Future of Food: Journal on Food, Agriculture and Society
4 (1) Spring 2016

Local food security initiatives: systemic limitations in Vancouver, Canada

Alfred Wong* [1] and Alan Hallsworth [2]

[1] Friends of Aboriginal Health, Vancouver, Canada
[2] University of Portsmouth, Portsmouth, United Kingdom
* Corresponding author: *taiping@fnaboriginalhealth.net* | Tel.: +1-604-732-9608

Data of the article

First received: 21 September 2015 | Last revision received: 08 March 2016
Accepted: 11 March 2016 | Published online: 10 April 2016
URN:nbn:de:hebis:34-2015102649203

Key words

Cropping conditions, Economics, Food security, Land use, Urban gardening

Abstract

This paper approaches the topic of urban/community gardening not through the lens of urban theory per se but in light of basic farming realities such as growing season and land availability. Food security comprises availability and affordability. In the context of North American and Western European societies, only food affordability normally merits public discourse. In practice, governments have little or no means to change food affordability, in view of prevailing capitalistic free-market structures. In the current wave of popular exuberance, civic politicians and others have promoted the belief that community gardening could be the pathway to produce affordable food. The formidable obstacles to this pursuit include the availability of (low-cost) land within the highly-densified city limit, insufficient ambient temperature and water supply during the growing season and the contemporary structure of society. Overcoming these fundamental hurdles carries significant negative environmental and economic consequences.

Introduction

Food security relates to both food availability and food affordability (Pinstrup-Andersen, 2009). In North America and Western Europe, the issue of food availability has essentially been resolved by increasingly efficient international transportation networks. Food affordability is, however, an intractable problem which is tied closely to the structure of the prevailing free-market capitalistic system (Kneasfsey et al., 2012). Low-income citizens are routinely exploited, resulting in their having access to low-cost foods at low quality and/or higher quality foods at exorbitantly high pricing.

In North America and Western Europe, many civic politicians and a growing minority of urban populations have come to believe that fresher and safer food could be produced locally at comparable or lower costs (see, for example, City of Vancouver, 2011a; City of Vancouver, 2011b). For Vancouver city politicians, the promotion of food security from local production is considered to be risk-free. The obvious truth is that no citizen would ever be against the increased availability of less expensive foods. But is this food security proposition meaningful? The economic and technical fundamentals are weak. For example, there is little or no consideration of the impact of corporate structure of food supply and distribution on food security (see, for example, Hallsworth & Wong, 2015b). After all, the sole purpose of a modern corporation[1] is to maximize prof-

Citation (APA):
Wong, A. & Hallsworth,A. (2016). Local food security initiatives: systemic limitations in Vancouver, Canada, *Future of Food: Journal on Food, Agriculture and Society*, 4(1), 7-28

it for its shareholders (Wong & Hallsworth, 2013). There is no other legal mandate (Friedman, 1970). It follows that food security is of no topical concern to the corporation controlling food supply and distribution to the urban masses. The exception would of course be if participation in building food security from local production will result in substantially higher profit for the corporation. Furthermore, vital technical issues such as land availability (priced under any political ideology), geophysical conditions and labour supply have largely been unaddressed in the relevant literature (see, for example, Colasanti & Hamm, 2010; Jenkins et al., 2015).

Interest in local food production, notably of vegetables and fruits, has increased substantially in North America during the past decade (Onken & Bernard, 2010) even as macro-economic pressures push commercial operations in the opposite direction (Sacks, 2010). The geographic definition of "local" in local food production is still being contested (Feagan, 2007; Hand & Martinez, 2010). There appears to be considerable elasticity in geographically focused definitions. For example, in Canada, Smith and MacKinnon (2007) have popularized the 100-mile diet as being "local". This distance limit appears to be largely arbitrary and expediently fit the local geography (see for example, Byker et al., 2010). Conversely, 'local' can simply mean that the product has not crossed a national border. Using that definition, in Sweden for example, "local" might cover produce from Skåne (e.g., Kristianstad, 56.03 ºN-14.16 ºN in the south) sold in Pajala kommun (67.18 ºN-23.37 ºE in the north), a distance of over 1,500 km (Jeswani, 2009). In reality, vegetables delivered from example neighbouring Tornio (65.85 ºN-24.15 ºE, in Finland) would certainly be more "local", at a distance of about 160 km. For national-boundary reasons, Finnish produce sold in Sweden might not be considered to be "local". It may be noted that Swedish and Finnish populations are culturally very similar in this North Baltic region.

From a broader perspective of human geography, "local" does not necessarily mean purity in, among other things, community spirit (see, for example, DuPuis & Goodman, 2005). Similarly, "local" does not always mean lower carbon footprints (see, for example, Wong & Hallsworth, 2012). Will the prices of "local" goods be lower? The pursuit of maximum profit is the only guidepost. In other words, a local producer (or merchant) would strive to sell "local" products at whatever price the market will bear (Wong & Hallsworth, 2016). There is no higher motive or driving force. This philosophical viewpoint of community spirit and social justice might be just wishful thinking to afford equality and social justice to a community at large. Self-interest in a cash economy will always remain paramount.

The definition of "urban" is itself also highly debatable. Urban (used as a noun) might be best defined to be an agglomeration of human dwellings in a relatively small area, for example a location of high human population density, which is opposite to "rural", wherein human dwellings are widely dispersed. But there is no threshold parameter to qualify an agglomeration of dwellings to be urban and not rural, vice versa. The definition "peri-urban" originated in France as a description of the area between a city and its countryside (see, for example, Lambert, 2011). *Banlieue* (suburban) is also used routinely in France to designate the area between urban (*ville-centre*) and peri-urban. But in many instances, these designations are meaningless. For example, the city of Timmins, Ontario in Canada (48.5 °N, 81.3 °W) has a registered area of 2,979 km^2 (Statistics Canada, 2015). The actual inhabited area of Timmins is estimated[2] to be only about 15 km^2 for its ~43,000 inhabitants. The "peri-urban" area where many active gold-copper mines are located was annexed several decades ago for taxation reasons. In this example, what is considered urban (or city) is merely a political boundary that could be changed at will. Does a "peri-urban" space exist if there was no agricultural countryside (as in the French context), just forested or mountainous wilderness?

Notwithstanding the continued interest in the promotion of urban gardening in developed northern-latitude countries (see, for example, Jenkins et al., 2015), the perplexing issue is whether prevailing physical and societal circumstances could actually support such a model for food supply in an urban setting. This study was aimed to examine the realities and limitations of producing fresh vegetables locally, in the context of contemporary North America. In particular, the issues of physical, social and cultural constraints will be addressed. Vancouver was chosen as the example because it is located in

ISSN-Internet 2197-411x OLCL 862804632

the mildest climatic zone of Canada. Staple cropping and large-scale meat production are usually already excluded from the discourse because of the relatively large land base and specific processing facilities required. In this paper, "urban agriculture" or "urban farming" is synonymous with "urban cropping".

Methods

This study relies on the analysis of available public-domain publications, for example scientific/ agricultural journal papers, government reports and newspaper articles which are pertinent to the particular case studied. All documents analyzed were cited appropriately in the text. No field research or interviews were undertaken as they were not deemed to be relevant to this case study. The interview approach was deemed to be highly problematic in view of the considerable heterogeneity of, among other things, the ethnicity, age structure, immigration status and employment income of the population. For example, mid-income young professionals living in small (example 75-m^2) apartments of high-rise buildings would intuitively have a very different interest in local food supply from low-income immigrants living in crowded single detached dwellings. There is an extreme paucity of citable literature on Vancouver-specific agricultural practices. After all, large scale food cropping ceased to be practiced within Vancouver city limit more than 50 years ago. Anticipated logistical needs for the re-introduction of large-scale cropping in Vancouver had to be reconstructed from available meteorological and other ancillary infrastructure data.

