Journal of Agriculture, Food Systems, and Community Development
ISSN: 2152-0801 online
www.AgDevJournal.com

Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries? Matching consumption requirements with growing spaces

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Submitted 4 June 2010 / Accepted 30 November 2010/ Published online December 2010
Citation: MacRae, R., Gallant, E., Patel, S., Michalak, M., Bunch, M., & Schaffner, S. (2010, Fall). Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries? Matching consumption requirements with growing spaces. *Journal of Agriculture, Food Systems, and Community Development, 1*(2): 105–127. doi:10.5304/jafscd.2010.012.008

Abstract
Is it feasible for Toronto to produce and market 10% of its fresh vegetable requirements from within its own boundary, without competing with existing Ontario vegetable producers? We used zoning maps, aerial photography, and numerous exclusionary and inclusionary criteria to identify potential food production sites across the city and, after identifying organic vegetable production yields, to calibrate supply potentials against current vegetable consumption estimates for the Toronto population. It was determined that Toronto required 2,317 hectares (5,725 acres) of food production area to meet current demand, if all production were organic to fulfill other municipal environmental objectives. Of this, 1073.5 ha (2,653 acres) of land could be available from existing Census farms producing vegetables, lands currently zoned for food production, certain areas zoned for industrial uses, and over 200 small plots (0.4–2 ha or 1–4.9 acres) dotted throughout the northeast and northwest of the city. In addition, 1243.5 ha (3,072.8 acres) of rooftop space would also be required. The land and rooftop space available suggests, however, that there would be difficulties meeting requirements for land-extensive crops such as sweet corn, squash, potatoes, cabbage, carrots, and asparagus.

Keywords
urban agriculture, land inventory, vegetable consumption

Introduction: Why Food in Cities?
By 2025, two-thirds of humanity will live in cities. Many experts wonder where food to feed five billion urban people will come from. A portion may well come from cities themselves. Many urban areas are now producing over 20% of their vegetable production from within city boundaries,

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including such cities of the Global South as Havana, Singapore, and Accra. Feeding urban populations has long been thought of as a challenge for the Global South, not for the cities of the industrialized North. But many cities of the North have also invested in urban food production, including Berlin, San Francisco, Burnaby (British Columbia), and potentially Detroit. In many ways, cities of the North are recapturing spaces that were devoted to food production in the past. In 1944, the United States had 20 million "victory gardens" in backyards that produced 46% of the nation's fresh vegetables as a national effort during World War II (Kortright & Wakefield, 2010). Urban agriculture has been defined as "the production of food and nonfood plant and tree crops, and animal husbandry, both within and fringing urban areas" (UN Organization for Economic Cooperation and Development as quoted by Kaufman & Bailkey, 2000, p. 3). Approaches to urban food production range from these victory gardens to new ideas for intensive farming in dedicated high-rise structures (Gorrie, 2009). However, in this study we focus specifically on commercial-scale vegetable production within the boundaries of the city of Toronto.

Recent Census of Population data affirm that Canada is an increasingly urban nation: Between 2001 and 2006, Canada's population grew by over 1.6 million people—a 5.4% increase (Statistics Canada, 2007a). Nearly 90% of Canada's population growth is concentrated in large metropolitan areas. At the same time, loss of agricultural land around cities has continued, with the production mix in the urban shadow continuing to shift away from basic foods toward, for example, horse breeding, animal feed for export, and crops for industrial applications, such as plastics and lubricants. In some quarters, concerns about the reliability and security—economic, biosecurity and climate-related—of supply chains continue to mount. If nearby Waterloo, Ontario, estimates are comparable to Toronto, the average imported food is traveling about 4500 km (2,796 miles) (Xuereb, 2005), much of it by truck. By some industry estimates, Toronto has only three to four days of perishable food within its boundary at any given time (Lue & Koc, 1999).

Despite repeated calls over the last 20 years to expand food production in the city of Toronto, the municipal government has responded only modestly with some investments in community gardening and some rooftop garden pilot sites. However, recent developments suggest that the city is primed to significantly expand urban food production.

Space (with its associated urban norms and rules) is typically assumed to be the limiting factor in urban food production. This study, part of a larger inquiry into policy and infrastructure changes to support urban agricultural development in Toronto, was undertaken to determine if growing space is available in the city to provide 10% of its main vegetable requirements from within its own boundaries. To set the stage for subsequent reports, which we hope to publish in this journal, we provide some descriptive context on urban agriculture in Toronto and details on the method employed to analyze potential growing spaces. We conclude with some analysis of significant challenges that will be further explored in later articles.

The Planning Context

The land use planning system in Ontario is generally referred to as a provincial policy–driven system. The provincial *Planning Act* provides the overall procedural framework, outlines matters of provincial interest such as the preservation of agricultural land, and grants municipalities the authority to plan through official plans, zoning bylaws, and a host of other planning tools. The province also sets out inter-regional legislation that sets the overall planning framework. Several inter-regional acts and plans apply to the city of Toronto, specifically the Greenbelt Plan, empowered by *The Greenbelt Act,* and the Growth Plan for the Greater Golden Horseshoe, empowered by *The Places to Grow Act.*

The Greenbelt Plan

The Greenbelt forms a wide band across a large portion of southern Ontario and extends into Toronto from the north to encompass the Rouge River Park in the northeast corner of the city. The

Greenbelt acts to connect the Oak Ridges Moraine Area with the Niagara Escarpment and the Parkway Belt West through the designation of lands as Protected Countryside. Rouge River Park forms a key part of the Natural Heritage System within the Protected Countryside, as it acts as a corridor connecting the Oak Ridges Moraine to Lake Ontario. The Natural Heritage System policies allow the full range of existing agricultural, agriculture-related, secondary uses, and normal farm practices within Rouge River Park, and also limit new development.

The Greenbelt Plan's Natural Heritage System works in concert with the Provincial Rouge Park Management Plan and The Little Rouge Corridor Management Plan, which zone 318 ha (785.8 acres) of the park's land as an Agricultural and Agricultural Heritage Reserve. The close proximity of agriculture to the natural heritage system highlights a significant tension for urban agricultural development in Toronto: should ecologically sensitive lands and amenity spaces be used for food production? This question is ultimately reflected in the exclusionary screens used to identify suitable production lands (see methods below).

The Growth Plan for the Southern Ontario Region (Greater Golden Horseshoe)

The Growth Plan sets out policies for directing where and how to develop southern Ontario. It requires that, by 2031 and for every year thereafter, 40 percent of all new development within upper-tier municipalities (regions) and the city of Toronto must occur within the already built-up areas of municipalities. The remaining 60 percent must occur within designated greenfield areas on the immediate periphery of the built-up areas. Within both built-up areas and greenfields, growth is directed to a series of municipally designated nodes and corridors. Greenfield areas must develop at densities of greater than 50 people and jobs per hectare (123 people and jobs per acre), while designated Urban Growth Centres such as downtown Toronto must develop at densities of at least 400 people and jobs per hectare (988 people and jobs per acre). The entire city of Toronto is designated as a built-up area, with the exception of the Rouge River Park, which is designated as greenbelt. There are no greenfield areas within the city.

The Growth Plan's direction of growth to nodes and corridors has two primary repercussions for agriculture within city limits. First, it encourages growth along arterials and may thereby turn some development away from established neighborhoods and institutional, commercial, and industrial lands. In doing so, the Growth Plan may tend to relieve some competition for scarce space within these areas. Second, in prioritizing arterials (referred to as avenues in the city's official plan) as places for growth, it ensures that spaces along these routes are likely to be considered for higher-value development before they would be considered for urban agriculture. Thus, larger scale agricultural uses, such as the ones we are proposing (>0.4 ha or 1 acre), are not likely to find their way into Urban Growth Centres or any other identified nodes within the city.

