GNG 1103

Design Project User and Product Manual

SustainHouse

Submitted by:

SustainHouse, C2

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Abstract

In this deliverable we will provide an account of how we made the SustainHouse, the materials necessary for its construction as well as the necessary procedures for replacing pieces, how to recognize structural issues and when the greenhouse is beyond repair. We will examine the tools required for its assembly as well as provide the final bill of materials and final remarks in terms of our journey in its design process.

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1 Introduction

This User and Product Manual (UPM) provides the information necessary for members of the community to effectively use SustainHouse and for prototype documentation. We will start with the overview of the product, why it was designed, who its designed and anything to keep in mind while reading the report. Then we will explain the day-to-day functioning of the greenhouse, who should be using the greenhouse and other information. We will go over how to use the features such as the doors and the windows and we will go over possible problems you may have with materials or the green house and how to solve them. Then we will go over the materials and the tools needed to build the green house. Finally, we will demonstrate how to assemble the greenhouse and plans for future expansion.

1 Overview

The greenhouse designed by SustainHouse promotes education for the growing of plants to supplement the diets in the Inuit community. Transportation of food causes a huge amount of greenhouse gasses. Although buying locally can help reduce the number of emissions created, usually transportation accounts for less then 10% of the total emission caused for food. furthermore, since buying local only cuts the long part of the trip which is usually done with efficient modes of transportation such as boats the drop in green house gases is negligible (*You Want to Reduce the Carbon Footprint of Your Food? Focus on What You Eat, Not Whether Your Food Is Local*, 2020). So, the best way to cut most emission is the grow your own food. Furthermore, as inflation skyrockets (Government of Canada, Statistics Canada, 2023b) being able to have your own independent source of nutrition is very important. It helps you reduce your grocery bill by producing your own food.

Our client wanted to help the Inuit community by giving them a greenhouse that would help extend their growing season throughout the spring and fall. Furthermore, it is important for the greenhouse to keep animals out, to ensure the well-being of the plants. Ventilation was also important to ensure a constant temperature for the plants to grow in. To insure all these criteria were met, we built a small wooden wall around the greenhouse to ensure that that small animals could not get into the plastic easily. Furthermore, we added a window to cool the greenhouse in case area got too hot.

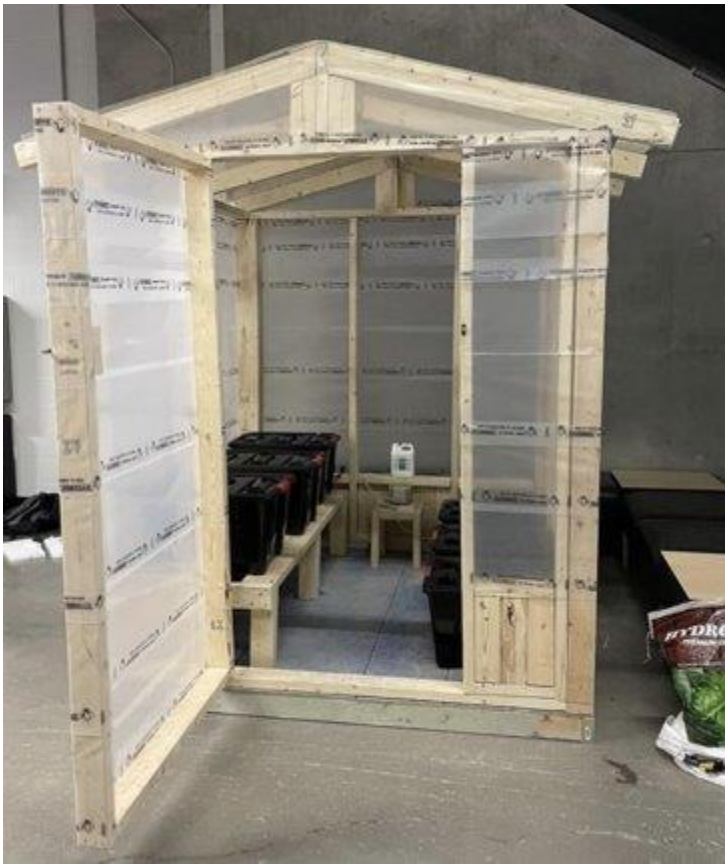

Figure 1: Final Product

The green house 6 feet by 6 feet with a wooden base. The walls are 6 feet tall, made of wood and wrapped around with a plastic wrap to keep the greenhouse well insulated. The door is 3 feet wide and 6 feet tall to ensure that is easy to bring plants or gardening tools into the green house. The roof is 8 inches tall and securely attached the walls, it a wooden shell with a harder plastic sheet placed on top of it since it is more likely to be damaged.

