National Association of Wheat Growers

&

Wheat Industry Resource Committee

Research Priorities for Fiscal Year 2002

March 2001

Table of Contents

The National Association of Wheat Growers Research Priorities for Fiscal Year 2002
Executive Summary ……1

Background Information

- National Association of Wheat Growers…….. 3
- Wheat Industry Resource Committee…….. 4
- National Wheat Improvement Committee ……....4

Supporting Documents for Each Research Priority: Background and Significance

- Additional Support for the USDA-ARS Wheat Quality Laboratories…….5
- Proposal to Create Four Regional USDA-ARS Small Grains Molecular Genotyping Laboratories ……..7
- USDA-ARS Cereal Disease Laboratory (CDL), St. Paul, MN…….10
- Advanced Genetics Laboratory at the National Small Grains Germplasm Research Facility, Aberdeen, ID ……12
- Appendix I ……14

Note: A PDF version of this document is available at http://www.wheatworld.org and http://www.scabusa.org.

The National Association Of Wheat Growers Research Priorities For Fiscal Year 2002

Executive Summary

The National Association Of Wheat Growers, in consultation with the Wheat Industry Resource Committee and the National Wheat Improvement Committee, has established its FY2002 funding priorities. These priorities have been selected in regards to their ability to provide the greatest impact on the wheat industry. They are listed below in order of priority.

Priority 1. Provide additional funding to the regional wheat quality laboratories in Wooster, OH (Soft wheat quality laboratory); Manhattan, KS (Hard wheat quality laboratory); Pullman, WA (Western wheat quality laboratory); and Fargo, ND (Hard red spring and Durum wheat quality laboratory). Requested amount: $3.25 million ($ 1 million, OH; $ 1million, KS; $ 750,000, WA; $ 500,000, ND).

In 1936 the USDA established the four regional wheat quality labs to work with breeders to improve the quality of U.S. wheat. The number of samples evaluated by each lab has climbed steadily, and the number of end uses for each market class continues to increase. The labs need additional funding to handle more samples, modernize equipment, and develop new predictive quality tests to insure that U.S. wheat remains competitive.

Priority 2. Create regional small grains molecular plant breeding laboratories at Pullman, WA; Fargo, ND; Raleigh, NC. Requested amount: $ 2.25 million. Allocate additional funding for the existing small grains molecular plant breeding laboratory at Manhattan, KS. Requested amount: $ 500,000. Total amount requested: $ 2.75 million.

The establishment of these laboratories will allow public and private sectors to collaborate for the benefit of all components of the wheat, barley and oat industries, from producers to consumers. Molecular markers linked to important traits like Fusarium head scab resistance could mean rapid relief to the US wheat and barley industries which lost $ 3 billion to this disease in the 1990s. Markers linked to value added traits could also hasten the development of emerging markets leading to higher grain prices for farmers.

Priority 3. Construct additional laboratory space at the USDA Cereal Disease Laboratory (CDL) in St. Paul, MN. Requested amount $ 3 million, USDA-ARS Building and Facilities budget.

The CDL exists to provide research in the control of cereal diseases, primarily through the identification of resistance genes that can be used in breeding resistant cultivars. The long term focus of the CDL has been the rust diseases of cereals, but it has recently added research efforts to control Fusarium head blight of barley and wheat. Research efforts have increased by 50% over the past two years, with the result that laboratory space is inadequate. Additional laboratory space is critical if the mandate of this facility is to be met.

Priority 4. Construct an Advanced Genetics Laboratory and the National Small Grains Germplasm Research Facility in Aberdeen, ID. Requested amount: $ 4.3 million, USDA-ARS Building and Facilities budget.

The ARS program at Aberdeen, ID includes several advanced molecular genetics research programs in barley, oats, and potatoes. Ongoing research in genetic improvement of feed and malting barley, particularly low phytic acid grains for fish, swine and poultry diets, and potato varieties with enhanced quality and storage characteristics, is greatly constrained by inadequate laboratory facilities. Furthermore, the University of Idaho's (UI) wheat genetic research capabilities at Aberdeen will be greatly enhanced by the proposed advanced genetics laboratory addition at the ARS facility. Currently, the UI wheat genetics program conducts laboratory experiments in limited areas, without a single dedicated laboratory.

