

Agriculture MREDI Grant
Quarter 1 Report
November 18, 2015

The Agriculture component of the MREDI Grant has gotten off to a great start. Field trial locations have been identified, samples have been collected and are currently being analyzed and new technology is starting to take shape. Tracy Ellig from the MSU Communications Office also produced a short YouTube video detailing the components of the Agriculture project titled 'Improving Revenues & Efficiency of Montana's Farm & Ranch Lands' – we invite you to view it at: <https://www.youtube.com/watch?v=UWoTrwG0o6A>.

Research Center/MAES subproject of the Agriculture MREDI Grant

41W225 – Principal Investigator: Barry Jacobsen; Email: bjacobsen@montana.edu

Progress towards milestones

Overview of grant presented to Leadership MSU, Leadership Montana, Montana Pulse Day, MAES Advisory Committee and Advisory Committees at NARC-Havre and SARC-Huntley.

Hiring

- Roger Hybner: 0.75 FTE Research Associate at the NARC; will assist with the planning, design and implementation of field crop research projects and coordination of livestock related research pertaining to this project
- Shana Wold: 0.25 FTE Ag MREDI Project Coordinator

Expenditures

- Total Personnel Services: \$10,999.60
- Total Operations: \$39.17

Pulse Crop Research subproject of the Agriculture MREDI Grant

41W211 – Principal Investigator: Chengci Chen; Email: cchen@montana.edu

Progress towards milestones

- Samples of 8 varieties were collected from 10 locations across Montana to analyze protein contents (320 total samples).
- 320 Soil samples corresponding to pea test sites above were also collected and sent to John Peters' lab to analyze microbial community.
- Protein contents of pea samples will be analyzed this winter.
- One postdoc research associate is yet to be hired to study pea nitrogen fixation.

Expenditures

- Total Personnel Services: None to date
- Total Operations: None to date

Soil Microbiology and Pea Protein subproject of the Agriculture MREDI Grant

Progress towards milestones

- 1) Research sites identified and soil samples collected from all sites – Collaborator: Dr. Perry Miller
 - a) Post Agronomy Farm- Samples collected every two weeks. Six sets of samples from 8/13/15, 8/27/15, 9/10/15, 9/24/15, 10/9/15, and 10/22/15 already collected. Have not sampled after 10/22/15. The site has winter wheat planted and with changing weather conditions don't want to damage crop. If weather dries out, will continue to sample.

- b) Montana Ag Experimental Stations – Collaborator: Dr. Chengci Chen: all samples have been collected
- | | |
|------------------|--------------|
| Northern | Eastern |
| Western | Central |
| Southern | Northwestern |
| Western Triangle | |
- 2) Soil samples prepared for sequencing of 16s rRNA and soil chemistry
- Able to extract high quality DNA from soils
 - Tested and begun screening 16s rRNA with 515F/806R primers
 - Michigan State identified for cost effective/ high quality Illumina MiSeq sequencing
 - University of Idaho identified for broad range soil chemistry
- 3) Perry Miller has made contact with Montana State Grain Lab and United Pulse in attempt to streamline collection of 1000 farmer-produced, field-specific pea samples from throughout MT for protein content determination
- 4) Carl Yeoman reports that his team has begun organizing previously collected samples of Bison, Elk, Sheep, and Deer rumen and will soon collect fresh cow rumen to use for screening and isolation of nitrate and nitrite reducers. We also expect to have our AACUC submitted by the end of September.
- 5) Timeline
- All samples processed and ready to be sent sequencing and chemistry by mid-December.
 - Analyze data through winter and into spring
 - Begin to identify follow up experiments.
 - Greenhouse experiments using intervention for higher pea and wheat yield.
 - qRT-PCR to better analyze nitrogen fixation.
- 1) **41W212 – Principal Investigator:** Perry Miller, Email: pmiller@montana.edu

Hiring

- Mike Bestwick: Research Associate scheduled to start 01/04/2016

Expenditures

- Total Personnel Services: None to date
- Total Operations: None to date

- 2) **41W220 – Principal Investigator:** John Peters; Email: john.peters@chemistry.montana.edu

Hiring

- Julie Zickovich: research associate hired August 2015. Julie has a Masters in Evolutionary Biology from San Diego State University and has been at Montana State University in the Department of Microbiology and Immunology since 2007. Julie was hired because of her experience in multivariate statistics which is a key component in the analysis and interpretation of this project
- Justin Vetch: research associate hired to start January 1, 2016. Justin Vetch is a senior in the department of Chemistry and Biochemistry. Justin is receiving research credit for being involved with the project and plans on attending graduate school.

