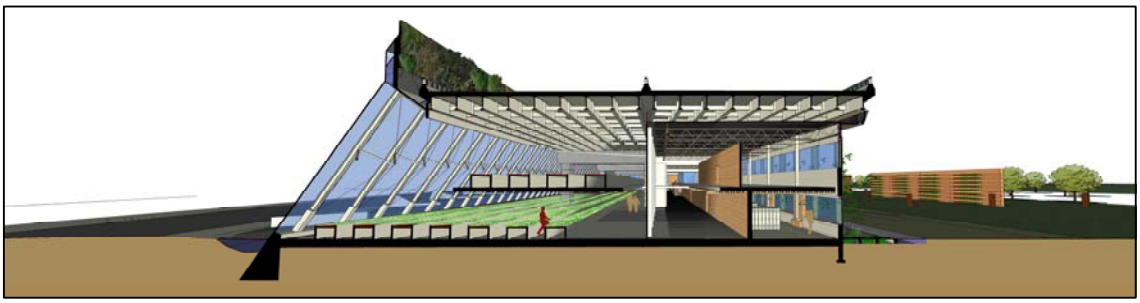

Fig. 1: The Gardner Expressway Agriculture Centre

Two other projects in Toronto demonstrate the potential for unused industrial buildings to be adapted for community benefit and integrate food issues with community engagement, education, recreation, and promote healthy eating and a healthy lifestyle. Artscape Wychwood Barns is a multiuse cultural space with a substantial urban agricultural component housed in a repurposed early 20th century repair and maintenance facilities for Toronto's streetcars. It incorporates a productive greenhouse and offices for The Stop Community Food Centre together with event spaces, artists' studios, live-work studios and non-profit arts and environmental organizations. Fruit trees, a playground and parkland surround the barns, mediating between this large facility and the small-scale residential buildings in the neighbourhood. The Evergreen Brick Works, a disused brickworks in the Don Valley, aims to become a resource for "nature, culture and community". Among the buildings that were repurposed are The Pavilions, a sheltered outdoor space made from one of the former factory buildings. It is now a 2,500 m^2 area for farmers' markets, festivals, plant nurseries and other activities held in the warmer months. Between The Pavilions and The Welcome Centre, a Welcome Court was created as a sheltered garden with benches and 13 different garden beds planted with a variety of edible plants, native trees, shrubs, wildflowers, and marsh plants.

2.2 Vertical Farms

Producing food in high-rise farms has attracted considerable attention in recent years particularly following the pioneering work of Dickson Despommier, a professor of public health at Columbia University, in the Vertical Farm Project for New York [9]. The vertical farm concept has grown out of the realization that as the world population grows there may be a shortage of suitable horizontal surfaces available close to urban areas to produce the quantities of food needed to feed cities. Despommier used data from NASA to estimate that each person could be fed from the produce of about 30m^2 of intensively farmed land using current technologies and he speculated that this could be reduced with innovation. His team proposed that an urban farm the size of a city block rising 30 storeys high, and providing about 300,000m^2 of agricultural space could supply the nutritional needs of 10,000 people. Despommier claims that benefits would include zero need for food transportation, on site waste recycling, year round food supply with reduced reliance on weather, and urban renewal providing economic benefits to the city.

The Pyramid Farm conceptual design by Despommier and Eric Ellingsen of the Illinois Institute of Technology for Dubai embodies the research at Columbia University, and presents an architectural interpretation for a vertical farm. The first full scale vertical farm based on Despommier's ideas is proposed to be built in China. These concepts have inspired many architects and students of architecture to develop visions for high-rise, vertical farms all over the world [10].

For example, the Plantagon Greenhouse is a Swiss-American proposal for a massive 100m high glass dome designed to grow plants on a spiral platform. It is based on an idea from Swedish innovator and eco-farming expert Åke Olsson. Crops are planted at the bottom of the sphere and gradually climb higher before ultimately being harvested at the top. The Plantagon project is expected to cost about $100m to build, and a feasibility study suggests that the largest version of the structure would take three years to recoup its initial investment, while smaller versions of the greenhouse would take around 10 years. Another example is Pig City, which is a provocative solution offered to deal with the concentration of pig-farming operations in the Netherlands.

