2016 REACCH Summer Internship Program
Research Projects Description

University of Idaho

Agronomic, environmental and economic sustainability of organic, irrigated vegetable production

Mentors: Jodi Johnson-Maynard (Soil Science, UI) and Kate Painter (Agricultural Economics, UI)

Interest in local food production has increased within the Palouse region where non-profits, small business owners, and extension faculty are working to connect small-acreage vegetable producers with buyers. Vegetable production requires irrigation, unlike the typical, large-scale systems in the area that primarily produce dryland wheat. Increased water use is a concern given declining water levels in the aquifer that serves as the sole source of water for over 60,000 residents. A comprehensive study of water use by small-acreage vegetable producers has not been done, and the cost of common systems such as drip have not been evaluated in crop budgets. In this project, students will take a system-wide approach to assessing the impact of irrigation in the region, including uniformity of crop production, economic returns, and the sustainability of water resources (Hassan-Esfahani et al, 2015). In this project students can ask multiple questions and approach the sustainability of local food production from both an agronomic and economic standpoint. These questions include: What are the irrigation needs on small-acreage vegetable farms within the Palouse? What is the overall impact of local food production on the water levels in the aquifer system? Can increased costs of using drip irrigation be recouped when selling to a local system?

Learning objectives: Students will learn how to estimate water usage and assess water use efficiency. Development of enterprise budgets for crops, including calculating variable and fixed costs of production, with a specific application to organic vegetable production under drip irrigation in northern Idaho.

References:

Hassan-Esfahani, L., A. Torres-Rua, M. McKee. Assessment of optimal irrigation water allocation for pressurized irrigation system using water balance approach, learning machines and remotely sensed data. Agricultural Water Management 153:42-50.

Aphid and virus forecasting in pulse crops

Mentor: Sanford Eigenbrode (Entomology, UI)

Aphids pose an intermittent and therefore very challenging pest problem in dry legume production in northern Idaho and eastern Washington, one of the principal pulse growing regions of the U.S. Intermittent outbreaks of the pea aphid in the Palouse have been documented over several decades (Clement et al. 2010), and are associated with significant reduction in yields and economic returns to farmers (Elbakidze et al. 2011).

Aphids are direct pests of the crops (pea and lentil), but they are primarily injurious as vectors of *Pea enation mosaic virus* and *Bean leaf roll virus*. A monitoring system has been deployed for several years to help farmers anticipate aphids and virus risk based on monitoring aphids in a pan trap network, testing them for virus, and posting the results on a web site. Our group's recent work has shown that pea aphids arriving in the traps are from different host races that potentially represent significantly different levels of risk to the legume crop. In this project, students will improve this monitoring system by considering host race identity of pea aphids migrating into the region. Specific research questions include: What are the virus transmission efficiencies of each of four identified host races, now maintained in laboratory colonies? How does host race composition of immigrating aphids detected in traps relate to incidence of virus in adjacent legume fields?

Learning objectives: Students will learn how to identify pea aphids in the field and in trap contents, rear aphids and use them in virus transmission studies, take tissue samples from plants for virus detection using ELISA, and extract DNA from aphids for use in biotyping.

References:

Clement, S., L. Husebye, and S.D. Eigenbrode. 2010. Ecological factors influencing pea aphid outbreaks in the US Pacific Northwest. P. 108-128; In Global Warming and Aphid Biodiversity: Patterns and Processes, Kindlmann et al (eds). Springer, Dordrecht.

Elbakidze, L., L. Lu, and S. Eigenbrode. 2011. Evaluating vector-virus-yield interactions for peas and lentils under climatic variability: A limited dependent variable analysis. Journal of Agricultural and Resource Economics 36:504-520.

Understanding phosphorus dynamics for management of water quality

Mentors: Erin Brooks (Hydrologic Modeling, UI) and Scott Fennema (UI)

Eutrophication ranks as a leading cause of water quality impairment in the United States (U.S. Environmental Protection Agency 1996; Sharpley et al. 2003). To improve water quality, states are required to develop nutrient management plans in places where nutrient levels exceed a given standard based upon a beneficial use of a water body. These standards can be set through a myriad of methods from data-driven decision making (U.S. Environmental Protection Agency 1999) to simple index modeling exercises (Sharpley et al. 2003). This variation leads to question how much data is enough to provide an accurate representation of nutrient loading; our project will focus on the transport of phosphorus. Potential student research questions include: how do phosphorus concentrations vary spatially through various soil types and land use? How accurate is the coefficient loading model at quantifying phosphorus transport? This project would require a blend of field work, lab work, detailed literature searches and computer modeling.

Learning Objective: Students will gain an understanding of phosphorus distribution within a landscape. Students will develop a simplistic decision support tool that provides an estimate of phosphorus loading which will aid managers in the development of a nutrient management plan.