1.1 Cautions & Warnings

During the construction of our greenhouse, certain nails poked out slightly from the surface of the wood. Since they were put there with a nail gun, it was difficult for us to remove them however they have been pushed to the side. We however recommend caution around the nails; we recommend finding them and covering the sharp parts of these. If you need to fix or remake a section, a hammer or drill is recommended.

2 Getting started

The greenhouse will be separated into five major subcomponents: the floor base, the walls (including the window), the roof, the door, and the baseboards. For the safety of the user and ease of assembly, it is essential that the greenhouse should be constructed starting with the base, carefully attaching the walls, assembling the roof, adding the door and window, and finally attaching the baseboards. Once the greenhouse is assembled, you may wrap the greenhouse using a plastic wrap of your choice (which can be picked up are your local hardware store) using a staple gun. Once the greenhouse is fully constructed, the corresponding hydroponic system can be implemented into the greenhouse.

2.1 Configuration Considerations

When constructing the greenhouse, it is important to be careful with the power tools needed to complete the assembly. You will need specific types of tools such as nails, Simpson ties, right angle brackets, hurricane ties, and hinges to attach to specific components. Before commencing assembly, it is important to understand and learn how the tools needed to assemble these attachments work to minimize safety risks and the probability of system failure.

2.2 User Access Considerations

For users who are taller than average height, they may have to slightly bend down when entering the greenhouse to safely enter the greenhouse. It is also important to consider the slight ledge at the door when entering the greenhouse to prevent tripping or falling.

2.3 Accessing/setting up the System

1) **Constructing the Walls**

Cut six 2 by 4’s of length 5’5”. Using 4 of the pieces, construct a square shape using the nail gun. With remaining two pieces insert them in between the square such a way that they are evenly spaced. Once they are put in place nail them in using the nail gun. Attach an extra piece

of wood on the ends for the California joints. Repeat 3 more times to complete the remaining walls.

2) **Attach the Walls to the Base**

With the help of two or more people, lift one wall and place it on the base such that it is flush. Nail the wall into the baseboard using a drill or a nail gun. Repeat with remaining walls.

3) Constructing and putting on the Roof

To construct the roof, see section 5.3. Once the roof is assembled, carefully lift the roof on top of the greenhouse with the help of two or more people (a ladder is recommended). Once the roof is resting on top of the greenhouse, drill the appropriate holes into the wall, and use the hurricane ties to attach the walls to roof.

4) Implementing Door and Window

To construct the window and door see section 5.3. In the entryway of the greenhouse, install three hinges evenly spaced from each other. Once the hinges have been put into place, attach the door to the hinges using a drill. On the right-hand side of the door, install a lock at a comfortable height also using the drill. The window is installed in a similar fashion inside the greenhouse (on the left-hand side when entering the greenhouse).

5) Implementing Door and Window

To construct the baseboards, see section 5.3. Between each beam of the walls, insert the appropriate baseboard (they should be labelled according to relative position). Once the baseboard is squeezed between the pillars, attach the baseboard by drilling the bottom of the baseboard to the floorboard. Repeat for each section.

6) Wrapping the Greenhouse in Plastic Wrap

Once the greenhouse has been fully constructed, you may wrap the greenhouse in plastic wrap that can be picked up at your local hardware store. Ensure that the greenhouse is wrapped horizontally, and the wrap is securely stapled onto the walls of the greenhouse.

2.4 System Organization & Navigation

2.41 Attachments on Roof

The roof is linked together using hurricane and Simpson ties to ensure maximal stability. The hurricane ties are located in the middle edge of the roof where the attach to the walls, and the Simpson ties are located on the edges on the roof to keep it intact and stable.

2.42 Attachments on Walls

The doors and windows are attached to the greenhouse using standard hinges that can be picked up at the local hardware store. The windows require two hinges while the door requires three. There is also a lock on the right-hand side of the door and the window which is used to open/close the desire components.