Some Toronto Context

Toronto is the largest city in Canada, and a top 10 urban centre in North America. It occupies an area of 63,175 ha (156,109 acres), with 75% of the city's land developed and, apparently, the remaining 25% available for new growth over the next 30 years (City of Toronto, 2006). One estimate is that 18% of the city surface is green space,[1] and 65% of residents have a lawn or garden (Statistics Canada, 2007c). The population is 2.5 million. Toronto is now considered the most culturally diverse city in the world, with more than 200 countries of origin for its residents and over 100 languages spoken (Lister, 2007). The city has many places to eat and shop; according to 1996 data, it has some 6,000 food service establishments and almost 5,000 food shops and grocery stores (Food and Hunger Action Committee (FHAC), 2001; Lister, 2007). Given urban development pressures on farmland around Toronto and the globalization of the food system, a significant percentage of farms has likely

[1] A study is currently underway at Ryerson University to refine this estimate (Nina Marie Lister (personal communication), Ryerson University, 2009).

shifted to nonfood uses and production for markets beyond the city of Toronto.

The city was a significant food producer in earlier periods. In 1915, some 2,000 garden plots coordinated by the Rotary Club generated almost $1 million in produce in current dollars (Johnson, 2009). In 1934, an 80 ha (198 acre) garden site in the western part of the city was created to help 5,000 unemployed families. During WWII, Toronto was part of the Canadian cities Victory Gardens effort that created 200,000 wartime gardens nationally and produced 52 million kg of vegetables (Johnson, 2009). Market gardens and greenhouse operations were very common in Toronto until the 1930s (Fram, 2009). Up until the 1960s, much of the northern part of the city was still farmland, but it was gradually converted as population and commercial pressures resulted in redevelopment.

Numerous efforts to expand urban food production are underway and, combined with mounting interest in local and direct food procurement, suggest the moment is right for a coordinated and long-term urban food production strategy. The city has a Community Garden Action Plan (1999), an Environment Plan (2000) that called for urban agriculture pilot projects, a Food Charter (2001), and is preparing to adopt both an associated Food Strategy and a climate change mitigation strategy (the Climate Change, Clean Air and Sustainability Energy Action Plan). Urban food production is viewed as part of all these strategic developments, yet significant food production measures remain unrealized. The city's Official Plan now makes reference to urban food production, and Toronto City Council is now, more than ever, receptive to including urban farm scenarios within its Official Plan (W. Roberts (personal communication), City of Toronto, 2009).

Current Food Production Activities and Potentials in Toronto[2]

Backyard and Community Gardening

Back- and front-yard gardening remains a significant activity in multicultural Toronto. Some 4,500 private garden plots produce a substantial amount of food (Cook, 2008), but it is likely that a substantially larger percentage of households[3] have small cook's gardens (Kortright, 2007, p. 16). City Farmer found that 40% of people living in the Greater Toronto Area (GTA)[4] were producing some of their own food. Kanengoni, (2010), working with data presented by Kortright and Wakefield (2010), suggests that there might be about 650 ha (1,606 acres) of gardens currently in the city, a little more than 1% of the city's surface area.

Toronto is also reported to have at least 1,000 community garden plots in parks, public lands, and social housing complexes, and 20 municipal allotments containing 2,500 plots (FHAC, 2001). The municipal government runs 52 community gardening sites and 12 of the allotments (1,674 plots), providing outreach, training, technical supports, and some seedling production (City of Toronto, 2009). The waiting lists for sites are reputed to be long, but no new allotments gardens have been established since 1998. According to some municipal officials, however, spaces are soon to increase.

Census Farms and Food Production Businesses

According to Statistics Canada (2007a), there are 76 census farms[5] on 2,710 ha (6,697 acres) within the city of Toronto, 52 of which report crops (not

[2] We do not consider small livestock production because municipal bylaws currently do not permit poultry and livestock production except on land zoned agricultural. There is some momentum building, however, to change the bylaw (Schrivener, 2008).

[3] Toronto has some 391,000 detached, semidetached, and row houses.

[4] The GTA includes many suburban municipalities with larger housing lots.

[5] To be a census farm, the farm must produce agricultural products with the intention to sell.

including Christmas trees) on 1,613 ha (3,986 acres), and an additional 310 ha (766 acres) in pasture. Located primarily in the northeastern corner of the city, they produce mostly soybeans, grain corn, and small grains (about 1,000 ha or 2,471 acres), most of which is likely for animal feed. Seventeen farms report growing fruits, berries, and nuts on 194 ha or 479 acres (the majority in grapes), and 11 farms report growing vegetables on 126 ha (311 acres). Data suppression rules limited information on what vegetables are produced, but it would appear to be diverse. Seven farms reported greenhouse operations, mostly flowers with some vegetable production (likely transplants), totaling 30,487 sq. m (328,159 sq. ft.) of greenhouse space.

According to a representative of the Toronto and Region Conservation Authority (TRCA), there are 530 hectares (1,310 acres) that are currently farmed in the Rouge Park under lease arrangements (318 ha or 786 acres of which are zoned agricultural), with 150 ha (317 acres) of that coming out of agricultural production in the near future for natural habitat restoration (Bob Clay (personal communication), TRCA, 2008). There are approximately six farmers who manage these parcels of land. Most of the farms in the park operate on a rotation of soybeans, winter wheat, and corn, although there is one dairy herd and one beef herd. There are also some parcels of private land within Rouge Park, probably covering some 100–200 hectares (247–494 acres).[6] The TRCA Natural Heritage Plan (2007) suggests that pressures on land cost are pushing producers out of field crops and into greenhouse, nursery, fruit and vegetables, and specialty production.

In 1996, there were six nonfarm food production businesses within the city (including sprout operations), employing 93 people (Toronto Food Policy Council (TFPC), 1999). A more current estimate is lacking.

[6] Data suppression rules make it difficult to overlay information from the TRCA with that of Statistics Canada.

Green Roofs

Rooftop gardens are increasingly common in Toronto. In 2007, installations of green roof infrastructure reached 7,700 sq. m or 82,882 sq. ft. (or 0.77 ha or 1.9 acres), though how much of this is in food production is not currently known. Toronto is ranked first among Canadian cities in green roof installation.[7]

In 2004, the city commissioned a study of the suitability of green roofs (Banting, Doshi, Li, Missios, Au, Currie & Verrati, 2005) that found about 13,478 ha or 33,305 acres (21% of the city land area) represented a roofed area. About 4,984 ha (12,316 acres) of the roofed area (8% of the total city land area) would be suitable for greening of some form (roofs of 350 sq. m (3,767 sq. ft.) or more at 75% roof coverage in buildings that had heating and cooling). How much of that area would be suitable for food production is unknown, as the survey was based on spatial GIS data and did not fully examine issues of structural integrity, access, and growing infrastructure—all pertinent to commercial rooftop production. The authors did recommend a follow-up survey of structural requirements to accommodate a range of media thickness on roofs. The city followed this study with a pilot program that offered $50 per square meter for any resident or building owner to install green roofs. A green roof bylaw has recently been adopted to require roof greening on many new types of construction in the city[8]; however, it may not be well designed to encourage food production.

