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RESEARCH PAPER 11

# Indoor Farming and North Pickering

October, 2020

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# Indoor Farming and North Pickering

## Executive Summary

**Section 1** of this paper quotes several Durham Region politicians extolling the advantages of indoor farming as an adjunct to a future airport in North Pickering. Their comments raise many questions, which this paper sets out to answer.

**Section 2** defines indoor farming (called by some in the media a new "global craze"), as both greenhouse farming and artificially lit horizontal or vertical farming inside buildings. Indoor farming is differentiated from "urban agriculture" and the broader category known as "protected agriculture."

**Section 3** compares advantages and disadvantages of indoor and outdoor farming. While indoor farming offers benefits in terms of managing lighting, heating, and pest control, boasts faster yields, and has the ability to deliver fresh produce year-round, its crop range is severely limited and the cost (both financial and environmental) of operating such facilities can be prohibitively high. Indoor farms grow none of the food staples (wheat, rice, corn, pulses, root vegetables, etc.) that the world's population relies on for survival. Canada's greenhouse acreage is insignificant when compared with that of countries closer to the equator. North American farmers find it economically smarter to practise their well-honed skills and evolving techniques outdoors, in their fields.

**Section 4** takes a closer look at the challenges faced by indoor farming operators – especially, how to assess future viability when developing a business plan. The cost of heating for indoor agriculture can be a deciding factor in a northern clime. Furthermore, the significant energy needs of indoor farming leave a big carbon footprint. The more northerly the locale, the greater the energy demands, making the more-northern product uncompetitive with field-grown crops or those grown under glass further south, even if those products must then be transported a considerable distance.

**Section 5** describes how, in 2018, greenhouse-grown cannabis began encroaching on greenhouse-grown vegetables in provinces across Canada. But early 2020 saw a market correction, as production was found to be far outstripping demand. Many of the greenhouses now stand vacant. Meanwhile, the COVID-19 pandemic has heightened global awareness of the need to increase and ensure food security, potentially prompting the reassessment of aspects of the agricultural sector, to reduce our reliance on imports.

**Section 6** explains why indoor farming, despite much hope and hype, is incapable of feeding the planet. Its tender products are perishable, low in calories and nutrients, and, owing to the method's high energy costs, will continue to be priced beyond the means of much of the world's population.

**Section 7** explains why the idea of putting indoor farms on North Pickering's prime farmland is ill-considered and self-defeating. Rather than benefitting the Region, the facilities would increase economic instability, enlarge the Region's carbon footprint, and, if attached to a Pickering airport, help destroy an irreplaceable natural asset – the land's Class 1 soil, which (unlike indoor farms) is capable of reliably producing some 200 different agricultural products and enhancing the food security of Canada's largest urban centre. A recent research paper for the Greenbelt Foundation outlines the impediments and constraints involved in attempting to expand Ontario's existing indoor farming industry.

**Section 8** synthesizes the content of the previous sections to answer the questions posed in Section 1.

# 1 Questioning What Durham Region's Politicians Have Been Saying

"Large-scale greenhouse agriculture would work alongside an airport. It would extend the growing season, enable the growth of nonindigenous crops for our diverse population, and ensure a supply of locally grown fruits and vegetables."

– Pickering Mayor Dave Ryan, op-ed, *Pickering News Advertiser*, August 24, 2017

"A modern airport would also allow us to showcase one of our biggest economic drivers: agriculture. Imagine on-site farming that highlights state-of-the-art, year-round growing practices and innovation? What about a food hub highlighting greenhouses and vertical farming? A regional centre of culinary excellence could support locally-grown and supplied food."

– Durham Region's Chair, John Henry, op-ed, DurhamRegion.com, August 15, 2019

"A specific concern I've heard revolves around farming. Innovative solutions could see retention of agricultural uses on hundreds of acres of land, reimagined (e.g. as stacked greenhouses) to produce year-round indoor farming opportunities that will have direct access to world markets thanks to proximity to the airport. I see this as a win/win."

– Ajax Mayor Shaun Collier, op-ed, *Ajax News Advertiser*, August 22, 2019

"I've researched a little bit what farming means to the community […] we look at it in a very closed-box way, that farming has to be on farmland. But there is a huge scope that the entire world is looking at, because space is getting congested in many countries and there are urban agriculture, urban farming […] we can grow our vegetables, we can grow our – anything […] and we can do it anywhere. […] And I support this [airport motion, based] on the fact that farms can be grown anywhere."

– Whitby Councillor Maleeha Shahid, transcribed from recorded debate on Whitby Council Airport Motion, May 27, 2019

"This will be an airport of the future. It's not just about moving people. It will be a magnet for jobs in robotics, artificial intelligence, and advanced vertical agriculture… that will be fed by the talent graduating from our post-secondary schools."

– Durham Region's Chair, John Henry, quoted in article "Toronto East Aerotropolis a Glimpse Into the Future," promotional insert on Durham Region, *Globe and Mail,* October 17, 2019

Are these politicians right? Is indoor farming the way of the future? Can such farming produce anything and be done anywhere, as the councillor states? Will it create urban resiliency and help meet the world's food security needs? Will it even help end world hunger, as claimed by a hydroponic-nutrients supplier [4] and many others? Or will it remain a long-held yet elusive dream here, unable to sufficiently reduce its high costs to be competitive with traditional outdoor farming? In Durham Region's North Pickering, could indoor farming serve world markets, as one mayor suggests? And would it confer enough green credentials on the aerotropolis vision of some politicians to defuse the decades-old arguments for protecting North Pickering's prime farmland?

These questions cry out for answers. The present paper is a distillation of what we discovered when we went in search of the facts. The short answers to the questions are in Section 8.

# 2 Indoor Farming Defined

The term "indoor farming" – also and most accurately called Controlled-Environment Agriculture (CEA) – encompasses a narrow range of farming processes. Not to be confused with "urban agriculture," indoor farming is that part of "protected agriculture" that includes:

- **greenhouse farming**, regardless of whether the farming takes place using a soil, hydroponic, aquaponic, or aeroponic system; and
- **horizontal or vertical farming inside artificially lit, climate-controlled buildings**.

Indoor farming has been carried out, in one form or another, for well over a century. But technological innovations, especially in the past decade or so, have allowed a scaling-up and proliferation that some news media have begun to describe as a "global craze."[1]

A Swiss multinational investment bank and financial services company, UBS Group AG, noted in a 2019 online article that such food and agriculture innovation (which the writer called "the new agricultural revolution") is attracting more and more investor capital. UBS is predicting that "food innovation could become a USD $700bn market by 2030 – a fivefold jump from USD $135bn today."[2]

This is pretty heady stuff, and an opinion not unique to UBS Group. Indoor farming is increasingly and broadly touted as a way to produce more food for a growing population (and a growing middle class) while having a lower environmental impact than traditional farming.[3] But how realistic are these claims, both in general and with respect to North Pickering? And does indoor farming put traditional farming at risk?

**Fig. 1: Explaining "Urban Agriculture" and "Protected Agriculture"**

**Urban agriculture? Not the same thing**

"Urban agriculture" is different from indoor agriculture, as it tends to be done for personal use and mostly outdoors. "Grow your own," increasingly popular with local urban food movements, is widely embraced as an important contribution to future food supplies. It can be as simple as growing cherry tomatoes on an apartment balcony or microgreens in the kitchen.

Larger "kitchen gardens," prevalent in many countries and often fertilized with compost from kitchen scraps, are relied on to provide as much food as possible for the table. In Canada, such gardens are common in rural areas, especially on farms. But now, city dwellers are starting to establish urban gardens in their own backyards, on rooftops, in allotments, or in community parks.