References:

Sharpley a N, Weld JL, Beegle DB, et al (2003) Development of phosphorus indices for nutrient management planning strategies in the United States. J Soil Water Conserv 58:137–152.

U.S. Environmental Protection Agency (1996) Environmental indicators of water quality in the United States. EPA 841-R-96-002 30.

U.S. Environmental Protection Agency (1999) Protocol for Developing Nutrient TMDLs.

Social analysis of Producers' Integrated Perspectives on Agro-Ecological Classifications

Mentor: J.D. Wulfhorst (Rural Sociology and Social Science Research Unit – SSRU, UI)

Agricultural producers in the Inland Pacific Northwest region face unique impacts and opportunities from climate change effects. As a core region of cereals grain production, producers' decisions about climate adaptation will affect food security as well as local rural economies tied to their production capacities and efficiencies. The perspectives producers hold will guide change to operations, risk management, and potential adaptation in scale and form that could be unprecedented in rate, complexity of factors needed, and new phenomenon (eg, seasonal shift to a wetter and warmer regime). Our group's work within REACCH (Obj4) has collected cross-sectional survey data (2012 & 2015) from representative populations of producers in the region. These datasets will serve as the basis for agro-ecological classification (AEC) analyses of the farm population as a whole. To aid climate model forecasting of potential AEC shifts and changes, integration of multiple datasets is needed in conjunction with ongoing response from the producer and stakeholder (sh) communities. In this project, the student will collaborate with a small team to lead development of the following: 1) design and logistics for two workshops to create producer input in AEC-related analyses; 2) design of data collection instruments to measure producer/sh responses; and 3) design outreach/extension materials for disseminating workshop results, including academic presentation and publication. The specific research question is 'what factors dominate producer perspectives about the risks and benefits of changing operations from climate change?'

Learning objectives: The student will learn how to conduct qualitative sampling for social science research, analysis and presentation of quantitative survey results, create data integration options, workshop design and facilitation, collaborate across team/objective groups, and get training in a variety of software skills needed to conduct the workshops.

Oregon State University

Sensitivity of Fine Indicators for Evaluating Quality Changes in Soil Organic Matter to Tillage under Winter Wheat - Spring Pea Rotation in Dryland Pacific Northwest

Mentors: Stephen Machado (Agronomy) and Rakesh Awale (Post-Doctoral Scholar) Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, OR

The ongoing long term wheat-pea experiment (WP-LTE) experiment (established in 1963) at Oregon State University (OSU) Columbia Basin Agricultural Research Center (CBARC) located near Pendleton, OR aims to identify the potential effects of tillage intensity and timing on soil quality, particularly soil organic carbon (SOC). Physical, chemical, and biological fractions of SOC are typically more sensitive to changes in soil management practices and provide early indication of changes in the SOC dynamics than commonly reported total SOC alone. This study will compare the influences of different tillage systems (fall chisel, fall plow, spring plow, and no-till) on total SOC and N, as well as on several fine indicators of soil quality (mineralizable C and N, soil microbial biomass C and N, particulate organic matter C, and water extractable organic C). This project will help develop management strategies to improve soil quality and productivity for sustainable wheat-pea cropping systems, as well as inform the growers, researchers, and policy makers with potential soil C sequestration strategies to offset anthropogenic CO_2 emissions in the PNW.

Learning Objectives: The student intern in the program will closely work with faculty and research technicians at the CBARC, and will be exposed to field and laboratory experiments and experimental design, soil sampling techniques, laboratory analyses of samples, field and laboratory equipment and instruments, data recording, spreadsheet management, and statistical analysis techniques. The individual will perform a wide range of duties which include but are not limited to:

- Soil sampling and conduct laboratory assessment of soil quality parameters.
- Data collection, management, and analysis.
- Writing report and presentation.

Creating online tutorial materials for AgBiz Logic, a decision support tool for farmers.

Mentors: Clark Seavert (Agricultural and Resource Economics, OSU), Susan Capalbo (Applied Economics, OSU) and Laurie Houston (Applied Economics, OSU)

The AgBiz Logic TEAM is seeking an individual to develop online visual tutorials for AgBiz Logic and its upcoming AgBizClimate application. The individual must be self-motivated and able to work independently to develop a video with narrative that can help users navigate through the product features. AgBiz Logic is a suite of economic, financial, and environmental decision tools for businesses that grow, harvest, package, add value, and sell agricultural products. The tutorial will be used to show users how alternative management practices such as those initiated in response to climate change and climate change policies will impact the farm level net returns and environmental outcomes. For more information about AgBizLogic, go to www.agbizlogic.com.

The student will work with faculty members to develop a tutorial package for AgBiz Logic, and will gain first-hand experience with climate change impacts and adaptation implications for farmers, environmental outcomes, and the economics of agricultural systems.

Skill level: Must have significant experience with visual communications and multimedia technologies and an understanding of the challenges users experience as they maneuver through online programs. Must also have experience with editing videos, creating multimedia presentations and/or learning modules using programs such as PowerPoint, ispring, adobe captivate or similar programs.

