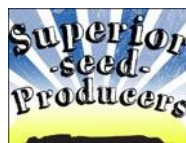
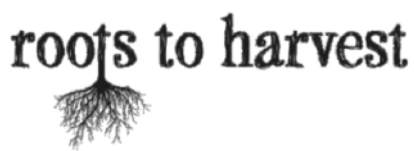


Agroecology and Seed Sovereignty in Northern Ontario Year III Report (2020-2021)



Lakehead
UNIVERSITY

Agricultural
Research Station



ROOT CELLAR GARDENS
Ecologically Grown Vegetables



LSLLN
Lake Superior Living Labs Network



This project is supported by the
Lakehead University Agricultural Research Capacity Development Program

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Land Acknowledgement

This project involves people that are living and working on the traditional land of the Anishinabek people— signatory to the Robinson Superior and Robinson Huron Treaties of 1850. We acknowledge the political representatives of Indigenous Nations in northern Ontario: the Anishinabek Nation, Grand Council Treaty #3, Nishnawbe Aski Nation, and independent First Nations. We also acknowledge the original custodians of this land who have protected the land, water, and beings for time immemorial despite ongoing efforts to displace and disconnect them. We aim to support their work by building and continuing relationships with the Indigenous people around Gitchi-Gami based on the principles of mutual trust, respect, reciprocity, and collaboration in the spirit of reconciliation.

Project Overview

The availability of healthy, locally produced food is essential for food security, ecological sustainability, and economic prosperity. Building on the relationships with Lakehead University faculty, staff and students, the Lakehead University Agricultural Research Station (LUARS), Roots to Harvest, The Superior Seed Producers and several community partners, the *Agroecology and Seed Sovereignty in Northern Ontario* project's goals are to improve knowledge, skills and capacity to produce healthy and sustainable food in Northwestern Ontario. Adopting a community-based, participatory research methodology, the project has four broad objectives:

1. To increase access to ecological seed varieties adapted to Northern Ontario's agro-ecosystems through participatory, farmer-led research;
2. To support peer-to-peer knowledge exchange about seed saving and help farmers scale-up, diversify, and increase the quality of regionally adapted seed;
3. To improve biological conservation, food security and farmer livelihoods through improving the viability of ecological farming and food businesses; and,
4. To make LUARS a hub in Northwestern Ontario for ecological agriculture and sustainable food systems through strengthening partnerships with regional farmers, nonprofit organizations, small businesses and Indigenous communities.

The project was initiated by a team that included Drs. Charles Levkoe, Lindsay Galway and Brian McLaren at the Sustainable Food Systems Lab¹ Lakehead University and community partners with expertise in ecological agriculture, including Roots to Harvest², Superior Seed Producers³, Bauta Family Initiative on Canadian Seed Security⁴, the Ecological Farmer's Association of Ontario⁵, and the Lakehead University Sustainability Office. These primary partners helped to guide and implement the project and manage knowledge mobilization. With the establishment of the Lake Superior Living Labs Network (LSLLN)⁶ in 2019, the *Agroecology*

¹ The *Sustainable Food Systems Lab* is a hub for academics and community-based practitioners engaged in sustainable food systems research and action (<https://foodsystems.lakeheadu.ca>).

² Erin Beagle, Executive Director at Roots to Harvest a non-profit organization providing educational and employment opportunities through agriculture and cultivate healthy communities (<http://www.rootstoharvest.org>)

³ Evalisa McIlffaterick, Owner/Operator of Root Celler Gardens and members of Superior Seed Producers, a collective of growers that promote saving and distributing locally adapted, sustainably grown, open-pollinated seeds, while educating and supporting about saving seeds (<https://superiorseedproducers.wordpress.com>)

⁴ Aabir Day, Director and Helen Jenson, National Research Program Manager of the Bauta Family Initiative on Canadian Seed Security, a Pan-Canadian organization working to conserve and advance biodiversity, maintain public access to seed, deliver research and training programs, and promote the wisdom and knowledge of farmers (<http://www.seedsecurity.ca>)

⁵ Rebecca Ivanoff, Research and Seed Program Coordinator, Ecological Farmers Association of Ontario (<https://efao.ca>)

⁶ The Lake Superior Living Labs Network aims to increase the impact of sustainability related teaching, research, and action with a focus on issues at the nexus of water, land and food, climate and energy, and individual and community well-being across the Lake Superior Watershed. See www.livinglabsnetwork.org

and Seed Sovereignty in Northern Ontario project has become a core project of the Thunder Bay Hub.

In the first year of the three-year funded project, we focused on establishing the partnerships and hiring a community grower at Roots to Harvest. We also focused our collective energy on feasibility and research planning to determine current needs, interests and capacity to meet the project objectives. We worked closely with staff at LUARS to plant and maintain plots for ecological seed trials of carrots and peppers.

In year two we continued to build partnerships and grow for the seed trials focusing on radicchio, carrots and spinach. February of 2020 saw the onset of the COVID-19 pandemic and the shutdown of all in-person research and gatherings for the remainder of the year. During the Spring-Summer of 2020, Rachel Portinga joined the project as an intern funded by a Mitacs Research Training Award. Rachel brought additional capacity to the project through research with local seed savers, a literature review, and a series of virtual workshops on planting, cultivation, harvesting, preserving, and seed saving.