National Association of Wheat Growers

The National Association of Wheat Growers (NAWG) serves as the eyes and ears for America's wheat producers in Washington, DC, and is their only national organization. Through a well-developed grassroots network and professional staff, NAWG is in daily communication with the decision-makers in Congress, USDA, and other government agencies and organizations that affect the lives and operations of our farmer members.

NAWG works hard to ensure that the wheat producer's voice is heard loud and clear on Capitol Hill and is hard at work on several key issues. These issues include securing federal financial support for farmers, promoting federal funding of research, making meaningful reforms to the federal crop insurance program, and the elimination of trade sanctions on U.S. agricultural products. In fact, NAWG was a primary facilitator in urging President Clinton to lift sanctions on the commercial sale of agricultural products and medicine to Sudan, Libya, and Iran.

NAWG's long record of achievements would not be possible without the participation and leadership of its 23 state associations, which are made up of over 25,000 individual wheat producers. NAWG, in conjunction with its wheat partners, U.S. Wheat Associates and the Wheat Foods Council, hold a Wheat Industry Conference and Exposition each year that brings together wheat producers, industry leaders, researchers, government officials, and other agribusiness professionals.

Contacting NAWG

NAWG Staff

Jack Eberspacher……...……...CEO
Wayne Hammon…Director, Government Relations
Amy Bowland……..Director, Communications
June Silverberg……..….....Director, Development
Mike Lawson……...……....Director, Finance
Annie Leftwood……...…...Meetings and Events

NAWG Contact Information

Phone..…….……..202-547-7800
Fax…...……...202-546-2638
E-mail...…wheatworld@wheatworld.org
Website……http://www.wheatworld.org
Mail……415 Second Street, NE,
Suite 300
Washington, DC 20002

Wheat Industry Resource Committee

The Wheat Industry Resource Committee (WIRC) is a committee composed of scientists from land grant institutions and the private industry. The objectives of the WIRC are those that are generally associated with an educational and scientific corporation qualified for exemption under Section 501(c)(3) of the Internal Revenue Code of 1954 as amended or a comparable section of subsequent legislation. The activities of the WIRC encompass the following more specific objectives:

1. To provide a common forum for the exchange of research and educational information among members of the WIRC and the National Association of Wheat Growers (NAWG).
2. To serve in an advisory capacity to the NAWG on research and educational matters.
3. To coordinate multi-state educational and applied research efforts involving wheat.
4. To conduct educational programs and applied research efforts as deemed necessary by WIRC and NAWG.

Wheat Industry Resource Committee Officers

Mike Edwards, Ph.D., Chair, DuPont Ag Products, CO, E-mail: michael.t.edwards@usa.dupont.com
Russ Karrow, Ph.D., Vice Chair, Oregon State University
Travis Miller, Secretary, Texas A&M University
Ron Madl, Ph.D., Past Chair, Kansas State University

National Wheat Improvement Committee

The National Wheat Improvement Committee (NWIC) is a non-profit, independent organization representing public and private wheat researchers from each of the four major U.S. wheat-growing regions. The NWIC addresses issues that have a direct, or indirect, effect on U.S. wheat; including areas of research, production, marketing and end-use. The committee provides information and counsel to congressional leaders and U.S. Agricultural policy makers, with the long-term goal of improving wheat production and marketing opportunities. NWIC members serve as an expert committee and are willing to provide either written or verbal testimony regarding wheat research issues in the United States.

The NWIC meets annually. Minutes of the Committee meetings, resolutions, and letters are published each year in the Annual Wheat Newsletter.

National Wheat Improvement Committee Members

Dr. Dave Van Sanford (Chair) University of Kentucky, PH: (859) 257-5811, Email: agr038@pop.uky.edu
Dr. Greg Marshall, Pioneer Hi-Bred International, IN
Dr. Anne McKendry, University of Missouri
Dr. Carl Griffey, Virginia Tech
Dr. Jackie Rudd, South Dakota State University
Dr. Yue Jin, South Dakota State University
Dr. Elias Elias, North Dakota State University
Dr. P. Stephen Baenziger, University of Nebraska
Dr. Scott Haley, Colorado State University
Dr. John Moffatt, AgriPro Seeds, Inc., CO
Dr. Bob Zemetra, University of Idaho
Dr. Tim Murray, Washington State University
Dr. Richard Ward, Michigan State University
Mr. Jack Eberspacher, National Association of Wheat Growers, DC
Mr. Ben Handock, Wheat Quality Council, SD
Ms. Susan Canty, Michigan State University