Greening the Towers

The previous mayor of Toronto endorsed a pilot project to renew Toronto's postwar residential tower building stock, focusing particularly on energy efficiency. As part of this effort, the architectural team[9] has numerous proposals

[7] 2008 Green Roof Industry Survey, http://www.greenroofs.org/index.php?option=com_content&task=view&id=1015&Itemid=135

[8] See http://www.toronto.ca/legdocs/bylaws/2009/law0583.pdf

[9] http://www.era.on.ca/news/index.php?news_id=20

illustrating the potential for urban agriculture around the tower grounds and in some cases on rooftops and balconies. However, there are numerous barriers related to the official plan to using the space around the towers for food production. Some of the towers are compromised as growing sites by the way the buildings cast shadows and traditional approaches to landscaping, so significant food production will be difficult (Danyluk, 2009).

Institutional Lands

Toronto and Region Conservation Authority (TRCA)
The TRCA is one of the largest landholders in the Greater Toronto Area, with thousands of existing farm acres (Gary Wilkins (personal communication), TRCA, 2009), including existing farmland rentals in the Rouge Park in northeast Toronto. TRCA has adopted a policy on sustainable near-urban agriculture for its current agricultural land base, including some not currently in agricultural production. The TRCA believes that it can play "a role in helping to revitalize agriculture in the Toronto region by establishing new partnerships and venturing into new agricultural projects on its lands that are more community-based, support the local food system and are environmentally sustainable" (Toronto and Region Conservation Authority (TRCA), 2008). One site in northwest Toronto, the Toronto Urban Farm, is managed by the city of Toronto, consists of eight acres, and began in 2004. Its original feasibility study estimated that it could feed 254 people. The focus of this farm is on local food production, youth employment, and leadership training.

Downsview Park
As part of the redevelopment of the federally owned park in the northwestern part of Toronto, a small portion (approximately 20 acres) of the 230 hectare property is slated for various types of agriculture. In 2009, FoodCycles, a nonprofit organization whose goals include education around healthy eating, helping at-risk youth, and creating jobs in the community through vermicomposting and food-growing operations, started its first season. The farmers (including many volunteers) sell their produce at a farmstand on site. Food-Cycles's plan is to use waste from the weekly Downsview Farmers' Market as raw product for its compost operation in order to produce healthy soil for sale to the public in addition to local, organic produce. In terms of marketing its produce, one of the goals for the future is to offer the fruits and vegetables grown through a community supported agriculture (CSA) operation.

Toronto District School Board
The Toronto District School Board (TDSB) commissioned a feasibility study to examine urban production possibilities on a number of school sites in the northern part of the city. The board sees this as part of an effort to create new learning opportunities for students, especially as part of a co-op training program. In its model, it would tender a contract to manage the farm and retain management of the education efforts associated with the site. No citywide targets for food production have yet been set.

Hydro Corridors
Ontario Hydro, the biggest landowner in the province, has right-of-way, some unused, over some 12 km^2 (4.6 $miles^2$)in the city (Danyluk, 2009), with 243 ha (600 acres) already devoted to parkland, recreational activities, and community gardens. Currently, there are nine allotment gardens in corridors and four community gardens (Danyluk, 2009). The city Parks, Forestry and Recreation Division has proposed that a similar amount of land could be used to expand recreational activities in existing corridors.

Nongovernmental Organization Projects
There are some examples of entrepreneurial agriculture happening on private lands within the city. For example, the nonprofit agency FoodShare Toronto, dedicated to food and hunger issues, established Sunshine Garden, a 650-square-meter certified organic operation, on the grounds of the Centre for Addiction and Mental Health (CAMH) in downtown Toronto where CAMH participants grow vegetables and herbs. Its produce has been sold on the property in a makeshift farmers' market

and is included in the thousands of boxes that FoodShare's Good Food Box program delivers in the city each month.

Another antihunger and community development agency, The Stop, has established its Green Barn project. A sustainable food production and education center in a heritage building renovated to LEED standards, the facility houses a sheltered garden, greenhouse, community kitchen, and bake oven. The Stop has also conducted a feasibility study on a six-acre site in the northwestern corner of Toronto, examining its potential as an urban farm, with four acres to be cultivated. At this point, no commitments to developing the site as a farm have been made (staff at The Stop (personal communication), November 2009).

Demand-side Interest in Local Markets

Parallel to this interest in urban production, increasing numbers of food buyers are focusing on expanding local food purchasing. For several years, through an organization called Knives and Forks, many Toronto chefs have been expanding their connections with Ontario farmers. There has been, as well, exceptional growth in the number of farmers' markets within the city during the 2000s, rising from seven to 27 (as of 2008), many having requirements that sales are of Ontario food only (Young, 2009). A new nongovernmental organization, Local Food Plus, has been working with several Toronto educational institutions, retailers, and restaurants to revamp their food supply chains to provide more local product on their menus. The city of Toronto recently adopted a local procurement policy and will focus first on expanding local food offerings in city daycare centers. The provincial government recently expanded its program promoting Ontario foods and is looking at increasing the proportion of Ontario foods in its cafeterias.

Most of these new initiatives report that demand is very strong and that the limited supply of local food and the need to rebuild local processing and distribution infrastructure are their biggest operational challenges.

Methodology

The Consumption Side of the Scenario

To estimate how much food would be needed to meet 10% of Toronto's vegetable consumption requirements, we adapted a method developed by Desjardins, MacRae, and Schumilas (2010), focusing solely on the vegetable consumption and production elements of their work and using their framing to help determine what fresh vegetables on which to focus. As part of their study, they estimated vegetable consumption from national Statistics Canada food disappearance data and organized vegetable consumption and production data according to the optimal consumption patterns set out in Canada's Food Guide (Health Canada, 2007). They accounted for food waste factors and then applied typical yields in organic production to estimate hectares of land required.

We used a similar national analysis because current data available for Toronto did not meet our data requirements.[10] Our assumption, therefore, is that Torontonians consume vegetables comparable to the national average.[11] We did, however, update food disappearance data using 2006 figures.[12]

To select vegetables to study, we used the Desjardins et al. (2010) criteria and selected many of the same vegetables because of their significance in the diet, their suitability for growing in the region, the availability of reliable horticultural data, and the popularity of vegetables, based on their frequency of consumption. We made a few adjustments to balance the Desjardins et al. analysis with Toronto's proximity to the Holland Marsh vegetable production region (which supplies a large

[10] The city of Toronto periodically collects data on frequency of consumption of fruits and vegetables through its Rapid Risk Factor Surveillance System (RRFSS, http://www.rrfss.on.ca). However, these data could not be used because the survey doesn't report quantities consumed and does not distinguish between fresh and processed consumption.

[11] Since Toronto is the most multicultural city in Canada, this is not likely true, but not enough is known to make reasonable adjustments (see footnote 10).

[12] http://www.statcan.gc.ca/pub/21-020-x/2007001/5211860-eng.htm

percentage of Ontario's carrots, onions and celery) and the top 10 vegetable imports into Canada.

However, our analysis does not imply that these are the only vegetables that should be grown in a Toronto urban food production scenario. They serve as proxy measures to help with the determination of land-use requirements and likely marketing channels. In reality, any combination of such vegetables (and other domestically produced ones) would be feasible, but specifying serving sizes across defined categories allows specific crop production requirements to be determined. It also permits estimates in future research of how much more urban food production would be required to meet a more optimal (for the health of Torontonians) pattern of vegetable consumption, similar to the work conducted by Desjardins et al. (2010) in Waterloo Region, Ontario.

We identified 13 vegetables on which to focus our production and marketing analysis, and then calculated the production of each one required to meet the current consumption amounts (see table 1, next page). Annual per kilogram fresh consumption[13] (unadjusted for losses) was multiplied by the current Toronto population. We then multiplied this amount by 10% (our production target).

