

Exploring the Food Journey for Five Commonly Wasted Fruits and Vegetables

Technical Memo and Fact Sheets


zero WASTE
NATIONAL ZERO WASTE COUNCIL
An Initiative of Metro Vancouver

LOVE FOOD hate waste

About Love Food Hate Waste Canada

Love Food Hate Waste Canada is Canada's leading resource to prevent household food waste – helping Canadians make their food go further and waste less by offering simple and actionable tips. Love Food Hate Waste Canada is led and delivered by the National Zero Waste Council, in collaboration with the following campaign partners: The City of Toronto, City of Vancouver, City of Winnipeg, RECYC-QUÉBEC, the Recycling Council of Alberta, the Capital Regional District, Metro Vancouver, and major Canadian food retailer, Walmart Canada. www.lovefoodhatewaste.ca

About the National Zero Waste Council

The National Zero Waste Council, an initiative of Metro Vancouver, is leading Canada's transition to a circular economy by bringing together governments, businesses and NGOs to advance a waste prevention agenda that maximizes economic opportunities for the benefit of all Canadians. The Council has been advancing food loss and waste prevention since 2012, advocating for fiscal incentives, policy change, and the adoption of best practices. LFHW Canada is delivered by the National Zero Waste Council in collaboration with Campaign Partners. www.nzwc.ca

Project Acknowledgments

This research was prepared for Love Food Hate Waste Canada by Belinda Li and Tamara Shulman, with the financial support of the Government of Canada through the federal Department of Environment and Climate Change.

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de:

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August 2023

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Executive Summary

This research is one element of a larger multi-stream project entitled, *Toward Circular Food Systems in Canada: Scaling Citizen and Place-Based Interventions*. It was undertaken for the National Zero Waste Council in support of Love Food Hate Waste (LFHW) Canada.

The research objective was to quantify the environmental, economic, and social impact associated with the production of five commonly wasted fruits and vegetables: tomatoes, apples, lettuce, blueberries, and potatoes.

A series of produce fact sheets were created. These fact sheets summarize the food journeys from farm to retail of selected fresh produce items. This summary provides highlights related to each of the five produce items considered.

Tomatoes

- Almost all fresh tomatoes in Canada are grown in greenhouses. Greenhouses provide a controlled environment that allows for regular harvests year-round. The yield in a greenhouse is 10 to 20 times more than in the field.
- Tomatoes take a long time to grow: four to five weeks for seedlings, then four to eight weeks for blossoms, and another six to eight weeks to grow the fruit.
- Tomatoes need a lot of maintenance, including clipping off side shoots (suckers), twisting the plants up nylon cords, pruning off excess flowers and deformed fruit, trussing (using plastic arch supports to protect stems from kinking), and lowering plants so they don't get too tall.
- Growing tomatoes in greenhouses is an energy-intensive process. Fossil fuels are typically used to heat the greenhouses. Electricity is needed to power the lights and control the systems necessary to maintain an optimal growing environment.

Apples

- Apples are Canada's largest fruit crop, with over 100 varieties and three Canadian cultivars.
- Apples are grown coast-to-coast across Canada. Many apple orchards are close to cities, which keeps transportation distances short.
- Thanks to advances in cold-storage technology, apples are one of the few fruits that can be eaten fresh year-round.
- Apples take a long time to grow. Trees generally need two years before they bear fruit and up to 10 years before they reach full production. Apples themselves take six to eight months to mature for harvest. Apple trees can keep producing fruit for over 20 years.
- Apple trees require extensive year-round care. This includes pruning, monitoring for over 75 types of pests and disease, overseeing pollination, ensuring adequate water, and multiple rounds of harvesting.

Lettuce

- Lettuce is available in two types: head lettuce and leaf lettuce. Head lettuce is usually harvested and sold whole, whereas leaf lettuce is often chopped and processed into salad mixes.
- Leaf lettuce takes about 50 days to mature; head lettuce takes about 75 days.
- Field-grown lettuce requires a great deal of maintenance. This includes fertilizing, watering, monitoring and managing pests, and controlling weeds.
- Growing lettuce in a greenhouse is a highly controlled process that requires a significant amount of electricity. Growing one kilogram of lettuce in a greenhouse is equivalent in energy use to running a refrigerator for almost two days.

- Most lettuce eaten in Canada is imported from California. That's a long way to travel.
- Drought and other environmental problems in California have made lettuce much more expensive in Canada.
- Lettuce needs careful handling from the time it is harvested until it arrives in the store. Cold temperatures are crucial to avoid spoilage. The lettuce is packed in the field or chopped and packaged in a warehouse, then put into refrigerated storage before being transported in refrigerated trucks.

Blueberries

- Blueberries are Canada's second-largest fruit crop (after apples) and the most profitable.
- Wild 'lowbush' blueberries are a perennial native fruit that has grown in northeastern North America for over 13,000 years. They self-generate and sprawl across the landscape.
- Cultivated 'highbush' berries originated when wild blueberries were domesticated in the 1900s. They are grown in B.C. Highbush berries are larger, and are primarily what we eat fresh from the store. When well-tended, the plants can produce fruit for 50 years or more.
- Blueberry plants need two years to begin bearing fruit and don't reach full production until they are about four years old.
- Blueberries are harvested multiple times during the growing season. They take five to seven months to ripen and three to six days after they turn blue. When picked prematurely, they remain sour, so harvesting them at exactly the right time is very important.