By taking advantage of renewable resources or by sharing existing ones, urban agriculture (unlike large indoor growing facilities) can produce food with a low carbon footprint.

**Protected agriculture? Not *quite* the same thing**

"Protected agriculture" isn't quite indoor farming. Covered vegetable-growing around the world was reclassified in 2018,[5] so that "greenhouse" became the term reserved for permanent structures for food-growing, whereas "protected agriculture" was chosen to describe the full range of methods – greenhouses, tunnels, row covers, etc. – in use to extend plants' growing seasons.

Making this distinction has been worthwhile. In 1980, the global greenhouse vegetable area had been reported as covering 371,000 acres; in 1995, the "protected vegetable cultivation" area was reported as 1.2 million acres.

But in 2019, after the reclassification, the World Greenhouse Vegetable Statistics report estimated that vegetable production under glass covered 1.2 million acres worldwide, whereas total protected agriculture crops covered 13.9 million acres – confirming that most protected agriculture is actually happening on farm fields.

# 3 Outdoor *versus* Indoor Farming

Comparing these two methods wasn't as straightforward as expected. The topic is complex, direct correspondences turned out be be elusive, and a thorough list of each method's characteristics and consequences could fill many pages. We zeroed in on the most important and pertinent aspects. Where an advantage or disadvantage showed itself to be particularly relevant to conditions in North Pickering, this is noted. Other considerations pertinent to North Pickering are covered in Section 7.

## A. Outdoor Farming (Field Crops)

### Advantages

- plants particularly thrive on rich Class 1 soil, which can reliably grow crops every year; North Pickering is almost entirely Class 1 soil
- plants do well on Class 2 soil, the second-best farming soil, which produces approximately 80% of the yield of Class 1 soil;[1] North Pickering has some pockets of Class 2 soil
- farmers can make good use of lesser classes of soil; e.g.,classes 5 and 6 are ideal for growing forage and fodder for livestock
- crops benefit from the soil's inherent complex nutrients and from the natural work of worms and microbes
- crops attract and support pollinators (bees and other insects) and can stimulate biodiversity
- crops thrive in a temperate climate; North Pickering's climate is just that
- crops utilize nature's free light (sunlight) and free irrigation (rain and snowmelt), which are also free of greenhouse gas (GHG) emissions; in Ontario, except for fruit and vegetable growing, outdoor crops rarely use irrigation but depend instead on natural precipitation for moisture
- farms can grow or provide more than 200 different agricultural products (see partial list, p. 10)
- farms can grow the kind of nutritious crops (e.g., beans and legumes, root vegetables, grains) that lend themselves to long-term storage and to processing
- fields allow in-ground food production throughout the growing season, which can be extended by using hoop houses and high tunnels[2]
- farmland delivers eco-benefits, stores carbon, and will continue to do so if farmed using conservation/regenerative practices
- farming offers healthy outdoor work

### Disadvantages

- is location-dependent: while high-quality soil increases yields and profits, crop productivity suffers in poorer soil
- can't grow crops during coldest months
- is at risk of soil and crop damage caused by the vagaries of weather (overly wet or dry weather, temperature extremes: heat waves, cold snaps, late-spring and early-fall frosts)
- can suffer crop damage from airborne diseases, insect infestations, bird- and animal-caused injury
- can need irrigation for fruit and vegetable crops, to supplement natural precipitation

## B. Indoor Farming (Including Greenhouse Production)

### Advantages

- protects crops from extremes of weather and temperature
- allows year-round production
- allows calibrated control of light, ventilation, temperature, water (where used), and nutrients
- requires far less water (where used) than outdoor crops under irrigation
- promotes faster crop growth than outdoor farming
- can deliver yields many times greater than can the same crops grown outdoors[3]
- suffers fewer plant diseases; has fewer food-safety issues

### Disadvantages

- grows an extremely limited crop range (the Ontario government lists only 6 main crops grown by the province's commercial greenhouse growers: tomatoes, bell peppers, cucumbers, lettuce, eggplant, and strawberries; beyond these and fresh-cut flowers, everything else is a niche product, not tracked in the agribusiness system)
- can't grow food staples (e.g., cereals, root vegetables) on any scale[4]
- its food crops, even combined, contain insufficient nutrients and calories to meet our dietary needs[5]
- its harvested crops are time-sensitive (tender and perishable)
- involves steep start-up costs, which can be astronomical for large-scale operations that are planning to use advanced robotics and artificial-intelligence systems to reduce labour costs
- involves steep ongoing energy costs: *for greenhouses*, around-the-clock temperature control and ventilation, plus artificial lighting during winter months; *for all other kinds of indoor farming*, around-the-clock, year-round temperature control, lighting control, and ventilation fans (a study in the UK showed that lettuces grown in traditionally heated greenhouses used ~250kWh of energy/year per sq. metre of growing area, while those in the same growing area but within a vertical farm used ~3,500kWh of energy/year[6])
- is not emissions-free when fossil-based energy sources are used for heating, ventilation, lighting
- is not emissions-free in terms of the sourcing and production of the necessary artificial nutrients. Hydroponic facilities require hydrogen, nitrogen, sulfur, phosphorus,* potassium, magnesium, and calcium; aeroponic and aquaponic facilities add to this list micro-nutrients such as iron, zinc, molybdenum, manganese, boron, copper, cobalt, and chlorine.[7,8] Organic operations must use nutrients that are natural, not man-made. (Outdoor farming, on the other hand, primarily adds only nitrogen, potassium, and phosphorus as artificial fertilizers – or, for organic farming, their natural equivalents – while the remaining nutrients are supplied by the soil.)
- product is mostly marketed in clamshell containers, adding to the plastics waste stream
- is not a good source of long-term jobs for low-skilled, lower-income workers; the robotics and electronics required to increase indoor farming's cost competitiveness mean jobs for a limited number of highly educated, highly specialized employees

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* Phosphorus, used in fertilizers of all farming methods, is a finite resource, its looming scarcity already of concern.[9]

## C. Types of Agricultural Products (Indoor and Outdoor)

Food crops listed in the Indoor Farming category of Table 1 are those that are grown today in large-scale indoor facilities, mostly greenhouses, in North America, and are the most likely to be grown locally.

All foods and other agricultural products in the Outdoor Farming Agricultural Products category are, or could be, grown in (or produced in or on) North Pickering's soil. The crops for forage, fodder, and feed provide food for livestock which in turn produce dairy, meat, and fibre products. The list is not exhaustive.

