Overview

Dry pea (*Pisum stivum* L. ssp. *Arvense*) presents unique opportunities for Minnesota farmers to build soil health, protect water quality, reduce inputs and provide a high demand plant-based protein for food products.

Winter pea and spring dry peas are part of the pulse family of crops that also includes lentils, chickpeas and dried beans. Pulses are recognized globally as an excellent source of low fat, high fiber protein and are expected to play an increasingly important role in feeding a growing global population. Additionally, increased consumer demand for foods that contain plant-based proteins makes pea a potentially highly profitable spring-sown cash crop. For growers, winter pea is one of a very few annual crop legume species capable of surviving harsh winters and is thus a good candidate for winter cover cropping that may also increase profitability.

To meet these exciting opportunities, a pea breeding and genetics program was recently launched. A top priority for the team is identifying the best genetic plant material, or germplasm, that has survived other northern environments and thus could successfully overwinter in Minnesota. Researchers are also assessing the physiological mechanisms that support winter survival among species and are developing tools to more rapidly assess which plants are likely to survive Minnesota winters.

The UMN Food Science and Nutrition team will be working with both spring and winter peas to develop platforms that quickly and efficiently assess protein functionality in winter and spring pea varieties. This information will be shared with industry partners and stakeholders through the Plant Protein Innovation Center, a one-of-a-kind center based on the UMN St. Paul campus that brings together food and ingredient companies from across the world to share information and advance plant protein research and development.

The highly collaborative efforts between the breeders and the food scientists will enable and accelerate data-driven decisions for the breeding pipeline that facilitate variety development tailored for Minnesota growers.

COMMERCIALIZATION

The demand for protein ingredients surged over the last few years and the global protein ingredient market was valued at USD 38 billion in 2019 and is expected to grow at a rate of 9.1% from 2020-2027. With a growing interest in plant-based proteins, the market for plant protein ingredients is expected to reach USD 3 billion by 2029. There are multiple factors driving the demand for plant proteins and these include increases in the vegan, vegetarian and flexitarian populations, increase in consumer demand of healthy ingredients and foods, and the high demand for sustainable protein sources. Therefore, developing winter and spring pea varieties will benefit Minnesota growers and provide unique crop supply to ingredient companies.

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Research Status and Goals

**BREEDING AND GENETICS**

**Activities:** Winter survival trials on a collection of pea accessions have been initiated in two Minnesota locations: St. Paul and Lamberton. The accessions tested in this trial were selected from within three different collections: (1) Accessions from a preliminary winter survival trial being conducted by public sector researchers working on cover crops throughout the USA; (2) Advanced selections from the USDA pea breeding program in Pullman, WA; (3) Private sector accessions that have exhibited winter survival in other northern environments. This initial evaluation will establish a baseline of variation in winter survival in these collections, and provide insight into the potential to select for superior survivability. Genotyping diverse materials from a broader germplasm collection will also provide a basis for testing similar and diverse materials in subsequent seasons.

**Outcomes:** A breeding program will be developed by identifying the best current germplasm for Minnesota as parents for initial crosses. Early selections will be conducted based on identifying the most winter hardy progenies and advancing these to more extensive testing in subsequent years. The best parental lines will be identified based on winter survival of their progeny. These parent lines will be used more frequently as parents in future crosses. The development of breeding lines and ultimately new varieties will be conducted in subsequent years. However, if we find existing breeding lines or varieties in initial evaluations that are suitable for Minnesota growing conditions, those varieties will be promoted and used to bring winter pea into the Minnesota farming portfolio at an earlier timeline.

**AGROECOLOGY**

**Activities:** The development of winter and spring peas for Minnesota cropping systems will occur from an ecological perspective to develop products that are economically valuable and beneficial to the overarching ecosystem. To increase winter survivability, we will evaluate growing practices such as seeding depth and date to determine optimal practices for Minnesota. Next, we will evaluate companion cover crops, such as cereal rye, for their influence on winter pea survival and vegetative cover. Lastly, we will study and improve the present cropping system compatibility of winter and spring peas with established summer annual crops and newly developed perennial crops such as Kernza.

**Outcomes:** Pea is an environmentally friendly crop. First, as a legume, growing peas provides nitrogen credits to the soil. Furthermore, a successful winter hardy pea would reduce soil erosion and field water runoff in the spring, protecting both fields and our Minnesota waterways. Acquiring knowledge of optimal growing practices for winter and spring peas will improve grower profitability and the ecosystem services provided. It will also provide a contextual framework to guide the breeding program. Additionally, understanding the timing and nuances of pea production in relation to other Minnesota-grown annual and perennial crops will improve the function and productivity of sustainable cropping systems.

**FOOD SCIENCE**

**Activities:** Pea protein is gaining traction in the protein ingredient marketplace, however it is lagging behind soy protein in functional and nutritional quality. Hence there is a need to investigate ways to bring pea protein up to speed. First it is crucial to understand the impact of protein composition and distribution in pea on the over all functionality. Therefore, we will determine the impact of varying the proportion of pea storage proteins on functional and nutritional properties for enhanced breeding efforts. Storage pea protein components, namely legumin, vicilin, and convicilin, as well as the albumin fraction, will be separated and purified. Separated fractions as well as reconstituted protein isolates will be subjected to structural and functional characterization. We will utilize these wet chemistry-based data to model spectral information using infrared spectroscopy to develop rapid means of screening many lines for protein quantity, protein profile (i.e. globulin protein distribution) and functional quality. Data generated will aid in determining the association between different pea protein components and functional properties, as well as identifying the optimal protein profile.

**Outcomes:** Understanding the association of protein profile and functional property will help with screening for pea protein cultivars that could potentially have superior functionality and nutritional quality, which could be used as parental cultivars in breeding for improved functional aspects of pea protein and not just yield. Additionally, the development of rapid method of screening will aid in rapid phenotyping for protein functionality traits in spring-sown pea lines. Identifying DNA molecular markers that predict the best functionality traits for a specific market class will further enhance the efficiency of breeding for this trait by cutting down the research time devoted to phenotyping efforts. Ultimately, this information will be used to release varieties desirable to Minnesota growers and food processors.