Potatoes

- Potatoes are the largest vegetable crop in Canada.
- Unlike other plants, potatoes don't grow from seeds. Instead, they grow from seed potatoes, which look like regular potatoes. Canada is a global leader in the production of seed potatoes.
- Potatoes cannot grow on the same plot of land year after year because they require a great deal of nutrients from the soil. To replenish the soil, farmers plant other crops – like beans, grains and leafy greens – in rotation.
- Potatoes are very susceptible to pests and diseases, so farmers spend a lot of time monitoring and managing their fields to prevent infestations and outbreaks.
- Potatoes must be cured for several weeks so that they are ready for long-term storage. This involves keeping the potatoes in a dark place, and carefully maintaining the temperature, humidity and ventilation to allow the potatoes to dry out completely so that they do not spoil.

Methodology

Five fresh produce items were selected based on a combination of factors, including what is commonly wasted in households across Canada according to the 2018 Food Waste Data Model, their perishability, and potential connections to local producers. The selected items were:

- Tomatoes
- Apples
- Lettuce
- Blueberries
- Potatoes

Research was conducted on each of the five items to gain a general understanding of their Canadian supply, including how and where they are grown domestically, major import sources, and quantities grown and consumed. The primary sources of information were data and reports from Agriculture and Agri-Foods Canada, which provide an overview for the entire country (1–5). Further web searches were then done to fill information gaps. Environmental impacts for the produce items were also compared using information from a global multi-indicator database (6). Findings from this database are summarized in a separate section.

Fact sheets for each produce item follow.

Tomatoes

Food Journey Overview

In Canada, tomatoes are grown in the field and in greenhouses. Almost all (92%) field tomatoes are grown for processing (4), while greenhouse-grown tomatoes are grown for fresh consumption (7). Since the intention of this research is to examine fresh produce, the focus of the food journey is on greenhouse-grown tomatoes.

Greenhouse-grown tomatoes are typically hydroponic, meaning that they are not grown in soil, but rather in a growing medium (1). This controlled environment allows the nutrients, temperature, carbon dioxide levels and other growing conditions to be maintained at an optimal level for the plants (1). Greenhouses are kept at a temperature of 21 to 25 degrees Celsius during the day and 12 to 16 degrees Celsius at night; lighting systems provide 18 hours of artificial sunlight to enable continuous bloom and tomato production (8). Year-round production is therefore possible, and greenhouses can have up to three crop cycles per year (1). Greenhouse tomato yield is about 10 to 20 times greater than for tomatoes grown in the field (9). Greenhouses also mean less food waste, through better quality management and less damage from weather, pests and disease (10).

Greenhouse tomato production begins by growing seedlings in rockwool, a material made from basaltic rock, coke and lime (1). Seedlings take four to five weeks to grow, after which they are transplanted to a greenhouse (1). In the greenhouse, the seedlings grow in media such as coco-shell fibres and are irrigated with about four litres of water

mixed with fertilizer solution each day (8). Unused irrigation water is typically recycled and reused in the greenhouse (8,9). Bees are normally used for natural pollination, but mechanical devices are also sometimes used (1,8). Tomato blossoms develop after 30 to 55 days (8). Plants grow about 20 to 30 centimetres per week and can reach heights of 11 metres (8). Plants need weekly maintenance, including clipping off side shoots (suckers), twisting the plants up nylon cords, pruning (to remove excess flowers and deformed fruit), trussing (using plastic arch supports to protect stems from kinking), and lowering plants so they don't get too tall (1). After about eight weeks (or as little as six in the summer (10)), tomatoes are ready to harvest (8). Harvesting is done weekly. Typically, a cluster of tomatoes is ready for harvest at the bottom of the plant, while a new cluster develops at the top (8). One tomato plant can produce about 200 large tomatoes or 500 cherry tomatoes (8).

In large greenhouses, tomatoes go through a conveyor system for grading and packing (8). Unripe fruit is removed at this step, although it is unclear what happens to them afterwards. Large tomatoes are typically packed in cardboard boxes and stickered by machine (8). Cherry tomatoes are typically packed in clamshell containers (8).

Production and Consumption in Canada

Canada is one of the world's largest producers of greenhouse tomatoes, and the leading producer in North America (10). Tomatoes make up nearly half of the greenhouse-grown vegetables in Canada (5).

About 70% of greenhouse tomatoes are produced in Ontario (7). Production is concentrated in the southern part of the province, in particular in Leamington, known as the tomato capital of Canada (9). Other major sources of greenhouse tomatoes are British Columbia and Quebec, which produce about 15% and 9% of the supply, respectively (7).

In 2021, 279,627 tonnes of tomatoes were produced in greenhouses in Canada (5). Of this, 158,191 tonnes (57%) were exported, almost all (99%) to the United States (5). Canada also imported 75,306 tonnes of greenhouse tomatoes in 2021, mostly (80%) from Mexico and some (9%) from the United States (5).