Additional Support for the USDA-ARS Wheat Quality Laboratories

Background and Significance

Amount Requested*: *$3.25 million

The four USDA-Agricultural Research Service (ARS) wheat quality laboratories, established by Congress beginning in 1936, have played a pivotal role in the improvement of U.S. wheat quality and in the development of analytical tools. Their work in evaluating the quality of new potential varieties very early in the development process is vital to private, state, and federal breeding programs. Over 95% of all of the new wheat varieties that are released in the U.S. by these programs are currently evaluated in these laboratories.

Changes in the grain marketing system that place a greater emphasis on end-use quality and functionality in determining value are dictating that these laboratories modernize their equipment and produce accurate, inexpensive, reliable test methods for these traits that can be applied throughout the marketing chain. In addition, these laboratories are expected to provide analytical services with emphasis on the development of tools that can predict end-use performance as early as possible in the development of new experimental lines.

The U.S. has lost a significant amount of the world wheat export market. From 1987 to 1997, U.S. wheat exports decreased by approximately 40% (from 43.2 million metric tons (MMT) down to 27.2 MMT). This represents a loss of approximately $1.6 billion in sales per year in 1999 dollars. During this same time period, U.S. competitors increased or maintained their market shares. For example, Australian exports increased by approximately 100% (from 9.3 MMT to 19 MMT). Quality is a major factor determining market share. This market competition will continue to increase as more countries target specific customer end-use quality needs and increase their wheat exports.

Objectives:

This proposal describes a comprehensive plan to increase the cooperative efforts between these four ARS laboratories located in Wooster, OH, Manhattan, KS, Fargo, ND, and Pullman, WA, and other groups in the wheat industry, including private, state, and federal breeders; producers; private, state, and federal research scientists; and a wide variety of end users.. The changes that must take place in order for these laboratories to more efficiently meet the quality evaluation needs of modern domestic and foreign U.S. wheat customers include:

- **Enhancement of Performance Prediction Early in the Development of New Lines**
- **Expansion of Quality Analysis Methodology to Include a Wider Variety of Products**
- **Development of Accurate, Inexpensive, Analytical tools**
- **Increased Understanding of Needed End-Use Quality Traits.**

The ultimate goal of these activities is to improve the ability of U.S. producers to meet the needs of domestic and foreign customers by offering quality grain with proven end-use performance.

This increased funding is critical if the U.S. is to keep pace with its competition and maintain or even increase its share of the world market. Specific funding requests are:

1. USDA-ARS Soft Wheat Quality Laboratory, Wooster, OH
Proposed annual budget increase over current budget of $498,402 . This laboratory currently evaluates breeding lines from 26 breeding programs. Increased funding will allow the development of new predictive tests that will allow more precise breeding for end use quality.

2. USDA-ARS Hard Winter Wheat Quality Laboratory, Manhattan, KS
Proposed annual budget increase over current budget of $1,690,000. Nearly 100% of released varieties are evaluated at the HWWQL prior to release. The focus in this market class will be on novel food uses of hard winter wheat, as well as modernization of tests to reflect industrial needs.

3. USDA-ARS Hard Red Spring & Durum Wheat Quality Laboratory, Fargo, ND
Proposed annual budget increase over current budget of $ 495,000. The focus will be on development of new uses and markets for spring and durum wheat as well as vaue-added flour quality of pre-harvest sprouted wheat.

4. USDA-ARS Western Wheat Quality Laboratory, Pullman, WA
Proposed annual budget increase over current budget of $ 495,000. The focus will be on enhanced evaluation of breeding samples and identification of quality traits for Asian foods.

Proposed Budget Increase Over Current Budgets For The Four Wheat Quality Laboratories.

Item Description	Wooster, OH	Manhattan, KS	Fargo, ND	Pullman, WA
Salaries, wages, and benefits	$400,000	$315,000	$150,000	$250,000
Indirect costs	$25,000	$195,300	$90,000	$60,000
Equipment	$215,000	$183,000	$110,000	$227,000
Material and Supplies	$200,000	$96,7000	$100,000	$138,000
Cooperative Research Support	$60,000	$50,000		
Research Associates		$60,000		
ARS Administrative Costs	$100,000	$100,000	$50,000	$75,000
Total	$1,000,000	$1,000,000	$500,000	$750,000

Proposal To Create Four Regional USDA-ARS Small Grains Molecular Genotyping Laboratories.