Accordingly, this paper also contains no new discussion of urban theories as the crucial issue of interest is not how or why cities have grown to be unsustainable in many forms. Instead, only the practical science behind food production and supply is considered. It is conceded however that multiple conflicts inevitably would arise over satisfactory allocation of scare resources for sustenance versus profit (including excess profit). The interested reader is directed to an extensive discourse on underlying "urban" issues including sustainability and conflict over space (see, for example, Soja, 2000; Mayer, 2012; Brenner, 2014; Brenner & Schmidt, 2014; Catterall, 2014; Soja & Kanai, 2014; Peck & Theodore, 2015). Moreover, this paper does not discuss the societal aspects of local food production which are well debated elsewhere.

The scope of the present paper is deliberately restricted narrowly to the subject of the formidable practical barriers to achieving local food security in the dense clustering of human dwellings that is contemporary Vancouver, Canada.

Reality of food security

There is essentially no food availability crisis in present-day North American and Western European societies to warrant urban food cropping. Advances in refrigeration technology and transportation logistics since 1950s have largely eliminated the principal logistical restraints on delivering fresh food supply to large cities (see, for example, Hallsworth & Wong, 2012). The issue of food affordability is recognized to be real only for low income families; this problem could only be solved by substantial changes in the hegemonic economic system of oligopolistic corporate control of food supply and distribution, market exploitation of well-meaning citizens, increasing income inequality, etc. (see, Hallsworth & Wong, 2015b).

Throughout North America and Western Europe, food supply for cities is now controlled by a few large corporations. For reasons of profit maximization, produce might be procured from distant farms from virtually anywhere in the world. The key success factors include cheap labour, warm climate, good water supply, intensive monoculture and low environmental protection standards. The rising market dominance of food production and distribution by large corporations has also limited already scant opportunities for small scale production in the fringe area of urban centres. Moreover, the freedom of choice of consumers has steadily been eroded by the profit-maximization interest of large corporations (Hallsworth & Wong, 2015). It is generally recognized that the sole legally-mandated objective of every corporation is the pursuit of profit (see, for example, Wong & Hallsworth, 2013). The equilibrium price of goods is simply what the contemporary market will bear. Shelf-edge pricing[3] in grocery stores has essentially nothing to do with food grown, locally or not, in an urban or peri-urban setting (see, for example, Hallsworth & Wong, 2015a). Typically, a middle-income[4] family with *x*

ISSN-Internet 2197-411x OLCL 862804632

income can purchase a food item at y price. Regrettably, all too often, a family with less than *x* income cannot afford *y*-priced food. In the hegemonic discourse of the currently-dominant neoliberal regime, the deprived family has clearly failed to "work harder" to achieve *x* income. This is reminiscent of the Irish potato famine exacerbated by the neoliberal economic policy of the English colonial government in the mid-1800s. Food remained available but only if one only had the money to purchase it. A lack of adequately-paid work for the starving Irish people (Woodham-Smith, 1962) was the "problem". Consequently, millions of poor people perished from what was, at root, avoidable starvation. Resolution of the present food affordability problem will be achieved only by a substantial re-structuring of the customary free-market regime. After all, the sole purpose of a modern business entity is the pursuit of profit by all means available (see, for example, Friedman, 1970). It is generally recognized that free-marketing pricing means what the market will bear. Measures such as government control of prices and profit margins contradict the principles of free-market economics. Such a task of reforming free-market economics, - if attempted at all by governments at any level - would be very daunting.

It follows that food security (especially affordability) provides an essentially frivolous driving force for the promotion of urban agriculture, in the context of modern-day North American and Western European societies. For example, dairy products are consumed routinely by a large segment of contemporary population of North America and Western Europe. But dairy cows would need to be fed with on-purpose barley grain crop (or purchased forage crops which are grown elsewhere) or to be raised in open pastures. Neither of which is practicable in Vancouver. The exuberance expressed by most civic politicians, some academics and various advocacy groups in the endorsement of cropped food production (i.e. production of grains, vegetables, tree fruits and roots) in an urban environment would thus appear to be somewhat irrational. It would equally appear that many politicians do not have a clear understanding about the practicalities of urban agriculture.

Systemic limitations of local food production

The intractable fundamental issues of urban cropping in Vancouver are very simple and should be obvious. There does not appear to be any logic in attempting to construct a "theoretical framework" or any other complex urban theories, to justify urban cropping as a practical means to supply foods to citizens in a large city. There are three very basic barriers hindering the realization of urban agriculture as means to provide food security.

Land base

Historic land use

In Pre-Contact days[5], the entire lower reaches of the Fraser River were heavily forested. The *Coast Salish* aboriginal people had inhabited this region in widely dispersed hamlets for millennia. There was considerable spatial separation between hunting, fishing and berry-gathering sites. See Galois (1997, pp. 112-114) for an example description of the seasonal movements of the pre-Contact *Tsimshian* people. Self-sufficiency in food supply was maintained from the harvesting and gathering from the natural environment (see, for example, McMillan, 1988, pp. 201-209; McMillan & Yellowhorn, 2004, pp. 190-232). Harvested foods were preserved routinely by the indigenous people for use during the winter months. Trade in foodstuffs (with distant communities) was largely limited as the transportation routes were difficult. Moreover other coastal or inland aboriginal communities were largely self-sufficient. Various site-specific food delicacies such as oolichan (Pacific smelt; *Thaleichthys pacificus*), and oolichan grease were traded periodically (see, for example, Green, 2008). Food security (in terms of seasonal availability of indigenous supply) was largely maintained in equilibrium (Robinson, 1996). In effect, the lower reaches of the Fraser River (i.e. present-day Metro Vancouver and Fraser Valley) which are densely forested never had planned crop cultivation on a large-scale for reason of food self-sufficiency. The land had no monetary value. By tradition, it was, in effect, a common. The development of Vancouver (as a European settlement) began in the 1850s with the discovery of gold by European prospectors in the upper reaches of the Fraser River (Kloppenburg et al., 1977). The completion of the transcontinental railway in 1887 facilitated the mass influx of European settlers into the region from present-day Eastern Canada. Land was subsequently expropriated by the Crown (in the right of the Colonial government

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of the day) for distribution to loyal (white) subjects of the British Empire (see, for example, Cardinal, 1969). The deliberate policy of the government was race-based colonization by alienation of the indigenous people from the land (see, for example, Perry, 2001, Chapter 5). The indigenous inhabitants (i.e. the aboriginal people) were herded to live in miniscule reservations. Monetization and *bétonisation*[6] of the common land then began in earnest as much of the intact virgin forest was liquidated entirely.

Present land use

There is no possibility for the city of Vancouver to expand its land base. It is hemmed in by the seas and mountains, and by other established adjoining cities. As shown in Figure 1, the geographical constraints of Vancouver eliminate any possibility of "peri-urban" land allocation for urban-agriculture purposes. In reality, there is no such "peri-urban" space. Unlike recently de-industralized American cities such as Detroit (Colasanti & Hamm, 2010; Rudolf, 2010; Crouch, 2011), there was only 1% vacant land recorded in Vancouver in 2006. See Table 1. In 2014, the amount of vacant land was even less. In essence, there is insufficient urban land to provide even just staples for the "massive" population in Vancouver. In the example of medieval England, it has been estimated that one person would require about 0.8 hectare of wheat crop for sustenance (Hallsworth & Wong, 2015a). Over the centuries, improved grain crop yield has largely been offset the increased per capita consumption of staples in modern-day England as elsewhere. It is an inescapable fact is that cities have become too large by design or by accident. They long ago lost any capacity to provide a within-city land-use base for any cropped food production that might result in self-sufficiency of the citizenry. It follows that food sovereignty becomes a moot issue if staple cropping could not be realized.

Civic government intervention

There are several City government directives to promote and regulate urban gardens (syn., community gardens) on a micro-scale (City of Vancouver, 2011a). Using highly-masked publicly available data from the City of Vancouver, Wong and Hallsworth (2016) have estimated the total area of city-recognized and –supported community gardens to be about 40,000 m^2. This figure corresponds to an allotment of about 0.07 m^2 per city inhabitant. It is unlikely that this land allocation could sustain any one person. The underlying problem is of course the acute shortage of "unused land" in the city of Vancouver.