Another major design parameter of our scenario is that all urban food production would be organic. This parameter was introduced for several reasons: (1) it corresponds to Toronto's efforts to reduce pesticide use in the urban environment; (2) the absence of spraying may make this land use more acceptable to residents in surrounding areas; (3) it supports Toronto's climate change strategy, as organic production generally is a good greenhouse gas mitigation and climate-change adaptation strategy relative to conventional production (Gomiero, Paoletti, & Pimentel, 2008); and (4) organic production commands market premiums, especially when the farm is certified, and this could be important for the financial viability of some urban farms. Consequently, to determine hectare requirements for each of the 13 crops, we used organic yields by assuming they would be 75% of conventional commercial vegetable operation yields.[14]

The Supply Side of the Scenario

To determine whether sufficient growing space is available in the city of Toronto, we used an inventory approach consistent with somewhat more narrowly focused initiatives in other jurisdictions, such as Portland, Oregon, and Vancouver (Mendes, Balmer, Kaethler, & Rhoads, 2008), Oakland (McClintock & Cooper, 2009), and Seattle (Horst, 2008), and guidance provided by Resource Centres on Urban Agriculture and Food Security (RUAF).[15] An inventory of this kind has not previously been undertaken, although the city of Toronto is currently conducting one of a more limited nature, focusing on oddly shaped and underutilized parcels that might be useful for community gardens (City of Toronto, 2009). Similarly, the provincial government has yet to assess its land holdings for their potential to support urban agriculture, but appears to be interested in doing so (Ontario Reality Corporation staff (personal communication), January 2010).

We investigated several categories of land types:

1. Lands still zoned for agricultural uses;
2. Lands zoned for other uses that might be suitable for agriculture;
3. Existing census farms;
4. Institutional lands, e.g., Toronto District School Board, Downsview Park, Toronto and Region Conservation Authority;

[13] In choosing fresh consumption only, we assume that there are very limited processing possibilities. For example, we assume that Toronto production would not be sold to processors such as french fry and potato chip manufacturers, and frozen corn and pea operations. However, some entrepreneurs could use Toronto production in processing facilities.

[14] This average hides considerable variability between crops. Also, intensive small-plot production generally produces higher per-area yields than larger commercial vegetable operations, so this estimate of organic small-plot yields relative to conventional large scale yields is likely conservative.

[15] http://www.ruaf.org

Table 1. Estimated Optimal Amounts (by Weight) of Specific Foods Required by the Toronto Population in 2006 using 2006 Food Disappearance Data (unadjusted for losses)[a] (adapted from Desjardins et al., 2010)

	Current Intake by food weight		Total requirement in 2006 (2.5 million population)		10% of total requirement		Current yields		Organic yields @ 75% conv.[b]		Area required	
Food, Fresh	Kg/ person/ yr.	Lb./ person/ yr.	Millions kg/yr.	Millions lb./yr.	Millions kg	Millions lb.	Kg/ha	Lb./acre	Kg/ha	Lb./acre	Hectares	Acres
Broccoli	2.86	6.31	7.15	15.76	0.72	1.6	6,530	5,746	4,900	4,300	147	324
Cabbage	4.86	10.71	12.15	26.79	1.22	2.7	24,500	21,560	18,400	16,200	66	146
Bok choy	0.74	1.63	1.85	4.08	0.18	.41	17,800	15,664	13,400	11,800	13	29
Green and waxed beans	1.08	2.38	2.70	5.95	0.27	.60	4,030	3,546	3,000	2,600	90	198
Carrots	7.0	15.43	17.50	38.58	1.75	3.86	38,300	33,704	28,700	25,300	61	134
Squash	2.68c	5.91	6.70	14.77	0.67	1.48	11,200	9,856	8,400	7,400	80	176
Peas	0.33	0.73	0.82	1.81	0.08	.18	4,400	3,872	3,300	2,900	24	53
Sweet Peppers	4.17	9.19	10.4	22.93	1.04	2.29	17,800	15,664	13,400	11,800	78	172
Tomatoes	7.64	16.84	19.1	42.1	1.91	4.21	17,400	15,312	13,000	11,400	147	324
Lettuce	10.57	23.3	26.42	58.25	2.64	5.83	17,900	15,752	13,400	11,800	197	434
Asparagus	0.6	1.32	1.5	3.3	0.15	.33	2,240	1,971	1,680	1,500	89	196
Sweet corn	3.39	7.47	8.48	18.70	0.85	1.87	4,930	4,338	3,700	3,300	230	507
Fresh Potatoes	30.04[d]	66.23	75.10	165.57	7.51	16.56	20,500	18,040	15,400	13,600	488	1,076
Total	75.96 / 102.99[e]= 73.8%	167.46 / 227.05[e] = 73.8%			18.99	41.87					1,710 / 2,317	3,770 / 5,108

[a] http://www.statcan.gc.ca/pub/21-020-x/2007001/5211847-eng.htm

[b] Post-transition (MacRae, Martin, Juhasz, & Langer, 2009).

[c] Because squash is reported with pumpkin in the 2006 data set we used, we took the 2005 squash consumption estimates from Desjardins et al. (2010) and multiplied by the waste factor to derive the production requirement for squash alone.

[d] The data are reported for fresh and processed as fresh equivalent, so since typically about 45% of potato consumption is fresh potatoes, we take the per capita total of 66.8 kg (147.3 lb.) x .45 = 30.04 kg/person/year (66.29 lb./person/year).

[e] Total fresh vegetable consumption is 139.75 kg (308.1 lb.); adjusting for potatoes means subtracting 36.76 kg (81.04 lb.) = 102.99 kg (227.05 lb.).

5. Potential roof top sites; and
6. Hydro corridors.

Although some recent media attention has been given to vertical farming (Fischetti, 2008; Gorrie, 2009), we did not include that possibility in our analysis because the concept is in its early stages and the technical and financial challenges are considerable.

Land Inventory Analysis

Of the six former local municipalities that were amalgamated to form the current city of Toronto,[16] only two retain land zoned for agricultural or market garden purposes: Etobicoke in the west and Scarborough in the east. Etobicoke contains three zones—Agricultural, Private Open Space and Open Space—with provisions for agricultural and

[16] Areas of the city are still identified by their former names.

market garden uses. Scarborough has one Agricultural zone specifically designated for agricultural uses. Several of the other former municipalities—the former city of Toronto and the former North York—also have zones containing agricultural use provisions, but these are mixed residential/agricultural zones. A survey of each borough revealed that these zones are now primarily occupied by residential buildings, rendering their agricultural designations moot. The continued existence of dedicated agricultural and market garden lands in both Scarborough and Etobicoke, combined with their large amounts of open space, guided our selection of these boroughs for the purposes of our land inventory analyses.

Digital geospatial data for both Official Plan land use and zoning information were not available from the city of Toronto. The land use layers found in the city of Toronto Official Plan are not intended to be accurate or precise for the purposes of analysis and are hence not available for public use. Digital zoning information is also not available for public use. Potential agricultural land identified through the parcel analysis was therefore broken down into zoning categories by visually cross-referencing available paper and PDF copies of zoning maps. We amalgamated specific zoning categories into broad designations.

In order to identify the land potentially available for urban agriculture in the city of Toronto, we used two separate and successive analyses. First, using GIS, we undertook a parcel analysis that identified potential land based on a set of basic physical criteria. Second, a policy analysis examined these potential parcels in order to understand how the land use policy framework in the city of Toronto might act to restrict or facilitate their conversion to agricultural use. We describe the analysis below.

For both these analyses, data were provided by the planning units of the pertinent former municipalities of the city of Toronto.