Expenditures

- Total Personnel Services: \$14,537.13
- Total Operations: None to date

3) 41W213 – Principal Investigator: Carl Yeoman; Email: carl.yeoman@montana.edu

Hiring

- Sarah Olivio: post-doctoral student hired August 2015 has been assigned/funded to my portion of the project.

Equipment Purchased

- Have not purchased the bioreactor yet because the company has been slow in responding to the purchase request.

Expenditures

- Total Personnel Services: \$13,449.70
- Total Operations: \$2,208.20

Cover Crop/Grazing subproject of the Agriculture MREDI Grant

Progress towards milestones

Cover crop research trials were planned with co-PIs Glunk and Hatfield and faculty at the 7 MAES Agricultural Research Centers. Specific trials planned are mixtures of fall seeded cover crops, these trials will be done in fall of 16 with initial research this year on survivability of single species at the 7 MAES Agricultural Research (it is likely there will be great difference between Research Centers) and 30 mixtures or single species of spring seeded cover crops. Protocols were developed for experimental design, forage harvest and quality measurements and for grazing by beef cattle at Havre and sheep at Bozeman.

1) 41W214 – Principal Investigator: Darrin Boss; Email: dboss@montana.edu

Hiring

- None to date

Expenditures

- Total Personnel Services: None to date
- Total Operations: None to date

2) 41W227 – Principal Investigator: Emily Glunk; Email: emily.glunk@montana.edu

Hiring

- None to date

Expenditures

- Total Personnel Services: None to date
- Total Operations: None to date

On-Farm Precision Experiment subproject of the Agriculture MREDI Grant

1) 41W215 – Principal Investigator: Bruce Maxwell; Email: bmax@montana.edu

Progress towards milestones

- Philip Davis was hired as technician to facilitate communication, data transfer and manage logistical aspects associated with collaborator farms. Phil has made site visits to 8 farms and we now have 5 farms that will act as full cooperators in the On-Farm Precision Experiment (OFPE) field research.
- We purchased a CropScan protein analyzer for combines and have mounted it on Chuck Merja's combine for calibration and testing. Phil has been to the Merja farm repeated times to help conduct calibration tests.

- We are also working close with Triangle Ag consultants in Fort Benton to learn about protein analyzer combine installation and identify more collaborators.
- We are negotiating with Next Systems (manufacturer of CropScan protein analyzer) to purchase 3 or 4 more protein analyzers.
- We will have 2 or 3 levels of cooperators in this project.
 - The 5 or 6 farmers named below will provide full participation in the study because they have stored previous spatial yield data from the fields that we will study and implement the OFPE, they are technologically savvy and they have the ability to site specifically apply fertilizer.

Current OFPE farmers:
 Gary Broyles, Rapelje, MT
 Jess Wood, Fort Benton, MT
 Chuck Merja, Sun River, MT
 Mark Van Dyke, Hyline Farms, LLC, Manhattan, MT
 Herb Oehlke, Conrad, MT
 - A second level of participation will be from farmers that have some aspect of the above criteria, but not all, and are interested in implementing the OFPE at some level.
 - A possible third level are farmers without any of the technology but are interested in adding some aspects of the technology and possible implementation of the OFPE.
- We have created a database of all of these farmers and will invite them to meetings of the reconstituted Precision Agriculture Research Association (PARA) with the first held in Great Falls in February 2016.

Hiring

- Philip Davis: technician hired to facilitate communication, data transfer and manage logistical aspects associated with collaborator farms.

Equipment

- CropScan protein analyzer for combines: \$23,030

Expenditures

- Total Personnel Services: \$20,580.53
- Total Operations: \$648.51

2) **41W226 – Principal Investigator:** John Sheppard; Email: john.sheppard@coe.montana.edu

Hiring

- Janette Rounds: Graduate Research Assistant
- Michael Trenk: Student worker

Expenditures

- Total Personnel Services: \$1182.82
- Total Operations: None to date

3) **41W228 – Principal Investigator:** Clem Izurieta; Email: clem.izurieta@gmail.com

Progress towards milestones

- We have created separate Forge projects for the CORE, QA/QC, Decision Support & the DB schema design work.
- We have already logged issues/action items with all groups.
- We have established regularly scheduled meeting times.
- Started evaluating existing raw data files from two separate sources.
- Mike Trenk is developing an initial prototype NoSQL DB.
- Seth Mason has designed an initial DB schema.
- Jenna Lipscomb is investigating the viability of using OpenMI as a way to provide information.

