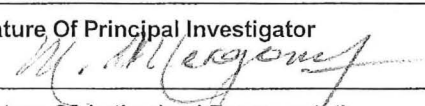



## Minnesota Wheat Research and Promotion Council

### RESEARCH PROPOSAL GRANT APPLICATION

<b>1. NAME AND ADDRESS OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE</b>  <b>Name:</b> North Dakota State University <b>Address:</b> Office of Sponsored Programs Administration Dept #4000 PO Box 6050, Fargo, ND 58108-6050		
<b>2. TITLE OF PROPOSAL</b> <b>Developing Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers</b>		
<b>3. PRINCIPAL INVESTIGATOR(S)</b>  Mohamed Mergoum  _____ PI# 2 Name:  _____ PI# 3 Name:	<b>4. PI #1 BUSINESS ADDRESS</b>  Department of Plant Sciences NDSU Dept. 7670 PO Box 6050 Fargo, ND 58108-6050	
<b>5. PROPOSED PROJECT DATES (calendar years)</b> 2015-2016  Note: Research Reports are Due November 15th of Each Year	<b>6. TOTAL PROJECT COST</b>  \$67,000/year (\$134,000/2 years)	<b>7. PI #1 PHONE NO.</b>  701-231-8478
<b>8. RESEARCH OBJECTIVES:</b> (List objectives to be accomplished by research grant)  The goal of this project is to develop superior spring wheat cultivars targeted to MN, particularly the Western wheat growing environments. These cultivars should possess the following traits: <ul style="list-style-type: none"> <li>• High yield potential.</li> <li>• Good quality characteristics which would allow premiums for wheat growers and sustainable competition on the international market. These traits include mainly protein content, milling and baking characteristics.</li> <li>• High levels of resistance to dominant diseases such as leaf diseases which include leaf and stem rusts, a continuous threat to wheat.</li> <li>• Good resistance to Fusarium head blight (Scab), still a major disease for wheat in MN and the region.</li> <li>• Resistance to leaf spotting diseases and bacterial leaf diseases that can be devastating in some years.</li> </ul> <p>Attach a 2-page detailed discussion of importance of the proposal to wheat profitability; how study complements previous research in area; procedures to be used; and competency of the research group in achieving research objectives. (Please keep the proposal concise, only 2 pages will be provided reviewers).</p>		
<b>Signature Of Principal Investigator</b> 	<b>Date</b> 04/14/15	<b>Phone Number</b> 701-231-8478
<b>Signature Of Authorized Representative</b> 	<b>Title</b>	<b>Date</b> 4/14/15
<b>Address Of Authorized Representative</b> Jill Mackenzie Award and Program Officer Office of Sponsored Programs Administration Dept 4000, PO Box 6050 Fargo, ND 58108-6050		<b>Phone Number</b>  701.231.8045

**Minnesota Wheat Research and Promotion Council**  
**RESEARCH PROPOSAL GRANT APPLICATION**  
**(2-pages maximum)**

**Project Title: Developing Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers**

**Importance of this project to the profitability of wheat producers:**

Wheat is still a major crop in the region although there was a decline in its acreage due to a substantial increase of other crops namely corn and soybean. More than seven million acres are still grown to wheat in MN and ND in 2014. Historically, cultivars released by the public (universities) breeding wheat programs at the three states (MN, ND and SD) have played a major role in the wheat production in the region. In general, this is still true except for a few cultivars released by private companies. Among these wheat breeding programs, NDSU is well known for its well adapted and high quality germplasm and cultivars. While our intentions are still to maintain that hallmark germplasm/cultivars, our emphasis is also focused on developing high yielding cultivars to meet our growers' demand, particularly those in the Western MN and Eastern ND regions.