While not specific to greenhouse tomatoes (a small amount of field tomatoes are also eaten fresh), an average of 7.23 kilograms of fresh tomatoes were consumed per person in Canada in 2021, not accounting for food wasted (11).

Environmental Impacts

While there are many advantages to growing tomatoes in greenhouses, it is an energy-intensive process. A lifecycle assessment on the sustainability of greenhouse tomato production in Ontario found that most of the environmental impact is associated with heating by fossil fuels (12). The lifecycle assessment included the following stages of greenhouse tomato production: infrastructure, seedlings, cultivation, packaging and waste (12). Between 50 to 85% of the total environmental impact for ozone depletion, global warming, smog, acidification and respiratory effects was attributed to combusting natural gas or bunker fuel for greenhouse heating (12). Another large contributor was cardboard packaging, which accounted for 8 to 28% of these impacts, as well as 61% of the eutrophication impact (12). This study suggested that to make greenhouse tomatoes more sustainable, alternative heating sources should be used, such as biomass in the form of willow pellets (12). While willow pellets decrease global warming and ozone depletion, they also increase eutrophication, acidification, smog and respiratory effects (12).

Apples

Food Journey Overview

Apples are Canada's largest fruit crop and second-most profitable fruit crop after blueberries (2). Over 100 varieties of apples are grown in Canada (13), including three Canadian cultivated varieties: McIntosh, Ambrosia and Spartan. Canada's main production areas, by cultivation area, are Ontario, Quebec, British Columbia and Nova Scotia (2).

Apples are primarily grown from grafted trees (15). They require year-round care with ongoing pruning, monitoring for pests and disease, ensuring adequate water, overseeing pollination, and harvesting (13). Once harvested, apples must be handled carefully to optimize longer-term storage capacity. Apples are one of the few fruits that can be placed in cold storage for up to a year for later consumption (2).

Orchards tend to grow best on gently sloped hillsides with plenty of sun exposure and loamy, well-draining soils with high organic matter and balanced pH (2). Apple trees are grown in warmer climate zones in Canada and must have a dormant period of about 1,000 hours below 5 degrees Celsius, but they do not survive winter temperatures below -40 degrees Celsius (16). Between 2,000 to 4,000 trees are grown per hectare, with trees trained to tall, narrow fruiting walls to optimize yields, sunlight exposure, harvesting access, and pest spray coverage (2). Global positioning systems are used to plant trees to optimize accuracy and growing benefits (18).

Apples are generally not bred from seed; desired cultivars are propagated by budding and grafting with some intentional cross-pollinations between cultivars to generate seeds for new varieties (16). Tree size is managed by rootstock and is often trellised to increase production by more than 30% in the first five years (17). Apples take six to eight months to mature for harvest (14). Apple trees generally need two years before they bear fruit and five to six years until they reach full production, which they can maintain for 20 years (17).

Apple production involves a year-round approach in order to manage the plants, care for the soil, monitor and minimize damage from disease and insects, minimize weeds, and manage other factors including rodents and birds (2).

From December through late April, trees are pruned; this helps to manage the amount of apples produced, create air space in the canopy, allow for optimal sun exposure, remove disease-infected shoots and ensure apples can be picked efficiently (13). Preparing soil for new plantings and adding nutrients and dormant sprays where needed are also done in winter (2).

In spring, several beehives per acre are brought to orchards to support pollination and complete the growth cycle of the fruit (17). Pruning continues and

tree supports and trellis systems are added to begin training new trees (2). About 10% of blossoms are left to grow to ensure nice-sized apples and to help optimize the tree lifespan (13). This is done by hand or through the use of blossom-thinning sprays (2). Irrigation and fertilization are applied depending on region (2).

Throughout summer, apples are thinned to pick off smaller, misshapen or damaged fruit, optimize quality for the remaining apples, and reduce stress on the trees (13). Given that over 75 diseases and insects can attack an apple, using an integrated pest management (IPM) approach is essential (13). Monitoring is ongoing, with employment of physical controls (such as pruning and removing damaged fruit on the orchard floor), mechanical controls (mowing for weeds, for example), and chemical treatments (should scab and other summer disease take over) (2). Supplemental nutrient sprays, irrigation and new tree fertigation are also employed where needed (2).

Apple harvest occurs between August and November, depending on the variety. Given that apples are fairly delicate, they are hand-picked by trained harvesters who grade fruit along the way. Each tree can be harvested three or four times given varying ripening times (13). Apples are gently transferred from picker bags to large storage bins; once filled, they are moved by tractor to a loading area (17). Disease, insect and weed management continues throughout the harvest period (2).

Sweet ripe fruit needs to be eaten within a few days and goes to direct markets. The majority of apples, though, are transferred to a packing house. There, a water system moves them across gentle brushes using conveyors as apples are cleaned, sorted and graded based on Agriculture and Agri-Food Canada (AAFC) requirements. Sorting can be augmented by high-tech colour and infrared cameras to segregate the apples into packaging lines based on grade and end-use prior to packaging for market (13). Often apples are washed, then a very thin layer of non-toxic wax is applied to help increase their shelf life. This can be washed off at home before eating (13). Cold storage can extend apples' storage life for an additional six to eight months (2,13).