- Jenna Lipscomb and Thomas Heeterderks are identifying VOEIS components we can use.
- Clem Izurieta has initiated an initial workflow prototype.
- Nic and Philip have started working on Qa/QC of data through the Yield Editor. Our group will use this data to help with the design of the DB and programatic interfaces.

Hiring

- Mike Trenk: Student worker set to start September 2015 (MSU student). Mike is hired as an MS student for Clem for the duration of the grant. He is currently on track to finish his undergraduate degree and will commence in the Spring of 2016 as an MS. He is working on DB schema design.
- Jenna Lipscomb: Student worker set to start September 2015 (MSU student). Jenna is hired as a coder until the end of the Fall 2015. She is a senior in CS and she will be re-evaluated at the end of the semester; working on the reverse engineering of the current VOEIS architecture.
- Seth Kurt Mason (Lotic Hydrological). Hired for the duration of the grant at an amount not to exceed \$36K; working on DB schema design.
- Thomas Heeterderks (Research Computing Group). Hired 0.2 time; working on the reverse engineering of the current VOEIS architecture.
- Pol Lovet (Research Computing Group). Hired 0.05 time.

Equipment

- \$20K encumbered for storage with the Research Computing Group

Expenditures

- Total Personnel: None to date
- Total Operations: None to date

Durum Quality subproject of the Agriculture MREDI project

41W221 – Principal Investigator: Mike Giroux; Email: mgiroux@montana.edu

Progress towards milestones

- Samples collected: Durum field trials were harvested and have been cleaned and prepared for further testing. The samples collected consists of current and future varieties grown at MT research stations as well as populations in development. For the populations under development a total of more than 700 rows were harvested and seed from a selection of these individual rows will be planted in Arizona by Northern Seeds personnel to advance toward Montana field trials in 2016. Grain hardness and protein content have been measured on half of the samples grown in Bozeman.
- New durum populations: Advanced durum genotypes and varieties were selected and planted in the greenhouse for crossing. First crosses for these new breeding populations have now been completed and the F₁ seeds are maturing.

Hiring

- Andrew Hogg, M.S.: hired as a research associate. Andrew has ~15 years of experience in wheat genetics and end product quality.
- Kendra Hertweck: hired as an undergraduate lab assistant; she is currently a MSU senior.

Equipment

- Quotes were obtained and purchase orders were placed for the equipment required to complete this project, including:
 - Perten Glutomatic. The order has been placed and it will arrive in late November 2015.
 - Brabender Quadrumat Jr. Mill. This mill is on order and due to arrive in late December 2015.
 - Perten falling number apparatus was ordered and has arrived. We are now proficient at using this piece of equipment and it will be used to screen several durum populations.

Expenditures

- Total Personnel: None to date
- Total Operations: None to date
- Total Equipment: \$17,680.00

Wheat Stem Sawfly subproject of the Agriculture MREDI project

41W222 – Principal Investigator: David Weaver; Email: weaver@montana.edu

Progress towards milestones

- We have cursorily collected one site thus far and did a quick comparison on the size of the pre-pupal parasitoids inside cocoons. At this point in development of the immature overwintering parasitoids the ones from fields next to peas were 17% larger than those next to fallow.
- We have identified 10 potential contacts, over a broad area of the State, where we can make paired observations on the abundance and size of wheat stem sawfly parasitoids in wheat adjacent to fallow; compared with wheat adjacent to flowering crops.

Hiring

- Ben Fischer, undergraduate student, was hired for the project and started on November 1st.

Expenditures

- Total Personnel: None to date
- Total Operations: None to date

Weed Imaging/Pulse Crop Herbicide subproject of the Agriculture MREDI project

1) 41W217 – Principal Investigator: Prashant Jha; Email: pjha@montana.edu

Progress towards milestones

- Herbicide carry-over studies for successful integration of pulse crops in cereal-based cropping systems: field studies have been initiated across multiple locations: Huntley, Moccasin, Havre, and Sidney, MT, starting September 20, 2015. There are 3 major objectives of these field studies:
 1. Effect of fall-applied soil residual herbicide programs on pea, lentil, and chickpea tolerance and weed control (emphasis on kochia and Russian thistle control) in the following year (*plots established*)
 2. Effect of Group 2 Sulfonylurea herbicides applied in the fall PRE and spring POST in winter wheat (including Clearfield wheat varieties) and carry-over to pea, lentil, and chickpea (*plots established*).
 3. Spring-applied PRE/POST herbicide tolerance (variety response) and weed control in pea, lentil, and chickpea. Protocol for Objective 1 (multi-location field study) is shown below (as an example):