**Table 1: Indoor and Outdoor Agricultural Products**

| Indoor Farming Crops | Outdoor Farming Agricultural Products | | |
|---|---|---|---|
| • ***Vegetables and Fruit*** | • ***Vegetables and Fruit Crops*** | | • ***Crops for Forage, Fodder, Feed*** |
| cucumbers | apples | leeks | barley |
| eggplant | apricots | lettuce (assorted) | corn (silage) |
| herbs (assorted) | artichokes | muskmelon | corn (feed) |
| kale | asparagus | nectarines | grass |
| lettuce (assorted) | beans (assorted) | onions (assorted) | hay/haylage |
| microgreens | beets | parsnips | oats |
| mushrooms | blueberries | peas (assorted) | • ***Foods from Natural Habitat*** |
| peppers (assorted) | bok choy | peaches | honey |
| sprouts | broccoli (assorted) | pears | maple syrup |
| strawberries | Brussels sprouts | peppers (assorted) | • ***Grains*** |
| tomatoes | cabbage (assorted) | plums | canola |
| • ***Horticulture*** | carrots | potatoes | corn |
| cut flowers | cauliflower | pumpkins | pulses (esp. dried beans, peas) |
| potted houseplants | celery | radicchio | soybeans |
| fruit and vegetable seedlings | cherries | radishes (assorted) | wheat |
| | corn (sweet) | rapini | • ***Horticulture/Landscaping*** |
| | crabapples | raspberries | field-grown flowers |
| | cranberries | rhubarb | sod |
| | currants | rutabagas | trees and shrubs |
| | cucumbers (assorted) | spinach (assorted) | • ***Livestock*** |
| | eggplant | sprouts | cattle (beef, dairy) |
| | garlic | squash (assorted) | goats |
| | gooseberries | strawberries (assorted) | pigs |
| | grapes | sweet potatoes | poultry (eggs, meat) |
| | herbs (assorted) | Swiss chard | sheep |
| | kale | tomatoes (assorted) | • ***Specialty Crops*** |
| | kohlrabi | watermelon | buckwheat |
| | | zucchini | Christmas trees |
| | | • ***Nut Crops*** | flax |
| | | hazelnuts | millet |
| | | walnuts | rye |
| | | | sunflowers |

*Sources:* Foodland Ontario; Ontario growers and suppliers

The chart shows that indoor farming could not be a substitute for outdoor farming. Greenhouses and indoor farms can offer high crop yields, but the range of plants is limited to a few fast-growers with compact roots and a small growth habit.

While research is ongoing into ways – gene-editing being one – to increase versatility,[10] the typical crops grown in vertical farms are low-calorie foods and mostly limited in terms of nutrients. However fresh and tasty they might be, they do not, on their own, provide a balanced and nutritious diet, and cannot replace the wide range of essential foods and related products that come from actual farms. Wheat, corn, potatoes, sweet potatoes, other root vegetables, tree fruits, dairy, meat, and honey are the foods on which our survival depends. These foods either cannot be grown or produced in indoor farms, or cannot be grown or produced indoors in anything like the vast quantities needed to keep us fed and healthy.

## D. Distribution of the World's Greenhouse Production

Interestingly, North America accounts for *less than two percent* of all global greenhouse production. Canada accounts for just one-third of one percent.

In the list below, with two exceptions, the greenhouse acreages shown are totals per continent. "North America" includes the total combined greenhouse acreages of Canada, the U.S., Mexico, Central America, and the Caribbean. Statistics Canada was the source for the "Canada" and "Ontario" acreages.

**Global greenhouse acreages, 2017** [11,12]

- Asia: 556,000
- Europe: 430,000
- Africa: 91,000
- South America: 31,000
- North America: 18,000
- Oceania: 5,000
- Canada: 4,000
- Ontario: 3,000
- Antarctica (research station): <1

In the U.S. and Canada, few growers want to be in the greenhouse business. The reason? Our very efficient farmers find it costs them far less to grow fruit and vegetables on North America's farmland.

# 4 Indoor Farming's Challenges

## A. Assessing Viability

There is a lot of loose talk these days about what indoor farms (especially vertical farms) are, what they can do, and how they will change (even save) the world. Research shows that the benefits aren't manifold and that financial viability is not assured.

A useful website called Vertical Farming lays out some of the reasons why this is so. It presents the findings of an "emerging industry" study commissioned in 2016 by Monark Group, a property developer in Surrey, B.C. The researchers did a scan of the vertical farming industry across North America, included in-depth market assessments, and applied "a critical lens to the often rosy projections of industry supporters and companies competing in the current startup funding environment."[1] The study uncovered a great many constraints. Its findings are still valid today.

The main takeaways are these:

- The capital costs are high, and the high energy costs are ongoing.
- While continued advances in lighting technology may help to gradually lower production costs, the need for facilities to be in or near dense urban centres to be profitable can also mean higher property costs, and these are likely to keep climbing as population numbers increase.
- Higher prices must be charged for indoor farming's ultra-fresh specialty crops. This restricts the potential market to consumers who can afford such produce, and this in turn limits the number of competitors (growers) that can expect to be financially viable.
- Cost recovery requires near-100% sale of product at all times, regardless of market conditions.
- New entrants may be hard-pressed to attract customers in a market already penetrated by the competition.
- Various claims (e.g., indoor farms produce food with higher nutritional value; indoor farms increase food security) can stretch consumer credibility and trigger backlash.
- The size of the operation must be precisely matched to local consumer demand because the indoor-farming model does not allow for storage, seasonal considerations, variations in customer requirements, or other fluctuations in demand.

There has always been a high degree of uncertainty to do with market size for pricey agriculturally derived products. There are often so many startups in a "new" industry that the market for their produce is soon saturated, resulting in business failures or the eventual consolidation of jobs and facilities into fewer locations to match real consumer demand. Market saturation appears to be surfacing as an issue even in today's "new" cannabis and microbrewery sectors, and is already leading to job losses and abandoned facilities.[2,3,4] The number of remaining jobs and their location will depend on which businesses survive.

Global crazes and rosy projections do not guarantee a new venture's success. For indoor farming, comprehensive, *up-to-the-minute* market research and a meticulous business case are crucial to assessing the potential viability of an operation at a given location. Even then, new legislation, such as laws that would limit emissions, could up-end the assumptions and conclusions of the most thorough business plans. A significant number of indoor farming operations do not thrive or do not thrive for long, and many do not survive.[5]

## B. Indoor Agriculture Heating

### Heating Degree Days

Soil temperature (or the temperature of other types of growing media) needs to be at 5°C minimum for agricultural crops to start growing. Grasses start above this temperature, providing forage and fodder for grazing livestock; these in turn produce meat, dairy, and fibre agricultural products. Indoor growing facilities must supply artificial heat during cold weather months to attain and maintain typical target temperatures of 23°C during the day and 18°C at night.

A good indicator of the heat needed for indoor growing in a specific location is a measurement called the *heating degree day*,[6] which quantifies the demand for energy needed to heat a building. For a specific day, the heating degree equates to the number of degrees the average outdoor air temperature is below an 18°C base.

*Examples:*

- Jan. 10, with an average outside air temperature of –7.3°C: the heating degree for that day is 25.3°C – the difference between the average outside air temperature and 18°C.
- July 10, with an average outside air temperature of 19.1°C: the heating degree for that day is 0°C. For an 18°C base, no artificial heating is required that day.

For practical use and planning purposes, individual heating-degree-day calculations are added together to give monthly and annual totals. For an indoor growing facility, lower annual numbers give it a competitive heating advantage over an identical facility elsewhere with a higher number of annual heating degree days. Table 2, on the next page, provides a revealing comparison.

The takeaways from Table 2:

- The annual heating-degree-day data for Ontario show the competitive advantage enjoyed by the traditional growing "hotspots" in southwestern Ontario and the Niagara Peninsula. Most of the province's indoor growing facilities are clustered in those areas because less heating is required there.
- Downtown Toronto's buildings need less heating because of the urban "heat island" effect.
- Oshawa's proximity to the moderating influence of Lake Ontario reduces the annual heating demand. Locations further north of the lake do not enjoy the same benefit.
- Tyrone and Burketon Station, both in Clarington, are rural locations comparable to North Pickering's Federal Lands in terms of latitude and distance from Lake Ontario. Indoor growing facilities in those locations would require substantially more artificial heat than similar facilities located in Oshawa proper.
- Buildings in rural areas further north of the Great Lakes (i.e., not on their shores) tend to have the highest heating requirements.
- The Netherlands' massive indoor growing clusters in Westland have a much lower heating requirement than do Ontario's clusters. The same applies to Vienna, Austria, the site used in the research of Theurl et al., described in subsection C (see p. 15).
- The massive indoor growing complexes in northern China's Shandong province have a huge advantage in terms of reduced heating needs compared with anywhere in Ontario. (Nearly half of global greenhouse acreage today is in Asia.)