The baseboards are also attached along the bottom of the walls using standard nails. The baseboards are to prevent large pests from entering the structure.

2.5 Exiting the System

To properly exit the greenhouse, one must open the door using the lock that is situated on the right-hand side of the door at the front of the greenhouse. Simply pull the handle to the left and open the door. To close the door, put the rod back into the hole and rotate the rod upwards (note: it may require a little force to open and close). The window can be opened and closed in a similar fashion.

3 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features SustainHouse.

3.1 Door

The door is a very simple and easy to use, we have a sliding bolt lock which we are using as the lock for the door as well as the handle. You simply slide the lock out and it will open. A bit of force may be needed to put the lock back as it is not perfectly straight. Just lift and push into position before sliding the lock.

Figure 2: Locks for the Door and Window

3.2 Window

The window is very similar to the door as we have used the same sliding bolt locks. You unlock the window from the inside and push the window outwards. Less force is needed for the window as there is less weight dragging it down.

3.3 Ventilation

The ventilation system is very simple to use, you can open the door and open the window. This will allow the air to flow throughout the greenhouse and bring down the temperature. Additional bug screen may be added to make sure bugs do not get in.

4 Troubleshooting & Support

During the transportation of the greenhouse, conditions were less than optimal, and pieces such as the panels, roof, and plastic sheets were subject to breakage and must be replaced.

4.1- Polyethylene roof

The roof material was provided by the school but was described by the professor as "cheap and poor quality". This material is subject to breakage under duress. During the transportation of the greenhouse, assure that no heavy materials lie on top of the sheets. During the intended uses of the greenhouse, the polyethylene sheet may be subject to breakage under accumulated pressure, such as from snow, leaves, or stray animals putting pressure on the top. To assure optimal protection; please reduce pressure on the roof to the best of your abilities and replace the roof when breakage and cracks are noticeable.

4.2- Plastic sheets

The plastic sheets were provided by our designated funds and purchased at *Home Depot*. The material is very light and not very durable, and it would have been of higher quality with a higher budget. During the transportation of the greenhouse, we were required to use the exact-o knife to remove the sheets to gain access to the walls for disassembly. Under regular circumstances, the plastic sheets are subject to slippage and breakage under conditions such as heavy wind and rain, as well as regular wear and tear over time. If breakage and slippage occur, please replace and repair using a similar method as was used for the application, from bottom to top.

4.3- Wooden panels

The wooden panels were not damaged during the initial transportation of materials. However, the panels will be subject to breakage primarily through accidental damage inflicted by humans or intentional damage from animals trying to break into the greenhouse, as well as unforeseen circumstances. If an individual plank is damaged, the panel becomes futile, and the entire section must be replaced. The panels can be reconstructed using the same measurements that were used to create them.

4.4- Lock handles for doors and windows

Handles for the door and window were not subject to breakage during the dismantling of the greenhouse. However, under the conditions that the handles become misaligned, please adjust the height of the lock accordingly such that lock handles can be continued to be of use. Under the circumstance that the handles are beyond repair, please replace the lock entirely.

4.5- Overall structural integrity

Pieces used for the construction of the roof, wall, and baseboard were not subject to breakage during the dismantling of the greenhouse. Under regular circumstances, these materials will be subject to maintenance checks, and the greenhouse as an entity must be replaced if structural integrity issues occur. These structural integrity issues include but aren't limited to: slanting of the walls, loose nails for connecting hinges, cracks along wood, and holes through baseboard from excess pressure.

Under high winds and other extreme weather conditions, please be sure that no humans are harmed by avoiding having anybody within the proximity of the greenhouse. If structural problems occur, please replace and dismantle the entire greenhouse to assure maximal safety.