In year three we continued to build partnerships and grow for the seed trials focusing on spinach, radicchio, rutabaga, Gete-Okosomin squash, and other local varieties. Jordan Lees was the Roots to Harvest grower this season and led the planting, growing, and evaluation of the seed trials. Rachel Portinga assisted in those trials and spent time developing educational videos about seed saving throughout the season for tomatoes, dry beans, spinach, and radicchio. The project also took part in the LSSLN Climate Action Field School in August 2021⁷.



Gete-Okosomin Squash Flower



Pruning the Gete-Okosomin Squash

⁷ The LSSLN Climate Action Field School was a week-long experiential training program consisting of virtual workshops, site visits, and events in coastal communities across the Lake Superior Watershed in the summer of 2021.

Budget

In 2018, the *Ecological Agriculture, Food Security and Economic Prosperity in Northern Ontario* project received a \$30,000 award from the Lakehead University Agricultural Research Capacity Development Program. The funding has been used to support a community grower staff position in partnership with Roots to Harvest. Through this partnership, the community grower spent approximately eight hours per week on the project and with the Roots to Harvest staff, played an important role in integrating the work into broader agroecological and food systems work across the region. Other contributions to the project included a cash contribution from the Bauta Family Initiative on Canadian Seed Security (\$500/year), and in-kind time and resources from all the partners. This included support from the Superior Seed Producers to organize workshops and providing overall advisory duties. A Research Training Award from Mitacs (\$6,000) funded an intern through the summer of 2020, to support the project. In addition, the SSHRC Partnership Development Grant entitled Lake Superior Living Labs Network awarded in 2019 contributed funds and resources to this project. During the 2020-2021 season, the \$10,000 was split between the Roots to Harvest staff and Rachel Portinga, a graduate student at Lakehead University.

Roots To Harvest Seed Variety Trials

Prepared by Jordan Lees

In partnership with Roots to Harvest, a community grower was employed to coordinate the Canadian Organic Vegetable Improvement (CANOVI) rutabaga and radicchio seed trials at Roots to Harvest's Lillie Street Urban Farm at 125 Lillie Street South, Thunder Bay, ON. The variety trials are part of a national project coordinated by the Bauta Family Initiative on Canadian Seed Security to observe and participate in the CANOVI Project. The CANOVI Project works with the growers to determine the best parent line for breeding. Through participatory breeding, vegetable varieties are optimized for specific geographical locations and organic growing.

In addition, Evalisa McIlfaterick, owner and operator of Root Cellar Gardens coordinated a spinach seed trial which Roots to Harvest participated in. Guidelines for the spinach trials were designed by Evalisa McIlfaterick and Rebecca Ivanoff, Seed Program Manager with the Ecological Farmers Association (EFAO). Once evaluations were complete, they were uploaded to a national app called Seedlinked. The data collected is then made available to farmers and seed growers to help determine which variety will grow best to their local conditions. The spinach seed trials were grown on two sites in the Thunder Bay area; Roots to Harvest's Lillie Street Urban Farm at 125 Lillie Street South and Root Cellar Gardens located southwest of the city of Thunder Bay.

Rutabaga Trails

Five "core" varieties of rutabaga were grown out at the Lillie Street site. These core varieties were selected based on the varieties that had the best performances in previous years. Varieties were planted into a double row, 12 feet per variety. Seeds were direct sown on June 29, 2021 and harvested as a crop for eating on October 10, 2021.

Information gathered from this trial will be used to help farmers:

- Identify the best performing varieties for their region, both for market production and seed production
- Identify varieties that would be suitable parents for future regional breeding projects
- Build the capacity to conduct on-farm variety trials useful for their farming operation

Table 1. Varieties evaluated at various stages of growth, ranked from 1-5, (5 being the best). Insect resistance is specific to cabbage maggot.

Variety	Would you grow again?	Germination	Vigour	Uniformity	Winter Hardiness	Appearance	Disease Resistance	Insect Resistance	Yield	Marketable Yield	Marketability	Flavour
Helanor	Yes	1	3	2	N/A	3	5	5	4	4	4	4
Joan	Yes	1	4	3	N/A	4	5	5	4	4	4	4
Laurentian	Maybe	1	4	4	N/A	4	5	5	3	3	3	3
Nadmorska	No	2	4	4	N/A	4	5	5	4	4	4	2
Altasweet	No	5	5	5	N/A	4	5	5	4	3	3	2

No significant disease was found to be present, and there was minimal insect pressure.

Blind taste tests were conducted with members of the Roots to Harvest staff, who brought home one of the five varieties at random to cook and evaluate based on flavour and preferability. Through these tests it was determined that Helanor and Joan were the highest ranked for flavour with Altasweet and Nadmorska being the least preferred.

Radicchio Trails

The trial included two sets of radicchio: early assorted and midseason variegated. The early assorted set consisted of six varieties of radicchio; Pasqualino, Bel Fiore, Early Treviso, Mirabella, TVG1, and Variegata di Castelfranco. Midseason variegated trials consisted of four varieties; Beatrice, Fenice, Delta, and Radicchio di Lusìa.

Trials were started in Roots to Harvest's four-season greenhouse on June 16, 2021. The conditions of the greenhouse were not an ideal location to start seedlings due to lack of airflow, high/irregular levels of heat, and high humidity. This resulted in several seedlings dying off and having to start a second set of seedlings. Due to reseeding radicchio, sets were transplanted on August 3, 2021, instead of the suggested mid-July transplant date. Due to setbacks in their seedling stage the anticipated harvest date, which would have been September/October, was pushed to November. An unseasonably warm fall offered an extended growing season allowing the later seeded plants to reach maturity. Mature plants were harvested on November 3, 2021.