**Table 2: Total Heating Degree Days (Monthly/Annual Averages)**

| Location and Timeframe | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ontario: 1981–2010** [1] | | | | | | | | | | | | | |
| Kingsville, Essex County | 670 | 570 | 510 | 308 | 120 | 21 | 2 | 5 | 57 | 205 | 389 | 580 | 3437 |
| Toronto (downtown) | 674 | 581 | 515 | 306 | 135 | 26 | 2 | 5 | 63 | 227 | 392 | 573 | 3498 |
| Port Dalhousie, Niagara Region | 664 | 591 | 522 | 319 | 154 | 29 | 2 | 7 | 67 | 226 | 384 | 575 | 3537 |
| Vineland, Niagara Region | 672 | 584 | 523 | 322 | 156 | 34 | 3 | 8 | 69 | 228 | 390 | 573 | 3561 |
| St. Catharines, Niagara Region | 682 | 591 | 524 | 321 | 150 | 34 | 4 | 10 | 75 | 239 | 401 | 584 | 3613 |
| Oshawa Water Pollution Control Plant | 706 | 610 | 547 | 341 | 180 | 46 | 8 | 13 | 82 | 265 | 414 | 595 | 3806 |
| Toronto Pearson Airport | 728 | 636 | 556 | 330 | 164 | 39 | 5 | 12 | 83 | 266 | 428 | 626 | 3873 |
| Toronto Buttonville Airport | 738 | 666 | 566 | 337 | 169 | 37 | 6 | 15 | 91 | 284 | 448 | 649 | 4004 |
| Bradford Muck Research Station | 772 | 675 | 596 | 354 | 184 | 54 | 16 | 29 | 118 | 291 | 469 | 662 | 4218 |
| Tyrone, Town of Clarington | 784 | 676 | 602 | 361 | 181 | 51 | 12 | 23 | 113 | 303 | 476 | 666 | 4248 |
| Burketon Station, Town of Clarington | 787 | 678 | 604 | 364 | 177 | 53 | 13 | 19 | 115 | 299 | 479 | 681 | 4270 |
| **Europe: 2017–2019** [2] | | | | | | | | | | | | | |
| Rotterdam-Hague Airport (Westland, Netherlands) | 436 | 381 | 332 | 231 | 143 | 50 | 34 | 38 | 102 | 169 | 321 | 369 | 2604 |
| Wien Schwechat-Flughafen (Vienna, Austria) | 557 | 449 | 344 | 187 | 109 | 15 | 13 | 10 | 83 | 181 | 341 | 469 | 2758 |
| **China: 1995–2003** [3] | | | | | | | | | | | | | |
| Shandong, China | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 2000 –3000 |
| Shanghai, China | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1000 –2000 |
| Fujian, China | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | < 1000 |

Data Sources:
[1] https://climate.weather.gc.ca/climate_normals/index_e.html
[2] https://www.degreedays.net/
[3] https://www.jstage.jst.go.jp/article/jaabe/4/2/4_2_533/_pdf

Would the existence of a heat-island generator such as an aerotropolis make enough difference in North Pickering to render the area more conducive to profitable indoor farming? In Table 2, Pearson (our existing aerotropolis) and Buttonville (another airport at North Pickering's latitude and surrounded by suburbia) can be seen as indicators. They might be benefitting from a decrease of 200 to 300 heating degree days compared with Tyrone, for example, but no *inland* site compares, in terms of heating degree days, with Oshawa and downtown Toronto, both closer to Lake Ontario. And Oshawa and downtown Toronto, in turn, can't compete with the "hotspots" further south.

### A Building's Heating Costs

Numerous factors determine what it costs to heat a building. The cost and availability of heating energy sources can vary between jurisdictions and from area to area within jurisdictions. In Ontario, a building in a more-northern rural area would cost more to heat than an identical one in Toronto, not only because more heat is required but also because the most economical source, natural gas, is unavailable throughout most of rural Ontario, including on North Pickering's Federal Lands. In cold weather, buildings in rural areas must depend on more costly heating sources, such as propane, heating oil, electricity, or wood pellet fuel.

If the fields of the Federal Lands were to disappear under the steel, asphalt, glass, and concrete of an aerotropolis, this development would certainly precipitate a hook-up to the Trans Canada pipeline, which crosses the Lands. Natural gas would likely provide the necessary heat to a vertical farm on the site. There would also be a reduction in heating requirement due to the "heat island" effect of all the surrounding built infrastructure, but not enough, as we have shown, to close the heating-degree-day gap between North Pickering and Ontario's hotspots. Nothing in the aerotropolis scenario changes the fact that North Pickering's location makes it less profitable for indoor farming.

## C. The Massive Carbon Footprint

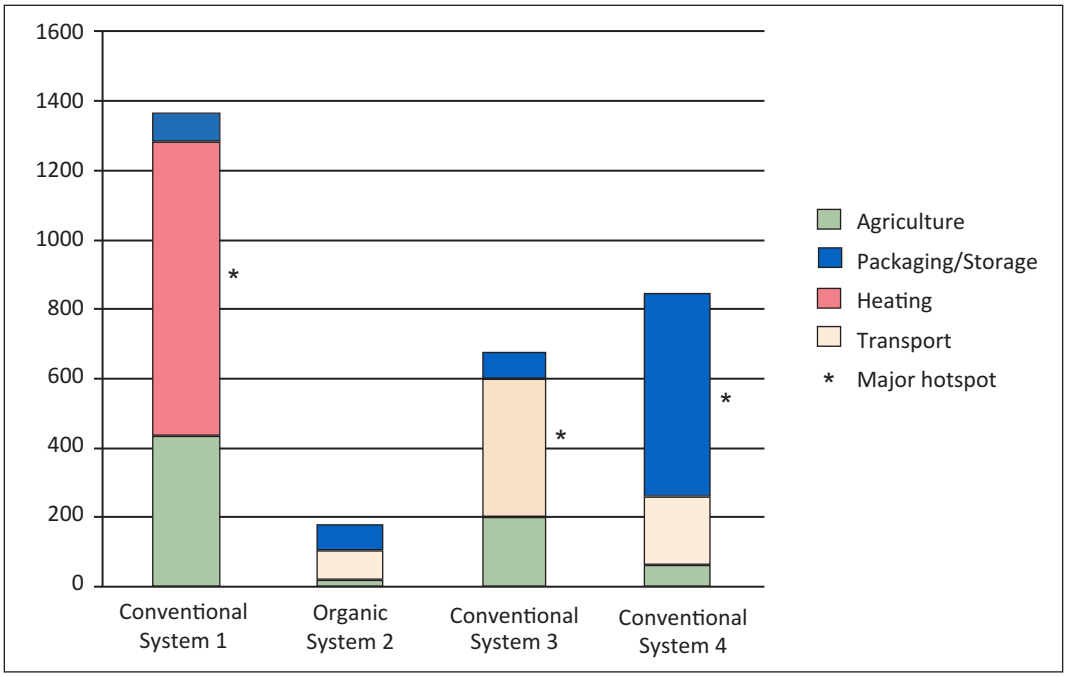
In 2014, Theurl et al.,[7] set out to determine the 100-year global warming potential for tomato production sold to a supermarket in Vienna, Austria. The researchers assessed the greenhouse gas emissions that were produced by various tomato-growing methods, and found that the dominant source of emissions was the artificial heating required to grow the indoor tomatoes.