Recommendation: *The National Wheat Improvement Committee, National Barley Improvement Committee, and National Oat Improvement Committee recommends establishment of* ***four regional USDA-ARS molecular genotyping laboratories*** *with funding of* ***$750,000 per laboratory ($2.75 Million total in new funding for FY2002)****. These proposed regional laboratories would be located at Raleigh, NC (east), Fargo, ND (north central), Manhattan, KS (central, partially funded at $250,000 in FY2001), and Pullman, WA (west) and would impact small grain breeding programs in at least 30 states. The laboratories would facilitate application of DNA molecular marker information to plant improvement in wheat, barley and oat breeding programs.*

Precedent: The USDA-Agriculture Research Service has provided leadership and services when local resources have not been available to meet national needs in crop improvement. USDA-ARS regional laboratories have been established to improve end-use quality and to reduce grower risk in small grain cropping systems. Current regional ARS laboratories characterize and improve end-use quality, and improve resistance to rusts, smuts, blights, and insect pests of wheat, barley, and oats. They also preserve, characterize and distribute small grain germplasm.

Justification: *Molecular markers are available that are associated with disease resistance, grain quality traits, and other desirable agronomic traits in wheat, barley and oats. Additional molecular information is being compiled daily through the International* Triticeae *EST consortium (ITEC), the USDA-ARS Wheat Endosperm sequencing project, the NSF Wheat Genome project, the North American Barley Genome Mapping project and the USDA-NRI funded barley EST project.*

A gap exists between the discovery of molecular information and the use of that information in practical wheat, barley, and oat improvement programs. Molecular breeding tools represent the technology of promise as we transition into the next era of plant breeding. As markets move away from a commodity basis toward a value-defined, end product basis, plant breeders must equip themselves with gene-specific markers that give them rapid access to traits of value.

Regional genotyping centers will overcome the barriers to practical use through automated DNA extraction, and high-throughput marker screening procedures. They will provide a bio-informatics interface between molecular genetic data and practical breeding programs. Regional laboratories providing molecular genotyping technology will position the USDA-ARS to facilitate the rapid deployment of critically needed genes for wheat, barley, and oat improvement through support of public and private breeding programs

Regional laboratories are proposed in order to enhance close alignment between breeders and mappers for traits of value to particular geographical production areas. The regional concept is justified because of anticipated high genotyping demand, the regional nature of market classes,

production systems and constraints and the critical mass of breeding programs in each of the regions.

Objectives: *Proposed objectives for the laboratories:*

- *Identify new DNA markers associated with valuable traits such as end use quality and resistance to important pests like rust, scab, wheat streak mosaic virus, Karnal bunt, aphids, and Hessian fly. Map new markers in commercially relevant breeding populations.*
- Create marker profiles of cultivars and breeding lines and provide this information to plant breeders. Marker profiles will be cross-linked to other genetic information currently available in the Regional Cooperative nurseries, the USDA-ARS Small Grains Germplasm Center, and through the USDA-NAL crop databases.
- Develop and deploy breeder friendly markers for widely used genes derived from cereal wild relatives and other germplasm resources.
- Develop and deploy microarray technology for basic gene detection research and selection in breeding programs.

Impact: The establishment of these regional laboratories will allow public and private sectors to collaborate for the benefit of all components of the wheat, barley, and oat industries, from producers to consumers.

Molecular markers will facilitate the development of fingerprints for economically important traits i.e. yield, wheat and oat quality traits, barley malting and nutritional quality, dormancy, biotic and abiotic stress. These fingerprints can then be used to facilitate selection in early generations. For example, in barley, molecular markers are being used to convert traditional high quality malting barley to modern high yielding and disease resistant cultivars that maintain their traditional malting quality. Similarly baking, cookie, or noodle quality in wheat can be maintained while upgrading the yield, disease resistance and adaptability traits of a cultivar.