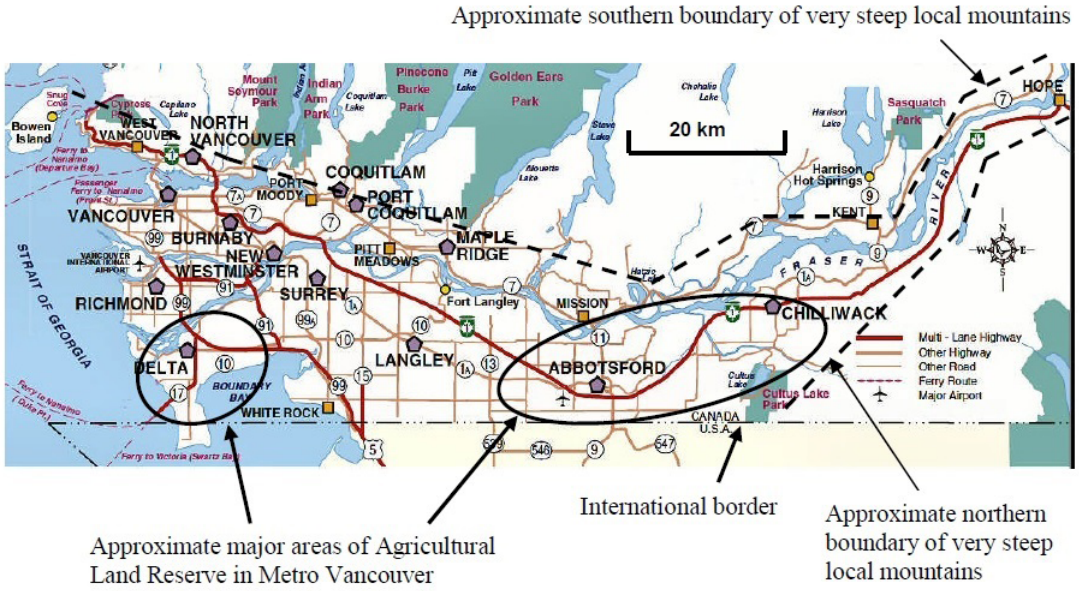
The application of local tax incentives for the promotion of urban gardening for commercial-sale purposes is not practicable. In Canada, sales taxes are collected and retained solely by provincial and federal governments. It may be noted that provincial sales tax is only applied to foods processed at the point of sale. The principal revenue sources for Vancouver city government are property taxes, licensing fees, water usage fees, garbage collection fees, and fines for infraction of various city by-laws. Despite the professed interest of civic politicians to promote "urban gardening for food security", there is no political reason to provide any tax concessions (within its remit) to commercial urban farmers.

Food production scenario

In the matter of food security, production of staples would be the obvious first priority. If all land (i.e. 11,467 hectares in total) within the city limit of Vancouver was converted to wheat cropping, the expected output would be about 26,000 tonnes, at the reported 2011-2012 yield of 3.03 tonnes per hectare (Agriculture and Agri-Food Canada, 2012), and corrected for typical ~25% lower organic cropping yield (de Ponti et al., 2012). The use of herbicides and pesticides for community gardening is prohibited by the City of Vancouver (2014). And if the average Canadian consumption of wheat (i.e. ~225 kg per person per year) was applied, this amount of wheat produced would have sustained only about 116,000 persons. The population of Vancouver in 2011 was already more than 600,000. Moreover, in this food self-sufficiency scenario, the citizens of Vancouver would have to relocate elsewhere as all the land within the City of Vancouver would be appropriated for wheat cropping. If the example sustenance data of medieval England from above was used, the total land area within the city boundaries of Vancouver could only support less than 15,000 persons. This outcome leads to the only conclusion that there is absolutely no possibility of self-sufficiency in the production of cropped staple foodstuffs.

From another perspective, for an example 10 m x 10 m (presently viewed as large[7]) yard of a detached

ISSN-Internet 2197-411x OLCL 862804632



Population pattern of contiguous "large" communities

West Vancouver Pop. 42,694* Density 489/km^2	North Vancouver Pop. 84,412* Density 4,074/km^2	Port Moody Pop. 32,975 Density 1,274/km^2	Coquitlam Pop. 126,840 Density 1.037/km^2
Vancouver Pop. 603,502 Density 5,249/km^2	Burnaby Pop. 223,218 Density 2,464/km^2	Pitt Meadows Pop. 17,736 Density 205/km^2	Port Coquitlam Pop. 55,958 Density 1,918/km^2
New Westminster Pop. 65,976 Density 4,222/km^2	Langley Pop. 104,177* Density 338/km^2	Maple Ridge Pop. 76,052 Density 285/km^2	Mission Pop. 36,426 Density 161/km^2	Kent Pop. 5,664 Density 34/km^2
Richmond Pop. 190,473 Density 1,474/km^2	Surrey Pop. 468,251 Density 1,480/km^2	Abbotsford Pop. 133,497 Density 356/km^2	Chilliwack Pop.77,936 Density 298/km^2	Hope Pop. 5,969 Density 145/km^2
Delta Pop. 99,863 Density 554/km^2	White Rock Pop. 19,339 Density 3,774/km^2			

* municipality or incorporated city with adjoining municipal district

Source: adapted from BC Ministry of Transportation map; Statistics Canada, 2015

Figure 1: Geographical constraints of Vancouver

mum yield of wheat (cropped organically) would be about 23 kg wheat as whole-grain flour, assuming ideal growing conditions (i.e., adequate sunlight, temperature and water) and zero loss in grain milling. Note that the typical yield of milling to flour is 74% (Canadian Grain Commission, 2011). On the basis of the UK average consumption of bread[8] (Flour Advisory Bureau, 2013) of 4 slices (20 slices per 800-gram loaf) per day per person, the amount of wheat grown in the example front yard would suffice the bread consumption of a 2-person household for about 72 days. It may also be noted that more 30% of the Vancouver population are of non-European ethnicity (Statistics Canada, 2008); they do not necessary consume ordinary bread in their daily diet. Nor is rice cropping technically feasible in Vancouver.

What then is the true economic perspective for food cropping? The average price of bare land inside the Vancouver city limit hasgrown to be very high during the past four decades. By 2012, the average Vancouver housing price became the highest in Canada (Anon., 2012). A publicly-available document has revealed that in January, 2010, the disused Shell gas

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Table 1: Selected statistics on population and land use

Vancouver city (49.15°N 123.10°W) land area, km²	**114.67**			
	2001*		2006#	
City population (Statistics Canada, 2013)	~546,000		~578,000	
Apparent density, persons per km²	4,761		5,041	
Land use (within city limit)	km²	% of total	km²	% of total
Single family dwellings	37.67	32	28.49	24
Multiple family dwellings (including duplex, rowhouse, apartment and mixed apartment and commercial)	10.13	9	24.68	21
Commercial	4.47	4	3.82	3
Industrial, utilities and port	6.77	6	5.61	5
Parks or public services (including social or public service, school, cultural or recreational, park and other open space, exhibition grounds and golf course plus 193 hectares of 2 lakes inside the city limit)	21.34	18	22.16	19
Vacant	2.50	2	1.10	1
Streets, lanes, sidewalks	33.72	29	30.74	26
Others	---	---	---	---
Total (the total is larger than the cited land base as this figure includes the two lakes within city limit)	116.60	100	116.60	100

* latest available data source from http://vancouver.ca/commsvcs/planning/stats/landuse/index.htm
# latest available data source from http://www.metrovancouver.org/about/publications/ Publications/KeyFacts-LandusebyMunicipality-2006.pdf

single-family dwelling in East Vancouver, the maxi oline filling station site located at 4000 Main Street in the central east side of Vancouver was sold for C$3.875 million[9] on an as-is basis, including the incurred cost of building removal but excluding the cost of environmental remediation of the site. At the lot size of 1,618.2 m², the value of the *bare land* value is calculated to be C$2,395 per m². The site was subsequently re-zoned and a typical 4-story apartment with ground-floor retail shops stands at this site today. Using the methodology of Davis and Palumbo (2008), the land share[10] of the original (gasoline-filling station) property is estimated to be about 94%. This example also illustrates that the price of the land, and not the building cost of the property, is the principal causal element of the present housing crisis in Vancouver. It is thus evident that there is no economic possibility for the implementation of any urban food cropping activities.

