

Minnesota Wheat Research and Promotion Council
RESEARCH PROPOSAL GRANT APPLICATION

1. NAME AND ADDRESS OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE		
Name: North Dakota State University Address: Office of Sponsored Programs Administration Dept #4050 PO Box 6050, Fargo, ND 58108-6050		
2. TITLE OF PROPOSAL		
Continuing Breeding Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers		
3. PRINCIPAL INVESTIGATOR(S)	4. PI #1 BUSINESS ADDRESS	
Mohamed Mergoum	Department of Plant Sciences NDSU Dept. 7670	
PI# 2 Name:	P.O. Box 6050	
PI# 3 Name:	Fargo, ND 58108-6050	
5. PROPOSED PROJECT DATES (calendar years)	6. TOTAL PROJECT COST	7. PI #1 PHONE NO.
2014-2015	\$65,000/year (\$130,000/2 years)	701-231-8478
Note: Research Reports are Due November 15th of Each Year		
8. RESEARCH OBJECTIVES: (List objectives to be accomplished by research grant)		
This project aims to continue developing 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"> • 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 resistances 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. 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).		
Signature Of Principal Investigator Mohamed Mergoum	Date 11/01/13	Phone Number 701-231-8478
Signature Of Authorized Representative Amy Scott	Title Assistant Director Office of Sponsored Programs Administration	Date 11-7-13
Address Of Authorized Representative Amy Scott Sponsored Programs Admin. NDSU Dept 4000 P.O. Box 6050 Fargo, ND 58108-6050		Phone Number 701-231-8045

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

Project Title:

Continuing Breeding Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers

Importance:

Although there is a continuous decline in wheat acreages due to a substantial increase of other crops namely corn and soybean, wheat is still a major crop in the region. More than 6 million acres are still grown to wheat in MN and ND in 2013. Historically, cultivars released by the university (public) breeding wheat programs at the three state (MN, ND and SD) have played a major role in the wheat production in the region. In general, this is still true except for few cultivars released by private companies. Among these wheat breeding programs, NDSU is well known for its high quality germplasm and cultivars. While our intentions are still to maintain that hallmark germplasm/cultivars development, recently more emphasis was oriented to develop high yielding cultivars to meet our growers demand, particularly those in the Western MN and Eastern ND regions.

Support from the Minnesota Wheat Research and Promotion Council (MNWRPC) has been substantial and steady for many years now. This funding has allowed our breeding program efforts 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 when spring wheat ‘Faller’ (Mergoum et al., 2008) was released by NDSU. 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. By 2010 30% of MN total wheat acreages were grown to Faller. 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 was expected to enhance the wheat production and improve income of wheat growers in MN and ND as did Faller. Indeed, just like Faller, Prosper, after just two years of its release, become the leading cultivar in MN with 17.3% followed by Faller. Combined together, the MN wheat acreage grown to both Faller and Prosper surpassed 34.5% in 2013. Demand for new adapted cultivars to the MN environments which combine high productivity and good, marketable quality traits such as grain protein are needed and continue to be a major challenge for the wheat breeding programs. The MNWRPC is well aware of this important research and breeding components and appreciate the potential impact of new adapted cultivars on the MN wheat growers and the wheat industry. Therefore, continuing support by the MNWRPC to our program will allow us to continue our efforts to release adapted cultivars to the MN wheat growers. Without this support cultivars like Prosper would not be released. Hence the main objective of this project is to continue improving wheat cultivars that will meet the demand of the MN wheat growers with acceptable levels of “marketable” quality traits such as grain protein. NDSU breeding program is well positioned to address these issues given the success of recently released cultivars including Faller and Prosper.

Background:

Given some similarities of environmental conditions and production constraints, many of NDSU wheat cultivars targeted to the Eastern regions of ND perform very well in MN, particularly the Western environments. This has prompted us and the MNWRPC to explore how our breeding program can incorporate in its breeding strategy, objectives that address developing spring wheat varieties adapted to MN wheat growing regions. This should complement the efforts of our colleagues/breeders at the U. of MN and SDSU to develop adapted cultivar to the region. Indeed, many cultivars from these successful breeding programs are also commonly grown in ND as well. Wheat growers in the region will be better served if many research/breeding programs are addressing their challenges.

This research proposal is a logical continuation of the successful project that was funded by the MNWRPC and spanned from 2011 to 2013. Based on several discussions and feedback from MN growers' representatives, wheat scientists, and stakeholders, the release of Prosper in 2011 and previously Faller was a significant milestone in the recent NDSU HRSW breeding program. This project should also be seen as a direct consequence of the MNWRPC support to our breeding program in the past and the significant contributions of NDSU wheat cultivars to the MN wheat growers. Their willingness to enhance their NDSU support -as they do for MN and SD- breeding program through the NWRPC at a significant level of funding is a result of our success to release adapted cultivars and a testimony for the MN growers commitment to our breeding program. This project will continue to open new horizons to the public spring wheat breeding programs in our region to be strong and competitive in the long term in a time when a huge wave of private sectors (large companies) are re-investing again in wheat breeding. While this investment -by major companies- may well benefit wheat growers in the future, it is in the best interest of wheat growers to keep public breeding programs alive and strong to have alternatives and choice for wheat cultivars in the future. We may take lessons from the past, particularly what happened to the public breeding programs for crops such as corn, cotton, soybean, etc. *Arguably, many people strongly believe that it is in the best interest for growers and end-users to encourage a private sector to flourish in wheat research but in the same time keep the public wheat breeding well and strong.*

Relationship to Past Projects:

In 2011, with the support of the MNWRPC – actually it 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 the project results benefited substantially the wheat growers in MN and ND by growing NDSU released cultivars.

