2018 USAFRI Research Project Objectives

Identifying Optimal Alfalfa Germplasm Types & Characteristics for Compatibility and Performance in Mixed Cropping Systems
The Land Institute - Schlautman

Project Award: $48,557

Justification:

- Each year, nitrogen (N) fertilizer is applied to millions of acres of annual crops across the US. The mobility of inorganic N fertilizers combined with the small roots of annual crop species results in less than 50% fertilizer N-recovery efficiency, and substantial amounts of the remaining N leaves the cropping system as N2O and NO3 which have negative environmental impacts elsewhere. Unlike annuals, perennial species, like alfalfa, have large root systems and longer growing seasons which increase their ability to capture sunlight, to sequester carbon, and to reduce nutrient and N loss through leaching, runoff, and soil erosion. Despite the long-term economic, agronomic, and environmental stability provided by alfalfa, other perennial crops, and perennial cropping systems, the acreage of cropland in the United States planted to alfalfa and hay crops have continually declined in past decades. In fact, US acreage planted to hay crops in 2016 and 2018 were the lowest since 1908.

  Growing alfalfa between rows of annual or perennial grain crops (i.e. as intercrops) in dual-purpose cropping systems that produce both grain for human consumption and forage for livestock is a promising new use for alfalfa. Recent work by our team has demonstrated that these alfalfa mixed cropping systems can allow farmers to both acquire the environmental benefits associated with growing alfalfa and the additional economic benefits of growing a saleable forage between rows of a grain cash crop.

  New perennial grain crops are being domesticated and developed for perennial cropping systems in response to declining hay acreage and in recognition of the benefits of perennial crop plants for soil and ecosystem health. Kernza®, the perennial grain from domesticated intermediate wheatgrass, is beginning commercialization with active interest and investment from US farmers, bakeries, and food companies like Patagonia Provisions and General Mills, Inc. However, yields of Kernza grain remain below those of wheat and conventional cereal grains, and research and innovative agronomic strategies are needed to ensure that farmers can grow it profitably on a large scale while bringing its environmental benefits to consumers, farmers, and agricultural landscapes.

  One possible way to achieve greater ecological intensification and profitability with Kernza is to interseed it with alfalfa. Alfalfa is an excellent high protein feed source for grazing livestock which could boost the forage yield and quality of Kernza residues while also improving soil structure, nutrient cycling, and cropping system fertility through biological nitrogen fixation (BNF). Dual-purpose alfalfa+Kernza cropping systems would produce grain for human consumption and forage for livestock while requiring limited synthetic N inputs. While little to no research has been performed comparing Kernza monocultures to alfalfa+Kernza intercrops, alfalfa+Kernza acres are already being contracted in the US by food companies racing to source grain grown using regenerative, low input, ecologically sound agricultural practices for the rapidly expanding organic and sustainable food industries. Emerging grain+alfalfa mixed cropping strategies that focus on longterm economic and agronomic stability while producing high-value products represent untapped market potential for alfalfa and previously underutilized alfalfa germplasm.

  Success of alfalfa+Kernza intercrops depends on maximizing the compatibility of alfalfa with Kernza to optimize the benefits of BNF and increased forage quality without decreasing forage and grain

yields. Ongoing research by Grabber et al. has observed substantial variation in compatibility between alfalfa lines and corn when grown in mixtures for silage production during the alfalfa establishment year. We assume similar amounts of variation in compatibility exists for alfalfa with Kernza and with other grains.

Therefore, our research proposes to compare grain yields, forage yields, and forage quality of alfalfa+Kernza intercrops planted with multiple alfalfa varieties at multiple locations and managed as a dual-purpose forage and grain perennial cropping system. Data generated about the compatibility and economic potential of the tested alfalfa varieties and germplasm types will be useful to farmers choosing alfalfa varieties for their farms and to researchers developing new breeding and management strategies to further improve alfalfa for mixed cropping systems. Additional control plots of Kernza monocultures with and without fertilization and intercropped with a non-nodulating alfalfa variety will be included in the research trials to compare economic and ecological productivity in Kernza monoculture versus alfalfa+Kernza cropping systems. The data collected in control plots will provided ecological knowledge that can be shared with consumers, processors, and growers to promote alfalfa's role in Kernza grain production and in modern sustainable agriculture.

Objectives:

- The objective of this project is to 1) Determine the feasibility of including alfalfa as an intercrop in a potentially high-value, dual-use, alfalfa+Kernza mixed cropping system by generating data about expected forage yields, forage quality, and grain yields in alfalfa+Kernza compared to Kernza monocultures; 2) Quantify potential positive changes in soil organic nitrogen pool size, nitrogen mineralization rates, and nutrient availability when including alfalfa in alfalfa+Kernza mixed cropping systems; 3) Compare the compatibility and performance of diverse alfalfa varieties and germplasm types when grown across the three states and five sites in intercrops with Kernza; 4) Explore the potential for alfalfa+Kernza cropping systems to serve as a new market for underutilized alfalfa germplasm and germplasm types that have already been developed through public and private breeding programs; 5) Estimate ecological and economic returns from each alfalfa+Kernza variety combination at each site to help farmers in the tested regions select compatible alfalfa varieties/germplasm types to be used in alfalfa+Kernza cropping systems; and 6) Disseminate findings through peer-reviewed and extension articles and through presentations at farmer field days, NAAIC, and oltscientific meetings.