Parcel Analysis

For this preliminary supply analysis we employed ArcGIS 9.0 to identify and map parcels and calculate their areas. Using 2005 20-cm resolution orthorectified color air photos of the city of Toronto as a base layer, we conducted a thorough visual survey of two former municipalities of the current city of Toronto: Scarborough and Etobicoke. A property boundary layer and road centerline layer from the city of Toronto were used to help identify locations.

Through the visual survey, we identified parcels that we characterized as suitable to be converted to agricultural purposes. Parcels were digitized as a separate polygon layer for later area calculations.

In this parcel analysis, we sought both dispersed small plots that could be converted to small-scale but intensive production operations, and larger parcels that could be converted to more traditional forms of organic agriculture. The same seven criteria were used to identify lands for both types of agriculture: size, shape, site coverage, accessibility, proximity to watercourses, proximity to roads, and use of park space.

- *Size*
  In order to ensure the viability of dispersed agricultural plots, the minimum size we considered for agricultural parcels was 0.4 hectares (1 acre). The only exceptions to this rule occurred where multiple parcels of slightly less than 0.4 hectares occurred within close proximity to one another. Often this would occur where parcels were separated by a foot path or a small but significant natural barrier.

- *Shape*
  For the purposes of conceptualization, only parcels in shapes that could efficiently be worked by a small tractor (e.g., Kuboka) were considered. A degree of flexibility was exercised, but, in general, the aim was to only include shapes with primarily straight sides and widths of at least 20 meters. Thus square, rectangular, L-shaped, T-shaped and C-shaped parcels were the most common formation. However, given

that the aim in this initial phase was to determine the full amount of available land area, in a number of instances curvilinear borders were utilized.

- *Site coverage*
  A primary assumption guiding the selection of parcels for urban farming is that the existing on-site soils would be utilized. Thus, our parcel analysis sought sites where access to soils would not be significantly impeded by the site coverage. In this process we employed a number of exclusionary and inclusionary screens. Lands excluded from consideration consisted of:

  a. Buildings, concrete, pavement, or other constructed material
  b. Roads, trails, paths, or other transportation routes
  c. Baseball diamonds, soccer fields, or other active recreation space
  d. Active utility corridors
  e. Forest
  f. Water

  Ideal sites possessed none of the above coverage types and had one of more of the following:

  a. Agricultural uses
  b. Disturbed soils
  c. Gardens
  d. Grasses (maintained and non-maintained)
  e. Herbs and shrubs
  f. Patches of young forest (diameter at breast height <10cm)[17]

Ground Truthing (Site Inspection)
In the early phases of the parcel identification process, 10 parcels of apparently different coverage types were selected for ground truthing. Through these site visits, we calibrated our visual analysis of coverage types with the existing conditions on the ground. This process was used primarily to aid in distinguishing between different vegetative types visible in the 2005 orthophotographs.

A second round of ground truthing was undertaken after a complete preliminary analysis of the orthophotos. Over the course of three months, site visits were completed on 150 parcels (about 37% of 401 sites originally selected). Sites were not randomly selected, but rather were chosen because they were perceived from orthophotos to be potentially less suitable. These sites were also examined through aerial maps on a website providing current aerial data (http://www.maps.live.com). This allowed a closer look at certain parcels that may not have been easy to examine from the ground, due to borders of trees, for example. To gain ownership and development plan information, the city Planning Department, along with the Facilities and Real Estate Department, provided general information on whether development plans were pending for any particular parcel. While they were not able to disclose specific ownership information,[18] they did indicate whether the parcel was owned by the city. Some ownership information was already known, such as the parcels within Rouge Park managed by the TRCA.

Ground truthing eliminated about 22% of the parcels from our original estimates (see figures 1 and 2).

- *Accessibility*
  Again, a number of exclusionary and inclusionary screens were used to determine

[17] Given the unclear picture regarding green space in Toronto, it is difficult to determine potential conflicts with food production. Regarding tree cover, 17% is the current level, but the city target is 35%.

[18] Note that to find specific ownership information, the Ontario Land Registry maintains electronic records on ownership information and history that may be obtained for a fee. This can become an expensive process, as any parcel may have many deeds attached to it, and each deed is a separate record, with a separate fee.

whether sites were sufficiently accessible for our purposes. Parcels were excluded where no access point was visible or where sole means of access was provided:

a. By highway or highway off- or on-ramp (exception: where parking was visible alongside a highway or off- or on-ramp, indicating the potential for parking and access),

b. Through existing active recreational space, or

c. Only by travelling over manicured lawns.

Parcels were included where access was provided:

a. Directly by arterial, collector, or local municipal roads,

b. By bicycle path or wide pedestrian path, recognizing that city Parks, Forestry and Recreation staff access these spaces, or

c. Over lawns that were not heavily managed.

- *Proximity to watercourses*
  Although contamination and nutrient enrichment impacts from organic agriculture are generally considered to be minimal (Lynch, 2009), a riparian buffer is required to mitigate potential water quality issues. In this light, using GIS, five-meter buffers were created from the approximate bankfull width of all streams and rivers within the Humber, Don, and Rouge watersheds. These areas were excluded from the inventory.

- *Proximity to roads*
  Contaminants from roads and traffic can be a problem for urban agricultural soil quality and crop health. However, it has been recognized for some time that effects can be reduced with separation distances from the roadways (cf. Lagerwerff & Specht, 1970). We used GIS to create a 10-metre exclusionary buffer on all roads and highways within proximity to a potential parcel.

- *Use of park space*
  Park space is a precious commodity within densely populated urban areas. Within the city of Toronto, parks are often the only open arable lands remaining for conversion to agriculture. Used for both passive and active recreation, parks are valued by for a multitude of reasons by any number of users. Although the city may soon reassess its view of agriculture in parks, we expect that the conversion of park space to agricultural use is likely to generate a range of responses from park users. In recognition of this, our selection criteria within urban parks were necessarily restrictive.

  In general, we excluded land:

  a. In parks under 1.2 ha (3 acres) where our minimum 0.4 ha (1 acre) parcel size would represent more than one-third of the total park area,

  b. Currently dedicated to active recreation, or

  c. In the centre of parks, or in other locations where the agricultural parcel or access to it would negatively affect the continuity of park space or park uses.

  We included land:

  a. In apparently unutilized or underutilized corners of parks,

  b. Near an access point, but not impeding access, or

  c. In locations that could enhance the overall form and function of the park.

In this phase or our analysis, we were unable to factor in:

- Nonobvious slopes (from orthophotos) that might limit production
- Tree line impacts—we were unable to account for all possible tree line buffers to reduce shading on plots
- Space in highway off-ramps and medians, on the assumption that contamination and

access issues would be significant obstacles to agricultural use

- Access to water—whether it would be impossible to effectively deliver water to a site
- Site histories that would identify contamination, although the city of Toronto is developing a new system for site appraisals that can be considered in the next phases of the inquiry
- Ownership—limited analysis was undertaken
- Full ground-truthing of all identified parcels
- Complete assessment of development pressures associated with parcels. For example, those on main avenues may face significant and relatively immediate redevelopment pressures, though there is a provision in the city's Avenues development plan for urban gardens to be retained and developed.

Because of our criteria for including and excluding parcels, we were not fully able to account for all potential institutional sites that might be targeted for food production. The institutional actors will apply their own criteria that might differ from ours, resulting in a different inventory. However, we did communicate with key institutional actors—the Toronto District School Board, the Toronto and Region Conservation Authority, and Parc Downsview Park—regarding their urban agriculture plans, and we cross-referenced their information with our identified parcels. We added the total area from their sites not already identified in our estimates to our total, as reported below.

