Overview

Interest in flax (*Linum usitatissimum*) is being renewed primarily because of the health benefits of oils high in omega-3 fatty acids, of which flax has the highest concentration in the seed oil of any cultivated plant (about 50 percent of total oil as linolenic acid). Clinical studies in humans have shown that diets rich in flax seed oil result in improved cardiac health. Therefore, food industry partners, such as General Mills, are interested in flax as an addition to whole grain foods. The horticultural industry is also interested in flax as an ornamental bedding plant with added value as a cut flower crop, although more must be known about its potential vase life. Perennial flax (various *Linum* species) could provide beneficial ecosystem services to an agricultural landscape because the cold hardy perennial species retain green vegetation late into the fall and begin regrowth early in the spring, retaining soil-water and stabilizing soils. Flax would work very well in buffer zones on Minnesota farms, while also producing a high-value grain for sale. Unlike most wild perennial plants, perennial flax already possesses many domestication traits, which should make breeding easier. Some perennial flax accessions will bloom twice a year (June and September) under agricultural management in Minnesota, providing forage for native and honey bees at times when annual flax and other bee-pollinated crops are not flowering. This combination of potential ecosystem services would make perennial flax a useful addition to Minnesota cropping systems. This project will enhance yield and quality for multiple end uses in the Minnesota climate, working with our food industry partners.

Forever Green Initiative: PERENNIAL FLAX

A high-value grain to improve human, environmental, and economic health

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Research Status and Goals

We will study agroecology of perennial flax production and food and end use quality traits of perennial flax.

**AGROECOLOGY AND FOOD SCIENCE**

**Activities:** With collaborating agronomists, we intend to determine appropriate production practices for perennial flax to maximize value to consumers and producers, while optimizing environmental benefits. Food science research, in collaboration with food industry partners, will seek to find suitable grain and fiber characteristics for commercialization.

**Outcomes:** Best management practices for Minnesota producers to maximize yield and production of specialty food traits that are important for end markets and consumers.

**BREEDING AND GENETICS**

We look to add one full time research technician and one graduate student to conduct breeding research on perennial flax, with an additional student working on genomics beginning in 2021. Two faculty and one outside scientist will continue to volunteer by providing support to these personnel.

**Activities:** Despite the lack of dedicated personnel, the University has been conducting germplasm surveys and breeding activities for more than a decade on perennial flax species. Breeding efforts with these populations have produced lines that yield nearly 100 lb/acre more than the existing perennial flax variety Appar (382 vs. 298 lb/acre) in one harvest, which is also about one-third of the annual flax yield in the region. Our plan is to expand the program to include new, promising lineages of perennial flax from local collections to international exchanges with collaborators, such as the Vavilov Institute of Plant Industry in Russia, who are experts in Eurasian landraces of perennial flax.

We hope to 1) further the improvement of yield and quality traits using recurrent selection of existing breeding populations of wild perennial flax from Eurasia and North America, 2) further the improvement of native Lewis flax (L. lewissii) using similar techniques to produce a cultivar with North American origins, high yield, and acceptable quality, and 3) introduce the perennial trait to cultivated annual flax by interspecific crosses with wild perennials, if possible.

**Outcomes:** Provide germplasm and plant variety resources to our agroecology and food science partners to further research and to Minnesota producers to begin integration of perennial flax into perennial cropping systems.

Pilot Studies

Yield trials and experiments will begin at the University of Minnesota Research and Outreach Centers. After one breeding cycle (three to four years), this will transition to include private landowners in cooperation with the Soil and Water Conservation Districts. The on-farm experiments will involve pre-variety germplasm that is available in quantities suitable for larger scale commercialization assessments. These assessments will include data collection on agronomic and horticultural value of the experimental varieties; their potential for reducing soil erosion and runoff, especially in buffer strips near waterways; their potential for wellhead protection; and assessment of horticultural and seed/fiber characteristics needed for marketing of a successful variety.

COMMERCIALIZATION PLAN

In three years, we plan to provide seed of a breeding line from at least one of our breeding approaches in large enough quantities to begin on-farm trials of perennial flax. No new equipment will be needed for many farmers, because standard windrowers and combines will be used for harvest. General Mills is already interested in evaluating pre-variety germplasm for suitability in their natural foods product line. Particularly for southern Minnesota, developing a market such as this through the food industry in the Twin Cities appears to be the most promising route for commercialization. In the case of northwestern Minnesota, standard supply and value chains already exist for flax. Companies are already buying and marketing flax products from northern Minnesota. These producers can also access established networks in North Dakota and western Canada.

**TIMELINE**

2017 through 2022 and beyond

- Agroecology and food science research to prepare crop for large-scale production
- Breeding and genetics to improve yield, horticultural, and agronomic fitness while releasing new varieties