Each production system under study turned out to have its unique "hotspot," the term used in the report to identify the part of each system – agricultural production, heating, packaging, processing, or transport – that generated the most greenhouse gas emissions. Significant differences were discovered, depending on the production system used, the distance to the consumer, the use (or not) of heating, the type of packaging involved, and the features of the supply chain.

Theurl's landmark study found that *just the heating* required to grow tomatoes in a greenhouse 6 km from a Vienna supermarket produced GHG emissions comparable to the *entire* GHG emissions from field-growing, canning, storing, and shipping tomatoes to the same supermarket all the way from Italy.

The chart on the next page presents the global warming potential of the key supply chains for tomatoes in absolute gram $CO_2$ per kilograms product at the point of sale in Austria.

**Fig. 2 Global Warming Potential (g $CO_2e$ $kg^{-1}$)**




*Source:* Theurl, et al., Fig. 3.

In each bar of the chart, total emissions are shown for:

- *Agriculture* (i.e., the fertilizers, pesticides, building infrastructure, soil, and growing operations)
- *Packaging/Storage* (i.e., the storage, packaging, and processing stages)
- *Heating* (calculated as a separate element)
- *Transport*

The four production systems were:

- System 1: Tomatoes grown in a heated greenhouse, artificial growing medium, including $CO_2$ enrichment, year-round production; 6 km from market
  *Major hotspot:* Heating.
- System 2: Tomatoes grown in unheated plastic tunnels, organic only; 70 km from market. Extremely low emissions in all categories, but tomatoes not available year-round.
  *Major hotspot:* None, really. The emissions of all phases were extremely low.
- System 3: Tomatoes grown in unheated multi-tunnels; transported from Spain.
  *Major hotspot:* Transport.
- System 4: Tomatoes grown conventionally in farm field, canned; transported from Italy.
  *Major hotspot:* Packaging/Storage.

Theurl's data show that the GHG emissions from growing local "hot house" tomatoes **are about 10 times greater*** than the emissions created by growing organic tomatoes locally on farm soil in

* Specifically, 7.6 times greater for packaged tomatoes, 11.9 times greater for loose tomatoes.

unheated tunnels.* Because the same hot house in Canada would consume more heat per year than it does in Vienna (as shown in Table 2), the GHG emissions gap could be even higher in Canada than in Theurl's study.

Theurl's data also indicate that the GHG emissions of indoor agriculture can be lowered by about 8% by utilizing existing infrastructure rather than building a new facility. The building of new infrastructure, including the sourcing and/or manufacturing of the materials and products used in the building phase, adds significant GHG emissions of its own.

The United Nations Intergovernmental Panel on Climate Change (IPCC), which assesses the peer-reviewed, scientific, technical, and socio-economic data in thousands of journals and other published materials from around the world, includes in its reports only those findings backed by broad or overwhelming consensus. The illustrative examples the Panel chooses to incorporate carry the same weight of authority as the text around them. In 2019, the IPCC's Special Report, *Climate Change and Land*, included Theurl's work.[8] Referring to the study's findings, the IPCC reaffirmed that local production may not always be better from a GHG emissions standpoint. For example, in winter months, imported food may have a lower carbon footprint than local food produced in a heated indoor growing facility. The *Special Report* emphasized that what matters is the GHG "emission intensity"† required to produce the food [emphasis added]:

> … environmental benefits associated with local food can be offset by inefficient production systems with high emission intensity and resource needs, e.g., water, due to local conditions. For example, **vegetables produced in open fields can have much lower GHG emissions than locally produced vegetables from heated greenhouses** (Theurl et al. 2014). Whether locally grown food has a lower carbon footprint depends on the on-farm emissions intensity as well as the transport emissions. In some cases, imported food may have a lower carbon footprint than locally grown food because some distant countries can produce food at much lower emissions intensity.

In a more-recent study out of Cornell University,[9] on the economics and global warming potential of controlled-environment agriculture, researchers looked into leaf lettuce grown in greenhouses as well as plant factories (indoor farms), and compared their findings with the same product grown in a field. The markets were in Chicago and New York, as were the greenhouses and plant factories, while the field-based production was in California's Salinas Valley.

The study's conclusions reinforce Theurl's. The GHG emissions from produce grown indoors remain higher than those of crops grown outdoors, and location remains a significant factor in greenhouse gas emissions, with energy and transportation costs ("intensities") found to be the main variables. The field-grown lettuce, although transported over long distances, was less costly than the lettuce grown locally indoors, regardless of the type of indoor facility used. In fact, the cost difference was "nearly double even in the 'best case' scenario."[10] It is clear that controlled-environment agriculture has high hurdles to leap if it hopes to offer a more affordable product *and* turn a profit. A California–Toronto pairing would deliver results not all that different from the California–New York example. In our cold winter months, it would likely still be cheaper to supply field-grown California lettuce to Toronto supermarkets, rather than local lettuce grown in an indoor facility.

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* The unheated tunnel is the same vegetable production system used successfully by Joyfully Organic Farms on the outskirts of the hamlet of Claremont, adjacent to North Pickering's Federal Lands.

† *Emission intensity* compares the amount of GHG emissions per unit of economic output. For example, a tomato produced in a fossil-fuel heated indoor farm has higher (more intense) GHG emissions compared with a tomato grown at ambient temperatures in a farm field.

### Beware False Equivalency Comparisons

***Important to know:*** The IPCC calculates GHG emissions for the agriculture sector by combining both direct and induced emissions.[11] This so-called life cycle calculation includes all pre- and post-production activities in the global food system, such as:

- raw material extraction, refining/smelting, fabrication, construction, and the ultimate demolition/disposal of all agricultural infrastructure, fertilizers, and chemicals
- crop-growing management/operations, including heating, ventilation, irrigation, and equipment operation and maintenance
- the gas emissions of agricultural soil, such as $N_2O$ and $CH_4$
- crop processing, packaging, and storage
- transporting to market

When the life cycle calculation is used, agriculture has a much higher GHG emissions rating than would be obtained by applying the direct method used for other economic sectors, such as transportation. The debate is ongoing as to how to determine the life cycle emissions of other sectors – where to start, where to end, what to include in between. The complications are myriad because virtually every activity, from initial sourcing to ultimate demolition and disposal, creates greenhouse gas emissions.

Life cycle calculations provide a far truer measure of agriculture's emissions contribution than the direct method would, but they put the sector at a distinct disadvantage when comparing sectors:

- Using the life cycle method, the IPCC Special Report, *Climate Change and Land*, showed the GHG emissions of the global food system to be 21–37% of total emissions[11]
- Using the direct method applied by other sectors, the GHG emissions of the global food system make up 9–14% of total emissions[12]

The disparity in emissions-assessment methods from sector to sector will have to be acknowledged and eliminated, and not just because of its unfairness. The direct method of measurement is misleading, in that it results in incomplete emissions reporting. This, in turn, produces distorted data, unsound policy decisions, and ultimately, misdirected and inadequate mitigation efforts. We can expect life-cycle assessment or analysis (LCA)[13] to become a rapid-growth industry.

## D. Can the Competitiveness Gap Be Narrowed?

It is a plain fact that Canadian indoor farms are unable to compete on price with the same crops grown outdoors where the sunlight, ventilation, and rainwater are free. And as we've seen, they cannot compete on range of produce either. Nor, in most respects, can they compete with a Canadian outdoor agricultural business sector that is constantly making improvements in efficiency and productivity while reducing costs. And not to be overlooked is outdoor farming's ability to sequester carbon in the soil.