Results

Consumption

We calculated that a total of 1,710 ha (4,226 acres) is required to meet consumption of the 13 crops presented in table 1. Total fresh vegetable consumption was 103 kg/person/year (227 lb./person/year) in Toronto in 2006, unadjusted for losses.[19] Our 13 studied crops represent 73.8% of current vegetable consumption. To determine the land area required to meet 10% of fresh vegetable consumption in Toronto, we multiplied 1,710 ha (4,226 acres) by 73.8% to come up with our estimate of 2,317 ha (5,725 acres) to meet 10% of Toronto's demand. If we assume that the current 126 ha (311 acres) of vegetables produced on Toronto census farms is, or readily could be, sold within the city and converted to organic production,[20] then an additional 2,191 ha (5,414 acres) in vegetable production are required. Our assumption is that it is unrealistic to expect all census farm acreage within the city to be converted to meet local vegetable consumption objectives.

Supply

Results for Scarborough and Etobicoke are presented in figures 1 and 2 and tables 2 and 3. Approximately 845 ha (2,088 acres) of land are available, with over half on lands currently zoned for agricultural uses. Another 25% is sited on lands currently zoned industrial. Given that only 3% of identified land area is zoned residential, 10% parks and open space, and 1% institutional, there may be opportunities to minimize conflicts over land uses that are typically associated with urban agriculture proposals.

This analysis does not include a full assessment of institutional lands owned by governmental and paragovernmental actors. The federal and provincial governments, school boards, hospitals, and postsecondary educational institutions may all have underutilized or surplus properties that were not all captured using our methodology. However, key institutional actors report the areas of future development in table 4.

We also did not include active hydro corridors in our geospatial analysis, although some abandoned utility corridors in Scarborough were inventoried and added (determined by orthophotography to

[19] http://www.statcan.ca/english/freepub/21-020-XIE/2007001/tablesectionlist.htm

[20] Note that we have no current information on the production systems used in producing these vegetables.