Table 2. Early assorted radicchio varieties evaluated at various stages of growth, ranked from 1-5, (5 being the best).

Variety	Would you grow again?	Germination	Vigour	Bolt Resistance	Uniformity	Winter Hardiness	Yield	Marketable Yield	Marketability	Appearance	Flavour
Early Treviso	Yes	4	4	5	5	4	5	4	4	5	3
TVG1	Yes	4	4	5	5	4	5	4	4	5	3
Variegata di Castelfranco	Yes	5	5	5	5	5	5	4	3	4	3
Pasqualino	No	4	4	5	4	4	4	3	4	4	2
Bel Fiore	No	3	3	5	3	3	2	3	2	3	3
Mirabella	No	5	3	3	4	4	3	4	3	4	3

Table 3. Midseason radicchio varieties evaluated at various stages of growth, ranked from 1-5, (5 being the best).

Variety	Would you grow again?	Germination	Vigour	Bolt Resistance	Uniformity	Winter Hardiness	Yield	Marketable Yield	Marketability	Appearance	Flavour
Fenice	Yes	3	3	5	5	4	3	4	3	3	4
Radicchio di Lusia	Yes	4	4	5	4	4	5	4	4	4	5
Beatrice	No	3	2	4	4	4	1	3	3	4	2
Delta	No	5	4	4	4	3	3	3	3	2	3

Spinach Trails

Commercial spinach seed is only grown in a few select locations due to its geographically specific requirements for seed production and is best grown in northern latitudes. Thunder Bay offers a unique climate with long summer days, making it a viable location for spinach seed production and leading to the motivation of this trial:

“The purpose of the spinach seed trial is to identify which varieties of spinach are well suited for seed production in northwestern Ontario. As it seems that the region is a viable, but not ideal, location for spinach seed production. This project will seek to see if there is a difference among varieties when it comes to viable, vigorous seed production. This trial will also seek to assess which planting dates produce the best spinach seeds.”

The soil at the Lillie Street Urban Farm was amended with alfalfa pellets adding to the organic matter of the soil. The soil was tilled and beds were shaped with a BCS walk behind tractor. Six varieties of spinach were planted. There was minimal maintenance of the trials (the occasional weeding and thinning). The majority of this work was completed by the Roots to Harvest’s Seasonal Horticultural Outdoor worker (SHOW) staff and Rachel Portinga.

For more information about the spinach seed trials see Appendix A, Ecological Farmers’ Association of Ontario report.



Harvesting spinach seed with the
LSLLN Climate Action Field School

Varieties were planted at four times throughout the season, spring 2020, early fall 2020, frost seeded 2020, and spring 2021. All trials were evaluated at 4 stages; emergence, leaf maturity, bolting, and seed harvest/maturity.

Table 4. List of open pollinated varieties of Spinach trialed.

Variety	DTM (Days to maturity)	Leaf-type	Growing Season	Source	Notes
Longstanding Bloomsdale	45	Savoyed	Spring/Fall	High Mowing	Cold hardy
Abundant Bloomsdale	45	Savoyed	Spring/Fall	High Mowing	High yield
Giant Winter	50	Savoyed	Fall/Overwinter	High Mowing	Cold hardy
Butterflay	40	Semi-savoyed	Spring/Fall	High Mowing	Productive
Matador	43	Flat	Fall/Overwinter	High Mowing	Cold hardy
Popeye	40-50	Savoyed	Spring/Fall	Root Cellar Gardens	Late bolting

Table 5. Planting date and seed set information for both growers.

Date Sown	Date Harvested	Location	Grew to produce Seed?
Spring: May 6, 2020	NA	R2H	Yes
Spring: May 10, 2020	July 25, 2021	RCG	Yes
Fall: September 8, 2020	August 13, 2021	RCG	No
Fall: October 6, 2020	NA	R2H	Yes
Frost Seeded: October 20, 2020	NA	RCG	No
Frost Seeded: November 3, 2020	NA	R2H	No
Spring: May 6, 2021	July 31, 2021	RCG	Yes
Spring: May 13, 2021; re-planted June 11, 2021	August 25, 2021	R2H	Yes

Early fall seeded varieties saw a much larger yield and viability than any other planting times.

Early fall plantings (September 8, 2020) were harvested August 13, 2021 by the Roots to Harvest grower and the SHOW participants. Plants were pulled at their maturity and left to hang dry in the Roots to Harvest four-season greenhouse as in prior years. This year plants were hung from the ceiling rafters and left to dry, eliminating the need to rotate plants by increasing airflow, helping with prior issues of humidity, and mixing of seed varieties. Heat levels exceeding 30 degrees Celsius were still an ongoing issue.



In this trial, growers found that frost seeding was not an optimal planting time for northwestern Ontario as seedlings germinated but did not survive over the winter. With only one replication, the fall planting showed higher seed production and this planting time might prove to be ideal for seed producers in northwestern Ontario. The 2020 frost seeded trials were unable to overwinter successfully.

Spring planting at Lillie site was also unsuccessful, so seeds were replanted on June 11, 2021 and harvested on August 25, 2021, by the Roots to Harvest Grower and the Climate Action Field School participants. Seed was stored for drying in the same manner as the early fall plantings. However, seed produced from this June planting was a much lower yield and viability compared to production from the early fall seeded trials, so planting in June did not provide enough time for plants to mature and produce viable seed.



Matador and Popeye ranked highest and were among the growers' favourite varieties planted. Giant Winter ranked poorly in almost every category and was the growers' least favourite variety.