5 Product Documentation

5.1 BOM (Bill of Materials)

Material	Quantity	Dimensions	Price	Link
Wood	47	2*4*8	$3.98/piece $187 total	https://www.homedepot.ca/product/2-inch-x-4-inch-x-8-ft-spf-dimensional-lumber/1000112108
Baseboard -can use plywood and 2 by 4s	1	6ft*6ft	Provided	N/A
Nails	1	N/A	$5.44 per pack of 200	https://www.homedepot.ca/product/paulin-1-1-2-inch-4d-smooth-finishing-nails-bright-finish-150g-approx-196-pcs-per-package-/1000683603
Screws	1	N/A	$49.97	https://www.homedepot.ca/product/paulin--8-x-3-inch-flat-head-square-drive-construction-screws-in-yellow-zinc-1000pcs/1000152354
Lock	2	N/A	$16.37	https://www.homedepot.ca/product/everbilt-8-inch-zinc-plated-heavy-duty-barrel-bolt-1pk/1000771789
Window Hinges	1	N/A	$6.93	https://www.homedepot.ca/product/everbilt-2-in-brass-narrow-hinge-loose-pin-2pk/1000773723
Door Hinges	3	N/A	$4.47	https://www.homedepot.ca/product/everbilt-3-in-satin-nickel-door-hinge-with-1-4-in-radius-1pc/1000769441
Simpsons Strong Tie	16	N/A	$1.61/each	https://www.homedepot.ca/product/simpson-strong-tie-h2-5a-18-gauge-zmax-galvanized-hurricane-tie/1000152530
Right angle brackets	4	N/A	$2.61/pack of 4	https://www.homedepot.ca/product/everbilt-3-4-corner-brace-zinc-plated-4pc/1000773655

Hurricane Ties	16	N/A	$2.96/each	https://www.homedepot.ca/product/simpson-strong-tie-hurricane-tie-zmax/1000170485

5.1 Equipment list

- Mitre saw
- Nail gun
- Power stapler
- Drill
- Heat gun
- Level
- Pencil
- Measuring tape
- Ruler

5.3 Instructions

1) Set up the base.

For our project, we used a premade base, provided by the professor. If this breaks or needs to be replaced, it is recommended to either use some pallets or get together some 2 by 4s and either plywood or OSB (oriented stranded boards) and nail them together in a similar pattern to the current base.

2) Build the walls.

Cut the 2 by 4s to 6’ and 5’5” pieces and assemble them similar to the figure below. For more detail, there will be two main 6’ pieces for the corners on each of the four walls. Two walls will have two additional 6’ pieces which will be sandwiched in between the top and bottom and the other two will use the 5’5” pieces. Two additional 6’ pieces will be put in the middle, spaced apart by 2’ for 3 walls and spaced 1.5’ from each side for the final wall to accommodate the door. These will be either drilled in or nailed in. Finally, two more 6’ pieces will be placed flush to the vertical corner pieces to act as California joints.

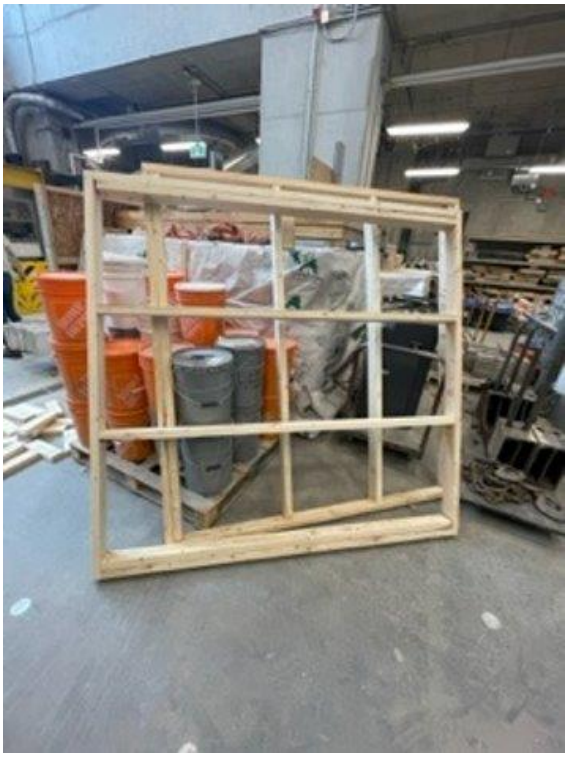

Figure 3: Walls of the Greenhouse

3) Attach the walls to the base.

Carefully lift the wall pieces and place them on the baseboard. The two pieces that are 5’5” across will be put across from each other and put in between the two 6’ walls. Using longer nails, drill or hammer into the bottom 2 by 4 into the baseboard, possibly at an angle to make sure the nail doesn’t stick out the end.

4) Build the roof.