Even land in the "peri-urban" area of Vancouver is still much too expensive to undertake urban agriculture for achieving food security. For example, farmland in the Fraser Valley[11] is valued between C$9.88 per m² to C$14.83 per m² (Anon., 2013). This range of pricing dictates that only very high-return commercial crops such as blueberries and strawberries should be grown (Anon., 2008). In the case of blueberries, the gross revenue[12] would be about C$7.40 per m². The economic return of other field crops would be substantially less. With such a large differential in land price between housing and farming, there is considerable pressure from farm land owners to repeal the designation of Agricultural Land Reserve for housing development (Anon., 2008). It is a matter of simple land-use economics.

Although many "urban agriculturalists" are still debating the possibility of diet change[13] to fit the "landscape", the fundamental foods for the present-day Vancouver city dwellers remain staples such as wheat (for bread) or rice, and fresh vegetables. Even if formidable society-wide dietary changes could be realized, large scale production of staples and vegetables to sustain the large population of Vancouver remains extremely problematic. In an ideal-

ISSN-Internet 2197-411x OLCL 862804632

ized situation in which the unsatisfactory neoliberal economic structure was destroyed instantly and the price of land in Vancouver was re-set magically to zero, there is still no possibility to convert existing housing land to agricultural land. As discussed earlier, in a clearly meaningless scenario, the city would have to be de-populated by nearly 85% to release land for realizing this scheme of growing sufficient food for the self-sufficiency of the remaining 15%. In a parliamentary democracy[14] , who would decide which segment of the population would have to be "expelled" and where would be surplus population be re-located? Axiomatically, there are no feasible circumstances that could realize increased deployment of land for agriculture within Vancouver city limit. For Vancouver, this synthesized conflict of land use, or in other words habitation versus food production, is essentially intractable.

The contest over scarce land and its use under the framework of neoliberalism (see, for example, Harvey & Chatterjee, 1974; Harvey, 2003; Harvey 2005) is particularly pertinent to the continued rising cost of land in Vancouver. Harvey (2008) had argued that the urban citizens have the right to remake their cities and themselves. But certain *a priori* fundamentals were never addressed. For example, why such a right should exist at all, and why cities should exist and expand? The situation of the "company town" in the earlier era of resource extraction in Canada is particularly noteworthy as the "company" owned everything including all housing and non-factory services needed by workers. There were no rights for the townspeople including general merchants who were not company employees. Engels (1845; 1872) had noted the dire social consequences of rising land cost on the affordability of housing of the proletariat (industrial workers) during the early days of the Industrial Revolution in Europe. During that period, people were migrating to the cities because of the emergence of factory work with lucrative wages. The countryside was effectively de-populated very quickly. But this reason for the influx of people to Vancouver has been absent for more than 50 years.

What, then, of other urban agricultural options to overcome the problem of land constraint? Vertical growing and rooftop gardening have been widely touted as a means to solve the land space problem. However, these approaches are fraught with techni-

Table 2: Limited space for rooftop gardening

Example calculation	Before re-zoning for development of apartments	After zoning for re-development of apartments
Typical single-family dwelling lot	100 ft x 30 ft (279 m^2)	100 ft x 30 ft (279 m^2)
Number of residents	4 (i.e. 2 adults and 2 children)	4 (i.e. 2 adults and 2 children)
Size of unit for living (maximum)	279 m^2	~75 m^2 (1)
Number of storied floor	1	4 (2)
Number of units per floor	1	3
Apparent density	~70 m^2 per person	~6 m^2 per person

Notes:
(1) CitySpaces Consulting (2009, p. 25) reported the average unit area of apartments to range from 65 m^2 to 88 m^2, depending on the sub-area of Vancouver. The minimum net size for a 2-bedroom apartment unit is set at 66 m^2 for a 3-bed unit and 84 m^2 for a 3-bedroom apartment unit (City of Vancouver, 2015a). Under the latest Micro Dwelling Policies and Guidelines, the Director of Planning of the City of Vancouver may permit a floor area as small as of 23 m^2 for a self-contained studio unit.

(2)Most post-2009 apartments built in former residential-zoned areas are typically 4 stories. Building height (i.e., number of stories) is negotiable; it is a matter of money paid to the City under the guise of "contribution to community amenities" by the development project proponent (City of Vancouver, 2015b).

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cal and logistical problems in affording significant food security for the local population. In the case of Vancouver, the vertical growing approach has unequivocally failed the economic test of viability (Howell, 2014; St. Denis & Greer, 2015). It has been intimated that the cropping of presently-illicit marijuana (*Cannabis sativa*) for medicinal uses might be the only economically viable means to sustain the vertical growing concept in Vancouver (St. Denis & Greer, 2015). The general deficiency of the community gardening (including vertical growing) is discussed in detail elsewhere (Wong & Hallsworth, 2015b). A rooftop gardening strategy has a limited utility to only a number of participating citizens. As illustrated in Table 2, the lack of space for rooftop gardening becomes particularly acute as single family dwellings are converted to apartment buildings. It is evident that 24 m^2 of space (maximum assignable) for food cropping could not support a family of two adults and two children. It is may be noted that from a structural engineering perspective, the rooftops of many older multi-storied apartments were never built to accommodate any extra weight of wet soil or water (hydroponic) used for rooftop gardening.

Would, or could, the City of Vancouver stop the conversion of single-family dwellings into multi-storied apartment buildings purely in order to preserve private gardens as growing spaces? An apartment building with considerably higher tax assessment would provide higher tax revenue. Because the City always seeks more revenue, creative justifications are already routinely formulated in order to placate the people at large who are encountering steadily decreased availability of affordable housing within the city limit. The conversion of single-family houses also serves the financial interest of real estate developers and speculators. In reality, any home (or community) gardening in microscopic-size plots could only be realized solely for personal enjoyment. Justification of urban cropped food production for increased food security must be seen as mere nostalgic fanciful thinking by some middle income citizens.

If staple cropping is not feasible within Vancouver city limits, would other less space-intense urban agriculture be practicable? Apiculture and mushroom cropping could qualify as alternative modes of urban agriculture. The practice of apiculture is sadly limited as no large fields of clover or other suitable forage crops could be developed in Vancouver. The insurmountable barrier is again the lack of "vacant" land. Mushroom growing is already practiced by several large commercial enterprises in the less-populated areas of the Fraser Valley. The control of toxic-gas emission from these intensive mushroom farms is particularly troublesome for workers as well as the receiving air environment (see, for example, Hoekstra & McKnight, 2012). In any case, if one considers alternative urban agriculture to be just another profit-making business, then the alternative mode does not necessarily embody the goal of providing food security. For example, the biggest field crop in the Fraser Valley is blueberry which is not an essential food for survival.

Comparative land use scenarios

It is conceded that the food-availability situation may be very different in many rural areas of low-income developing countries (See, for example, de Graff et al., 2011). Our question is whether or not they offer practical solutions for the food-supply problem in Vancouver. The urban gardening circumstances of Kampala, Uganda (Maxwell, 1995) and Freetown, Sierra Leone (Maconachie et al., 2012), for example, in affording food security are irrelevant in the context of the prevailing urban societal structure in North America and Western Europe. Perhaps even more marginal are the illustrations of Mayan-Yucatán and Byzantine-Constantinople civilization of the First Millennium CE expounded notably by various Swedish social scientists such as Ljungkvist et al. (2010), Barthel and Isendahl (2012), and Isendahl and Smith (2013). They may appear to demonstrate the role of urban gardening in city resiliency but is subject to the obvious criticism that the societal structure in ancient times was quite different from that of modern-day North American and Western European societies. There were also notable technical flaws in these researchers' omission of crucial dietary intake of cereal, viz., maize (*Zea mays* subsp. *mays*) in the case of Maya and wheat (*Triticum* spp.) in the case of Constantinople, which require large tracts of land for production. Neither city-state inhabitants could possibly survive on vegetables grown in urban gardens alone. Witness the 872-day siege of Leningrad (USSR) by the Third Reich military forces in 1941-1944. Starvation due to the shortage of essential grains (for bread) was the principal cause of death

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of most of the ~1.5 million people[15] who perished during the siege (see, for example, Jones, 2008). Prior to the siege, essential grains were imported routinely by rail from wheat-growing regions of the USSR. Despite the creation of "thousands of vegetable patches in parks, squares and on waste ground" (Reid, 2011, p. 345) in 1942 and 1943, mass death by starvation continued. It is evident that resilience of Leningrad was due to factors other than the emergence of urban gardening.