The Minnesota Wheat Research and Promotion Council (MNWRPC) support to our breeding program has been substantial and steady for many years. This funding has allowed our breeding program to focus on developing high yielding cultivars with good quality targeted to Western MN and Eastern ND wheat growers. These efforts have bared fruits in 2007 and 2011 when we released 'Faller' and Prosper, respectively (Mergoum et al., 2008 and 2013). Faller was truly the first variety that combined high yield potential with relatively good quality attributes, challenging all other high yielding cultivars released by other breeding programs in the spring wheat region. Just two years after its release, Faller became the leading cultivar in MN since 2009 to 2013. In 2013, Faller was still grown on 17.27%, second only to the other NDSU cultivar 'Prosper' (Mergoum et al., 2012) released jointly with the University of MN in 2011. Prosper is expected to enhance the wheat production and improve the incomes of wheat growers in MN and ND as did Faller. Indeed just like Faller, Prosper after just two years of its release became the leading cultivar in MN with 17.3% followed by Faller. Combined together, the MN wheat acreage grown to both Faller and Prosper surpassed 32% in 2013 and 2014. Wheat growers in MN needs new adapted cultivars which combine high productivity and good "marketable" quality traits such as grain protein. This continues to be a major challenge to the wheat breeding programs. The MNWRPC is well aware of this important research and breeding component and appreciates the potential impact of new adapted cultivars on the MN wheat growers and the wheat industry. Therefore, it continues to support our program which allows us to release adapted cultivars to the MN wheat growers. Without this support, cultivars like Prosper for instance would not be released. Therefore, the main objective of this project is to continue our breeding efforts to improve wheat cultivars that will meet the demand of the MN wheat growers with good levels of quality traits including grain protein, milling and baking characteristics. Specific objectives include: develop cultivars adapted to the Western wheat growing environments which possess the following traits:

- High yield potential.
- Good quality characteristics which allow premiums for wheat growers and sustainable competition on the international market. These traits include mainly protein content, milling and baking characteristics.
- High levels of resistance to dominant diseases such as leaf diseases including leaf and stem rusts, a continuous threat to wheat.
- Good resistance to Fusarium head blight (Scab), still a major disease for wheat in MN and the region. Resistance to leaf spotting diseases and bacterial leaf diseases that can be devastating in some years

**Procedures:**

To achieve the above objectives, several research activities have to be conducted. Although these activities have a multidisciplinary character, the wheat breeding program will be coordinating them and make

sure that the goal is achieved efficiently and timely. Among these research activities we list the following:

1. Crosses and populations development:

Cultivars and elite genotypes adapted to MN environments will be used as a parent for planned crosses in the Fall and Spring of each year in two greenhouse cycles. We plan to make 200 crosses per year in order to incorporate economic traits into adapted germplasm. The F<sub>2</sub> segregating populations generated from the F<sub>1</sub>'s are usually planted in the field each summer. Many of the new adapted parents now have diseases (leaf diseases, FHB, etc.), yield potential and quality. The key is to combine these important traits in one genotype. About 200-300 spikes will be selected from the most promising F<sub>2</sub> population to be advanced for further generations and selections. Subsequently, five to 10 spikes from each selected F<sub>3</sub> lines are threshed and shipped to New Zealand or Arizona as head-rows for generation advancement and selection for some agronomic traits (lodging, height, maturity, shattering, and other plant type). Similar procedures will be followed to advance and select this germplasm to achieve homozygosity and be tested in yield trials.

2. Diseases evaluation/screening:

The rusts and Scab screening nurseries are installed in many locations including Prosper, Carrington, and Langdon, ND. In addition, screening of elite material is also done in the greenhouse as well as by our colleagues in Dept. of Plant Pathology. These nurseries provide field screening for leaf diseases, FHB, bacterial blight, etc. resistance of germplasm coming from targeted segregating generations as well as advanced/elite lines. The experiment units include replicated hill plots for advanced/elite material and single hill plots for segregation material. FHB screening will be done within the USWBSI activities. Greenhouse screening will be also conducted for elite material.

3. Early evaluation of segregating generations and preliminary yield trials:

Our breeding program evaluates each summer about 2,000, 500, and 200 of F<sub>3</sub>, F<sub>4</sub>, and F<sub>5</sub> families for disease resistances and agronomic traits. Preliminary yield trials (PYT) which include mostly F<sub>5</sub> and F<sub>6</sub> are conducted in non-replicated plots using augmented design under natural conditions in the field. Selected genotypes from these trials are also evaluated for some quality traits. Lines are advanced from generation to next either by single-seed-descent in the greenhouse or pedigree method in the field using the New Zealand, Puerto Rico and Arizona winter nurseries. Known molecular marker, particularly for diseases, protein, etc. are being utilized to screen this germplasm. These markers are run in collaboration with the USDA-ARS, Fargo Genotyping Center.