Figure 1. Etobicoke Parcels

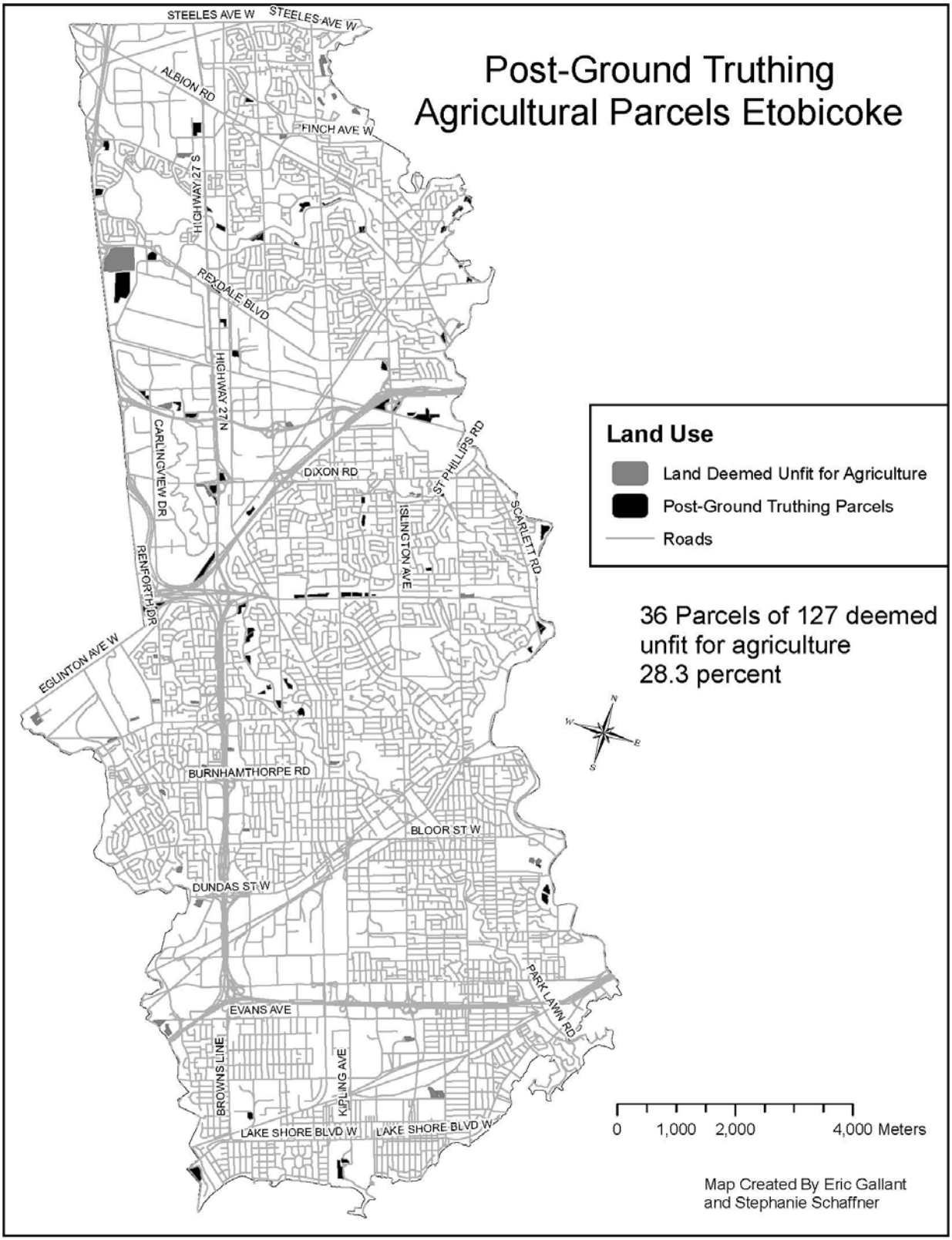

Figure 2. Scarborough Parcels

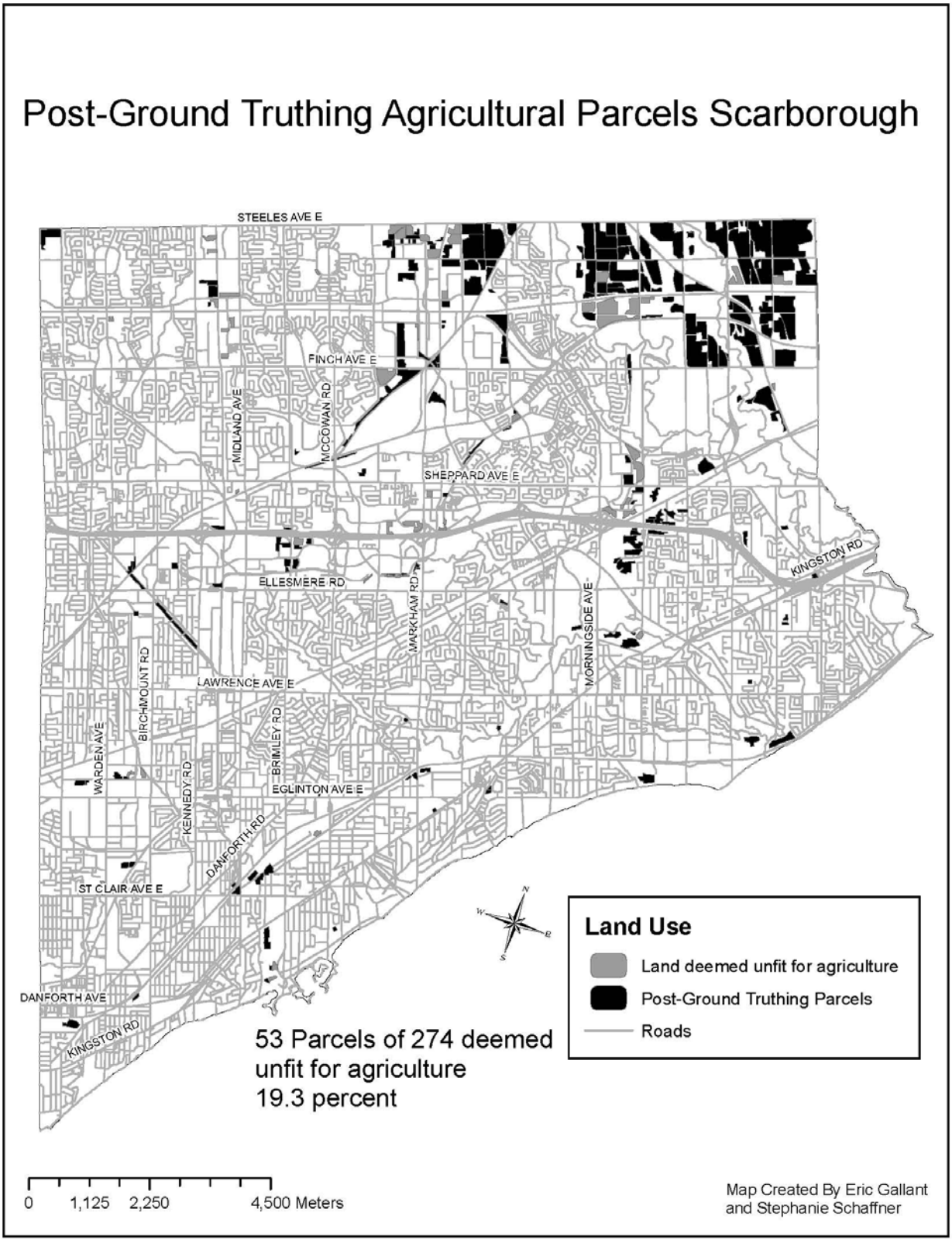

Table 2. Number of Growing Parcels in Scarborough, Organized by Zoning and Parcel Size

Area		Agricultural	Commercial	Industrial	Institutional	Residential	Utilities	Open Space[a]	Other[b]	Totals
Ha	Acres									
0.4–0.5	1–1.2	7	3	15	3	3	0	5	3	39
0.5–1	1.2–2.5	12	5	9	2	5	0	6	0	39
1–2	2.5–4.9	14	2	21	0	4	4	6	0	51
2–5	4.9–12.3	25	2	17	2	1	1	3	0	51
5+	12.3+	27	0	8	0	2	0	3	1	41
Total N		85	12	70	7	15	5	23	4	221
Total ha / acre		462.6 / 1,142.1	13.1 / 32.4	183.1 / 452.4	8.9 / 22.0	24.6 / 60.8	9.7 / 24.0	52 / 128.5	7.1 / 17.5	761.1 / 1,880.7
Parcel avg. (ha / acre)		5.4 / 13.3	1.1 / 2.7	2.6 / 6.4	1.3 / 3.2	1.6 / 4.0	1.9 / 4.7	2.3 / 5.7	1.8 / 4.4	3.4 / 8.4

[a] Includes Natural Environments
[b] Includes Office use and no zoning information available.

Table 3. Number of Growing Parcels in Etobicoke, Organized by Zoning and Parcel Size

ha	acre	Avenue	Industrial	Institutional	Open Space	Residential	Totals
0.4–0.5	1–1.2	3	5	3	23	2	36
0.5–1	1.2–2.5	1	4	1	18	0	24
1–2	2.5–4.9	5	8	0	10	1	24
2–5	4.9–12.3	1	2	1	1	1	6
5+	12.3+	0	1	0	0	0	1
Total N		10	20	5	52	4	91
Total ha / acre		11.7 / 28.9	32.6 / 80.6	3.3 / 8.2	33.2 / 82.0	3.6 / 8.9	84.4 / 208.6
Parcel avg. (ha / acre)		1.2 / 3.0	1.6 / 4.0	0.7 / 1.7	0.6 / 1.5	0.9 / 2.2	0.9 / 2.2

not include hydro poles and other aboveground evidence of current utility activity). The electromagnetic fields under power lines have been identified as a possible human carcinogen (Toronto Public Health, 2008). The concern is for urban farmers working on a daily basis in such fields. Toronto Public Health is recommending prudent avoidance. However, there is some evidence that the strength of the fields decrease significantly when measurements are taken outside the zone immediately under the lines. The highest levels were found directly under the wires, while median exposures decreased about 50% at a horizontal distance of 10 meters from the nearest power line, and to very modest levels, compared to baselines, at the edge of hydro corridors (Toronto Public Health, 2008).

Some community gardens are already located in hydro corridors, and there have been recommendations to increase their area in these zones. The Toronto Parks, Forestry and Recreation Division

Table 4. Significant Projects Underway or Under Consideration Not Captured by Our Analysis

Institution	No. of sites	Total area (ha (acre))
Parc Downsview Park	1	8 (20)
Toronto District School Board	2	5–10 (12–25)
TRCA[a]	2	3 (7) plus greenhouses
NGOs	1	2.5 (6.2)
Total	5	18.5–23.5 (avg. 21) (45.7–58.1 (avg. 52))

[a] Note that some TRCA lands have already been included in our assessment.

has concluded that the current 243 ha (600 acres) of parks space (including gardens) in corridors could be doubled. Although there are potential conflicts over uses, our presumption is that it is feasible to have one-third of that expanded space in commercial food production (81 ha or 200 acres), with such sites located on the edges of corridors to avoid higher intensity electromagnetic fields.

Such a scenario, however, is not without challenges, as identified by Danyluk (2009). Although private farmers do rent hydro lands in Ontario rural areas, within the city of Toronto secondary uses have to be consistent with the province's Public Use Principles and provincial legislation. The Official Plan does appear to permit agriculture in hydro corridors, though the municipality would likely have to set farm use as a municipal priority for the province to permit it. Secondary uses must also be compatible with adjacent land uses. This might restrict access to some locations. There are also issues around the land taxation rates to be paid by such farmers. In addition, soil quality may be low if the corridors have been disturbed; spraying for weed and brush control could contravene the organic status of urban farms; and structures and fencing are not usually permitted. Some hydro sites, however, may lie adjacent to other lands identified in our inventory, which would permit siting on these lands while use continued on the abutting hydro corridors.

Consequently, between sites identified in our analysis, institutional lands, existing vegetable farms, and hydro corridors, we presume to have about 1,073.5 ha (2,653 acres) of land (see table 5).

However, given a requirement for 2,317 ha (5,725 acres), this means 1,243.5 ha (3,072.8 acres) are required from rooftops, about 25% of identified rooftop greening area (Banting et al., 2005). As noted previously, the Banting et al. analysis did not include a review of load-bearing capacity or rooftop accessibility, so at this stage we are unable to determine how realistic a target this is.

Linking Supply and Demand

Our analysis reveals that sufficient land and rooftops are potentially available. However, matching the crops and suitable markets to the sites is a significant challenge.

Table 5. Summary of Growing Area Requirements, Scarborough and Etobicoke

Type	Area (ha (acres))
Land in Scarborough and Etobicoke	845.5 (2,089.3) (1.3% of surface area)
Active hydro corridors	81 (200)
NGO/Institutional projects	21 (52)
Rooftops	1243.5 (3,072.8) (25% or rooftop area for greening)
Existing vegetable production lands (assume conversion to organic and local marketing)	126 (311)
Total	2317 (5,725)

The 91 Etobicoke parcels are small, averaging 0.9 ha (2.2 acres), and dispersed (see figure 1). This pattern lends itself to more intensive production and localized distribution. The 221 parcels in Scarborough average 3.4 ha (8.4 acres), with the agricultural zonings having on average 5.4 ha (13.3 acres), with many significantly larger (see figure 2). Such holdings are better suited to more extensive production.