Other examples of genotyping needs waiting for the personnel, equipment and facilities in the proposed labs are:

- Molecular markers to select for *Triticum diccocoides*-derived high protein in wheat.
- Molecular markers to select for Sumai3-derived resistance to scab in wheat.
- Molecular markers to select for durable resistance to stripe and leaf rust in barley and wheat.
- Molecular markers for slow rusting to develop durable crown rust resistance in Oats.

Budget: Each laboratory will include a lead scientist to direct research and perform at the cutting edge of molecular breeding by discovering new methods to improve molecular marker systems and genotyping in cereal crops. New technology will be incorporated as it is developed.

A bioinformatics specialist is needed to facilitate interpretation and automation of data analysis. Two support technicians will assist the scientists.

Indirect research costs include utilities, printing, mailing, and items related to data dissemination. Materials and supplies costs are significant for a facility of this type and are estimated to be $1.00 per sample processed. Future improvements in efficiency and technology could reduce this cost.

Item Description	Cost
1 Scientist	$ 100,000
1 Bioinformatics Specialist	$ 75,000
2 Support Technicians	$ 100,000
Indirect Research Costs	$ 35,000
Materials and Supplies	$ 250,000
Equipment	$ 115,000
ARS HQ Administrive Costs	$ 75,000
Total	$ 750,000

Equipment costs are significant at startup and gradually reduce over time. A portion of the annual budget would initially be used for equipment and later go to supplies and processing costs.

Note that because of the very large operating costs, it is necessary that a total of $275,000 of funds should be used for personnel (including one Category I scientist and one Category 4 bio-informatics specialist. (See Appendix 1 for location justification details).

USDA-ARS Cereal Disease Laboratory (CDL)

St. Paul, Minnesota

Amount Requested: $3.0 million, USDA-ARS Building & Facilities Budget

The USDA-ARS Cereal Disease Laboratory (CDL) is a Federal research facility with the national mandate of providing improved methods for controlling cereal diseases that are effective, safe and environmentally friendly, mainly through the deployment of resistant cultivars. The primary focus of this laboratory (formerly the Cereal Rust Laboratory) prior to 1998 was to study and develop control measures for cereal rust diseases. Rusts are fungal diseases that are capable of destroying our nation's cereal crops. Indeed, catastrophic epidemics of stem rust devastated wheat crops across the United States in 1935, 1937, 1954, and 1955. Through the deployment of resistant cultivars and continued monitoring of pathogen races in the field, stem rust has been held in check and significant losses have not occurred for at least 35 years; however, other rust diseases still threaten our cereal crops. Losses to leaf rust in wheat alone totaled over $1.5 billion for 1990–1999. To combat these rust diseases, a sustained research effort is needed to 1) monitor the outbreaks and development of rust diseases across the country, 2) characterize races of rust pathogens to determine if they pose a threat to our current cereal cultivars, 3) discover new types of genetic resistance to rust diseases for use in cereal breeding programs, and 4) investigate basic aspects of host-parasite interactions to develop novel control methods using modern genomic and molecular technologies. As a national center for cereal rust research, these important objectives will continue to be a priority of the CDL.

In the early 1990's, another fungus disease called Fusarium head blight (FHB) or "scab" re-emerged in many areas across the eastern half of the United States. FHB epidemics of wheat and barley occurred as a consequence of minimal tillage practices and successive wet years with losses estimated at $3 billion for the years 1990–1999. To immediately address the threat of this new disease, the CDL expanded its mission to 1) discover new types of genetic resistance to FHB, 2) evaluate their usefulness against known and emerging strains of the pathogen, and 3) explore other approaches to augment levels of control of FHB that can be achieved with incomplete resistance. Basic research projects are also being conducted on host plant resistance, infection mechanisms of the pathogen, and identification of novel control measures by means of advanced genomic and molecular technologies.

The research activity at the CDL has increased by 50% over the past two years. Laboratory personnel now include six Ph.D. research project leaders, three support scientists, five research technicians, and two office staff. The expanded research effort has resulted in severe space shortages in the CDL. The original research facility was constructed in 1972 to house rust investigations of four project leaders and has 7,000 square feet of laboratory and office space, 4,000 square feet for growth chamber and head house activities, and 4,500 square feet of greenhouse space. Research activity has now spilled over into a 450 square foot laboratory temporarily leased in a neighboring U.S. Forest Service research facility. A new addition to the laboratory would provide space for the additional new project leaders, modern laboratories for the latest molecular, genomics, and computer technologies, and St. Paul-based ARS administrative staff, who are currently housed in temporary quarters.