Trt No.	Treatment Name	Form Conc	Form Type	Other Rate	Other Rate Unit	Appl Code	Appl Description	Rep 1	Rep 2	Rep 3
1	METRIBUZIN 75 DF	75	DF		4 oz/a	A	FALL-APPLIED	101	217	303
2	METRIBUZIN 75 DF	75	DF		8 oz/a	A	FALL-APPLIED	102	216	314
3	SPARTAN CHARGE		4 SL		6 oz/a	A	FALL-APPLIED	103	213	311

4	SPARTAN CHARGE	4 SL	12 oz/a	A	FALL-APPLIED	104	209	307
5	VALOR SX	51 WG	3 oz/a	A	FALL-APPLIED	105	210	317
6	VALOR SX	51 WG	6 oz/a	A	FALL-APPLIED	106	212	302
7	CORVUS	2.63 SC	4 oz/a	A	FALL-APPLIED	107	211	304
8	CORVUS	2.63 SC	8 oz/a	A	FALL-APPLIED	108	201	313
9	AUTHORITY MTZ	45 DF	8 oz/a	A	FALL-APPLIED	109	204	301
10	AUTHORITY MTZ	45 DF	16 oz/a	A	FALL-APPLIED	110	215	310
11	CORVUS	2.63 SC	3 oz/a	A	FALL-APPLIED	111	214	316
	METRIBUZIN 75 DF	75 DF	4 oz/a	A	FALL-APPLIED			
12	CORVUS	2.63 SC	6 oz/a	A	FALL-APPLIED	112	207	308
	METRIBUZIN 75 DF	75 DF	8 oz/a	A	FALL-APPLIED			
13	ANTHEM FLEX	4.3 SC	3.64 fl oz/a	A	FALL-APPLIED	113	205	309
14	ANTHEM FLEX	4.3 SC	7.28 fl oz/a	A	FALL-APPLIED	114	208	315
15	PROWL H2O	3.8 SC	16 fl oz/a	A	FALL-APPLIED	115	206	305
	OUTLOOK	6 EC	18 fl oz/a	A	FALL-APPLIED			
16	PROWL H2O	3.8 SC	32 fl oz/a	A	FALL-APPLIED	116	203	312
	OUTLOOK	6 EC	36 fl oz/a	A	FALL-APPLIED			
17	NONTREATED					117	202	306

- Precision Weed Control: Field studies on precision optical sensors and spot-spray system (WeedSeekers) will be continued in spring of 2016. During 2016, we will test the efficacy of WeedSeeker technology using a 30 ft. tractor-mounted precision sprayer (30 sensor units spaced 12 inches apart) in large-scale plots in fallow. Demonstration plots for growers will also be established across Montana during various MAES/DRC field days. Additionally, collaborative work has been initiated with the MSU Department of Electrical Engineering/Optics on testing new, low-cost optical sensors, for weed mapping and for hyperspectral imaging to differentiate between herbicide-resistant vs. susceptible weed species, such as kochia, wild oat, and downy brome predominant in MT cropping systems. Hyperspectral images and algorithms will be developed to differentiate between a crop and a weed species. The aim of this research is to utilize this technology for selective control of resistant weeds in the field, and detecting and spraying specific problematic weeds in a crop field. Plants are currently being grown in the greenhouse at SARC for the hyperspectral imaging data collection and analysis during this fall.

Hiring

- A post-doctoral research associate at SARC has been identified to work on this project.

Equipment

- We are in the process of purchasing an environmentally-controlled growth chamber at SARC, Huntley, as indicated in the grant budget (awaiting shipment). The growth chamber will be used starting this October, 2015 to conduct environmentally-controlled (representing MT) bioassays for herbicide carry-over issues in cereal-pulse rotation across diverse soil types in Montana. A portion of the funding from this grant has been allocated for greenhouse and field research supplies, and as subcontracts for conducting the off-station (multi-location) field trials across the state during this quarter.