Regarding farm size and location, certain crops are higher value than others. To maximize viability, it makes sense to match the scale of the operation with both the value of the production and the markets that are interested in high-value crops. For example, salad greens generate more production in a small plot than squash, and their production can be spaced out over the growing season to provide regular and consistent cash flow. This makes greens a more viable production option on small plots and rooftops. Squash, potatoes, and sweet corn, in contrast, work well in a more extensive production environment, as is found on some existing census farms. Many restaurants will desire lettuce deliveries 3–5 times a week, so significant postharvest handling and distribution infrastructure will be required to assure quality and reliability of supply. Squash and potatoes, in contrast, are easier to handle and distribute.

However, according to our analysis there exists something of a mismatch between crops that require larger parcel units and the amount of land available in those parcel sizes. Referring to table 1, sweet corn, squash, potatoes, cabbage, carrots, and asparagus require 1,014 ha (2,506 acres). This would require almost all the ground spaces available for production, including many individual sites that are too small for these crops (see tables 2 and 3). A related challenge is that for reasons of farm finances and appropriate crop rotations, it might not be feasible to allocate all the land in these parcels to this limited set of crops.

For small parcels and rooftop production, there appears to be a better match between requirements of intensively produced crops and available locations. Both small plot land parcels and rooftop locations, however, have some unique challenges. The dispersed locations and small scale suggest postharvest handling and distribution challenges. Rooftops present load-bearing, physical infrastructure, and access challenges that are different from land parcels. Moving inputs and harvest to and from the roof will be particularly challenging at many sites. They may also present some unique lease and insurance-related dilemmas.

Experiences with local food promotion in Ontario reveal that mainstream retailers and food service companies, and their distributors, tend to be hesitant to purchase local fresh vegetables.[21] Independent retail, table-service restaurants, specialty shops, farmers' markets, box schemes, and CSAs are more promising outlets for Toronto food. See table 6 in the appendix for an analysis of all crop and land use scenarios contrasted with market opportunities.

Conclusions

Is it feasible for Toronto to produce 10% of its fresh vegetable requirements from within its own boundary? This level of food production would require 2,317 ha (5,725 acres) to meet current demand. Of this, 1,073.5 ha (2,652.7 acres) of land could be available from existing census farms producing vegetables, lands currently zoned for food production, certain areas zoned for industrial uses, and over 200 small plots (0.4–2 ha or 1–4.9 acres) dotted throughout the northeast and northwest of the city. This area would have to be supplemented with some combination of production under hydro corridors (potentially problematic because of public health concerns about electromagnetic frequency), institutional lands in other parts of the city, and rooftop production. The maximum rooftop area required would be about 1,243.5 ha (3,072.8 acres), approximately 25% of the rooftop area identified as generally suitable for rooftop greening in the city of Toronto. Given the types of vegetables required, a combination of extensively (e.g., potatoes, sweet corn, squash,

[21] The senior author is a consultant to Local Food Plus, an NGO trying to rebuild local and sustainable food production and distribution capacity.

cabbage) and intensively (e.g., lettuce, bok choy) cropped areas would be required. The land and rooftop space available suggests, however, that there would be difficulties meeting requirements for crops such as sweet corn, squash, potatoes, cabbage, carrots, and asparagus. Additionally, there are some unique challenges associated with commercial rooftop vegetable production that would have to be addressed. These totals are modest in comparison with hollowed out urban cities, such as Detroit, where some 10,000 ha (24,711 acres) of land, currently abandoned, might be suitable for agricultural production (Dowie, 2010). But they are broadly consistent with a comparable Oakland study (McClintock & Cooper, 2009) that concluded that 5–10% of that city's fruit and vegetable requirements (for an estimated population 423,000) could be met from 486 ha (1,201 acres) of food production on 495 aggregated public land sites.

We will be exploring all these themes more fully in forthcoming reports being finalized by our team, including a detailed future scenarios analysis of policy and infrastructure changes to ramp up urban production,[22] an inquiry into the potential for urban CSAs, research on urban food distribution and related logistical challenges, and policy and program proposals to support farmers' market development.

[22] An earlier and more wide-ranging version of this paper was published by the Metcalf Foundation as *Scaling up urban agriculture in Toronto: Building the infrastructure* (Nasr, MacRae, & Kuhns, 2010). This paper addressed both commercial and self-provisioning issues. See http://www.metcalffoundation.com/downloads/Metcalf_Food_Solutions_Scaling_Up_Urban_Agriculture_in_Toronto.pdf

Appendix

Table 6. Production and Marketing Considerations (see key to abbreviations at bottom of table)

Crop	Types of product	Primary farm types	Processing & storage requirements	Seasonality	Competition focus	Markets
Broccoli	Fresh	Intensive, RT	PH handling	Limited distribution season; annual national imports > production	New organic sales, import substitution	Independent retail, restaurant, food service, NFS
Cabbage	Fresh	Farm, Institutional	PH handling, storage	Long distribution season with storage; production > imports	Import substitution, may not be sufficient organic demand	Ontario Food Terminal (OFT) Independent retail; new FMs, Box schemes, CSAs
Bok choy	Fresh	Intensive, RT	PH handling	Limited distribution season; imports > production	New sales, import substitution	OFT, Independent retail, NFS
Green beans	Fresh	All	PH handling	Limited distribution season; production > imports	New organic sales	Restaurant and food service, new FMs, CSAs, box schemes, NFS
Carrots	Fresh	Farm Institutional	PH handling, Storage	Long distribution season, production > imports	New organic sales	Independent retail, restaurant and food service, new FMs, CSAs, box schemes
Squash	Fresh	Farm Institutional	Storage	Long distribution season, production > imports	New organic sales, import substitution	Independent retail, restaurant and food service
Peas	Fresh, snow peas	All	PH handling	Limited distribution season; production > imports	New organic sales	Independent retail, restaurant and food service, new FMs, CSAs, box schemes, NFS
Sweet Peppers	Fresh	Intensive, RT	PH handling	Short distribution season; imports > production (but ON greenhouse production high)	Import substitution	Independent retail, new FMs, CSAs, box schemes
Tomatoes	Fresh	Intensive, RT	PH handling	Medium distribution season; production > imports	New organic sales,	OFT, independent retail, new FMs, CSAs, box schemes

Crop	Types of product	Primary farm types	Processing & storage requirements	Seasonality	Competition focus	Markets
	Processed	Intensive, RT	Small facility	Aseasonal	New organic sales	NFS, independent retail
Lettuce	Fresh	Intensive, RT	PH handling	Medium distribution season, imports > production	New organic sales, import substitution	NFS, CSA, box schemes
Asparagus	Fresh	Intensive, farm, institutional	PH handling	Short distribution season; imports > production	Import substitution	Independent retail, box schemes, CSA
Sweet corn	Fresh	Farm Institutional		Medium distribution season, production > imports	New organic sales	Independent retail, new FMs, box schemes, CSAs
Potatoes	Fresh	Farm Institutional	Storage	Long distribution season; Production > imports,; no consumption increases required	Expanding organic markets; import substitution possible for fresh market processing unlikely	Independent retail, NFS, box schemes, CSAs

Abbreviations:
Intensive: Small plots, intensive production
RT: Rooftops
PH: Postharvest
FM: Farmers' markets
NFS: New food service operations
CSAs: Community supported agriculture

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