The proposed building addition of approximately 10,000 square feet includes a isolation plant growth room and preparation laboratory with HEPA filter for exhaust air and a sterilization system for discharged water, two fully equipped research laboratories, a culture lab, expanded seed handling and seed storage rooms, five offices for CDL staff, a conference room for St. Paul-based ARS functions, and a suite of three offices plus equipment room for the St. Paul Location Administrative Officer and staff. The isolation plant growth room will be used for research with transgenic rust and *Fusarium* cultures as well as with foreign cultures of these fungi. The isolation room will have inoculation and incubation chambers for infecting plants, and a small lab for isolating DNA for study outside the isolation area. The conference room and the location administrative offices will be separated from the research area and will serve all three ARS research units at the St. Paul location.

Rusts and FHB pose a continual threat to our cereal crops. Personnel in the CDL are trying to meet the challenge posed by these devastating fungal diseases, but are severely limited in the physical space for research. **Thus, the National Barley Improvement Committee, National Oat Improvement Committee, and National Wheat Improvement Committees are requesting that Congress approve $3 million for the construction of a new addition to the CDL so it can maintain its vital national mission in reducing the threat of rust diseases and FHB to cereal crops.**

For additional information, please visit the Cereal Disease Laboratory website (http://www.cdl.umn.edu) or contact:
Kurt J. Leonard, Research Leader
Cereal Disease Laboratory
1551 Lindig St.
St. Paul MN 55108

Phone 612-625-6299
FAX 651-649-5054
e-mail: cdl@cdl.umn.edu

Advanced Genetics Laboratory at the National Small Grains Germplasm Research Facility, Aberdeen ID

Amount Requested: $4.3 million, USDA-ARS Building & Facilities Budget

The National Barley Improvement Committee, National Oat Improvement Committee, and National Wheat Improvement Committee request $4.3 million for the construction of an advanced molecular genetics laboratory addition to the ARS National Small Grains Germplasm Research Facility (NSGGRF) at the Aberdeen Research and Extension Center in Aberdeen, ID.

This request is also supported by The University of Idaho, Idaho Barley Commission, Idaho Wheat Commission, Idaho Grain Producers Association and Idaho Potato Commission.

Current Status: The ARS program at Aberdeen, Idaho, includes several advanced molecular genetics research programs in barley, oats and potatoes. Ongoing research in genetic improvement of feed and malting barleys, including low phytic acid grains for fish, swine and poultry diets, and potato varieties with enhanced quality and storage characteristics, is greatly constrained by inadequate laboratory facilities. Furthermore, the University of Idaho's (UI) wheat genetic research capabilities at Aberdeen will be greatly enhanced by the proposed advanced genetics laboratory addition at the ARS facility. Currently the UI wheat genetics program conducts laboratory experiments in limited areas, without a single dedicated laboratory.

Background/Justification: Construction of a $4,300,000 laboratory addition for advanced molecular genetics research in barley, oats, wheat and potatoes will provide significant benefits to the small grains and potato industries throughout the Pacific Northwest and the US. The USDA NSGGRF houses one of the foremost crop germplasm collections in the world, including over 100,000 small grain accessions. This institution maintains seed stocks, distributes seed to researchers worldwide and serves as a center of small grains and potato genetics research.

The proposed 12,000 square foot laboratory addition will greatly enhance the molecular genetics capability in both small grains and potatoes for the benefit of barley, wheat, oats and potato industries in Idaho, the Pacific Northwest, and the US. Laboratory space is planned for four grain and potato breeders/geneticists. For personnel safety, a radioisotope room is planned, allowing the localization of radioisotope research to one room that can be readily monitored and contained. A service lab is proposed to provide additional space for centrifuges, incubators, freezers and other large equipment items. The movement of these large equipment items to an adjoining separate service lab allows for more efficient use of laboratory space and will allow the sharing of expensive equipment among researchers. A tissue culture room and growth room are envisioned to accommodate the anticipated increased use of tissue culture methods in both the potato breeding and low phytic acid research. Additional facilities include a loading bay for the temporary storage and processing of plant material and a cold-storage area for long-term storage of plant material such as seed and tubers. Specific research objectives are outlined below:

Low phytic acid barley research -- Barley genetics research at the NSGGRF has led to the development of the world's first feed grains with essentially no phytic acid phosphorous (95% phytic acid free). The phytic acid or phytate form of phosphorous contained in grains cannot be digested by nonruminant animals and humans, causing antinutritional concerns in the diet as well as phosphorous

waste management problems. The objectives of this research are to develop genetic approaches to the phytic acid problem that are useful in crop breeding and improvement; to work with plant breeders in the use of these genetic resources; and to cooperate with human and animal nutritionists in studies on nutritional improvements and phosphorous waste reduction. The development of low phytic acid barley cultivars will lead to the increased use of barley in nonruminant animal and human diets.

Barley genetics research -- The NSGGRF supports extensive research in barley and oat breeding and biotechnology. The genetic complexity in the inheritance of various desirable traits makes the development of superior varieties an ongoing, long-term process involving many generations of crossing, selecting, and testing. This breeding process will be greatly enhanced by more precise genetic techniques. Specific work is currently focusing on understanding the genetics of plant regeneration and developing efficient transformation systems that are less dependent on tissue culture systems that generate undesirable changes in agronomic and quality traits.

Potato genetics research -- A primary objective of the ARS potato genetics research program at Aberdeen is to develop new superior russet cultivars with the desirable traits of Russet Burbank, without its susceptibility to environmental stresses. Benefits of improved varieties are expected to result in reduced production costs, more uniform quality, less storage problems, and better processing recovery. Ranger Russet is an example of a russet cultivar released from the Aberdeen program that has benefited the Idaho potato industry. Ranger Russet's improved yield, disease resistance, tuber size, and starch content as compared to Russet Burbank has resulted in increased profitability for both growers and the processing industry. It is now the second-most widely grown cultivar in Idaho after Russet Burbank, accounting for 9.0% of the planted acreage in 1999 (National Agriculture Statistics Service). In the United States, Ranger Russet is the third most widely grown potato cultivar, which demonstrates the importance of the breeding program to the national potato industry.

The Aberdeen potato breeding program will be developing molecular techniques to more rapidly incorporate desirable traits such as disease resistance from wild potato species to the cultivated potato. Incorporation of these molecular techniques into the program is limited at this time due to inadequate laboratory space with less than satisfactory HVAC properties.

The benefit to the US small grains and potato industries will be the more rapid development of barley, wheat, oat and potato cultivars that are adapted to our region and meet the exacting end-use specifications of global customers. Barley, wheat and potato production generates more than $2.5 billion in annual farm-gate receipts in the Pacific Northwest region (1996-1998 average) alone.

Appendix I

Location Justifications:

- **East: Raleigh, NC**

The laboratory will be part of the USDA-ARS Plant Science Research Unit. The unit includes two lead scientists in small grains plant pathology. The Department of Crop Science at North Carolina State University has lead scientists in small grain breeding and in molecular genetic analysis. The genetics and statistics departments at North Carolina State University include persons with expertise in molecular marker development, bioinformatics, and statistical genetics.

In the Eastern Region, research collaboration and service functions can be established with breeding programs in Michigan, Ohio, New York, Pennsylvania, Maryland, Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, and Louisiana. Private breeding companies active in the region include Syngenta, Pioneer Hi-bred, and Agripro. The Eastern Region is the primary soft red winter wheat production area of the U.S. The crops covered by the Raleigh lab include soft red and soft white winter wheat, six-row winter barley, and spring oats.

The main traits of interest for molecular genotyping in the east are

Quality traits: Protein functionality in soft wheat, sprouting resistance and soft wheat milling and baking quality; groat protein content in oats.

Pest Resistance: Resistance to powdery mildew, Hessian fly, *Septoria* tritici and *Stagonospora nodorum* in wheat. Resistance to leaf rust in wheat and barley, and crown rust in oats. Resistance to cereal leaf beetle and barley yellow dwarf virus in wheat and oats.

- **North Central: Fargo, ND**

The laboratory will be part of the USDA-ARS Cereal Crops Research Unit of the Northern Crop Science Laboratory with lead scientists in wheat and barley genetics and plant pathology. Collaborative research arrangements can be established at NSDA with wheat and barley breeders and geneticists, in the Department of Plant Sciences as well as plant pathologists in the Dept. of Plant Pathology at North Dakota State University. The crops covered by the Fargo genotyping center would be six-and two-row barley, spring oat, Durum, hard red, and hard white spring wheat. NDSU has established a state-funded molecular marker genotyping lab in the Department of Plant Science, but with limited funding and capabilities.