Possibilities for cost-reduction in both types of farming are shown in Fig. 3.

**Fig. 3: Cost-Reduction Possibilities**

| Indoor Farms | Traditional Farms |
|---|---|
| ***Land and building cost reduction***<br>• Lease rather than buy<br>• Consider peri-urban leases, which can be less expensive than those closer to the centre<br><br>***Energy (heating, electricity) cost reduction***<br>• Switch from fossil fuel to renewable energy sources where possible<br><br>***Labour cost reduction***<br>• Consider automating, including robotics; various types and degrees of automation are being trialled at some indoor farms today but the scale is minor compared with the vast scale of automation in use or being developed for use on outdoor farms, a far more lucrative market for manufacturers.<br>• Automate to reduce employee numbers. But higher remuneration will be required for those with the knowledge and skills to manage and run an automated operation, and could wipe out the automation gains. Indoor farming is labour intensive and must pay higher wages in or near urban areas, where the operations need to be.<br><br>***High carbon footprint reduction***<br>• Rarely mentioned in indoor farming communications, this topic will become an issue for the industry in the not-too-distant future as all sectors and activities undergo analysis of their GHG emissions and are tasked with offsetting them, lowering them, or even eliminating them. The transition to renewable energy will help the sector realize its biggest gain. Still, greenhouses and indoor farms cannot sequester carbon. They are emitters, not absorbers. | ***Land and building cost reduction***<br>• Lease rather than buy (this up-front cost-reduction strategy is already established practice on near-urban farmlands)<br><br>***Energy (heating, electricity) cost reduction***<br>• Switch from fossil fuel to renewable energy sources (this switch will occur across all economic sectors – electricity generation, infrastructure construction, building heating/cooling/operation, machinery, transportation – as fossil-fuel use is reduced)<br><br>***Labour cost reduction***<br>• Globally, most agricultural research and manufacturing resources are focussed on the highly lucrative market of high technology for *traditional* farms.<br>• Labour is a concern for all outdoor fruit and vegetable growers; both Canadian and U.S. farmers have trouble finding reliable local help to do the arduous, often repetitive, and sometimes back-breaking work in their fields, and must depend heavily on migrant labour. They are looking at high technology solutions to reduce their labour concerns and costs, and many prototype planting, weeding, pruning, and harvesting robots now exist. Some technology is now firmly established (e.g., state-of-the-art dairy farms in Durham Region use robots to milk their cows; Prairie grain farmers are buying autonomous tractors). Drones are starting to be used for many tasks – monitoring crops for pests and disease, and even handling pollination.<br><br>***Carbon footprint reduction***<br>• Outdoor farming thrives thanks to the many inputs provided by nature. But farmers have a number of other, proven options available to them to reduce their carbon footprint. These include conservation/-regenerative agricultural practices, which also increase the sequestration of carbon. |

By any measure, indoor farming faces an uphill battle to make its produce affordable to all. Karn Manhas, a British Columbia biotechnologist and founder and CEO of the agtech company Terramera ("Our Earth": Technology for Clean Food), explains:[14]

> ...the sun still vastly outshines even the most efficient LEDs, and it does so for free. [...] Lettuce grown in a traditional greenhouse, for example, takes about 250 kilowatt-hours per year for every square meter of growing space, compared to a whopping 3,500 kWh per year for lettuce grown in a purpose-built vertical farm. Add to that the energy costs of keeping urban farms perfectly climate-controlled and the overhead of leasing or buying real estate in some of the world's most expensive markets and it all adds up to produce that is both created and sold at a premium.

# 5 The Cannabis Factor

The indoor farming we've been discussing so far has had to do with the growing of food and the barriers our northern locale presents in terms of doing so profitably. Since 2018, in the wake of federal legislation, a new concern has had to be taken into account – the degree to which food farming under glass began to be significantly displaced by the big new players/competitors on the block: the growers of medical and recreational marijuana, who, along with their investors, had concluded that cannabis production had the potential to be hugely profitable. Growers began buying or converting greenhouses to meet the requirements of this product, and new players kept appearing on the scene.[1,2] Even open farm fields began to be repurposed to serve this non-food market.

Les Serres Stéphane Bertrand, a greenhouse operation on Quebec's Mirabel airport lands, had for decades been one of the largest producers of pink tomatoes in North America. But in 2018, they partnered with Canopy Growth (a Canadian corporation with a global reach) to become Vert Mirabel, and turned their 700,000 sq. ft. of greenhouses into a facility exclusively growing organic medical and recreational cannabis.[3,4,5]

Bruce Tropical Produce, in Kincardine, Ontario,[6] had operated a hydroponic greenhouse facility in that northern location since the 1970s, by taking advantage of the least costly of any artificial heat energy source: surplus steam from the adjacent Bruce nuclear plant, augmented by a very low electricity rate and Lake Huron's water supply. The company was profitably growing tomatoes (2.3 million pounds annually) and peppers, but an administration change at the power plant brought an end to the cheap energy supply. By 2016, the greenhouse was being operated by Supreme Cannabis, and the sole product was medical cannabis.[7]

Leamington, which styles itself "the Sun Parlour of Ontario,"and Kingsville, just to its west, which boasts "the second longest growing season in all of Canada," are home to some 60 per cent of Ontario's crops grown under glass. The main produce has been tomatoes, peppers, and cucumbers.[8] But this region too, has seen an influx of cannabis growers. PharmHouse (another Canopy joint venture), Aphria Diamond, and others are planning, or have opened, greenhouse complexes,[9] with the expectation of adding hundreds of tonnes of product annually to Canada's marijuana market.

There have been similar incursions into Saskatchewan[10] and British Columbia.[11] Greenhouse after greenhouse has been built for, or turned over to, this new and potentially vastly more-profitable crop. In 2018, one operator, in Delta, BC, announced plans to convert some 2.2 million sq. ft. of greenhouse space from food growing to cannabis growing.[12] When the federal goverment allowed growing outdoors as well, cropland started being converted from food to cannabis.

But the industry, still in its infancy, is already suffering a market correction, partly for the reasons discussed earlier (see "Assessing Viability," p. 12). Too many operations started up at once. Too many had been based on hopelessly optimistic business plans that were then oversold to over-eager investors. Too many operators ran into quality issues and unanticipated distribution problems.[13]

Today, many cannabis growers' expansion plans are being shelved and staff are being let go. In February, 2020, Supreme Cannabis announced a "rightsizing" of its Kincardine operation, shedding a third of its employees.[14] Canopy Growth is doing the same, but on a far larger scale, and closing some 3 million sq. ft.

of greenhouse space in Aldergrove and Delta, B.C.[15] Leamington, too, has taken a hit, with Tilray announcing the shuttering of a 662,000-sq.-ft. facility in May.[16]

And farmland? By April 2020, Health Canada had licensed close to 700 acres of farmland to cannabis growers,[17] who had begun to perceive that crops grown outdoors in sunlight would cost them a small fraction (in fact, about one-eighth) of the cost of growing the same crop indoors in artifical conditions. There is currently a glut of unsold product inventory, but the industry's thinking appears to be that once the over-supply issue is dealt with, field rather than greenhouse growing will become the option of choice.[18]

As quality and distribution issues are resolved, the industry will recover to some degree. Yet it is hard to imagine that protecting sufficient, reliable local *food* sources, especially productive farm fields, will not have higher priority in the mind of the public than the growing of cannabis. A new appreciation, on a global scale, of the importance of food security has been crystalized by the massive social and economic disruption triggered by COVID-19. The question will be: are we putting our fields and greenhouses to their best use for our basic needs? In the future, this consideration will undoubtedly be factored into public policy and is bound to have an impact on cannabis growers' business planning.