Cut one 6’ piece, 8 3’4” pieces, 6 8” pieces, 4 cut at a 15 angle on one end. For the 8 3’4” pieces, cut one end at an 15 degree angle and cut a 90 degree notch in the other end, approximately 3” up. On the ground, attach the 6’ piece to the 3’4” pieces in the configuration shown below. One at a time, place the angled pieces with the notch on the wall and the angled end flush with the 6’ piece on the top and in line with the 2 by 4s in the wall. While someone holds, and stabilizes it, slide in a hurricane bracket or a Simpson’s strong tie from underneath on the top of the piece and screw it into the wood to hold it. The Simpson’s tie is for the end pieces and the hurricane bracket are for the middle pieces.

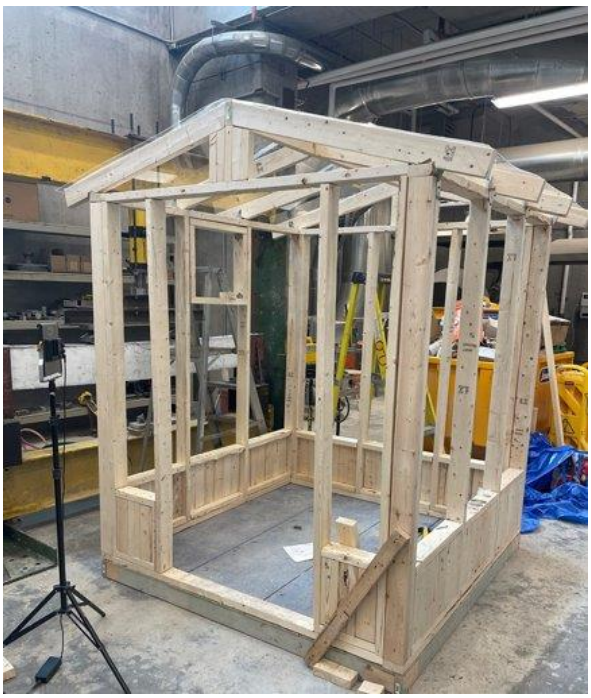
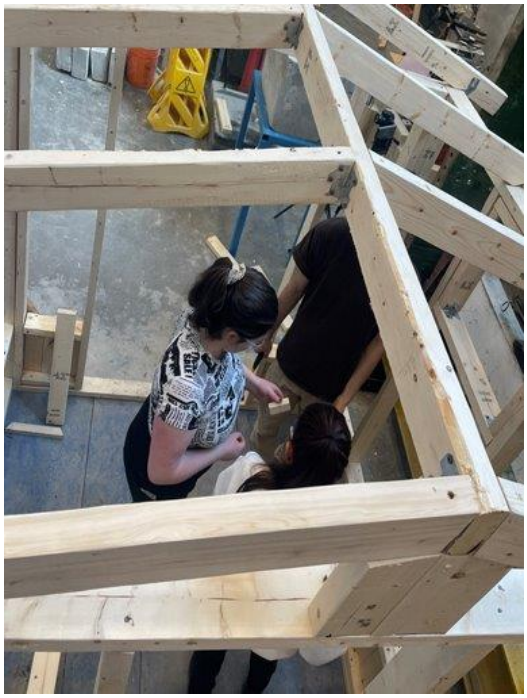

Figure 4 and 5: Roof of the Greenhouse

5) Attach the roof.

Lift the roof as it is built so far and place it over the walls, with the notch slotted into the top of the walls. Use the hurricane and Simpson's ties to attach the roof to the walls in a similar manner as mentioned in the previous step. Also screw in a few screws at an angle to the middle 8'' pieces into the wall.

6) Build the baseboards.

Cut 2 pieces of wood to the dimensions in between the structural posts of the walls (approximately 2' but measure to make sure and adjust accordingly). Cut several 1' pieces, mainly using the extra wood from previous cuts. Place one of the two longer pieces on the ground and place the 1' pieces on top, in the desired configuration. Place the other piece on top and screw each foot long piece in. Once that is done, flip and do the same thing on the other side. Once that board is done, place it in the wall where it was measured and screw it into the base. Repeat these steps for all the walls.

7) Build the window.