Climatic conditions

The northern-latitude climate is simply not suitable for the production of most of the wide variety of cropped foods consumed on a year round basis by middle-income/middle-class people of present-day North American and Western European societies. In addition to staples, fresh vegetables are generally recognized to be essential foods. Popular fruit crops[16] such as bell pepper (*Capsicum annuum*) and tomato (*Solanum lycopersicum*) are native to northern South America, and cropping conditions for bell peppers and tomatoes are largely similar (Masabni, 2009). In addition to mineral nutrients and CO_2, the essential elements affording satisfactory growing conditions, for example, temperature, incident solar radiation and water, are marginal in the Pacific coastal climate of Vancouver.

Temperature

The optimal temperatures for the cropping of bell peppers (or tomatoes) are about ~29 °C during the day and ~20 °C at night (see, for example, Masabni, 2011). Bell pepper and tomato plants are extremely frost intolerant. In Vancouver, there are essentially only 4 frost-free months, viz., June, July, August and September. Typically, 120 days would be required for direct seeded plant to harvest and 90-100 days would be needed for nursery-started plantlets to harvest (Masabni, 2011).

Growing degree days is an ambient air temperature-based indicator for assessing the development of plant growth, in the absence of extreme cropping conditions such as drought and disease. The growing degree-days indicator is calculated as follows:

Growing degree days for the month, GDD

$$= (T_{avg} - T_{base}) \text{ x days for the month} \quad \text{Eq. 1}$$

where

T_{base} = +10 °C is generally used as the lowest temperature for the growth of bell peppers and tomatoes.

T_{base} = simple daily average of maximum and minimum temperatures

Figure 2 shows that this vital growing climatic pre-condition for growing in Vancouver is deficient for the field cropping of present examples of bell peppers and tomatoes. Such tropical crops would best be grown in their natural environment such as in Martinique (Wong & Ribero, 2013). Calculations using the above growing degree-days approach suggest that the threshold GDD could be reached in just 3-1/2 months in Martinique; it follows that three crop cycles would be feasible annually.

In comparison, pak choy (*Brassica rapa var. chinensis*), a cool-temperature crop, could be grown rapidly in 15 to 20-day cycles (Wong, 2010). In theory, Vancouver would have the necessary cooler temperature conditions at least during spring time. But nutritious pak choy is eaten largely by local first-generation Chinese-ethnic citizens only.

Creating the necessary artificial growing climate, such as heated green houses, would require substantial input of energy for heating (see, for example, Wong & Hallsworth, 2012). Electric lighting would be required if cropping was continuous on a year round basis. Middle income citizens have come to expect these popular vegetables to be readily available in their grocery stores on a year round basis. Conversely, the notion of seasonality of vegetables has disappeared from grocery stores decades ago. As shown in Table 3, the avoidable CO_2 emission for "local" production of tomatoes in heated greenhouses would be about six times higher than that for tomatoes grown in the field in Mexico and transported by long-haul trucks to Vancouver. This estimation made by Wong and Hallsworth (2012) was based on the assumption of a) zero CO_2 emission using hydroelectric power for lighting and b) burning natural gas for heating. Furthermore, all forms of external energy production, including biomass-based and wind-based renewables, have appreciable environmental footprints. Biomass com-

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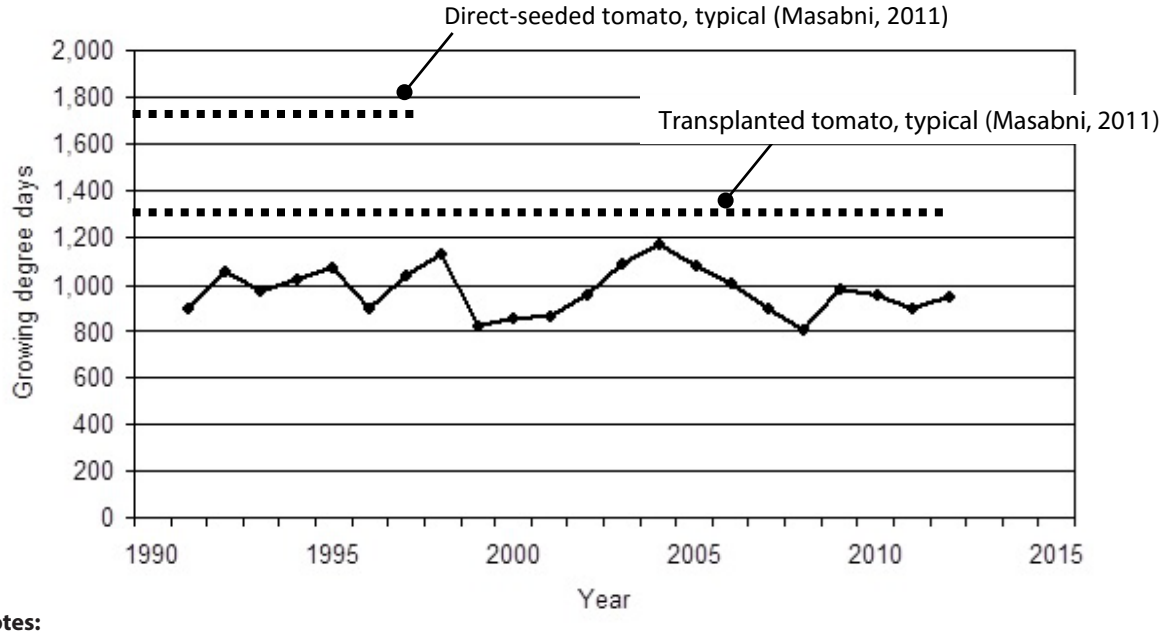

Notes:
(1) Calculated from meteorological data recorded at the Environment Canada weather station (World Meteorology Organization Identification Number 71892; 49°11'42.000" N, 123°10'55.000" W; elevation 4.3 metres) located at the Vancouver Airport (about 10 km south of Vancouver city centre).
(2) The "growing degree days" calculator available at www.farmwest.com was used for the period from May to September inclusive, at +10 °C base temperature.

Figure 2: Historical annual growing degree days in Vancouver

Table 3: Avoidable CO_2 emission in the supply of tomatoes to the Vancouver market

Supply Model		Avoidable CO_2 emission. kg/ kg tomatoes (on a "farm-to-fork" basis)
A	Buy Mexican imports from mega retailers (i.e. supermarkets)	0.31
B	Buy regional greenhouse-grown produce from mega retailers (i.e. supermarkets)	1.88
C	Buy direct from regional farmers (e.g. in a Farmers' Market)	0.25
D	Grow own produce (the original urban gardening concept)	0

Source: adapted from Wong and Hallsworth (2012)

bustion in Vancouver means procuring biomass from the temperate-zone rainforests. But there is already a lucrative market for the exportation of wood pellets; thus, the economic competition for local use can be expected to be very difficult. The underlying economics is that piped-in natural gas is considerably less expensive, even though its use for this purpose would lead to increased emission of greenhouse gases. Although Model "D" in Table 3 would provide the zero CO_2 emission, this option is impracticable because of constraints of land availability and seasonal climatic conditions.