Many of the greenhouses recently used for growing cannabis now stand vacant. They could offer new opportunities to food growers but, for those hoping to grow truly *affordable* food, retrofitting these facilities could be expensive and, as pointed out earlier, the cost of the energy required to operate greenhouses (or indoor farms) north of our Niagara Region hotspots can be prohibitive.

# 6 Can Indoor Farming Help Feed the World?

The short answer is "yes, it can help." But the follow-up question has to be: "By how much?"

As we've shown, the limited range of produce from indoor farms – today, at least – is short on dietary calories and nutrients. Greenhouse and indoor farming can provide urban areas with high volumes of the freshest of leafy greens but only outdoor farming has the ability to supply all the world's vast range of agricultural products – including those that can assure our long-term survival.

Today (October 2020), the world's population stands at **7.8 billion** and counting. There will be another billion mouths to feed by 2033 and a further billion by 2050. The total by the end of the century is expected to be **10.9 billion**.[1] Meeting this unprecedented demand for food will require the exploitation of all available sources of production, along with concerted efforts, worldwide, to reduce the prodigious amount (one-third) of food loss and food waste that occurs between harvest and consumption.[2]

None of the main staple foods (corn, rice, wheat, cassava, soybeans)[3] that the human population relies on can be viably grown in indoor farms. Nor can the next most-important staples – roots and tubers (e.g., potatoes, carrots, onions, yams) or nuts and fruits, with strawberries the exception. Even if the fruits and vegetables could be grown indoors, no number of indoor farms, however productive, could come close to matching the output of the 4.62 billion acres of land that were found by researchers at the United States Geological Survey (USGS) to be under cultivation in 2017.[4] The footprint (and yield) of all the actual and planned indoor facilities in the world is infinitesimal in comparison.

It has been claimed that indoor farms will provide cities with "urban resiliency"[5] as the climate changes and we face greater and more frequent weather extremes and other obstacles to the free movement of foodstuffs. But salad ingredients (pricey or not) offer only the barest whisper of resiliency.[6] They would provide only a tiny fraction of the daily dietary protein requirement. Humans could not stay healthy for long on such a diet.

Indoor farming today mostly sells its extra-fresh greens and herbs at premium prices to high-end food outlets, restaurants, and other food service clients. While greenhouse and indoor farming will undoubtedly see further advances in technology, scale, and scope, these types of farming will never replace the world's field crops in any imaginable tomorrow. Nor must greenhouses and indoor farming be allowed to proliferate *at the expense of* farmland. One of the truths brought home to the world during the COVID-19 pandemic is that people everywhere must beware of relying on imports for their food supply. Governments everywhere will have to act to protect local food sources. That means protecting their farmland.

# 7 Is Indoor Farming a Good Idea for North Pickering?

Not really.

**The prime farmland of North Pickering must remain farmland.**
Constructing an indoor farming facility, whether a building or a greenhouse, requires stripping off topsoil, adding fill, and putting down concrete flooring – all actions that permanently wreck the land. Building such facilities on North Pickering's farmland would be as egregious an act as building an airport there. Both would destroy a resilient, productive, irreplaceable natural resource when viable alternatives exist. With a global population increase of 2 billion expected within 30 years,[1] North Pickering's fields will have a role to play in helping to feed the growing numbers.

That said, indoor farming facilities *can* be located in warehouses, on rooftops, on former industrial sites, and on vacated land. They can even be in repurposed shipping containers (the verticality creates a smaller footprint). Companies looking for a place to establish an indoor farming facility in the municipality/region would be looking for possibilities in locations such as these – in urban areas, not on productive farmland.

**Indoor farming in North Pickering could not compete.**
It is the most expensive way to grow food. By any metric, just about every indoor farming operation south of North Pickering, whether in Canada, the U.S., or Mexico, would have a competitive advantage over any such farm operated in North Pickering, with its high heating-energy needs. And Ontario's electricity is the most expensive in North America. Natural gas is the most economical heating fuel today but isn't currently available on North Pickering's Federal Lands. What chance of success would operators have in North Pickering if growers find even much-warmer Leamington economically challenging?

In *A Future for the Lands*, the 2018 agricultural economics study of North Pickering's Federal Lands, the consultants were brief and blunt in their assessment[2] of the competitiveness issue:

> Not included in this vision [for the Lands] are a few types of agricultural production such as greenhouse vegetable production since there are existing clusters in other regions of the province (e.g., Leamington) that will have a competitive advantage over such production on the Subject Lands.

As we reported on p. 17, researchers at Cornell have shown that even food produced by indoor farms in the warmer U.S. is higher in cost, energy use, and carbon emissions than the same food grown locally by outdoor farms. It also shows that because indoor farms use so much energy in cold-weather months, outdoor farm produce still remains significantly cheaper and has a smaller carbon footprint, even when grown in California and transported across the country.

**Indoor farming would bring challenges to North Pickering (and Durham Region).**
What follows is not an exhaustive list but it raises some important issues that could exert a measurable, negative effect on the Region's economy and its ability to meet its climate-emergency mitigation goals.

- ***Financial vulnerability***
  Facilities with high energy requirements are vulnerable to shifts in political winds and to policy changes that would significantly affect energy costs, as happened in Ontario and as is happening in the U.S. (although being fought in a number of states). Ontario's cap and trade legislation – which went into effect in 2017 to help meet the Province's commitment to lowering its green-house gas emissions – made it even harder for indoor farming operations to turn a profit.[3] With

the change of government in 2018, cap and trade was overturned – yet the amount of fossil fuel required by growers to heat their facilities remains the same and is now subject to an annually increasing federal carbon tax. Increased energy costs can destroy a facility's viability – or cause the company to relocate some, or all, of its operations to a more favourable jurisdiction.[4]

- ***Economic instability***
  Farmers whose income is directly linked to their farm soil are stable economic and job contributors to their community. Unlike most businesses, they can't pack up the source of their income – their farm's soil – and take it with them if they decide to move elsewhere. While they can buy farmland in another location, it is increasingly difficult to do so in Ontario, where good farmland is a finite and shrinking resource. Every farmer wants to grow on the most profitable farm soil available – which is why, in 2018, Transport Canada had a waiting list of farmers eager to take advantage of the newly introduced 10-year leases on North Pickering's federal farmland, with its highest-production-capability soils. In contrast, food processors and indoor growers, whose businesses aren't dependent on local farm soil, can abandon their operations and move away more easily – and they do – thereby weakening the local economy and threatening the community's stability.
- ***Social justice/community issues***
  To have a hope of success, indoor-farming startups must concentrate initially on the most profitable crops, such as cut flowers or fast-growing lettuces, herbs, and microgreens, all commodities suitable for high-end markets but generally beyond the reach of lower-income families. Even when these products are grown in successful, large-scale indoor farms, they often remain in the higher price bracket. And such facilities provide few jobs. They mostly require a small number of specialized, highly skilled workers.
- ***Planet-unfriendliness issues***
  Artificial heating and lighting are not green if the energy used is derived from non-renewable or unsustainable sources (as is generally the case today). Indoor growing facilities tend to be energy hogs. And their produce is almost exclusively sold in clamshell packaging, adding to the plastics waste stream. Moreover, large-scale greenhouses are a source of light pollution, brightening the night sky in rural areas and causing harm to wildlife and nearby plant life[5] – a fact that would be of particular concern in North Pickering, immediately adjacent to Rouge National Urban Park.
- ***Climate-change mitigation issues***
  Passed by Council with near-unanimity in January, 2020, the Region's Climate Emergency Declaration[6] foresees an "emerging low-carbon economy" and commits the Region to protecting "our economy, our ecosystems and our communities from climate change" by reducing overall emissions. It also commits to developing action plans to meet the lower emissions targets. If a new airport were built in the Region, none of those targets would be met. Emissions would skyrocket. If vertical farms (either stand-alone or part of an airport complex) were allowed to replace outdoor farming on the Lands, today's low-carbon production method would be displaced by a high-carbon one. These aren't opinions. They are facts.