About one third of apples produced (those that don't meet grade or are damaged) are sent to secondary processing for juices, sauces or baking (13).

Production and Consumption in Canada

Over 90% of apple production is concentrated in Ontario, Quebec and British Columbia, with Nova Scotia and New Brunswick growing the remaining 10% (2). In 2021, 351,565 tonnes of apples were produced domestically in Canada, 47,333 tonnes were exported, and 198,031 tones were imported (3).

Apples meeting grade requirements are prioritized for fresh consumption, with 8.54 kilograms available per person in 2021. Another 4.40 kilograms per person per year are consumed in processed form including pie filling, apple sauce and juice, and in frozen, canned or dried products (11).

Environmental Impacts

Apples grow in multiple places across Canada, and in highly populated regions like Ontario, there is a large local supply year-round due to the proximity to growers (19). In addition, apple trees are able to sequester carbon; a one-acre apple orchard can remove about 15 tonnes of carbon dioxide from the air per year (19).

Despite the environmental benefits of apple trees, there are some negative environmental impacts of growing apples. Energy is needed for irrigation, pesticides, fertilizer and pest management (15). Compared to other fruits, apples use relatively little water, but excess fertilizer can leach into the surrounding environment (15). Additionally, because apple trees take two to 10 years to bear fruit, apples grown from seeds generally have a higher carbon impact than those grown from grafts (15).

Lettuce

Food Journey Overview

Lettuce is usually grown for its leaves and for use in salads (20). Lettuce cultivars are generally split into two types: head lettuce (Lactuca sativa var. capitata) and leaf lettuce (L. sativa var. longifolia and L. sativa var. crispa) (20). Head lettuce includes iceberg, crisphead, and butterhead (20). Leaf lettuce includes romaine, greenleaf, and redleaf (20). In Canada, butterhead lettuce is grown in greenhouses whereas other lettuces are grown in the field (20).

Field Lettuce

Field lettuce is seeded directly into soil in the spring or first started in a greenhouse (21). It grows best in black soil (22). Leaf lettuce is ready for harvest approximately 50 days after planting; head lettuce is ready after about 75 days (21). Lettuce is planted in succession (the second planting begins when the first planting has emerged) so that there is a continuous supply available during the growing season (21). Maintenance of field lettuce includes applying fertilizer to balance nutrients, monitoring and controlling pests using pesticides, and controlling weeds with a combination of herbicides, crop rotation and hand weeding (23).

Head lettuce is harvested with a mechanical harvester and by hand, and packed in the field into poly bags and boxes after damaged leaves are removed (21,22). Leaf lettuce is harvested by hand, chopped in a factory for salad, and packed into boxes (21,22). Lettuce is shipped in refrigerated trucks; cold storage is maintained for freshness (21,22).

Greenhouse Lettuce

Greenhouse lettuces are typically hydroponic, meaning that they are grown in soil-less media using nutrient film technique (NFT) (20). Plants are grown in troughs with a re-circulated, continuously flowing nutrient solution (20).

The growing process starts with seedlings grown in seed trays in peat-perlite, rockwool mini-blocks, foam medium or peat pellets (20). Seedlings in peat-perlite are transplanted into rockwool mini-blocks or foam media after seven to 10 days, when leaves start to appear (20). Otherwise, they can be transplanted directly into temporary NFT troughs with supplemental lighting to grow for two to three more weeks in the summer or four to six weeks in the winter once they have formed into seedling plugs with three to four leaves (20). At this point, they are placed in permanent NFT troughs and grow for six to seven weeks in summer or 10 to 12 weeks in winter before they are ready for harvest (20). Some faster-growing cultivars are ready for harvest in less than

30 days after transplant (20). Greenhouses can have eight to 10 growing cycles per year (20).

Growing greenhouse lettuce is a highly controlled process. Multiple environmental factors need to be regularly monitored and regulated. Maintaining these conditions requires a great deal of electricity – about 15 kWh per kilogram of lettuce (24), equivalent to running a refrigerator for almost two days. Greenhouse temperatures are maintained – with cooling fans, high-pressure foggers, ventilation, heating, and moveable shade cloths – at 18 to 19 degrees Celsius on cloudy days, 19 to 22 degrees Celsius on sunny days, and 15 to 18 degrees Celsius at night (20). Supplemental artificial lighting with high-pressure sodium lights or LEDs is used to optimize plant growth by providing 18 hours of light during the growing period (20). High humidity levels of 75 to 85% RH (relative humidity) need to be maintained during production; this increases to 80 to 90% RH for storage (20). Carbon dioxide levels are also controlled to support production (20). Additionally, the nutrient solution's pH, salt concentration and oxygen levels are regularly monitored and adjusted based on the cultivar and crop development stage (20). Fungicides are applied to prevent rot, mildew and mould (20). Pests are managed with biological controls (predators or parasites) or through the application of pesticides (20).

Whole heads of lettuce are typically harvested with their roots attached and placed in an open poly bag or clamshell container (20). Lettuce can be sold as heads or in pre-washed and pre-cut packaged salad mixes, which have increased in popularity (20).