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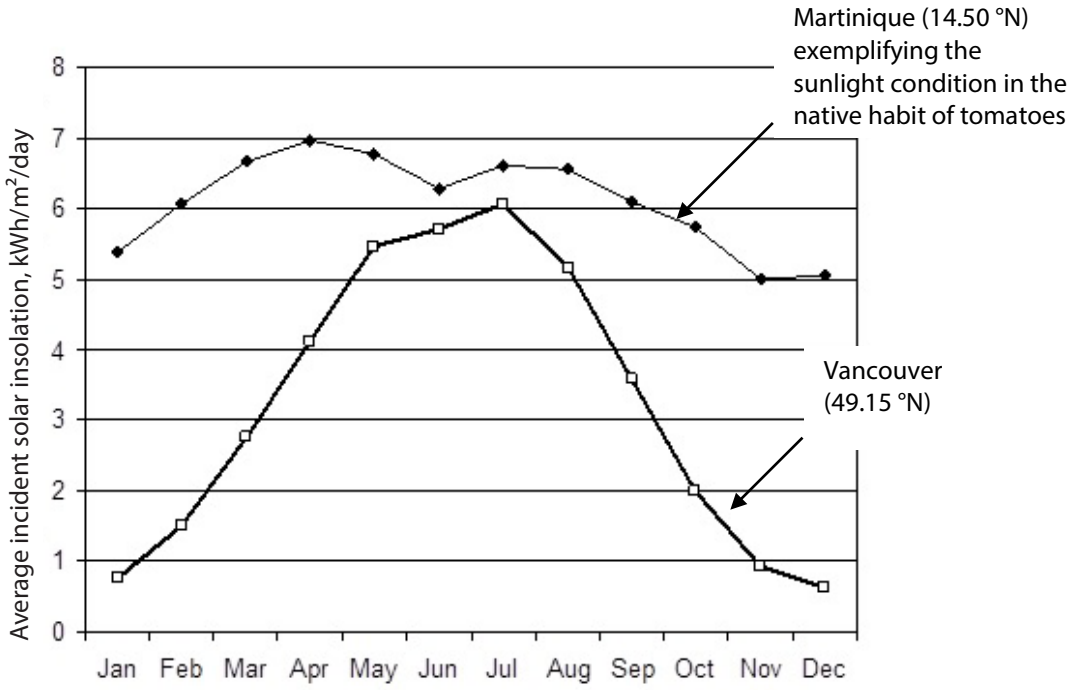

Source: ASDC, 2015

Figure 3: Monthly (22-year) average incident solar radiation on a horizontal surface

The economics of vegetable cropping does not support the use of solar panels (direct thermal or photovoltaic) to provide heating for greenhouses in northern latitudes. Natural Resources Canada (2014) had projected the average benchmark Alberta wholesale price of natural gas to be C$3.93 per gigajoule (about C$150/$m^3$) for the 2014-2015 heating season. In the longer term, domestic price of natural gas is expected to remain low in comparison to historical averages. Such low pricing outlook for natural gas would depress any economic justification for the installation of solar receptors. Of course, the combustion of natural gas has the direct consequence of higher emission of greenhouse gases to the atmosphere.

Sunlight

Incident solar radiation in Vancouver appears to be adequate during the field growing season, from May to September inclusive. Figure 3 compares the incident solar radiation between Vancouver (in the south coast of British Columbia) and Martinique in the Antilles). Artificial lighting would be required for the cultivation of most vegetable crops (in greenhouses) in other times of the year in Vancouver.

Water supply

If urban cropping was to be undertaken on a large scale, supply of sufficient water would be very problematic. The three water reservoirs supplying potable water to Metro Vancouver are dependent on local rainfall, and snow pack in nearby mountains. During the summer months, Vancouver has been under water-use restriction for the past decade. Figure 4 shows that the months with the lowest precipitation have the highest municipal water demand. Although the per capita consumption of water in Metro Vancouver (2013) has admirably decreased from ~659 litres per day in 1980 to ~487 litres per day in 2010, the growth in population has effectively increased the absolute demand from about 273 million litres per year in 1980 to approximately 292 million litres per year in 2010.

Tomatoes and peppers were chosen as examples of water demand of row field crops because Vancouver citizens (of all ethnic groups) consume them customarily throughout the year. Such food items are traditionally supplied from California and/or Mexico (Wong & Hallsworth, 2012). Dur-

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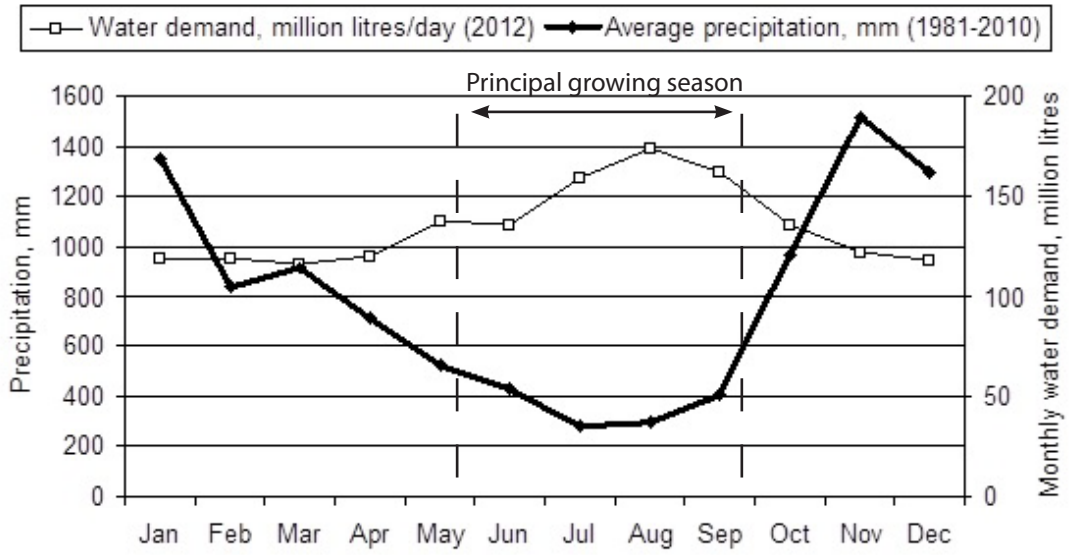

Sources: Environment Canada (2014); Metro Vancouver (2013)

Notes:
(1) Meteorological data recorded by Environment Canada at its Vancouver airport weather station.
(2) Annual pattern of monthly water demand is similar for earlier years.

Figure 4: Historical annual growing degree days in Vancouver

ing the summer months, some tomatoes and bell peppers are supplied from irrigated fields in the "hotter-summer" Okanangan Valley, located some several hundred kilometres east of Vancouver. More recently, several large heated greenhouses located near Vancouver have been supplying tomatoes and bell peppers to the local market. These operations have substantially larger GHG emissions (Wong & Hallsworth, 2012). Certainly other vegetable crops could be used as examples. The transpiration ratio[17] is defined as the weight of water per unit weight of total biomass produced. Crop plants usually range from 200 to 1,000 (Martin et al., 1976: 80-82). For field-grown tomatoes, the seasonal water used would be 60 kg per kg fresh tomato fruit (Yang et al., 2012). The percentage of fruit in total tomato-plant biomass is typically in the range of 55 to 65% (Agele et al., 2011). Moisture deficit is defined as the water removed by evapotranspiration. Water evaporated from soil plus water released through the plant, which is not replaced by precipitation (Allan et al., 1998). This means of estimating crop water requirements takes in account of, among other things, growing plant requirements, local soil and prevailing meteorological conditions. Equation (2) is applied to calculate the evapotranspiration (ET) for tomato crop. The computation protocol for ET is based on that described by Allen et al. (1998).

$$ETc = ETo \times Kc \qquad \text{Eq. 2}$$

where

ETo = calculated grass reference ET for Vancouver region, mm; data provided by Pacific Field Corn Association (2014) in *www.farmwest.com*

Kc = crop efficient (tomato was set conveniently at 1.0 over the entire growing season, in view of 0.7 in initial stage, Kc = 1.05 in mid-season, and Kc = 0.80 in the end stage; data provided by Pacific Field Corn Association (2014) in *www.farmwest.com*