In short, indoor farming in North Pickering is unlikely to provide much of an economic boost (if any); it is more likely to contribute a degree of economic instability. It would not significantly increase local job numbers or broaden the tax base. It would not lower local GHG emissions or increase food security.

On the other hand, if Transport Canada's plan to keep North Pickering's Federal Lands on perpetual hold for some future airport were replaced by a more forward-looking policy – by which we mean using this prime farmland for the growing of more diversified, higher-value-added food – Durham Region could enjoy the myriad benefits and proceeds of a stable and thriving agricultural and agri-tourism economy. That economy would be bolstered by innovation from an agricultural research centre on the Lands, from

more (and more varied) jobs, from the increase in local food security, and from a newly rehabilitated, strong, and reliable partner in the plans to lower GHG emissions.

In March 2020, the Greenbelt Foundation released the results of an economic study[7] providing guidance to "industry associations, supply chain participants, select government ministries and agencies and research institutions" on potential opportunities to expand the province's fruit and vegetable industry in Ontario. It describes the constraints that exist and suggests possible ways to address them. In terms of land use, the report made clear that vertical farming was not considered a particularly viable alternative for more northerly parts of southern Ontario, However, it saw potential for expansion onto under-used federal property in North Pickering, to make wise use of an existing asset – the soil.

> **Pickering Airport Lands can be Part of Fruit and Vegetable Production Expansion**
> The Federal government has approximately 6,500 acres of farmland in cash crop operations at the proposed Pickering Airport site, supervised by Transport Canada. This farmland can be a land base for expansion of certain fruits and vegetables suitable for the climatic and agronomic conditions to the northeast of Toronto. Long-term leases of at least 30 years are required for tree fruits. Lease arrangements of 10 to 20 years provide a planning horizon for vegetables and some fruit crops.
>
> ***Action:*** *The federal government should consider providing 20 to 30-year leases on the proposed Pickering Airport lands. Select commodity organizations could identify the benefits of fruit and vegetable production on suitable acreage on these lands with established growers.*

The report's suggestion conforms very well with our own vision for these Federal Lands – namely, their transformation into a revitalized agricultural and eco-tourism community we have called North Pickering Farms.[8] The plan could create 2,100-plus good jobs and have an economic impact in Ontario of over $230 million/year, starting now.[9]

**Fig. 4: Risky Business: Vertical Farming in Ontario, 2020**

The Greenbelt Foundation's economic study, "Plant the Seeds: Opportunities to Grow Southern Ontario's Fruit & Vegetable Sector," indicated in Chapter 11 of the report that the six known vertical farm operations in Ontario are limited to microgreens, leafy vegetables, and some herb production. Owing to the much higher energy costs of vertical farming, current economics suggest that fruiting plants, such as tomatoes and strawberries, are more cost effective when grown in Ontario greenhouses. The report details numerous impediments and constraints to the growth of vertical farming in Ontario:

- ***Lack of consumer awareness*** of the positive attributes of vertically farmed microgreens and leafy vegetables.
- ***The production costs for vertical farm crops***, which are higher than those in greenhouses and fields, owing to significantly higher capital costs, operating costs, and energy costs.
- ***High retail prices***, owing to higher production costs.
- ***A high carbon footprint*** that may only be reduced by the use of non-fossil-fuel energy sources.
- ***The complications of scale***. Vertical farms must be larger to be more cost competitive with greenhouse and field production. However, market needs must be carefully calculated so as not to overbuild production capacity.
- ***Disruptive technology threats.*** Significant venture capital investment has gone into vertical farming automation. Its adoption by one vertical farming operation can disrupt the competitiveness of other, existing, operations.
- ***The risk of bankruptcy.*** High costs and inattention t o market needs along with consumers' unwillingness to pay a premium for the produce have resulted in vertical farm bankruptcies.
- ***Need for highly specialized labour skills***. Specific skills are essential for efficient operation of vertical farms.
- ***The tax disadvantage.*** Vertical farms located in urban areas pay municipal taxes based on industrial/commercial tax rates, which are higher than the farm tax rate that applies to greenhouse vegetables and field crops.

# 8 Answers to Section 1's Questions

**Are the pro-airport, pro-vertical farming politicians right?**
No. They have been misled or are indulging in wishful thinking, as this paper has shown.

**Is indoor farming the way of the future?**
It has a place in farming's future, but its restricted scope and its dependence on expensive energy will keep it a supplier of a narrow range of produce commanding premium prices.

**Can indoor farming facilities be anywhere?**
To be viable as a sizable business, facilities need to be located in, or adjacent to, a dense urban area where (a) consumer numbers are large enough to sustain the operation, (b) purchasers can afford the premium prices, and (c) the harvest-to-table time is short. Indoor farms can be on vacant lots or rooftops, or in repurposed warehouses (assuming smart bylaws). They can be on "brownfield" sites or in near-urban locations with poor-quality soils. They can even be on abandoned runways![1] But where they must not be is on prime farmland.

**Will indoor farming create urban resiliency and help meet the world's food security needs?**
Indoor farms' narrow range of crops may keep residents of an urban centre supplied with fresh lettuce, peppers, tomatoes, and herbs, but to say that large-scale, local production of these foods creates urban resiliency is a misconception, and a dangerous one. Such foods, on their own, do not make a balanced diet. *Food security chiefly means staple crops grown locally, in fields*.

**Will indoor farming help end world hunger?**
Not even close. In a pinch, given the nature of the produce, indoor farms could provide some marginal sustenance to the hungry or those facing starvation. The sector may grow and evolve, but it appears destined only to be a limited supplement to the staple foods that come from outdoor agriculture.

**Will traditional outdoor farming become a thing of the past?**
Not unless we humans decide to produce and live on artificially constituted food.[2]

**Could North Pickering's indoor farms supply world markets?**
Unlikely. The main aim of indoor farms is to get ultra-fresh produce to the consumer's table in the shortest time possible. The crops are tender and perishable. They don't lend themselves to long-distance shipping, storage, or food-processing. Our most likely international customers would be in the U.S., but their own indoor farming sector is growing, enjoys warmer weather conditions than North Pickering does, and would beat us on price and freshness. We would not be competitive.

**Would indoor farming confer enough green credentials on the aerotropolis vision of some local politicians to defuse the decades-old arguments for protecting North Pickering's prime farmland?**
Airport proponents can harbour this hope until the cows come home, but facts are facts. In the context of COVID-19's global impact and the existential threat to civilization of accelerating climate breakdown, the promotion of a Pickering aerotropolis (or even just a Pickering airport) in this day and age is science denial of the first order. No number of vertical farms or other "green" initiatives attached to a new airport could begin to offset the permanent loss of so much Class 1 farmland so close to Canada's largest population centre. **Prime farmland is one of our most valuable natural assets. It provides us with our most important food staples and much more. The challenges we face call for urgent and enlightened policies to *protect* assets such as these. They are essential to our future wellbeing.**

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