

UW COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
GLOBAL PERSPECTIVES GRANT PROGRAM
Travel Report Due one month after completion (March 24th, 2013)

GLOBAL PERSPECTIVES GRANT REPORT

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Project Title: Assessing Biological N₂ fixation in dryland and natural ecosystems

Duration of Project: two approx.one-week visits

Funds were requested to cover travel expenses of Urszula Norton (UW Plant Sciences Department) to visit Bangor University in Wales, UK (<http://www.bangor.ac.uk>) and to host her collaborator, Dr. Thomas DeLuca (<http://www.bangor.ac.uk/senrgy/staff/deluca.php.en>) at the University of Wyoming. The first part of the grant (Urszula Norton's travel to Wales) was completed by July 22st 2012. The second part of the grant (hosting Dr. DeLuca on UW campus) was completed on February 25th 2013.

The leading hypothesis for this project was based on an increasing re-occurrence of cryptogamic crusts in dryland agroecosystem late in fall following crop harvest. The presence of these complex organisms (fungi associated with algae, and bacteria mostly) has been well researched in undisturbed natural ecosystems (Belnap, 2003, Burgoyne and DeLuca, 2009) and recognized for their importance as a soil cover and atmospheric dinitrogen (N₂) fixers (Anderson et al., 1982; Evans and Johansen, 1999, DeLuca et al., 2008). However, the precedence of the seasonal presence of cryptogams in agroecosystems and the contributions of cryptogamic crusts to the overall soil N budgets in dryland farming are not well known (Belnap et al., 2008). Interestingly, many dryland crop production systems do not have any fertilizer application mainly because of the sufficient soil N content determined by a soil test, which seems difficult to explain given the large amounts of N removed with annual harvest and crop residue. Nitrogen management in dryland agroecosystems is often mitigated by augmenting crops or hay with legume species. If cryptogams prove to be an important and sustainable source in dryland agroecosystem soil fertility management, then better understanding of the potential impacts on ecosystem biogeochemical processes need to be developed. Furthermore, the accounting for N inputs and N losses to GHG emissions need to be modified for these and possibly other dryland systems (DeLuca, 2009). Similar critical observations about the importance of non-symbiotic N fixers were made in boreal forests in between 2000 and 2008 in

Sweden and Montana, USA (DeLuca, personal communication). Therefore, I proposed to validate the importance of the cryptogamic crusts in managed cropping systems, which is a novel research direction in the area of dryland farming.

The goals of Urszula Norton travel was to learn and utilize methods for biological dinitrogen (N₂) fixation and utilize equipment and facility offered by Dr. Tom DeLuca at Bangor University in Wales, UK to analyze samples from on-going research projects located in WY. Tom DeLuca's generous offer to utilize his lab facility allowed assessing additional, yet unexplored aspects of the on-going research. Samples were collected from the following research projects: (1) the impact of no-till and conventional farming in long-term and transition to organic on soil nutrient cycling and greenhouse gas (GHG) emissions in High Plains of eastern Wyoming and western Nebraska awarded to Urszula Norton (PI) for a period of three years by AFRI NIFA Transition Organic Program (2) the impact of irrigated conventional, reduced inputs and organic cash crop and crop-livestock integrated systems on soil C and N budgets awarded to Urszula Norton (co-PI) for a period of three years by NRI Integrated Systems Program; and (3) the impact of massive scale bark beetle infestation on ecosystem N dynamics and GHG emissions in lodgepole pine forests awarded to Urszula Norton (co-PI) for three years through Agriculture Experiment Station Research grant.

Tom DeLuca (<http://www.bangor.ac.uk/senrgy//staff/deluca.php.en>) is an internationally well-known expert in the field of ecosystem C and N cycling with a broad expertise in environmental assessment of managed and natural ecosystems. His currently holds three independent affiliate positions: Professor at Bangor University in Wales, UK; Senior Associate for Subarctic Landscape Research in Ariablarg, Sweden and recently has accepted the position of the Director of School of Environmental and Forest Sciences at the University of Washington in Seattle WA.

SUMMARY OF URSZULA NORTON'S RESEARCH VISIT TO BANGOR UNIVERSITY

The main goal of the visit to Bangor was to conduct an experiment to solicit preliminary data that generate meaningful ideas for collaborative research and joint pursuit in grant writing in response to the upcoming NIFA AFRI rfp in spring 2013. This project managed to foster meaningful collaboration between University of Wyoming College of Agriculture and Natural Resources and Bangor University in UK and establish an open relationship for research and expertise exchange.

One week visit included laboratory work, a series of meetings with scientists and touring research sites. The total of 250 samples was analyzed. The process required method modification to establish appropriate QA/QC requirements for detection limits of the Gas Chromatograph. Sample analyses were also preceded by a series of sample pre-incubations as the only soil material we were permitted to ship was air-dried soil. This process required careful sample weighing, water addition, pre-incubation with and without-acetylene and troubleshooting the procedures.

The results of the laboratory analyses suggest that in order to assess optimum rates of non-symbiotic N₂ fixation from agricultural soils, it is best to analyzed field-moist material. However, surface residue, such as field residue and forest litter can be analyzed immediately

following a short period of laboratory pre-wetting. It was interesting to discover that forest floor litter material collected from bark beetle-infested sites had significantly greater presence on non-symbiotic N₂ fixers compared to uninfested sites. I am currently considering using this preliminary data in the process of development of a full NSF Ecosystem Studies proposal, which invitation I am still awaiting for pending the NSF acceptance of my pre-proposal submitted in January 2013. Pictures of laboratory set ups and analyzes are available upon request.