Etc = crop evapotranspiration or crop water use, mm

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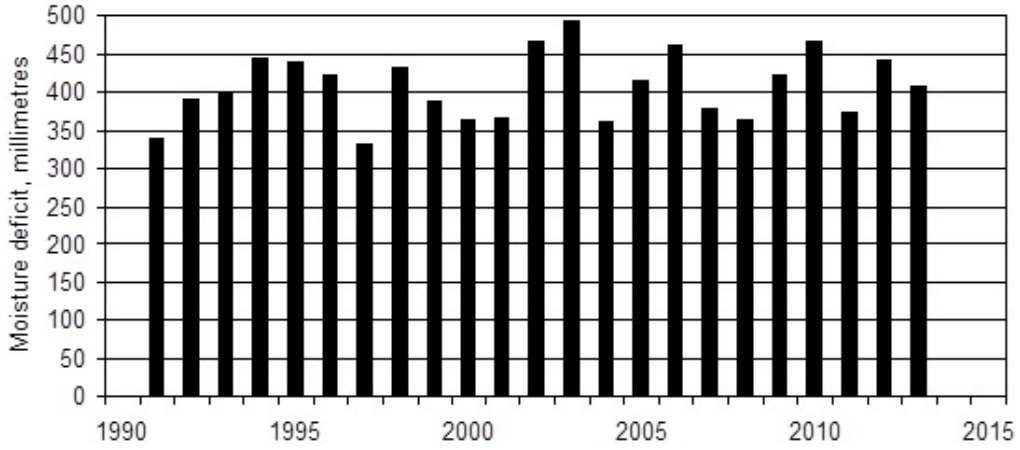

Figure 5: Calculated moisture deficit (for tomato cropping) in Vancouver, from May 1 to September 30 each year

The moisture deficit for cropping in Vancouver – for the period of May 1 to September 30 - is illustrated in Figure 5. In essence, field cropping of tomatoes in Vancouver would need an additional input of 300 mm to 500 mm of water over the growing season. The FAO (2014a) has cited a representative tomato crop demand of 400 mm to 800 mm of water (i.e. crop evapotranspiration) for the total growing period. The variation is due in part to the length of the growing period for different cultivars (FAO, 2014b). In the semi-arid San Joaquin Valley[18] of California (USA), the seasonal crop water use (i.e. crop evapotranspiration) of field-grown tomatoes is 645 mm (Hanson & May, 2006). It is evident that additional input of water through irrigation is required for satisfactory crop production in the Vancouver urban setting. However, Vancouver has inadequate rainfall and an acute (municipal) water supply deficit during the summer months. The only available source of additional fresh water is the nearby Fraser River estuary. An extensive irrigation infrastructure would need to be built for the provision of water to multiple urban food gardening plots. It is doubtful if such a costly infrastructure project could, or should, be undertaken.

The average per capita consumption of fresh tomatoes in the USA was reported to be 8.4 kg in 2008 (Boriss & Brunke, 2005) and we may assume that Canada has a similar level of per capita consumption. The estimated demand for Vancouver with a 2006 population of 578,000 (from Table 1) can thus be assessed at 4.86 million kg annually. If the aforementioned difficult issues of land pricing, GDD and water supply could all be resolved "magically", then the calculated land base needed for urban gardening of fresh tomatoes would be about 150 hectares, on the basis of reported average yield ranging from 29,000 to 35,000 kg intensively field-cropped fresh tomatoes per hectare achieved in the San Joaquin Valley (Strange et al., 2000; Boriss & Brunke, 2005). In theory, this supply scheme of using about 1.3% of the total land area for self-sufficient tomato cropping could be practicable for Vancouver. It may be noted at the prevailing land price of ~C$2,400 per m^2 (cited earlier), the set-aside 150-hectare land would be valued at C$3.6 billion. At the example retail price of C$3.29 per kg of fresh tomatoes[19] and an output of 4.86 million kg of fresh tomatoes annually, it would take about 190 years of fresh tomato sales to afford accumulated gross retail revenue to be equivalent to the "over-night" cost of the set-aside land. On a wholesale pricing basis, the 190-year time frame would at least be doubled. Moreover, all such field-cropped tomatoes would be harvested for distribution to the local market only during August and September each year. There would be no "local" fresh tomatoes for the other 10 months of the year.

The problem of using secondary sources of water for irrigation is difficult to solve. The Iona Island wastewater treatment facility (located ~10 km from

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Vancouver city centre) provides only rudimentary treatment of domestic wastewater. Suspended solids are removed by screening and gravity sedimentation, prior discharge to the receiving water (i.e. the Strait of Georgia). There is no removal of, among other things, pathogens, antibiotics from home use and household grease. Furthermore, there is enormous cost of re-piping the treated wastewater back to the city for distributed irrigation uses. Run-offs from storm sewer are a potential source of secondary water. But during the prime growing months of July and August, the rainfall is virtually nil. In essence, abundant street run-offs are available when the growing season has ended. Creating immense water cisterns and other water storage facilities for run-offs within Vancouver is economically impractical because of the high land cost.

Fertilizers and other crop inputs

The use of fertilizers is a necessity in any urban gardening undertaking for maximization of crop yield. The choice of mineral fertilizers will inevitably result in unwanted nutrients in run-offs to cause deleterious marine pollution. The deployment of organic fertilizers would entail the operation of large composting piles of highly bio-degradable food and residential garden wastes collected weekly by the City Sanitation Department. The City of Vancouver already operates a large-scale landfill composting facility in Delta (a municipality located about 20 km south of Vancouver) for the management of biodegradable household solid wastes. The end product is sold commercially to home gardening centres and hobby gardeners (City of Vancouver, 2015c). Using composted fertilizer may be practical, but crop rotation would still be required for the control of pest and other plant infestations. This practice adds restriction of discontinuous land use for cropping.

Changes in societal structure

The shift from an agricultural society to an urban society probably started in the Neolithic Age, circa 3500 - 1500 BCE (Roebuck, 1966, Chapter II). Irreversible[20] rapid changes in the structure of western societies during the past several decades have created new obstacles to "local food production". These structural obstacles include substantial changes in employment patterns, accelerated urbanization and altered family structures. Self–sufficiency in food could only be achieved if the society was still agrarian in nature; contrary to the Maya parallel (above). Growing sufficient food for one's own use could not be undertaken on a part time basis. The principal reasons include a) the land must be prepared and seeded, b) the growing crop must have control (manually or chemically) of weeds, pests and other infestations, c) the growing crop must be irrigated, and d) the crop must be harvested and prepared for storage. It is well known that in an agrarian society, it was always a full time task even to grow sufficient food for subsistence. Any occasional surpluses might produce to purchase seeds, farm implements, fertilizers, or other necessities of life.

Very few Canadians, educated or otherwise, would be willing to toil in the fields on a full time basis (see, for example, McLaren & Thompson, 2008). This problem has parallels with that of finding people to work in low paying agricultural jobs in all western societies. In the UK, "gangmasters" control contract agricultural workers though much such work is now undertaken by EU citizens from Poland. In Canada, foreign guest workers harvest field and tree crops, and Germany has offers the example of mass importation of *Gastarbeiters* from Turkey since the 1960s (Wong & Gomes, 2012). Most people would prefer full time work in well-paid jobs in comfortable offices and to simply buy food from shops. For similar reasons of "comfort", unemployed persons are not generally interested to toil in the field for a minimum wage. Nor are there (as yet) laws to force unemployed persons to accept such jobs. There are insufficient "young idealists" and "middle class green fingers" to render a city such as Vancouver self-sufficient in food, even for a single widely-consumed vegetable. Thus, if cropped food was to be grown in an urban setting and even if above issues of land and climate could be addressed satisfactorily, cheap migrant labourers would still be needed for any food cropping activities. Such a labour market policy as practiced in Canada and similar countries is overtly exploitative at best (see, for example, Wong & Gomes, 2012). Indeed, the practice of using cheap migrant workers imported from Mexico and Central America has already been evident in Fraser Valley farms for several decades (Fairey et al., 2008). The present labour situation in Vancouver (as well as

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that in many other "modern" cities in North America and Western Europe) might be a continuation of the master-slave relationship between "urban civilized life" and the peasantry since ancient times. Armstrong (2014, pp. 21-27) has noted succinctly that "Urban living would not have been possible without the unscrupulous exploitation of the vast majority of the population", in her commentary on the foundation of the first city-state in Sumer (present-day southern Iraq) in the third millennium BCE.