Table 6. Grower notes for each variety in the trial

	Root Cellar Garden (RCG)	Roots to Harvest (R2H)
Longstanding Bloomsdale	Taste and picking favourite along with Popeye. More susceptible to logging	Bitter, juicy, bitter, not bitter
Abundant Bloomsdale	Last to bolt in both plantings that survived. Last to mature seed as well.	Robust, solid, strong, bitter ending
Giant Winter	Least favourite in terms of taste and picking, bolted quickly – by far the shortest picking window	Fuzzy, bitter, bittersweet, little savoury, velvety, chewy
Butterflay	NA	Thin leaf, sweet, not bitter, no mineral taste, pleasant, light, not juicy
Matador	NA	Full, soft, not chewy, watery, nice after flavour, swiss chard taste
Popeye	Taste and picking favourite along with Longstanding Bloomsdale	Thick leaves, high water content, nutty, minerally, liked

Table 7. Mean rank data for germination at planting, plant vigour, grower preference, disease resistance, bolt resistance, lodging resistance, total seed yield (total grams collected from 12ft section of plants), seed germination (%), and seed vigour across both farms and all replications for the six tested varieties.

Variety	Germination at Planting	Plant Vigour	Grower Preference	Disease Resistance	Bolt Resistance	Lodging Resistance	Total Seed Yield (g)	Seed Germination (%)	Seed Vigour (Rank)
Longstanding Bloomsdale	3	3	3	3	2	4	91	34	2
Abundant Bloomsdale	2	3	3	4	3	3	185	46	4
Giant Winter	5	5	4	1	5	4	131	37	4
Butterflay	3	4	3	2	2	3	136	35	4
Matador	3	2	2	2	4	2	141	32	4
Popeye	2	2	3	3	3	3	143	44	3

Next Steps

Growers are curious to do more work around frost seeding and fall planting to assess a more reliable way to grow spinach earlier in the following growing season, so that plants are more mature when they bolt. Growers would use the Popeye variety to continue this work, since it performed well in this trial and was Root Cellar Gardens' favourite variety. Growers at Root Cellar Gardens would like to continue to collaborate with replicates at Roots to Harvest and want to continue working and learning together.

Root Cellar Gardens Seed Variety Trials

Prepared by Evalisa McIlffaterick

Root Cellar Gardens is a market garden located about 40km southwest of Thunder Bay. We grow produce for both a summer and winter CSA, as well as save/produce seed. Approximately 50% of our production space is for vegetable growing, 40% is for both seed and produce, and 10% is for exclusively seed production. The seed we produce is for our own use, for distribution through Superior Seed Producers, and to fill contracts for other Ontario seed companies. We are currently undergoing the transition to certified organic.

This summer was the 4th summer that we have taken part in the CANOVI variety trials. As part of the project we trialed radicchio and rutabagas. We also continued our two-year spinach variety trial as part of the Ecological Farmer's Association of Ontario Farmer-Led Research program. While our trials were not specifically a part of the Agroecology and Seed Sovereignty in Northern Ontario project, they mirror in a small part some of the on-farm work that the project is doing. Below is a summary of the results of the variety trials conducted at Root Cellar Gardens.

General Information

All trials were grown in their own 3'x50' raised bed. Trials received no special treatment/practices from the same crop grown for production purposes. Trials were observed and evaluated at several stages throughout the season, as outlined by the protocols provided.

The summer of 2021 was a particularly hot and dry one. Many crops responded to this extreme weather in a variety of ways. Germination from seed was lower than usual, yields were lower than usual, and many things bolted (went to seed) sooner than would regularly be expected. There was also higher insect pressure in the garden than previously observed.

Rutabaga Trials

We trialed five varieties of rutabaga in the summer of 2021: Helenor, Alta Sweet, Joan, Laurentian, and Nadmorska. Seeds were planted on June 7th. They were evaluated as per the rubric provided by CANOVI. As in the previous year, part of our motivation for taking part in this particular trial was to see if any particular variety showed stronger resistance to cabbage root maggot. Germination of all rutabagas was lower than we would typically expect. We were able to thin/transplant to create a full bed of the 4 varieties. We didn't find there to be a clear, stand-out favourite from these varieties. Nadmorska was the most variable, but ultimately had the greatest percentage of marketable roots. Joan grew best early on; despite the dry, hot conditions. However, it was the most susceptible to damage from root maggot and so ultimately

had the least number of marketable roots. Helenor was consistently middle of the road for all characteristics evaluated and ranked highest (tied with Nadmorska and Joan) for flavour.

We decided to participate in the rutabaga variety trial to see if any variety had particularly good resistance to cabbage root maggot (a problem for rutabaga in our garden). We trialed eight of nine varieties on offer. All grew vigorously and produced varying uniform tubers. Unfortunately, all were heavily damaged by cabbage root maggot upon harvest. The best of each variety was put in cold storage for 2 months before evaluation for flavour. The best tasting variety in our trial was Helenor, which was also our favourite overall.

We have grown Helenor rutabaga for many years at Root Cellar Gardens. We also produce seed for this variety. We have found it to be a great variety to grow for all reasons except the heavy damage it continues to sustain from root maggot. The results of this trial confirm for us that it is a fine variety to grow (that there isn't a magical rutabaga out there that we are missing out on).