Production and Consumption in Canada

In 2021, 94,833 tonnes of lettuce were produced in Canada – 80% (75,612 tonnes) in the field and 20% (19,221 tonnes) in greenhouses (4,5). Quebec is Canada's leading grower of field lettuce (50%) (21). Other main producing regions are Ontario (40%) and British Columbia (10%) (21). Nearly half (47%) of greenhouse lettuce production is in Alberta. Until recently, greenhouse lettuce production was led by Quebec, which now accounts for 27% (20). Other key production regions are Ontario (18%) and British Columbia (8%) (20).

Most lettuce consumed in Canada is imported. In 2021, 267,154 tonnes of field lettuce were imported, compared to 39,473 tonnes that were exported (4). Canada-grown greenhouse lettuce is consumed almost completely domestically (5). Lettuce from the United States makes up 95% of lettuce imports (4). A lot of this comes from California (specifically the Salinas Valley, the "salad bowl of the United States") which grows over 70% of the Iceberg, leaf and romaine lettuce in the United States (25).

An average of 7.84 kilograms of lettuce was consumed per person in Canada in 2021, not accounting for food wasted (11).

Environmental Impacts

Information on the environmental impacts of growing lettuce specifically in Canada was not available. Thus, general environmental impacts are discussed here.

Most of the greenhouse gas footprint of lettuce (82.7%) is in its growth due to pesticide, water and land usage (26). Harvesting, processing, packaging and transportation are fairly low contributors (26). Lettuce grown in greenhouses generally has a higher environmental footprint than that grown in the field due to the electricity used; when the electricity is from renewable sources, however, the environmental impact is reduced (24). Greenhouse-grown lettuce uses less water than field-grown lettuce (24).

Most lettuce eaten in Canada is imported from California. In recent years, multiple issues have affected the lettuce supply. These include viruses (27) and E. coli contamination (28), both of which contribute to food waste. Due to climate change, California has also been experiencing worsening droughts and floods (29), which may lead to more crop damage and thus more wasted food. Furthermore, as lettuce requires a lot of water for growth (26), competition for water resources in drought-ridden areas like California can be problematic.

Blueberries

Food Journey Overview

Blueberries are Canada's second-largest fruit crop with two primary types – lowbush (wild) and highbush (cultivated) – both derived from the Ericaceae or heath family.

Lowbush varieties include several species within the Vaccinium genus and are a perennial, native fruit that has grown in northeastern North America for over 13,000 years (30). They were harvested by Indigenous Peoples prior to European arrival; early settlers in the Atlantic provinces also harvested them for use and local distribution (31). Lowbush blueberries provide a crop every second year. They are most commonly processed within 24 hours of picking and flash-frozen to retain their structure and nutrient content (32). Their production has increased dramatically since the 1980s due to improved weed control and increased use of bees for pollination (31).

Highbush blueberries are also a perennial, deciduous, woody shrub in the Vaccinium genus. They were developed through selective breeding in the first half of the twentieth century (33). They produce larger fruit, can grow six to eight feet in height, and are available market fresh and frozen (32).

Both blueberry varieties need well-drained, low-pH, moist soil with high organic matter for productive growth (31,33). Wild blueberry plants develop from seeds which originate from mother plant germination. The mother plant develops underground stems (rhizomes) which form a large genetically distinct clone (34). The plants sprawl across the landscape, growing best in undisturbed soil. The system of shoots and roots can spread up to 38 centimetres in one season (31). Highbush blueberries are cultivated and planted four to five feet apart in rows with eight to 10 feet spacing; well-tended plants can bear fruit for 50 years or more (35). Blueberry plants need two years to begin bearing fruit and don't reach full production for four years (36).

The year-round activities necessary to care for lowbush and highbush blueberries are similar, with some variation by season. The primary activities include pruning to optimize fruit growth and minimize diseases, managing weeds through physical and chemical controls to optimize the growing area, applying fertilizers in spring, supporting pollination

including bringing in beehives, protecting plants from birds, and managing pests by monitoring and applying pesticides to control insects, mites and disease as needed (31,33). For lowbush blueberries, pruning and weeding are managed through fall and spring mowing or burning (37).

Blueberries take five to seven months to produce ripe fruit and are harvested multiple times (31,33). The berries become ripe three to six days after they turn blue. If they are sour when picked they will remain so; this makes timely harvest critical (38). Harvesting of lowbush blueberries is most commonly mechanized; they can also be hand-harvested using a metal rake (37). Half the acreage is harvested annually given the biennial growth pattern of lowbush crops. Highbush blueberries are harvested by over-the-row harvesters or hand-picked (39).

Lowbush berries are primarily flash-frozen using individually quick freezing (IQF) technology and sent for processing. Highbush berries are sent to processing facilities to be prepared fresh for market, as well as flash-frozen for processing (31,33). Fresh blueberries are packaged in plastic or paper containers and sent to market in refrigerated trucks. Blueberries sent for processing can be treated in a myriad of ways: frozen, dehydrated, freeze-dried, powdered, pureed, juiced and made into fruit filling (39).