4. Screening and evaluation of advanced and elites lines:

About 150, 100, and 50 lines are usually are evaluated every year in Intermediary (IYT), Advanced (AYT), and Elite Yield Trials (EYT), respectively. The EYT yield trials are conducted in Casselton, Prosper, and Langdon in Eastern ND (Red river valley). In collaboration with our colleague Dr Wiersma in MN, the EYT are planted at Alvarado and Wolverton, MN. We have been testing our EYT at these two locations for the past 4 years. These yield trials generate agronomic and quality data, reactions to pests including diseases and bacteria. These genotypes are evaluated in replicated hill plot nurseries grown in the Scab nurseries. Selected lines are subsequently included in New Zealand or Puerto Rico and Arizona winter nurseries to accelerate generation advancement and seed increase. The winter nurseries are also used to select for maturity, height, lodging resistance and shattering.

5. Quality Evaluation:

All yield trials samples will be sent to our quality lab to perform quality testing. For lines included in the IYTs, grain characteristics as well as milling and dough will be performed. For lines that are included in AYT, and EYT, additional test on baking performance will be added to the quality package tests. This data will be added to the other agronomic performance for further selection and decision making for further testing, seed increase, or eventual cultivar release.

#### 6. Markers Assisted Selection (MAS):

Available robust molecular markers will be used to screening the spring wheat germplasm developed by this project. The MAS will be conducted in collaboration with the Genotyping Center at the USDA-ARS at Fargo (Dr. Chao's Lab.). Several molecular markers for FHB resistance, leaf diseases, grain protein content, etc. will be utilized to discriminate between genotypes. The use of these markers may be very helpful in indicating the absence/presence of the genes of interest. MAS will allow us to start combining/pyramiding different genes and different traits.

#### 7. Uniform Regional Trials (URN):

While each breeding program has its own unique identity in terms of germplasm, breeding methodologies and philosophy to achieve their goal, many activities can be coordinated to increase efficiency of our breeding efforts in the region. The URN which will include elite material from the spring wheat breeding programs is conceived to test the elite lines from different breeding program under the same conditions for agronomic and quality performance as well as screening for major pests such as leaf and bacterial, scab, etc. This will allow an efficient germplasm exchange between breeding programs and further open new horizons in the future for joint release between these breeding programs of spring wheat cultivars as was the case of Prosper that was released jointly between NDSU and the U of MN.

#### **Regional linkages to other research activities:**

The support from the MNWRPC which started initially in 2006, the NDSU spring wheat breeding programs launched an initiative in the Western MN regions to identify high yielding wheat genotypes. Results from these studies showed that lines which yielded significantly higher than commonly grown cultivars can be identified. Subsequently, at least three cultivars with very high yield were released by NDSU targeted for the above region and Eastern ND. Other projects funded by the MNWRPC include screening for leaf spotting diseases and sprouting. All of the project results substantially benefited the wheat growers in MN and ND by growing NDSU released cultivars.

#### **List current or potential other funding sources for this project:**

This project will supplement our NDSU spring wheat breeding program. Developing cultivars is a long term objective and requires long term commitment and substantial infrastructure (Laboratories, greenhouse, and field resources), financial, and human resources. These assets are available and will be provided by the NDSU breeding program.

#### **Research Group:**

Principal Investigators: Dr. Mohamed Mergoum: Department of Plant Sciences, North Dakota State University, Fargo, ND 58108

#### Collaborators:

Dr. Senay Simsek: Department of Plant Sciences, North Dakota State University, Fargo, ND 58108

Wheat Plant Pathologists: Drs. S. Zhong; M. Acevedo, and Dr. Z. Liu, Plant Pathology Dept., North Dakota State University, Fargo, ND 58108

Dr. S. Chao and Dr. S Xu, USDA-ARS, Fargo.

Dr. J. Anderson and Dr. J. Wiersma, University of Minnesota, MN; and

Dr. K Glover: SDSU, SD;

#### **Relationship to past projects:**

This project will continue to use elite germplasm from the major breeding program in the spring wheat region. This will continue to be a channel to enhance the collaboration between researchers that already exist in

the states of MN, SD, and ND, and other major breeding programs in the region. Therefore, the results from this research project will continue its spillover to the entire region and will lead to further collaboration and strengthen the strong tie between the wheat research programs in the three states.