Radicchio Trails

We selected to grow six varieties of early radicchio. Transplants were started mid-April and planted out June 7th. We had no idea what to expect, as radicchio (as a food and a crop) is something completely new to us. The plants were beautiful and quite varied - between varieties but also within varieties. We grew: Mirabella, Early Travino, Bel Fiore, V. di Castlefranco, Pasquilino, and Tugi. Some plants bolted very early (mid-July), and some matured very late (early September). We left a few early bolting plants in to see how long it took to mature seed – they never did (but they did produce beautiful, chicory like purple flowers). We stored the last heads that we harvested to see how long they would keep in storage (nearly 2 months!). We harvested heads as they appeared to mature and shared some of these with our summer CSA customers. The feedback we got from them were unanimously favourable – all enjoyed the stunning appearance and the flavour. In August we harvested 1 mature head of each variety and evaluated flavour ourselves. We tried them grilled. We noticed a significant difference across varieties, our favourite being Mirabella and Bel Fiore. No variety produced a high yield of marketable heads. Despite this, we found radicchio to be a really interesting crop to grow and would definitely grow it again.

Spinach Trails

Finally, we completed a two-year spinach variety trial designed to see if there is a particular variety of spinach that lends itself well to seed production in our region. This trial involved four plantings of six varieties of spinach: one planting in the spring of 2020, one in the late summer of 2020, in the late fall of 2020, and one in the spring of 2021. Spinach was evaluated for its germination rate and early vigour, its taste and ease of harvest, its overall health and disease resistance, and finally its seed yield and viability. Each planting's data was evaluated

individually, and then comparisons across planting dates were made to determine the role that timing plays in good spinach seed production in our area.

Unfortunately, two of four of our plantings at Root Cellar Gardens did not germinate/survive: the fall planted and frost seeded plantings did not produce any spinach in 2021. Therefore, we were only able to evaluate 2 separate spring plantings. In 2021 we observed 2 distinctive flushes of seed germinating (one just a few days after planting, and then one nearly 2 weeks later when we got rain). Regardless, all plants seemed to bolt around the same time. Seed yields were higher in 2021 than in 2020. Data from all plantings at Roots to Harvest and Root Cellar Gardens was evaluated and analyzed by folks at the Ecological Farmers Association of Ontario (EFAO). Ultimately, there was no statistically significant difference observed through this trial. However, there was a grower preference observed for Matador and Popeye spinach. The fall planting done at Roots to Harvest in 2020 produced more seed (with better germination) than the other plantings.

Moving forward we will continue to work with growing spinach for seed at Root Cellar Gardens. However, the results of our research indicate that in practice, our region may not lend itself to consistent, quality, spinach seed production.



Educational Experiences

Prepared by Rachel Portinga

In the 2021 growing season, Rachel and Jordan coordinated to take video clips of four plants throughout the growing season: tomatoes, brittle rattle beans (dry bean), spinach, and radicchio. There were 16 visits to the garden over five months.

The goal was to produce four videos (approximately five minutes long) that would show each step of the seed growing and saving process including: planting, growth over time, development of the seed-producing bodies (showing male and female where appropriate), cooking the edible parts of the plant, seed harvesting, and seed cleaning (or other preparation such as fermentation).

These videos are in production and will be ready by mid-January 2022. They will be posted to the Roots to Harvest YouTube account and promoted over social media by Roots to Harvest and Superior Seed Producers as a build-up to the 2022 Thunder Bay Seedy Saturday event.

Additionally, on July 7, we hosted a Seed Saving Tea Hour over zoom for participants to learn tips about seed saving in anticipation of the second half of the season and ask questions of experienced seed savers. Nineteen people registered and a handful attended.

Looking Forward

This is the final year of funding for the Agroecology and Seed Sovereignty in Northern Ontario project through the Lakehead University Agricultural Research Capacity Development Program. The funding has played an essential role in helping to establish the project and build the relationship with the faculty, students, and community partners involved. The project will continue in future years, and we will look for additional funding and supports to continue our relationships, learning and knowledge mobilization.

FARMER-RESEARCHERS

Evalisa McIlffaterick
Root Cellar Gardens
**Janna van Blyderveen &
Jordan Lees**
Roots to Harvest

Root Cellar Gardens and Roots to Harvest are both located on the traditional lands of the Fort Williams First Nation signatory to the Robinson-Superior Treaty of 1850, and the traditional territory of the Anishinaabeg and Métis peoples.



RESEARCH REPORT 2021

Spinach variety trial for northwestern Ontario seed production

 Listen to audio summary of this report

IN A NUTSHELL

Growers in northwestern Ontario wanted to identify which varieties of spinach are well-suited for seed production in their area.

- Matador and Popeye were among the growers' favourite varieties, ranking high in most categories.
- Giant Winter was the growers' least favorite variety and was ranked lowest in almost every category.

- Spinach planted in later fall (frost seeded) did not survive to produce seed in this trial.
- From unreplicated data, early fall plantings overwintered successfully and show a trend towards higher seed production.

This project was funded by the Brian and Joannah Lawson Family Foundation and The Arrell Family Foundation.

MOTIVATION

Spinach is a crop with highly geographically specific seed production. This day-length sensitive species requires long days in order to flower, so it is best grown for seed in northern latitudes (1). Spinach plants respond to increasing day length by bolting: sending up a flowering stalk and setting seed. At the time of year when spinach seeds are ripening, optimal temperature, humidity, and air flow are key to harvesting spinach seeds at their peak. Most of the world's spinach seed production occurs in Washington State (49° N) and Oregon (44° N) in the USA and in Denmark (56° N) (2). The Thunder Bay region (48° N) is thus a viable location for spinach seed production due to its long summer days.