The essential question remains "could - or should- low-income families undertake to grow their own food for the sake of affordability?". Presently, recent immigrants earning low salaries are too busy in taking a second (or third) paid job just to survive. As of March 1, 2014, the general minimum wage in British Columbia (province) was raised to C$10.25 per hour (Government of British Columbia, 2014). For a typical 40 hour working week, the monthly wage would be C$1,640, before any tax deductions. For hand-harvested crops, the minimum wage is set according to the specific crop. For example, the minimum piece rate for hand-harvesting blueberries is C$0.396 per lb. (= C$0.872 per kg). Using data given by Zbeetnoff and McTavish (2011), a field worker would need to pick ~12 kg blueberries per hour in order to achieve the general minimum wage of C$10.25 per hour. Interestingly, Zbeetnoff and McTavish (2011) also found that almost 90% of the blueberry pickers were in the age group of 55 years or more. Women comprised nearly two thirds of the blueberry-picking workforce surveyed. The task of picking blueberries non-stop at this rate for 8 to 10 hours under the hot sun every day is generally considered to be very strenuous (Fox, 2013).

In 2014 in Vancouver the rental cost of a one-bedroom apartment in a modest cooperative housing complex was reported to be C$862 per month (Pablo, 2014), equivalent to ~53% of the above-sample worker's monthly gross income. As in other cities such as London, this level of income deployment for housing is obviously unsustainable. The Vancouver city government considers 30% of income dedicated to rental housing to be an acceptable benchmark of affordability (City of Vancouver, 2012a; City of Vancouver, 2012b; Howell, 2013). Note, however, current research that sees the low paid (ideally welfare) renter as the ideal conduit for profits to renter speculators (Wallace, 2015). More than a century ago, Friedrich Engels had recorded similar observations during his residence in Manchester, England in the mid-1800s (Anon., 2007). Separately, Ivanova and Klein (2015) have calculated the 2015 living wage meeting basic family needs in Metro Vancouver to be $20.68 per hour. One obvious solution for the minimum-wage worker is to generate additional income from a second paying job. It follows that low-income workers with the greatest need of supplementary food supply have no time to grow their own food in sufficient quantities for self-use throughout the entire year.

Conclusion

No matter how or why Vancouver emerged from a densely-forested area to a modern metropolis, there is little or no possibility that Vancouver's location could ever sustain food security or sovereignty. Notwithstanding the destructive role of neoliberal economic policies on the well-being of urban citizens, insurmountable farming realities block any possibility of self-sufficiency in food. The major systemic barriers to the realization of cropped agriculture in Vancouver were found to be 1) acute scarcity of low-cost land, 2) marginal growing temperature conditions, 3) water scarcity, and 4) changed socio-cultural circumstances of the population. Any attempt to overcome such obstacles would carry significant negative environmental and economic consequences. Despite these obvious fundamental constraints, successive civic governing regimes, not only in Vancouver but in many other cities as well, have somehow continued to pursue the goal of "local food production for increased food security". Such a public-policy position is demonstrably disingenuous when physically impractical. Even if all the claims of the societal benefits of local food production were true, the inconvenient truth of systemic limitations on urban gardening could not be ignored.

Acknowledgement

Authors would like to thank the anonymous reviewers for their helpful and critical comments.

Conflict of Interests

The authors hereby declare that there is no conflict of interests.

ISSN-Internet 2197-411x OLCL 862804632

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Endnotes

1. In this context, "corporation" denotes a publicly- or privately-owned corporation with a substantial annual turnover in revenue.
2. Estimated from topographical data of The Atlas of Canada published by the Government of Canada (*http://atlas.gc.ca/toporama/en/#index.html*)
3. Shelf-edge pricing means the price of goods offered to the shopper at the edge of a grocery store shelf.
4. The designation of middle class and low class is avoided because of certain cultural connotations. Thus, a middle income person can be a low class person.
5. Although Russians had been engaged in fur trading with aboriginal people of coastal British Columbia in the 1770s, the arrival of the fleet of Captain James Cook (from Britain) in the Nootka Sound in 1778 is generally considered to be the defining milestone of "Con tact".
6. Meaning "paving or concreting over by decree" in present-day colloquial French.
7. A representative lot size in this sub-area of Vancouver would be ~30 m x ~9 m (100 ft x 30 ft).
8. UK consumption: 12 million loaves sold daily to 63.1 million people (mid 2011 estimate). A representative full-pan loaf is considered to weigh 800 grams and to yield 20 slices. The calculated per capita consumption would be 55.5 kg per year.
9. The monthly average exchange rate in January, 2010 was C$1.00 = US$0.959 (*http://fx.sauder.ubc.ca/data.html*)
10. Land share = (land value from the Shell gasoline filling station example/ all-in home value listed in this lower cost residential neigh bourhood of Vancouver, in the same time period). The average 2011 price of "single-dwelling houses" listed for sale in nearby area was $2,551 per m^2 (= average C$ 888,500 for an average lot size of 348.3 m2). Even in the exclusive residential district, the land share could be as much as 99%, for a well-kept 5-bedroom single-dwelling house built in mid-1960s.
11. Located up to ~30 km south, and ~100 km east of the Vancouver city boundary.
12. Example yield of 11,200 kg per hectare at estimated farm-gate pricing of C$6.60 per kg. The retail price of locally grown blueberries was $13.20 per kg (Whole Foods Vancouver, July 4, 2014).
13. Frequently in the context of eating little or no animal meat.
14. With the continued ascendancy of neoliberal politics, parliamentary democracy has increasingly become a façade. "Guided democracy" might be a more apt description of contemporary democracy. In its simplest form, it has the appearance of genuine popular democra cy achieved through free and fair elections, but the electoral process as well as subsequent government agenda, goals, policies, etc. are largely controlled by a minority of moneyed elites. Guided democracy was last promoted unabashedly by the Sukarno Regime in Indonesia during the early 1960s (see, for example, Steinberg, 1971, pp. 383-384; Lev, 2009, Chapter VI).
15. The pre-siege population was approximately 3.7 million. About 1.5 million people were evacuated successfully. At the end of siege, the population of Leningrad had dwindled to ~700,000. During the darkest days of the siege, the bread ration was just 125 grams per person per day (Jones, 2008, pp. xxii).
16. Other vegetable crops such as lettuce and beets could be used as examples as well. But tomatoes are widely consumed by all eth nic groups in Vancouver. Cropping of staples such as cereal grains has already been eliminated because of extremely large land base required.
17. Alternatively, transpiration ratio may also be defined as weight (or mole) of water transpired per unit weight (or mole) of CO_2 fixed (Nobel, 1983, pp. 444-446).
18. The San Joaquin Valley has the largest commercial production of fresh tomatoes in North America.
19. Locally hot house–grown fresh tomatoes on-the-vine; November 14-20, 2014 special price offer at IGA Market Place supermarkets in Vancouver. It may be noted that lower retail prices, e.g., <C$2.00 per kg, are prevalent during the summer period.
20. Irreversibility means that both man and woman (of a family unit) will be working essentially full time throughout their adult lives, in the contemporary society. This situation arose largely from the changed social attitude about women in the work place. Since the 1960s, women working outside the traditional home (especially those of the traditional man-woman middle-class family units) have become the norm principally for reasons of a) fulfillment of the woman's personal aspiration and b) acquisition of additional disposable income to enjoy an enhanced "middle-class" consumption-oriented lifestyle. This paradigm shift has far reaching consequences. For example, in Vancouver, a whole new industry of day-care of young "middle class" children and general domestic help has effectively been created in which numerous imported lowly-paid Filipina workers are now employed. In contrast, within the low-income group, women working outside the traditional home become a necessity for the economic survival of the family unit.

ISSN-Internet 2197-411x OLCL 862804632