Oat Renewal through Advanced Germplasm, Genomics, Phenomics and Disease Resistance

- Oat grain provides numerous health benefits that include lowering of LDL cholesterol levels, reduced cardiovascular disease risk, and increased satiety and glycemic index stability.
- Oat is a valuable agronomic crop that is a key element in crop rotation to naturally improve soil fertility and control weeds.
- U.S. is a net importer of oat for human consumption, mostly from Canada.
- Alterations to agricultural practices, release of improved varieties, and targeted breeding for additional markets alternative to food oat are needed to regain cultivated areas in the US, and to increase crop diversity and farm income.
- Renewing oat as a stable commodity will require expansion of oat acreage into alternative cropping systems, such as organic, not formerly occupied by mainstream cultivars. In addition, changing markets and environmental conditions, such as rainfall patterns and diseases, will create the need for selection of new traits in oat cultivars.

1. **<u>Germplasm</u>: Enhancement of oat germplasm by evaluating the oat gene bank for new breeding targets and identifying molecular genetic markers suitable for marker-assisted selection (Aberdeen, ID).**

The National Small Grains Collection (NSGC) housed at Aberdeen, ID represents a large (more than 21,000 oat-related accessions), and largely un-tapped, resource for the genetic improvement of oat. The collection is a potential source of new traits in breeding for animal feed, forage and human food markets. The diversity within this collection can also be used to understand the genetic control of key traits. In addition to the NSGC, Aberdeen, ID currently has a successful barley and oat genetics research program that has generated improved oat cultivars for production and has deployed new traits for use in oat breeding by the release of improved germplasm but needs additional resources.

<u>Additional Funds could:</u> Support advanced genomic methods for crop improvement dedicated to oat, for enhancing the use of oat from the National Small Grains Collection and the development of improved oat germplasm.

2. **<u>Genomics</u>: Development of a high-throughput genotyping platform suitable for breeder use in genomic and marker-assisted selection (Fargo, ND).**

Genotypic data allows oat breeders to respond quickly to emerging challenges to crop production and quality by giving them access to trait information more rapidly than by phenotyping. Next-generation sequencing technologies have revolutionized genotyping for many species, including humans, but these advances for oat have lagged behind. There is currently no oat genotyping platform that makes effective use of the new methods that have emerged with next-generation sequencing technologies.

The USDA-ARS Regional Small Grains Molecular Genotyping Laboratory (SGRL) located in Fargo, ND provides a critical resource for oat breeders seeking basic marker data for simple traits, but are not able to provide detailed large-scale datasets for oat. Additionally, there is no bioinformatics support for breeders and scientists working with the complex oat genome.

Additional Funds could: Provide additional resources to design, validate and implement the adaptation of next-generation sequencing technology to the needs of oat breeders and to provide bioinformatics support to breeders seeking to use new technologies for oat improvement.

3. **Phenomics: Development of high-throughput methodologies suitable to capturing phenotypic information critical to meeting breeding targets (Fargo, ND).**

With the development of rapid methods of generating large genotypic datasets, gathering accurate phenotypic data for agronomic and quality traits has become a limiting factor in small grains breeding. The development of effective high-throughput automated phenomics for oat breeding has the potential to make phenotypic data available in an affordable and timely manner.

The Cereal Crops Research unit at Fargo, ND needs additional resources to develop and validate biochemical methods of rapidly screening oat genotypes in collaboration with oat breeding programs.

Additional Funds could: Provide additional resources to develop and validate high-throughput phenotyping methodologies for oat improvement.

4. **Disease Resistance: Identification and deployment of genetic resistance to meet emerging biotic challenges to oat production (St. Paul, MN).**

U.S. oat production is under threat by oat diseases endemic to North America including crown rust, stem rust, and barley yellow dwarf virus. Crown rust, in particular, is widespread and can reduce grain yields by 40%. In oat, the most economical means to prevent loss is through genetic resistance in oat cultivars. However, the natural adaptation of these disease-causing organisms to resistance in the oat crop has depleted the number of effective resistance genes to alarming lows. Effective genetic resistance can still be found, however, in the wild relatives of cultivated oat but their incorporation into breeding programs is a technically difficult and time-consuming process.

Additional resources are needed to work on disease resistance, as well as monitor the pathogen populations for virulence and characterize pathogen genetics to better understand the main enemies that destroy the crop.

Additional Funds could: Provide additional support to identifying new sources of disease resistance, and incorporating these resistance genes into adapted oat germplasm for use in oat breeding.

5. **<u>Agronomic Enhancement</u>: Identification of breeding targets for oat cultivars suited to the organic and mainstream animal feed markets, forage markets, food producers, and other users of oat; and evaluation of cultivar performance within specific cropping systems in terms of product quality, environmental impact and system profitability (Brookings, SD).**

Agronomic and cropping systems research is a critical link between small grains breeders and small grains producers and users. Oat is recognized as a valuable rotational crop because it requires few inputs, breaks pest cycles and improves soil quality. For every new oat cultivar there is a best management practice that will optimize performance and profitability. For every production system and market class there are cultivars that come nearest to providing the ideal product. For oat, however, this translational research is a need that is currently un-met.

The North Central Agricultural Research Laboratory at Brookings, SD conducts research to develop sustainable pest management and crop production systems. As part of long-term research projects aimed at diversifying crop rotations beyond corn and soybean, they have investigated the productivity and sustainability benefits of incorporating oat or other small grains. They are staffed by scientists contributing to cropping systems research with expertise ranging from entomology to agronomy to soil biology but none of them currently have time specifically committed to oat research. In addition to USDA-ARS staff, NCARL hosts a scientist from General Mills, Inc. who works in collaboration with them to enhance the sustainability of cereal crop management and to improve the domestic supply chain. They collaborate closely with South Dakota State University, one of the few Land Grant universities with an oat breeding program. Such resources offer a unique opportunity to gain for oat the agronomic and cropping systems support that is currently lacking.

<u>Additional Funds could</u>: Support a USDA-ARS scientist position with experience in agronomy and plant physiology research to evaluate current and emerging oat cultivars for their suitability to organic and mainstream cropping systems and their associated markets.