Forever Green Initiative

# Perennial Sunflower

## A NEW POTENTIAL PERENNIAL OILSEED AND FOOD CROP

## Overview

Annual sunflower (*Helianthus annuus* L.) is a valuable oilseed crop grown for food (oil), confectionery seeds and ornamental purposes. Forever Green researchers are breeding and developing a perennial sunflower for agricultural production that has the potential to provide similar end-use applications as annual sunflower, as well as new options for farmers to diversify their operations while improving profits and providing environmental benefits.

*Helianthus tuberosus* L., a tuber-bearing perennial sunflower species, is a prime candidate for the introduction of perenniality into domestic sunflower. The overwintering tubers of the perennial sunflower are the key to its perenniality and breeders are finding they can identify and select plants for good plant vigor, single stalk habit, and large head and seed traits with high oil and protein content. *Helianthus tuberosus* L. has been used to introgress, or transfer genes through hybridization and backcrossing, traits into H. annuus for nearly a century and has been grown as a specialty food tuber crop for many years.

Compared to annuals, perennial crops provide living ground cover for longer periods during the year as plants grow into the fall and emerge from dormancy early in the spring. Additionally, perennials do not require fall tillage and due to their extended growing season they take up more soil moisture, which decreases drainage and nutrient losses. For all of these reasons, perennial crops such as a perennial sunflower play an important role in protecting our soil and improving water use and quality.

The Forever Green breeding program is using two breeding approaches to create perennial grain sunflower; direct domestication of a perennial sunflower species (Rough sunflower, *H. divaricatus*), and genetic introgression of perennial habit from wild relatives into domesticated annual sunflower. Our team is combining traditional plant breeding with modern genomic tools to develop a perennial sunflower that is as productive as current commercial varieties but offers superior profit potential and ecosystem services for Minnesota farmers.

We envision working with sunflower growers and processors to further expand perennial sunflower production in Minnesota. As most of Minnesota's sunflower production is in the northwestern part of the state, we have developed close collaborations with the Sunflower and Plant Biology Research Unit of the USDA in Fargo, North Dakota. We believe that buffer zones around rivers, ditches, and well head protection regions provide an excellent opportunity for us to introduce this new perennial crop to landowners and provide new options for growers to protect their soil and water.


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# Research Status and Goals

Investments made in faculty, post-doctoral researchers, graduate students, technicians, and undergraduate employees support:

## AGROECOLOGY

Best practices for growing, maintaining, and harvesting perennial sunflowers.

**Activities:** We will develop experiments to identify 1) optimum nitrogen fertilizer rates and row spacing for maximized grain yields, 2) how to best control the spread of clonal plants by belowground tissue, 3) optimal planting times for seed or rhizomes/tubers, 4) the number of years a stand should be maintained before it is replanted, and 5) the appropriate scale of genetic diversity (i.e. the number of clonal genotypes) to plant in given field. Following initial evaluations and the release of material, we will work with farmers to determine the environmental impacts of perennial sunflower, focusing on soil erosion and chemical leaching to groundwater.

**Outcomes:** Best management guidelines for perennial sunflower production, extension documents for addressing specific agronomic challenges, and scientific reports highlighting the environmental effects.

## BREEDING AND GENETICS

**Activities:** The goal of the perennial sunflower program is to develop a high-yielding perennial sunflower with fertile seeds. Plants have been developed that are winter hardy, have single heads, but have limited seed seed set because of sterility issues. This limitation will be the focus of the breeding program in the near future. Toward this aim, researchers at the UMN have hybridized the annual sunflower, *H. annuus*, with cold hardy perennial species Jerusalem artichoke (*H. tuberosus*). Hybridizations are well underway and have demonstrated impressive gains in flower head size and seed size over five generations of breeding. We have identified a relatively simple genetic control for perenniality and aim to identify the genetic basis of other domestication traits, such as flower head size and seed viability, to increase the efficiency of selection and accelerate improvement. Current efforts focus on maintaining perenniality while increasing head size, and head filling and enhancing fertility and seed set.

**Outcomes:** Products from this research will include a perennial sunflower germplasm and ultimately a public release of perennial sunflower.

## FOOD SCIENCE

Investments in technicians and materials will support our evaluation of the chemical profile of perennial sunflower seeds.

**Activities:** We ultimately aim to develop a perennial sunflower whose oil can be blended with, or used in place of, high oleic sunflower oil. Towards this goal, we will measure the seed oil profile of our perennial sunflower and compare it to commercially sold high oleic sunflower.

**Outcomes:** Evidence that perennial sunflower oil is comparable to high oleic sunflower oil, making this product an easy sell to vegetable oil companies and consumers. To the extent that perennial sunflower oil initially deviates from traditional sunflower oil, we will continue to select for oil composition that resembles that of annual sunflower.

# Pilot Studies

Most of our work will be conducted at the University of Minnesota greenhouses and on the Minnesota Agriculture Experiment Station (MAES). As most of Minnesota's sunflower production is in the northwestern part of the state, we have developed close collaborations with the Sunflower and Plant Biology Research Unit of the USDA in Fargo, North Dakota and plan on testing experimental material in the Fargo/Moorhead area. We believe that state-mandated buffer zones around rivers, ditches, and well heads provide an excellent opportunity for us to introduce this new perennial crop to landowners. Depending on the success of the buffer zone plantings, we hope to work with sunflower growers to further expand perennial sunflower fields in Minnesota.

## COMMERCIALIZATION PLAN

Market opportunities currently exist within the annual sunflower oil and birdseed market. As we further develop our material, we will contact sunflower oil companies and explore two options towards commercialization: 1) Blending perennial and annual sunflowers for a consistent oil, and 2) Branding perennial sunflower as a green, sustainable product for a specialty oil.

## TIMELINE

We are currently advancing breeding material to achieve the outcomes outlined above. We plan to generate enough seed for larger trials in 2022, when we will also begin agroecology and seed oil experiments. By 2024, we plan to have material available for use as a trap crop to reduce bird predation in nearby commercial annual sunflower fields. We aim to stabilize the genome of this hybrid by 2022 and at that time deploy plants in buffer zones. This should allow for an initial set of experimental plants on farms by 2029.

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