There are 12 faculty members involved in seven different research groups in the School of Environment, Natural Resources and Geography (SENRGY): Crops and Livestock; Conservation Science; Environmental and Soil Science; Forestry; Rivers and Catchments; People, Space and Place; and Geospatial Analysis. All research programs are invested in domestic and international collaboration. I visited with a number of faculty and students and discuss their research. I met with the following people: Professor Dave Chadwick whose research concentrates on GHG emissions from livestock integrated agricultural systems (<http://www.bangor.ac.uk/senrgy/staff/chadwick.php.en>) and Dr. Morag McDonald (<http://www.bangor.ac.uk/senrgy/staff/mcdonald.php.en>) who focuses on soil conservation and fertility. I was not able to meet with Dr. David Styles, Senior Lecturer in Carbon Footprint due to scheduling conflict.

SUMMARY OF THOMAS DELUCA'S RESEARCH VISIT TO UNIVERSITY OF WYOMING

Dr. Tom DeLuca's accepted the invitation to visit UW, which took place in the second part on February, 2013. His visit provided an opportunity for other faculty and students to interact attend his seminars and solicit feedback for on-going sustainable agriculture and other research projects (located at SAREC, SREC, on-farm research in Big Horn Basin and Wheatland area). Equally important was to learn about his ideas for assessment tools developed to evaluate agroecosystem sustainability and alternative practices used in different regions of the world that can be potentially applied in research and instruction at the University of Wyoming. Details of Tom DeLuca's visit are provided in the agenda below:

Thomas DeLuca visit to UW

Thursday February 24th, 2013

11 am- Arrive to Laramie, UW

12:00 pm- Lunch with Jay Norton

2:00-4:00 pm-Tour the campus

4:00 pm- Visit with Thijs Kelleners

4:30 pm-5:45 pm- Seminar: "**Agroecosystems and the Carbon Problem**" followed by a discussion with AECL 4990 Agroecology capstone seminar undergraduate students

7:00 pm dinner with Urszula Norton and Jay Norton

Friday, February 25th, 2013

8:00-9:00 breakfast at Turtle Rock with Dave Williams (<http://www.uwyo.edu/dgw/home.html>) and Bob Hall (http://www.uwyo.edu/pie/who_we_are/faculty.html#Robert O. Hall, Jr.)

9:00-11:00 meeting with Plant Sciences and Ecosystems and Environment Management graduate students (Ag 4004) (<http://www.uwyo.edu/plantsciences/department-directory/norton.html>)

11:00-12:30 pm visit with Elise Pendall Lab (BOT, conference room) (<http://www.uwyo.edu/botany/faculty/elise-pendall.html>)

12:30-1:00 lunch with graduate students

1:00-2:00 pm PSD Seminar open to campus: **“Biological N₂ Fixation Explains Ancient Sustained Use on High Latitude Alluvial Meadows”** Ag C 1032 (attended by more than 70 people)

2:15-3:00 – meet with graduate student Janet Chen and tour Isotope Lab-Berry Center – BC 210 (<http://www.uwyo.edu/dgw/janet.html>)

3:15-4:15 –meet with Pete Stahl –Director of the Reclamation Center (Ag 23)

4:30-5:00 meet with Urszula Norton

5:00-7:00 PiE Symposium and graduate student poster presentations- (<http://www.uwyo.edu/pie/symposium2013.html>)

Saturday, February 26th, 2013

Meet with Urszula Norton and discuss the results and data analyses for N₂ fixation.

Sunday, February 27th, 2013: Depart for Seattle, WA

Outputs, Outcomes, and Impacts

Global Perspectives International Travel Grant offered through the Agriculture Experiment Station allowed me to generate new knowledge on understanding the agricultural production resource base of Great Plains. Data from this collaborative research will help identify and refine relevant questions about crop and soil management for future larger-scale investigations. Results generated through this research became preliminary data for a regional-

scale project aimed to assess N inventories and N cycling across High Plains that can be further extrapolated to other moisture limited geographical areas. The originality of this research can create an open venue to apply for federal funding through NSF DEB Ecosystem Studies or AFRI NIFA Soil Processes programs.

Anticipated findings provided novel information that once explored further, can be published in high impact journals, similar to the research on biological N fixation in boreal forests (i.e. Science or Global Change Biology and Nature authored by Tom DeLuca and collaborators). Outcomes from this grant ensured collaborative relationships and a rich dataset that will contribute to on-going work. Results will become a part of the at 2013 Extension Bulletin as well as disseminated during presentations offered at organized field days and workshops for producers and Cooperative Extension Service personnel.

Requested travel funds increased my global perspectives content within teaching, research, and extension programs. The class I am currently teaching this spring (AECL 4990- Agroecology Seminar) benefitted from Tom DeLuca's presence, seminar presentation and class discussion on topics relevant to sustainability of the international agriculture.

One of the important outcomes of this application was to increase the capacity of UW employees and students to appreciate cultural differences of the perception and the importance of research and research application to practice on sustainable agriculture and organic farming that are highly prioritized in Europe. Dr. Tom DeLuca's Friday Invited Speaker seminar was extremely well received by the audience. I received a very positive feedback through emails and oral communication from a number of faculty and students who attended the seminar and graduate student meetings.

BUDGET

Travel and hosting	\$	3,379.37
Sampling, supplies, analytical and miscellaneous	\$	620.63
TOTAL	\$	4,000.00

Department of Plant Sciences

Visiting Scholar Seminar

Biological N₂ Fixation Explains Ancient Sustained Use of High Latitude Alluvial Meadows

**Dr. Thomas DeLuca, Director
School of Environmental and Forest Sciences
University of Washington, Seattle**



Friday, February 22

1:10 - 2 PM

Agriculture C Room 1032

Sponsored by Agricultural Experiment Station Global Perspectives Grant