Production and Consumption in Canada

In 2021, Canada produced 146,551 metric tonnes of blueberries: 74,635 metric tonnes of lowbush (wild) blueberries and 71,916 metric tonnes of highbush (cultivated) blueberries (40). Lowbush blueberries are produced primarily in Quebec (approximately 44%) and the Maritimes (55%), especially in New Brunswick, Nova Scotia and Prince Edward Island. Most highbush blueberries (approximately 92%) are cultivated in British Columbia, with smaller amounts of production in Quebec (4%), Nova Scotia (4%) and Ontario (1%) (40).

In 2021, Canada exported 127.7 million kilograms of blueberries, mostly to the United States, Germany, Japan, China, Australia and Belgium (40). There were 1.38 kilograms of fresh blueberries available per person and 0.74 kilograms of frozen blueberries available per person in Canada in 2020 (31,33). For all berries including blueberries, a total of 9.43 kilograms per person were available for consumption in 2021 (11).

Environmental Impacts

Overall, blueberries have a relatively high carbon footprint compared to other fruits given pesticide use, a shift towards mechanized farming methods, the need for refrigerated transportation and the use of plastic packaging (36).

Blueberries have a relatively long maturation time, a low yield per hectare and a high pesticide use, all of which contribute to the growth of their carbon footprint (36). On a positive note, blueberry bushes have natural carbon sequestering properties that allow them to offset some of their own emissions during growth (41).

Many blueberries are machine harvested; this makes more of an environmental impact than hand picking. They are also processed mechanically, which requires energy (36). While there is a carbon footprint associated with refrigerated transportation, blueberries are grown on both Canadian coasts in proximity to higher-density populations, which results in a more moderate impact. One of the larger contributors to blueberries' carbon footprint is their spoilage rate.

Organic growing methods can reduce the carbon footprint of blueberries by over 1 kilogram of CO_2e (42). Additionally, by buying blueberries seasonally and locally, choosing reusable or cardboard packaging over plastic, storing them properly and eating them promptly to avoid food waste, we can reduce the environmental impact.

Potatoes

Food Journey Overview

Potatoes were cultivated more than 5,000 years ago in the Andes Mountains in Peru and Bolivia, and introduced in Europe in the 16th century before coming to Canada in 1623 through Annapolis Royal, Nova Scotia (20). Potatoes grow in all provinces in Canada and can tolerate a variety of conditions, but are best suited to locations with deep, well-drained sandy or silt loam soils with a neutral (6.5 to 7.5) pH (20). The leading fresh (also known as table) potato varieties in Canada are Superior, Russet Norkotah, Chieftain, Yukon Gold, Norland, Ranger Russet, Goldrush, Sangre and Umatilla Russet (20). As an international leader in seed potato production, Canada produces about 150 registered seed potato varieties (20).

Potatoes grow from these seed potatoes, which are planted as tuber seed pieces or whole small tubers in the spring (April to May) when soil temperatures are at least 7 degrees Celsius (20). They are planted 10 to 12 centimetres deep in rows spaced 75 to 95 centimetres apart, with seed pieces 20 to 45 centimetres apart (20). Irrigation is commonly used, and sometimes the irrigation is used to deliver nutrients (20). Potatoes are susceptible to adverse weather, pests and disease (20,43). Farmers use integrated pest management, which includes a combination of monitoring, insecticides, crop rotation, soil amendments, fungicides and biofungicides (20). Fertilizers are applied as necessary (20).

It takes about three to four months for potatoes to reach maturity. Harvesting takes place from September to October (20,43). Tuber pulp temperatures must be maintained between 10 and 18 degrees Celsius during harvest because they are prone to bruising at lower temperatures and breakdown (rotting) when temperatures are too high (20). Potatoes are cured in order to heal cuts and bruises from harvest, reduce pathogen spread, and reduce shrinkage losses (44). It can take up to several weeks to dry out the tubers using continuous ventilation (44). Potatoes need to be kept in dark storage facilities with good sanitation practices and carefully monitored temperature, humidity, and air movement to maintain quality, prevent greening and

control diseases (20). Sprout inhibitors may also be used to prevent potatoes from sprouting (20).

Managing soil health is also important. Potato growing involves frequent travel over the field and high soil nutrient demand without much crop residue after harvest to replenish the soil (20). Potatoes are grown on the same land every three to four years and rotated with other crops – including cereals, corn, forages, brassicas and pulse crops (20) – to replenish soil fertility (43). Cover crops like winter wheat are also used to help prevent soil erosion (20,43).

Production and Consumption in Canada

Potatoes are the largest vegetable crop in Canada, accounting for 26% of vegetable farm income (45). In 2021, 5.7 million tonnes of potatoes were produced in Canada (45). The top-producing regions are Prince Edward Island (22.7%), Manitoba (19.9%) and Alberta (19.6%) (45). In Prince Edward Island, nearly half (44%) of the total farm receipts come from potatoes, making them an important part of the economy (45).

Most potatoes grown in Canada (64%) are destined for processing (45). Many are made into French fries or chips (45). Fresh potatoes account for 24% of production; the remaining 12% are used for seed potatoes (45).