Expenditures

- Total Personnel: None to date
- Total Operations: None to date

2) 41W216 – Principal Investigator: Joseph Shaw; Email: jshaw@montana.edu

Progress towards milestones

The primary focus of this subproject is to develop optical remote sensing methods for enabling spot spraying to reduce herbicide costs and for detecting and identifying weeds growing amid crops. During this first quarter our accomplishments have been primarily identifying and appointing personnel, beginning procurement of specialized equipment, and making plans for experiments to be conducted in preparation for the 2016 growing season. For the latter, we visited with Dr. Prashant Jha at the Southern Agricultural Research Center to carefully examine the commercial system that Prashant is experimenting with as a possible method for enabling spot herbicide spraying (so that we could assess what needs to be done to adapt our potentially lower-cost alternative for this task). We also made plans for Prashant to grow several herbicide-resistant and non-resistant weeds in the greenhouse so that we can collect hyperspectral images to begin the process of developing possibly unique spectral reflectance signatures and associated algorithms that can be used for weed species identification. Finally, we also began training a new PhD student to conduct hyperspectral imaging experiments and process hyperspectral imaging data.

Hiring

- Dr. Joseph Shaw: subproject director (to receive partial summer salary only)
- Mr. Paul Nugent: Research Engineer and Ph.D. student (partial academic year salary)
- Mr. Andrew Donelick: Ph.D. student

Equipment Procurement

- We have submitted purchasing paperwork for a Resonon Pika IIg hyperspectral imaging system, scanning tripod, and narrow-field and wide-field lenses (Resonon is a local Bozeman optics company). Delivery is expected by early November 2015.

Expenditures

- Total Personnel: \$1.39
- Total Operations: \$287.95

Film Production for the Agriculture MREDI Grant

41W218 – Organizer: Eric Hyyppa; Email: eric_hyyppa@montanapbs.org

Progress towards milestones

Because the majority of the visual components of the video report take place in the warmer months of 2016, we are largely in the pre-production phase. This means that initial questionnaires have been sent to all involved parties regarding their role in the research and when said research takes place. Preproduction meetings have also taken place with Barry Jacobsen to get the “broad strokes” of the piece in place. That said, two days of filming *have* occurred on August 3rd and 4th, 2015 at Fort Ellis Research Farm outside of Bozeman. During this time, we filmed the harvest of lentils in crop/fallow fields; the sampling of pulse crops in formerly fallow fields; and the release of sheep into said pulse crops for grazing.

Equipment Procurement

- Please note that \$4195.00 of the \$8344.99 was towards the purchase of a camera that has subsequently failed mechanically and been returned for a full refund leaving the current spent amount for minor production equipment at approximately \$4149.

Expenditures

- Total Personnel: \$0.00
- Total Operations: \$8,344.99

Economic analysis subproject of the Agriculture MREDI project

41W219 – Principal Investigator: Anton Bekkerman; Email: anton.bekkerman@montana.edu

Progress towards milestones

I'm on track so far with the timeline that I submitted. I've acquired one set of data (daily historical elevator prices for various commodities in Montana) and am sending out a completed contract today to acquire the fertilizer price data. The next step, which I have already started working on, is to collect information about the factors influencing Montana's Ag market and develop and parameterize a model of those factors using estimates from the acquired data and information from the literature.

Hiring

- None to date

Expenditures

- Total Personnel: None to date
- Total Operations: \$7,500.00

Participatory research network subproject of the Agriculture MREDI project

Progress towards milestones

We have conducted two focus groups and have a third planned at the Montana Grain Growers Association (MGGA) Annual Conference in early December. The research team, Colter Ellis, Mary Burrows and George Haynes, has met and developed a research protocol, qualitative questionnaire and other tools to implement at the MGGA Annual Conference. PI Colter Ellis has submitted an IRB proposal that has been approved. Colter has also met with Perry Miller and Bruce Maxwell about recruitment for site visits and interviews. We have hired Tom Woods as a graduate research assistant from the Department of Political Science. The research team has a standing meeting every two weeks to discuss progress on these and other goals.

- 1) **41W224 – Principal Investigator:** George Haynes; Email: haynes@montana.edu

Hiring

- Tom Woods, a graduate student in Political Science has committed to the project and is working through the hiring process.

Expenditures

- Total Personnel: \$1,246.36
- Total Operations: None to date

- 2) **41W223 – Principal Investigator:** Colter Ellis; Email: colter.ellis@montana.edu

Hiring

- None to date

Expenditures

- Total Personnel: None to date
- Total Operations: None to date