Procedures:

The spring wheat cultivars that we aim to develop for MN, particularly the Western wheat growing environments in the future should 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.

To achieve this goal, several research activities have to be continued. 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:

We will select released cultivars and elite genotypes adapted to MN environments as a parent for planned crosses in the Fall and Spring of each year in two greenhouse cycles. About 150 crosses per year will be made specifically, to incorporate economic traits into adapted germplasm. The F₂ segregating populations generated from the F₁'s will be planted in the field each summer. Breeding cycles have now progressed such that many of the new adapted parents have diseases (leaf diseases, FHB...etc), yield potential and quality. The key is to combine these important traits. About 200-300 spikes will be selected from the most promising F₂ population to be advanced for further generations and selections. Subsequently, five to 10 spikes from each selected F₃ 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.

2. Diseases evaluation/screening:

Our 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., resistances of germplasm coming from targeted segregating generations as well as advanced/elite lines. 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:

Each summer, the breeding program will evaluate about 2,000, 500, and 200 of F₃, F₄, and F₅ families for disease resistance and agronomic traits. Preliminary yield trials (PYT) which include mainly F₅ and F₆ will be conducted in non-replicated plots under natural conditions in the field. Selected material from these trials will also be evaluated for some quality traits in the laboratory. Lines are advanced from this generation to next either by single-seed-descent in the greenhouse or pedigree method in the field using the New Zealand and Arizona winter nurseries. Known molecular marker, particularly for diseases, protein, etc., will be utilized to screen this germplasm. These markers will be run in collaboration with the USDA-ARS, Fargo Genotyping Center.

4. Screening and evaluation of advanced and elite lines:

We will continue to test about 150, 100, and 50 lines in Intermediary (IYT), Advanced (AYT), and Elite Yield Trials (EYT), respectively. As in the past 3 years, the EYT yield trials will be conducted in Casselton, Prosper, and Langdon in Eastern ND (Red river valley). In collaboration with our colleague Dr Wiersma in MN, the EYT will continue to be planted at Alvarado and Wolverton, MN. We have been testing our YET at these two locations for the last 3 years. The yield trials generate agronomic and quality data, pests' reactions, and other data on traits such as bacterial reactions. These genotypes will be also evaluated in replicated hill plot nurseries grown in the Scab nurseries. Selected lines will be included in New Zealand or 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:

Samples from all yield trials 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):

Known robust molecular markers will be used to screen 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 Lab.). Several molecular markers for FHB resistance, particularly those located on chromosome 3BS (Sumai3) and 3AS (*Triticum dicoccoides*), 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):

Starting 2013, the URN was launched again to replace the Tri-State trails. While each breeding program has its own unique identity in term 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 program which is conceived to test the elite lines from a 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 three states breeding programs of spring wheat cultivars.

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;

Regional Linkages to Other Research Activities:

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.

Additional Sources of Funding:

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.

References:

- Cox, T.S., J.P. Shoyer, Liu Ben-Hui, R.G. Sears, and T.J. Martin. 1988. Genetic improvement in agronomic traits of hard red winter wheat cultivars from 1919 to 1987. *Crop Sci.* 28:756-760.
- Donmez, E., R.G. Sears, J.P. Shroyer, 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: Continuing Breeding Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers			
Principal Investigator(s) / Project Directors(s) Mohamed Mergoum	<u>Funds Requested For</u>		
	Year 1 (2014)	Year 2 (2015)	Year 3 (2016)
A. Salaries and Wages	\$	\$	\$
1. Co-principal Investigator(s)			
2. Senior Associates			
3. Research Associates - Post Doctorate	12,000	12,000	
4. Other Professionals			
5. Graduate Students			
6. Prebaccalaureate Students	8,000	8,000	
7. Secretarial - Clerical			
8. Technical, Shop and Other			
B. Fringe Benefits @ 35% and 10%	5,000	5,000	
C. Nonexpendable Equipment (Planting and harvesting equipment use)			
D. Materials and Supplies	14,000	14,000	
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	
TOTAL AMOUNT OF THIS REQUEST (per year)	65,000	65,000	

Project: Continuing Breeding Adapted Spring Wheat Cultivars to Better Serve MN Wheat Growers

Budget Justification

Mohamed Mergoum, NDSU, Fargo, ND

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 is 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. This help is crucial for the spring wheat breeding program investigators to achieve the objectives of this project.

D. Materials and Supplies (\$14,000): 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 locations in MN and Eastern ND. The 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 and or technicians 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, peridium,...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.