Canada is the world's fourth-largest exporter of fresh potatoes (45). In 2021/22, 517,672 tonnes of fresh potatoes were exported; most of these (95.6%) went to the United States (45). Canada is also the world's seventh-largest exporter of seed potatoes, with 65,677 tonnes exported in 2021/22 (45). Canada is also the world's eighth-biggest potato importer, with 154,897 tonnes of fresh potatoes coming into the country in 2021/22, almost entirely (99.9%) from the United States (45).

An average of 17.1 kilograms of fresh potatoes were consumed per person in Canada in 2021, not accounting for food wasted (11). In addition, 16 kilograms of processed potatoes (for example, frozen, chips) were consumed per person in Canada in 2021, not accounting for food wasted (11).

Environmental Impacts

Compared to other types of crops, potatoes generally have a lower environmental impact in terms of greenhouse gas emissions and water use. According to data from the United Kingdom, fertilizer use (30%), field and storage energy (29%), and soil emissions (25%) make up most of the carbon footprint of potatoes (46). Seed potatoes (9%) and transportation (5%) are more minor contributors (46).

The impacts on soil and groundwater are also of concern. To maintain yield and quality, chemical fertilizers are used to supplement the nutrients in the soil (47). This can cause nitrogen and phosphorus contamination in groundwater (47). This contamination can be reduced by rotating crops, using cover crops, applying slow-release fertilizers and employing precision agriculture (47). These strategies can also help lessen the climate impact of potato production. Using less fertilizer or slow-release fertilizer and improving soil organic matter through crop rotations or cover crops helps reduce nitrous oxide emissions from soil (48). Some crops used in rotation can help sequester carbon, as well (48).

Another environmental consideration is the impact of climate change on potato production. Warmer temperatures place more heat stress on the tubers, a shift in growth from the tubers to the leaves, and more problems with pests and weeds (48). Changes in rainfall patterns can cause flooding and add excess water to the soil, which increases the risk of bacterial infection and seed contamination (48).

Environmental Impacts Comparison

Estimates of greenhouse gas (GHG) emissions, land use, water use, acidifying emissions and eutrophying emissions are shown in the following series of figures. The information comes from a global multi-indicator database, which was created with consolidated data from 570 studies covering about 38,700 farms in 119 countries (6). The numbers presented are the means (averages) reported in the study. Note that the range of values for these indicators may be large due to the geographic range and different methods of production (field-grown or greenhouse-grown, for example) that are included across the various studies.

The database includes specific estimates for only three of our five produce items: tomatoes, potatoes and apples. For blueberries and lettuce, proxy crop categories were used. The "berries and grapes" category was used for blueberries; the "other vegetables" category was used for lettuce. For these two foods, the environmental impacts as shown may be less representative, but they can nonetheless give a general idea of how the produce items compare.

The indicators included in the database are defined as follows (6):

GHG emissions: The greenhouse gas emissions associated with the product from farm to retail, including carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) to air. The impact is expressed as the CO2 equivalent (CO2eq) per kilogram (kg) of product.

Land use: The land that is used for producing seeds and growing the product. The impact is expressed as square metres (m2) of land used per kilogram of product.

Water use: The fresh water that is used for production, including irrigation, drinking, pond, and processing water. The impact is expressed as litres (L) of fresh water used per kilogram of product.

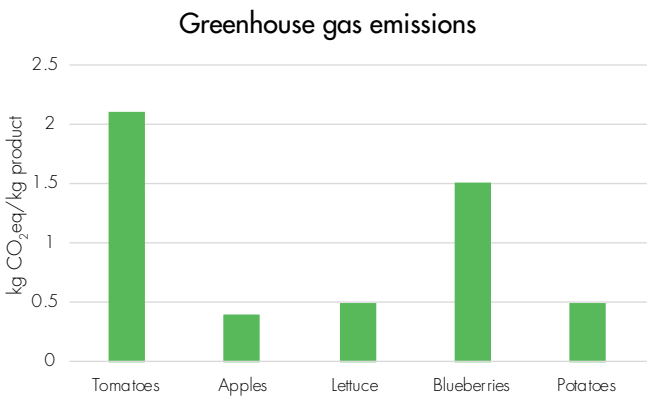
Acidifying emissions: The contribution to terrestrial acidification (soils becoming more acidic over time). These are the emissions – including sulphur dioxide (SO2), ammonia (NH3) and nitrogen oxides (NOx) to air – from growing a crop that would cause the soil to acidify. Soil acidification is problematic because it can reduce the ability of plants to absorb nutrients, damage roots and stunt growth (49). The impact is expressed as SO2 equivalent (SO2eq) per kilogram of product.