In Toronto there have been several proposals that integrate Despommier's ideas. Gordon Graff has designed a mixed use productive structure that is divided into several productive components: a living machine to filter waste water, a hydroponic farm to produce food and an anaerobic digester for power generation, six and a half stories of the building devoted to vertical hydroponic food production - enough to feed a thousand people, and a roofs that supports community gardens. Another student project by Brad Augustine, Vert adopted a more conceptual approach to analyse the impact of food production on the environment. The goal of this thesis proposal for a high-rise farm culminating in a penthouse restaurant was to demonstrate the size of building and resources needed to grow all the food consumed in the restaurant at the top of the tower. Feeding cattle to produce beef, for example, takes many times the space as producing vegetable. Restaurant patrons would travel in a glazed elevator through the floors of food production: cows, chickens, grain, vegetables, fruit trees, etc. into a restaurant where herbs are grown and the cooking is completely visible. By internalizing the growth and production of livestock and produce and examining the theoretical food plain required to support our food needs, Augustine sought to display in a literal fashion the impact of the food production industry on major urban centres.

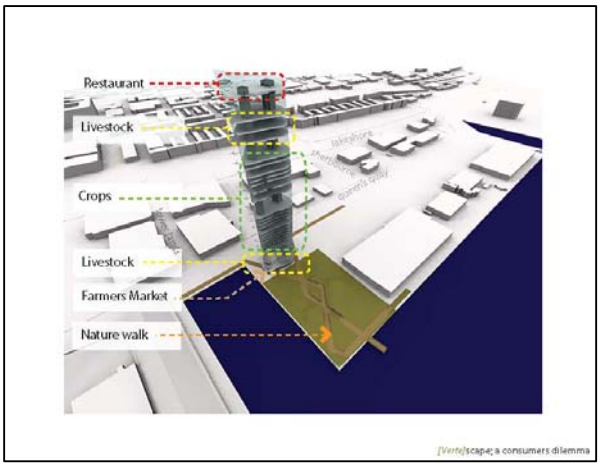

Fig. 2: Vertical farm proposal for Toronto by Brad Augustine

These utopian proposals generally rely on established technologies such as advanced greenhouse systems, hydroponics, aeroponics, passive solar systems, biogas energy generation, etc, but combine them in creative but untried ways. Nevertheless the vertical farm concept has been criticised as having little practical significance for addressing world food problems. Critics claim that even if vertical farming were feasible on a large scale, it would merely extend the dependence of food production on industrial inputs, chemical processes, and fossil fuels, removing agriculture daylight and without the use of significant amounts of artificial light the expected agricultural yields will not materialise. Even with all-glass walls, insufficient daylight will penetrate between the floors. Calculations suggest that to produce significant amounts of food in such buildings would be a huge drain on electricity supply, making them impractical. Cox and Van Tassel estimate that to grow 15% of US annual wheat produce would require all the electricity generated in the US in one year. The food would have a very high energy input per calorie of useful food energy [11]. In addition the embodied energy from the construction of the building should be considered.

2.3 Farming subdivisions

The consumption of farm land at the edge of urban conurbations is well documented, and of continuing concern. One response to this in North America has been the adoption of “Conservation Subdivisions” that aim to accommodate the pressure for residential development allowed under zoning regulations, while protecting agricultural land and natural resources [12]. A proportion of the land is set aside for uses such as food production, forestry, waste water disposal, or outdoor recreation. The number of residential units may not decrease, rather the lots are usually smaller leading the same overall density, but arranged in clusters of greater density with open space between. This reduces the need for infrastructure such as streets, sewer lines, and services, and provides financial and environmental benefits for the developer and the municipality. Other elements such as wells and septic systems can be shared reducing the costs of construction, operations and maintenance.

“Farming Subdivisions” have evolved in recent years as a particular type of conservation subdivision where residential uses are mixed with working agricultural land used for orchards, vineyards, annual and perennial crops, and livestock. Typically such subdivisions are protected through a conservation easement or land donation which limit what type of development is allowed, but do not always ensure the land will continue to be farmed. Usually long-term agreements with farmers in the community encourage adoption of organic and small scale farming practices to minimize impacts on the residents and provide jobs within the community. The accepted uses need to be clearly outlined and understood by both farmers and residents to maintain good neighbour relations.

The Agritopia Project [13] in the Town of Gilbert near Phoenix, Arizona is a 210-acre mixed-use community centred on a local farm owned by the Johnston family. The speciality crops, grown using organic methods, are sold at the Farm Stand and are used at a local restaurant. In addition to gardens, stores, educational facilities, restaurants, and community buildings, the zoning codes permit more than one dwelling unit on a lot. This provides for flexibility in the use of the lots as family needs change, including, family gardens, second units, or small business facilities. Community farm lots of 400 sq ft (37m2) in raised beds are available for community members to rent.

Colorado based consultant Matthew “Quint” Redmond has proposed the “Agriburbia” concept for suburban housing developments with food production facilities interspersing the homes [14]. The intention is to put residences into closer contact with the source of their food by providing fresh, local food for homes and restaurants, while providing economic benefit for the community. His proposals include a calculation of the calorific needs of the community and a design that can meet at least 50% of these needs from the site. Agriburbia projects have been proposed for many sites in the USA, often integrated with New Urbanism planning principles for the building components. For example, the Platte River Village is a proposal for a 618-acre development in Milliken, Denver for 944 planned homes surrounded by 108 acres of backyard farms and 152 acres of drip-irrigated community farms .