Cut 4 2' pieces (though double check sizing to make sure it fits in between the slats of the wall where you want it). The window needs to fit into the space of one of the wall sections so adjust accordingly depending on where you want the window. Nail or screw the pieces together and

then screw in two hinges on the edge of the sides of the window. Lift the window up and put it in place. With someone else holding it or someway to stabilize it, screw the other side of the hinge into the wall. Then, take an extra piece of wood and screw it on the inside of the window. Make sure this piece isn't too thin otherwise the wood will crack. For best results, take some left over 2 by 4 wood and cut it to approximately 2". Then screw in the lock to this extra piece of the wood (needed for more surface area). When screwing in the lock and the hinges, do not screw all the way in as this will impair the movement of these pieces. If the window doesn't stay level, place a right-angle bracket on the inside corners and screw in to stabilize.

8) Build the door.

The door is built in the same way as the window. The pieces cut are 5'9" and 2'9" (again make sure these fit in between the door opening with enough room for smooth movement). This also accommodates for the extra space needed for smoother movement. The door requires 3 hinges to carry the weight and the door must be propped up as the hinges are being screwed in. This can be done using some leftover plywood pieces, stacked up to the desired height. There also needs to be an extra piece of wood attached to the inside of the door to attach the lock.

9) Attach the plastic wrap to the roof.

The material we used on the roof is a lot more rigid than the material on the walls. To attach, bring a piece up on top of the roof, place it flush with the end of the posts, and carefully drilled into the wooden 2 by 4s. For the drilling, a slightly thicker piece is used first with no screw to create a hole then the screw is put in using the normal drill bit. For the top of the roof, use a heat gun to slightly melt the material, just enough so you can mold it to the shape of the roof, and then drill it in. Do the same thing for the other side.

10) Attach the plastic wrap to the walls.

For the plastic wrap, start at the bottom of the wall, just above the sideboards, right next to the door. Use a power stapler, or a regular stapler, if need be, and attach the first section right beside the hinges. When wrapping around, make sure to hold the wrap very taut to make sure that it does not warp. When nearing the door again, staple to the outside, just before the door, and cut the wrap with a few inches of extra material. Wrap this extra material around the post and staple on the inside. This is repeated for all the walls, overlapping the material similarly to shingles to keep the rain out and cutting when needed for the window. For the door, feed the material through the crack between the hinges and the door, cutting slits around any of the hinges. Staple

on the inside, wrap around in a similar manner to the walls, wrap around the other post and staple again. Cut off the extra material and cut out material for the lock. Continue this up, overlapping again to prevent water from getting in. The window is wrapped in a similar manner.

11) Final look over

Take a turn of the greenhouse to make sure all the pieces are in place and stable. If not, add some extra screws or brackets to ensure the safety of the structure.

6 Conclusions and Recommendations for Future Work

At the beginning of this project, none of the members of our team had done any sort of construction or carpentry before so we came across a few problems that we had to work through. The first one we came across was the California joint which we did not know existed until we had already started construction. The California joints changed the way our dimensions worked out, so we had the redo those before continuing. We had the same issue with the brackets as well as the general construction of the roof. The roof is the one of the more technically difficult aspects of the construction, so we had to redo a lot and work closely with the professor to make sure our roof was up to standards. Finally, we learned the differences between the nail gun and the drill in terms. We started using the nail gun throughout every aspect of the construction. However, the learning curve was a bit too steep for our timeline and we had to spend a lot of time trying to hammer out failed attempts. After a while, we switched over to the drill which definitely took longer but we were able to easily and quickly fix any mistakes.

For future work or things that could be added on if there was time, our original idea was to add on a vestibule over the door as an additional pest and heat control system. We were also going to add some bug screen to the window and door so those could be open to allow air flow without bugs getting in. There could also be another 2 by 4 added above and below the window. This would help support the window as well as have more area to staple the plastic sheeting to make sure water would not get in. If there was a bigger budget, a thicker material would have been used for the wall and roof material to add to the structure and waterproofing. Finally, we were initially going to add a gutter system so that rain water could be collected and used in the hydroponics system.

7 Bibliography

Government of Canada, Statistics Canada. (2023b, March 21). *The Daily — Consumer Price Index, February 2023*. https://www150.statcan.gc.ca/n1/daily-quotidien/230321/dq230321a-eng.htm

You want to reduce the carbon footprint of your food? Focus on what you eat, not whether your food is local. (2020, January 24). Our World in Data. https://ourworldindata.org/food-choice.