Several Ontario seed companies have expressed concerns around spinach seed supply. There is currently a conspicuous lack of Canadian grown spinach seed

available. The global pandemic in 2020 saw a huge increase in demand for seed worldwide, and then August brought intense wildfires to the main seed growing regions of the US. These realities heightened seed insecurity for the growers, and they decided to see if they could do some learning to help in their own way.

The purpose of the trial is to identify which varieties of spinach are well-suited for seed production in northwestern Ontario. This project will assess whether there is a difference among varieties when it comes to viable, vigorous seed production, and which planting dates produce the best spinach seeds.

METHODS

Growers evaluated 6 varieties of open-pollinated spinach (**Table 1**). They planted each variety at four planting dates (spring, summer, frost seeded, and spring) to see if the timing of seeding affects the

time when spinach plants go to seed and, in turn, yield. Due to planting delays summer plantings were moved to the fall. This was done at two replicate sites in northwestern Ontario: Root Cellar Gardens in South Gilles and Roots to Harvest's Lillie Street Seed Garden in Thunder Bay. A third site was planned for the Lakehead University Community Garden but due to unforeseen issues surrounding site space, the site was not used. At each site, growers amended soil as necessary.



Photo 1. Planting Summer Spinach Seed Trial at Root Cellar Gardens.

Table 1. Complete list of the open-pollinated spinach varieties that growers selected to trial.

VARIETY	DTM	LEAF-TYPE	SEASON	SOURCE	NOTES
Longstanding Bloomsdale	45	Savoyed	Spring/fall	High Mowing	Cold hardy
Abundant Bloomsdale	45	Savoyed	Spring/fall	High Mowing	High yield
Giant Winter	50	Savoyed	Fall/overwinter	High Mowing	Cold hardy
Butterfly	40	Semi-savoyed	Spring/fall	High Mowing	Productive
Matador	43	Flat	Fall/overwinter	High Mowing	Cold hardy
Popeye	40-50	Savoyed	Spring/fall	Root Cellar Gardens	Late bolting

Growers evaluated each spinach replicate in the same way for all planting dates. Growers measured germination rate and yield (of harvested seed), and ranked all other traits seen in **Table 2**. They ranked the 6 varieties against each other on a scale from 1 - 6, one being the best, and six being the worst for each trait. Anything noteworthy was recorded in their notes (**Table 3**).

Planting and seed setting information can be found in **Table 4**. When plants were mature and dried down, growers harvested seeds from each variety. After varieties were harvested, seed lots were tested for yield, germination rate and vigour of seedlings. Weighing and germination testing of harvested seed lots was done by Root Cellar Gardens.

DATA ANALYSIS

Both replicates of frost-seeded spinach and one fall-seeded spinach did not survive after planting. As such, we removed replicates 2, 3, and 6 from data analysis.

To evaluate the effect of variety on seed yield and seed germination, we used a statistical model called analysis of variance (ANOVA) with a 90% confidence level to calculate the least significant difference (LSD) needed to call the treatments “statistically different”.

Using a 90% confidence level means that if we measure a difference between any two treatments that is greater than the calculated LSD, we expect this difference would occur 9 times out of 10 under the same conditions. In this case, we consider the difference reliable and refer to the results as statistically significant. On the other hand, if we measure a difference between any two treatments that is less than the calculated LSD, we consider these treatments unreliably different or statistically similar. We could make these statistical calculations because the growers’ experimental designs involved replication of the farm sites over time.

To evaluate the effect of variety on the ranked data of germination at planting, vigour, grower preference, disease resistance, bolting resistance, lodging resistance, and seed vigour we used a statistical model called the Kruskal-Wallis Test with a 90% confidence level to calculate a significant difference to call the treatments “statistically different”.

FINDINGS

Germination at Planting, Vigour, and Grower Preference

Growers found no significant difference in the rank of germination at planting ($P=0.14$), plant vigour ($P=0.45$), or grower preference ($P=0.91$) among any of the varieties tested (**Table 5**). Abundant

Bloomsdale and Popeye ranked highest for germination and Giant Winter ranked lowest. For plant vigour, Giant Winter ranked the lowest; Matador and Popeye ranked highest. Matador ranked highest for grower preference and Giant winter again ranked the lowest.

**Photo 2.** Spinach at leaf stage, 2020.**Photo 3.** Ovary and pollen bearing spinach plants showing dioecious reproduction system of spinach.

Table 2. Ranked traits, stage of observation, information to consider when ranking, and what growers will do for each planting date.

TRAIT	STAGE OBSERVED	INFORMATION CONSIDERED WHEN RANKING	WHAT GROWERS WILL DO:
Germination rate	Emergence	# Seeds sown/ # seeds germinated	
Vigour of seedlings	Emergence/seedling stage	Robustness of seedlings/ # plants needing to be rogued	Rogue out weak seedlings
Disease	Full leaf/leaf maturity	How many plants have observable disease?	Rogue out diseased plants
Overall Quality	Full leaf/leaf maturity	Do you like it? (production, uniformity, taste, etc). Is it worth growing?	
Bolt Resistance	Bolting	Number of plants rogued out due to bolting	Rogue out any early bolting plants
Lodging Resistance	Seed production	Number of Plants that lodged	
Seed yield *	Harvest	Total grams/ per bed foot?	
Seed germ rate *	Germination	Seeds sown/seeds germinated	
Vigour of in germination tests	Emergence/seedling stage		

*These traits were not ranked data, seed yield was in total grams and seed germination was in percent.

Table 3. Grower notes for each variety in the trial.