Although such communities may reduce “food miles” travelled if the food which they produce is consumed locally, this has to be balanced by the potential of additional car transport and other environmental damage they generate. Farm subdivisions continue to fuel the development of exurbia, bringing people to the edge of cities, and exacerbating sprawl. Many of these developments have limited community diversity, and consist of large family houses located in places which are poorly served by public transport and require the residents to rely on cars for transport. However, if designed as mixed use communities with employment potential and close to public transport they can reduce the environmental footprint of their residents. Redmond has developed a tool to compare how a community addresses the carbon intensity of three key aspects of future resilience: transport, shelter and food. Many farming subdivisions score well in the food category, since they provide local food, but are in locations where cars are necessary for transport, and individual, large, single-family houses are energy intensive (per occupant). The Agriburbia concept aims to address this through New Urbanist, and energy efficient design principles.

Farming subdivisions are gaining acceptance from the development community in the US, and increasingly farms are seen as an amenity that adds value. The Urban Land institute estimates that there are currently at least 200 projects that include agriculture as a key community component [15]. While many of these are aimed at affluent homeowners and focus on speciality agriculture such as vineyards, some are beginning to integrate more diversity and agriculture targeted at the local community. Prairie Crossing is an example of a farm subdivision that addresses a variety of environmental and community issues, including diversity of residents.

Proposals for Treasure Island in San Francisco are another interesting example. This development on a 400-acre island former naval base integrates organic agriculture into a 6,000 resident new neighbourhood where all the homes are within an easy walk of a new ferry terminal that connects to the city. Plans include use of an old air hanger as a market hall and for artisanal food production.

In future developers need to consider how the principles of farming subdivisions can be integrated into existing urban areas, and address affordability, diversity, and access to public transport. Many existing suburbs have considerable areas of underused land with food production potential, but land ownership issues preclude easy integration of farming subdivision principles.

3. Conclusions

As urban agriculture's potential for promoting community, social, economic, and environmental goals has started to be widely recognized over recent years, it is increasingly being integrated into large-scale development projects by architects and developers. Furthermore, food production has moved up the municipal agenda, so city authorities in many countries have begun to take increasingly strong interest in it. Partly through increasing awareness by planners and partly through pressures from citizens, urban agriculture is thus being considered in many comprehensive plans and neighbourhood plans in North America [16].

Appropriate municipal policies are crucial to the wider adoption and success of urban agriculture. Some cities assist through zoning policies, land allocations, strategy development, and even funding. However, local policies are often still based on outdated planning and community health attitudes and can present significant barriers to food production. Other, perhaps more enlightened, municipalities have begun to recognize agriculture as a basic urban land use, and to look for opportunities for integrating it into broader urban and regional planning and policy.

Urban areas in western cities have zones that encompass very differing and distinctive characteristics that offer a variety of urban agriculture opportunities. These include:

- City centres often feature dense development due to the high cost of land. In such areas, buildings can be designed with integrated food production components.
- Traditional urban residential areas that feature a fairly dense urban fabric with small yards and limited public green space (e.g. Mole Hill in Vancouver) can focus on strategies that incorporate planters and raised beds, rooftop gardens on new buildings, and farmers' markets.
- Old industrial areas, some of which are in transition offer significant land and rooftop opportunities for urban agriculture while prior land contamination makes greenhouses, food preparation businesses, raised-bed gardening, rooftop gardening and small agricultural businesses most suitable for these areas.
- Older suburbs tend to have enough land to offer opportunities for growing in community spaces as well as front and back yards.
- Low-density suburbs often have considerable public land available for food production as well as the front and back yards of private homes.
- Commercial areas at the edge of cities (e.g business parks) and government complexes often have large parking lots and lawns that can be used for horticulture.
- Peri-urban agricultural land can be used for extensive food production as well as providing opportunities for integrating recreation and education with agricultural activities.
- Infrastructure – highway, rail, power line corridors, etc. often has considerable waste land affording opportunities to integrate the production of food with the spaces provided for

energy and transportation infrastructure.

- City solid waste and wastewater and storm water can be treated and reused as nutrient sources.
- Areas in transition such as sites awaiting development may provide short-term opportunities for community engaged food activity.

Architects, landscape architects and other designers are finally moving from reimagining productive cities to designing such cities and, ultimately, to implementing these designs. But cities need specific policies that address the opportunities in these different urban regions for food production and assist in making these projects happen. Such policies have many implications for the physical environment of cities.

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