**Estimate the budget requirements:**

**A/B: 1. Research Associates/Technician Salary: (\$12,000+ \$4,200 (35% Fringe Benefits (FB)):** This will continue to cover 40-50% of the salary and FB of a technical staff. This technician will help our research team for variety development which are adapted to MN and Eastern ND (Red River Valley). The technician will help conduct all field and greenhouse operations and prepare samples for quality and disease testing to accomplish our goal

**A/B2. Prebaccalaureates/ Time slip/Temporary Salary (\$8,000 + \$800 (10%) FB):** This salary is for undergraduate students working for HRSW breeding program. The individuals' help is crucial for the spring wheat breeding program investigators to achieve the objectives of this project.

**D. Materials and Supplies (\$16,000):** This amount is requested for the purchase of materials and supplies needed for field, greenhouse nurseries, and for lab analysis/testing.

**E. Travel (\$8,000):** Travel is for the PI and co-investigators to accomplish the project activities in MN and Eastern North Dakota. These costs will also cover travel expenses of the PI, technicians and the graduate student to plant, take notes and harvest the nurseries. It will also cover the PI, technicians and or student to attend field days and forum to present the results generated from this project to the MN growers/stakeholders. This will also be part of the travel (lodging, per diem, etc.) for the PI to go to winter nurseries in New Zealand, Arizona and Puerto Rico to select the advanced germplasm included in the winter off-season nursery.

**F. Publication Costs (\$2,000):** There will be approximately 1 or 2 refereed journal articles expected from this project.

**G. Computer Costs: (\$2,000):** Purchase 1 computer for the lab. The computer is needed to complete this project.

**H. All Other Direct Costs (\$14,000):** Funding to cover part of the off-season nursery expenses in New Zealand/Arizona/Puerto Rico. The funds will support seed shipment, sowing, management, and harvest of FHB segregating population, and seed increase of elite HRSW lines potential for release.

**References:**

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- Donmez, E., R.G. Sears, J.P. Shoyer, and G.M. Paulsen. 2001. Genetic gain in yield attributes of winter wheat in the great plains. *Crop Sci.* 41:1412-1419.
- Mergoum, M., R. C. Frohberg, T. Olson, T. L. Friesen, J. B. Rasmussen, and R. W. Stack. 2008. Registration of 'Faller' spring wheat. *Journal of Plant Registrations* Vol 2, No. 3: 224-229.
- Mergoum Mohamed, Richard C. Frohberg, Robert W. Stack, Senay Simsek, Tika B. Adhikari, Jack W. Rasmussen, Mohammed S. Alamri, Pawn K. Singh, and Timothy L. Friesen. 2012. 'Prosper': A High-Yielding Hard Red Spring Wheat Cultivar Adapted to the North Central Plains of the USA. *Journal of plant Registration* 7:75-80.
- Underdahl, J., M. Mergoum, and J. K. Ransom. 2008. Quality Traits Improvement and Associations in Hard Red Spring Wheat Cultivars Released in North Dakota from 1968 to 2006. *Cereal Chemistry* 85: 507-514
- Underdahl, J., M. Mergoum, J. K. Ransom. And B. G. Schatz. 2008. Agronomic traits improvement and associations in hard red spring wheat cultivars released in North Dakota from 1968 to 2006. *Crop Science* 48: 158-166.
- Waddington, S.R., J.K. Ransom, M. Osmanzai, and D.A. Saunders. 1986. Improvement in yield potential of bread wheats adapted to North-west Mexico. *Crop Science* 26:698-703

**Minnesota Wheat Research and Promotion Council  
RESEARCH PROPOSAL BUDGET**

PROJECT TITLE:			
Principal Investigator(s) / Project Directors(s)	Funds Requested For		
	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)
A. Salaries and Wages	\$	\$	\$
1. Co-principal Investigator(s)			
2. Senior Associates			
3. Research Associates - Post Doctorate			
4. Other Professionals			
5. Graduate Students			
6. Prebaccalaureate Students	\$8,000	\$8,000	
7. Secretarial - Clerical			
8. Technical, Shop and Other	\$12,000	\$12,000	
B. Fringe Benefits @ 10% and 35%	\$5,000	\$5,000	
C. Nonexpendable Equipment (Planting and harvesting equipment use)			
D. Materials and Supplies	\$16,000	\$16,000	
E. Travel	\$8,000	\$8,000	
F. Publication Costs	\$2,000	\$2,000	
G. Computer Costs	\$2,000	\$2,000	
H. All Other Direct Costs (Attach supporting data)	\$14,000	\$14,000	
<b>TOTAL AMOUNT OF THIS REQUEST (per year)</b>	<b>\$67,000</b>	<b>\$67,000</b>	