VARIETY	ROOT CELLAR GARDEN	ROOTS TO HARVEST*
Longstanding Bloomsdale	Taste and picking favourite along with Popeye. More susceptible to logging,	Bitter, juicy, bitter, not bitter
Abundant Bloomsdale	Last to bolt in both plantings that survived. Last to mature seed as well.	Robust, solid, strong, bitter ending
Giant Winter	Least favourite in terms of taste and picking, bolted quickly – by far the shortest picking window	Fuzzy, bitter, bittersweet, little savoury, velvety, chewy
Butterflay	-	Thin leaf, sweet, not bitter, no mineral taste, pleasant, light, not juicy
Matador	-	Full, soft, not chewy, watery, nice after flavour, swiss chard taste
Popeye	Taste and picking favourite along with Longstanding Bloomsdale	Thick leaves, high water content, nutty, minerally, liked

* Tasting notes in this chart are from multiple growers and vary based on palette.

Table 4. Planting date and seed set information for both growers.

DATE SOWN	DATE HARVESTED	LOCATION	REPLICATE	GREW TO PRODUCE SEED?
Spring: May 6, 2020	-	Roots to Harvest	4	Yes
Spring: May 10, 2020	July 25	Root Cellar Gardens	1	Yes
Fall: September 8, 2020	-	Root Cellar Gardens	2	No
Fall: October 6, 2020	August 13	Roots to Harvest	5	Yes
Frost Seeded: October 20, 2020	-	Root Cellar Gardens	3	No
Frost Seeded: November 3, 2020	-	Roots to Harvest	6	No
Spring: May 6, 2021	July 31	Root Cellar Gardens	7	Yes
Spring: May 13, 2021; re-planted June 11, 2021	August 25	Roots to Harvest	8	Yes

Disease, Bolt, and Lodging Resistance

Table 6 shows, there was no significant difference in rank among varieties for disease resistance ($P=0.99$), bolt resistance ($P=0.58$), or lodging resistance ($P=0.42$). Giant Winter ranked highest among varieties for disease resistance while Abundant Bloomsdale ranked lowest. Growers ranked Longstanding Bloomsdale and Butterflay most resistant to bolt, while they ranked Giant Winter most prone to bolting. They ranked Matador highest for lodging resistance, and Giant Winter and Longstanding Bloomsdale most likely to lodge.

Seed Yield, Germination, and Vigour

The mean seed yield and seed germination rate for each variety can be seen in **Table 7**. Growers found no significant difference in seed yields among the varieties tested ($P=0.96$). Using an LSD, growers would have needed to see a difference of 196 g among the varieties tested to have seen a significant difference.

Table 5. Mean rank data for germination at planting, plant vigour, and grower preference across farms and replications for the six tested varieties.

VARIETY	GERMINATION AT PLANTING	PLANT VIGOUR	GROWER PREFERENCE
Longstanding Bloomsdale	3	3	3
Abundant Bloomsdale	2	3	3
Giant Winter	5	5	4
Butterflay	3	4	3
Matador	3	2	2
Popeye	2	2	3
Kruskal-Wallis	NS*	NS*	NS*

* = Not significant

Table 6. Mean rank data for disease, bolt, and lodging resistance across farms and replications for the six tested varieties.

VARIETY	DISEASE RESISTANCE	BOLT RESISTANCE	LODGING RESISTANCE
Longstanding Bloomsdale	3	2	4
Abundant Bloomsdale	4	3	3
Giant Winter	1	5	4
Butterflay	2	2	3
Matador	2	4	2
Popeye	3	3	3
Kruskal-Wallis	NS*	NS*	NS*

* = Not significant

There was a significant difference between growers ($P=0.06$) in which on average in the spring plantings Root Cellar Gardens produced more seed than Roots to Harvest. With one fall planting replicate, growers noticed a trend that seed yields were more than doubled that of the spring plantings (**Figure 1**).

The growers also found no significant difference in seed germination among the varieties tested ($P=0.93$). Using an LSD, they would have needed to see a difference of 21% among the varieties tested to have seen a significant difference. There was a significant difference between growers ($P=0.06$) in which on average in the spring plantings, Root Cellar Gardens' germination was higher than Roots to Harvest's. With the one fall planting replicate, growers noticed that germination was higher than that of the spring plantings (**Figure 2**).

Growers think that overwintered fall planted spinach would make better seed than spring planted because the plants would be larger when they begin to bolt. Roots to Harvest noticed this in their fall planted spinach vs the summer planted spinach. Growers also think that because Thunder Bay is closer to Lake Superior it doesn't get the same extreme temperatures as South Gillies. It is very likely that cold weather in fall or spring, when there was no snow, killed the fall planted replicate at Root Cellar Gardens but not at Roots to Harvest.

There was no significant difference in the rank of seed germination vigour among any of the varieties grown ($P=0.72$). The growers ranked Longstanding Bloomsdale highest, followed by Popeye, and then Abundant Bloomsdale, Giant Winter, Butterfly, and Matador (**Table 7**).