In the North Central Region, major breeding and genetics programs exists for wheat, barley, and oats in Minnesota, Wisconsin, and South Dakota. There are currently 15 small grain breeding and genetics programs in the four states.

The main traits for molecular genotyping in the North Central Region include:

Quality traits: Protein quantity and gluten strength in wheat, kernel color and sprouting resistance in white wheat, percentage of deoynivalenol in wheat and barley, protein, malt and nutritional quality traits in barley. Milling quality and nutritional quality (including protein, antioxidants, lipids and nutritional fiber) in oat.

Pest Resistance: Resistance to *Fusarium* head blight in wheat and barley. Resistance to sawfly, tan spot, leaf rust, and stem rust in wheat. Resistance to leaf and stem rust, barley stripe, net and spot blotch, and scald in barley, Resistance to crown rust, and stem rust in oats.

- **Central: Manhattan Kansas (The laboratory at Manhattan was partially funded at $250,000 in FY2001).**

The laboratory is part of the Plant Science and Entomology Research Unit of the Grain Marketing Production Research Center in Manhattan, KS, which has lead scientists with expertise in germplasm development, mapping, and molecular biology. The unit already has an established wheat genomics facility that is a partnership with the Wheat Genetics Resource Center of Kansas State University. The major equipment necessary (automation and analysis) for a genotyping facility has already been purchased and a lead scientist will be hired in 2001/2002. At Kansas State University, expertise exists in wheat breeding, molecular genetics, and virtually all areas of wheat research.

In the Central Region, public breeding programs are active in Nebraska, Oklahoma, Texas, Missouri, Iowa, Illinois, and Indiana. Private companies with small grain breeding programs include Cargill, Pioneer, Syngenta, and Agripro. The central region produces the bulk of the hard winter wheat crop in the United States. The Corn Belt states of Missouri, Iowa, Illinois, and Indiana are major soft winter wheat and oat production areas.

Primary traits of interest for molecular genotyping in the Central Region include:

Quality traits: Improved gluten functionality, noodle quality, and bread baking quality for hard wheat. Forage and grain feed/food quality for oat and winter barley.

Pest Resistance: Resistance to Russian wheat aphid, leaf rust, stem rust, scald, wheat streak mosaic virus, *Fusarium* head blight and Hessian fly in wheat and/or barley and crown rust in oat.

- **West: Pullman, WA**

The laboratory will be part of the Wheat Genetics, Quality, Physiology, and Disease Resistance Unit at Pullman WA. The unit includes lead scientists in germplasm development, molecular genetics, disease resistance, and grain quality. In addition, the Department of Crop and Soil Sciences at Washington State University has lead scientists with expertise in barley and wheat germplasm improvement, molecular genetic analysis, and mapping. These scientists are also actively involved in molecular marker assisted plant breeding. However, new, developing technologies are difficult to adopt due to lack of funding for equipment and lack of bioinformatics expertise. A similar situation exists throughout the western states in which small grains are important agricultural commodities.

In the western region, research collaboration and service functions can be established with more than 15 public small grain breeding programs. The western states with public barley, oat, and/or wheat breeding programs include Washington, Oregon, California, Idaho, Utah, Montana, and Colorado. Private small grain breeding companies include Western Plant Breeders, Plant Breeders 1, Coors, Busch Ag. Res. Inc., and Agripro. Other states including Arizona, New Mexico, Wyoming, and Alaska grow cultivars developed from those breeding programs. Three western states rank in the top five among all states in barley production and two western states rank in the top five for wheat production.

The main traits of interest for molecular genotyping in the west are:

Quality Traits: Improvement of protein quality, club wheat quality, quality for Asian products, milling quality and sprouting resistance in wheat. Improvement of food, feed and malting quality in barley.

Pest Resistance: Resistance to stripe rust, eyespot, cephalosporium stripe, soil borne diseases, Hessian fly, and Russian wheat aphid in wheat. Resistance to stripe rust, soil borne diseases, Hessian fly and Russian wheat aphid in barley.