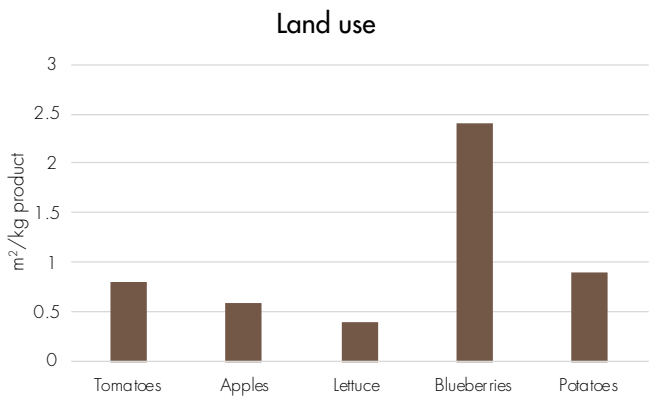
Eutrophying emissions: The contribution to eutrophication in fresh water and marine aquatic ecosystems. Eutrophication is what happens when there is an overabundance of certain nutrients in an ecosystem (typically in the water), which then causes an overabundance of algae and plants that eventually decompose and produce large amounts of CO2. This, in turn, causes the ecosystem to be off-balance and can kill fish and other wildlife (50). These emissions include ammonia (NH3) and nitrogen oxides (NOx) to air, and nitrate (NO3–), ammonium (NH4+), phosphorus (P), and nitrogen (N) to water. The impact is expressed as phosphate equivalent (PO43-eq).

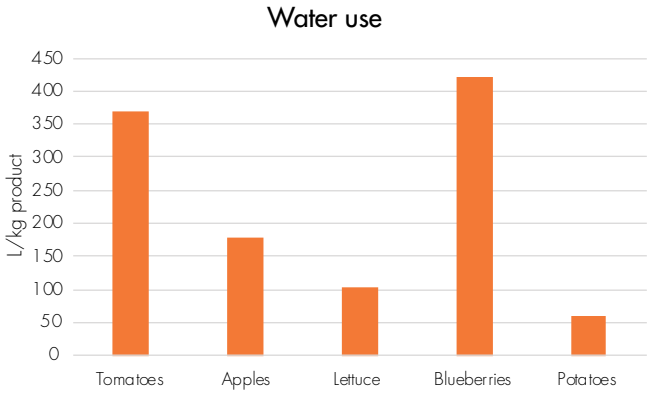
Greenhouse gas emissions, acidifying emissions and eutrophying emissions were highest for tomatoes. This is not surprising, given that a great deal of tomato production takes place in greenhouses, and is therefore very energy intensive. Since greenhouses can produce a lot of tomatoes in a small footprint, though, the land use is low compared to other crops.

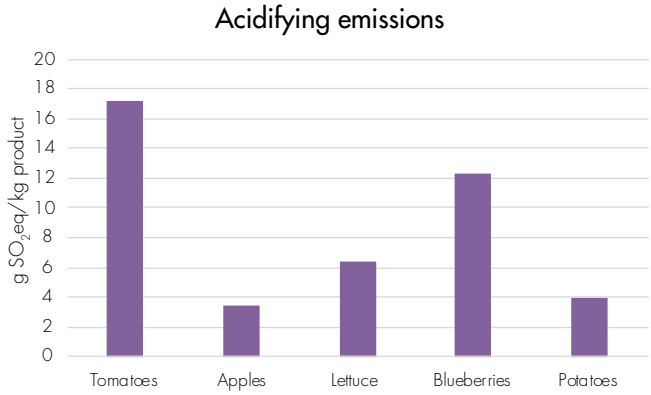
Blueberries had the highest water and land use since they require a lot of irrigation and space to grow. However, the environmental impacts shown here were based on grapes and berries overall, rather than on blueberries alone.

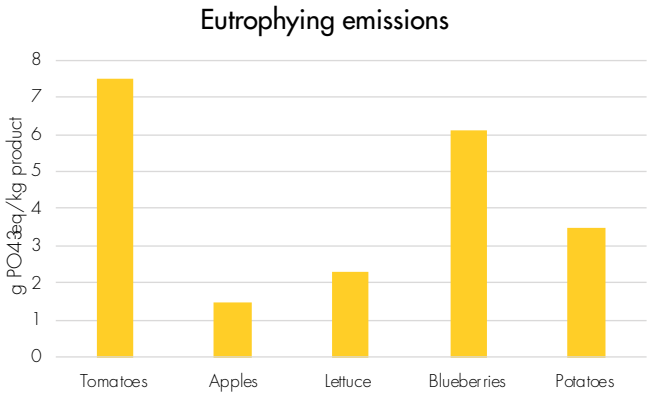
Apples, potatoes and lettuce had generally lower environmental impacts across the indicators in comparison to tomatoes and blueberries.


Greenhouse gas emissions
kg CO_2eq/kg product
2.5
2
1.5
1
0.5
0
Tomatoes
Apples
Lettuce
Blueberries
Potatoes


Land use
m^2/kg product
3
2.5
2
1.5
1
0.5
0
Tomatoes
Apples
Lettuce
Blueberries
Potatoes


Water use
L/kg product
450
400
350
300
250
200
150
100
50
0
Tomatoes
Apples
Lettuce
Blueberries
Potatoes


Acidifying emissions
g SO_2eq/kg product
20
18
16
14
12
10
8
6
4
2
0
Tomatoes
Apples
Lettuce
Blueberries
Potatoes


Eutrophying emissions
g PO_4eq/kg product
8
7
6
5
4
3
2
1
0
Tomatoes
Apples
Lettuce
Blueberries
Potatoes

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