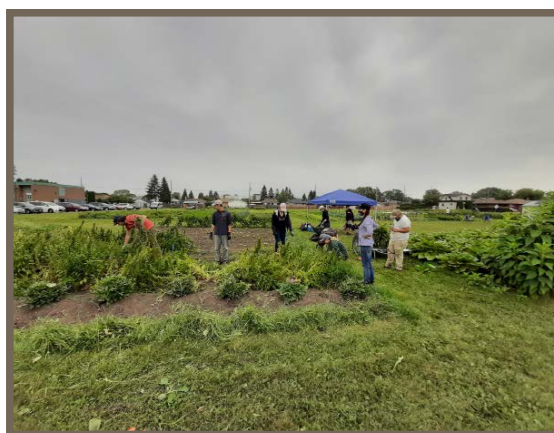
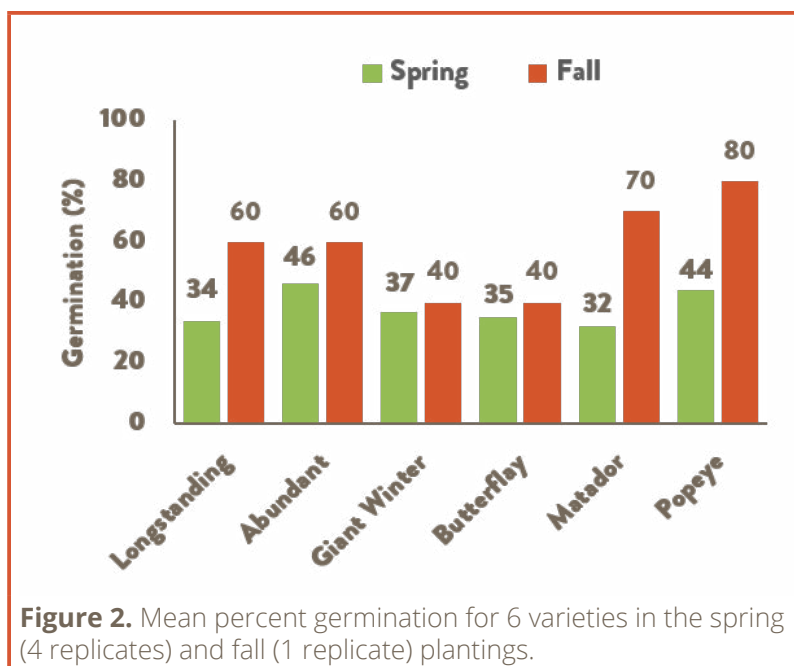
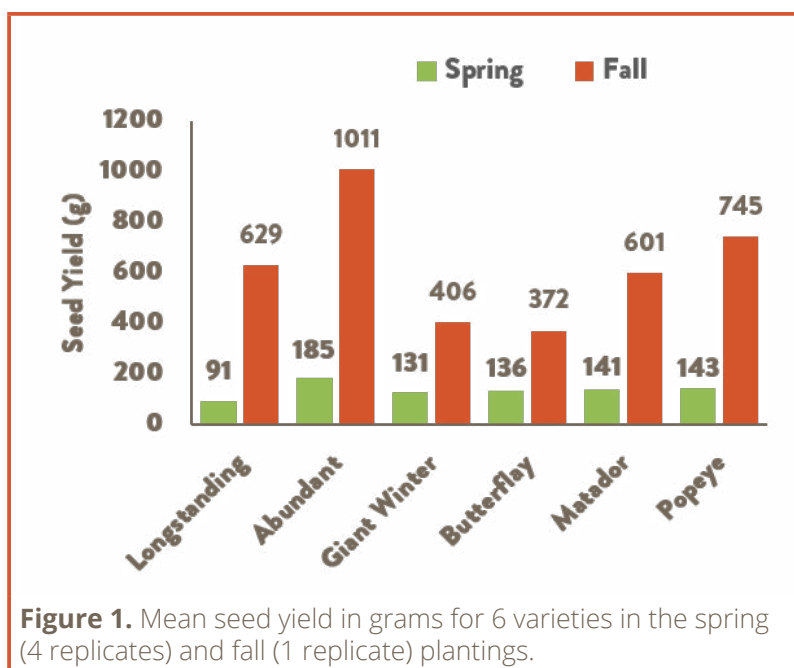


Photo 4. Spinach Seed Harvest with Roots to Harvest crew at the Lillie Street Garden.

CAVEATS

Replication four at Roots to Harvest produced a lot of seeds but due to lack of drying space some varieties were mixed. Because of this, growers could not take seed weights for Longstanding Bloomsdale, Giant Winter, or Butterflay for this replication.

Overall, as a consequence of space and staffing issues, growers lost replications and, in turn, some statistical power. To detect a potential effect in the rank data, growers would need to replicate the study again.

NEXT STEPS

Growers are curious continue to assess whether frost seeding and fall planting are reliable ways to grow plants that are more mature when they bolt.

Growers will use the Popeye variety to continue this work. Growers at Root Cellar Garden would like to continue to collaborate and learn with growers at Roots to Harvest.



Photo 5. Cleaned Spinach Seed, 2021.

Table 7. Mean seed yield, germination, and vigour across farms and replications for the six tested varieties.

VARIETY	SEED YIELD (G)	SEED GERMINATION (%)	SEED VIGOUR (RANK)
Longstanding Bloomsdale	91	34	2
Abundant Bloomsdale	185	46	4
Giant Winter	131	37	4
Butterflay	136	35	4
Matador	141	32	4
Popeye	143	44	3
LSD	NS*	NS*	NS**

* = Not Significant ** = A Kruskal-Wallis test was run for this rank data.

TAKE HOME MESSAGE

In this trial, growers found that frost seeding was not an optimal planting time for northwestern Ontario as seedlings germinated but did not survive over the winter. With only one replication, the fall planting showed trends towards higher seed production and might prove to be an ideal planting time for seed producers in northwestern Ontario.

Popeye and Matador ranked highest and were among the growers' favourite varieties planted. Giant Winter ranked poorly in almost every category and was the growers' least favourite variety.

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