Learning Objectives:

- Explore marketing and communication approaches for agricultural producers
- Understand how to recruit and retain agricultural producers with online economic and financial programs
- Learn how the diversity of age groups in agriculture approach online programs.

Development of a GIS Database to Support Ongoing Multidisciplinary Research on Coastal Resilience in Oregon

Mentors: Steven Dundas, David Lewis, Susan Capalbo, and Laurie Houston (Applied Economics, OSU); Christopher Parrish (Civil and Construction Engineering, OSU)

Researchers in the Applied Economics and Civil and Construction Engineering Departments at Oregon State University are seeking an individual to help develop and maintain a comprehensive Geographic Information System (GIS) database to support economic, engineering, and ecological modeling efforts for a multidisciplinary research program. This work will support various research pathways, including (but not limited to) analyses of the capitalization of chronic (climate change) and acute (tsunami inundation) risk in coastal housing markets and of the economic impacts of conversion of agricultural land to tidal salt marshes to stabilize estuaries against sea-level rise.

The individual must be self-motivated, able to work independently, and have experience with GIS and computer programming. The intern would receive some training on GIS methods and then would work with faculty members to develop a comprehensive GIS database of coastal Oregon. Duties include compiling existing publicly available spatial data (incl. hazard maps, climate data, and land use changes) and performing preliminary analyses associated with the risks and amenities in coastal areas. The student will also gain first-hand experience working alongside researchers from different fields of study (incl. environmental & resource economics, civil engineering, coastal ecology, and geomorphology) on a large multidisciplinary research project.

Skill level: A successful applicant will have an interest in applied economics, GIS and spatial analysis, environmental and resource policy issues and coastal resilience, with a plan to pursue a graduate education. The individual must also have significant experience with data processing and GIS systems (i.e. ArcMap).

Learning Objectives:

- Develop an understanding of GIS and how spatial data is a vital component of contemporary multi-disciplinary research.
- Learn about the linkages between economic actions and environmental consequences.
- Frame and discuss the spatial complexities of coastal management and risk.

Washington State University

Defining subsoil characteristics to improve crop water and nutrient use as climate change increases water stress of semi-arid lands

Mentors: Dr. Bill Pan (WSU Crop and Soil Sciences), Dr. Tai Maaz (WSU Crop and Soil Sciences) and Isaac Madsen (PhD candidate WSU Crop and Soil Sciences)

Intensive land management can lead to soil compaction and deficiencies of soil nutrients, poor soil structure, and water infiltration, all of which negatively affect plant growth and development (Pan, 2015; Brown and Huggins, 2012; Schillinger et al., 2007). Impacts on subsoil quality can vary depending on practice. Systems that incorporate diverse plant types, build soil organic matter and reduce soil disturbance have the potential to improve soil quality and reduce the negative impacts associated with management (Hanson et al., 2007; Liebig et al., 2007). The quality of the subsoil is particularly critical in semi-arid regions where crops rely on subsoil for water and nutrients. In this project, students will have an opportunity to analyze subsoil quality and soil management factors of agricultural systems in the dryland region of the Pacific Northwest (e.g., alternative broadleaf-cereal rotations, reduced tillage systems, pasture, and forage systems, and prairie rangeland). Information about specific management practices that improve soil quality will be prepared as educational resources for regional farmers and ranchers. Specific research questions include: How does subsoil water and nutrient holding capacity and availability compare among different systems? How do management practices improve root proliferation, subsoil water and nutrient use across varying crop ecological zones?

Learning objectives: Students will learn techniques in soil water and nutrient analysis, root sampling and digital root imaging and spatial analysis, and field experimental design and characterization. In addition, they will learn the geological history of soil formation in this unique region of the world during their team road travels to experimental sites. Finally, they will be able to relate information about subsoil quality in the context of management strategies to farmer and land manager interests.

References:

Brown, T., and D.R. Huggins. 2012. Soil carbon sequestration in the dryland cropping region of the Pacific Northwest. Journal of Soil and Water Conservation 67:406-415.

Hanson, G.J., L. Caldwell, M. Lobrecht, D. McCool, S.L. Hunt, D. Temple. 2007. A look at the engineering challenges of the USDA Small Watershed program. Transactions of the ASABE 50:1677-1682.

Liebig, M.A., D.L. Tanaka, J.M Krupinsky, S.D. Merrill, J.D. Hanson. Dynamic cropping systems: Contributions to improve agroecosystem sustainability. Agronomy Journal 99:899-903.

Pan, W. 2015. The Roots of Soil Fertility. Invited Leo M. Walsh Soil Fertility Distinguished Lectureship, presented at ASA-SSSA-CSSSA meetings, Minneapolis, MN, December 16, 2015. https://scisoc.confex.com/scisoc/2015am/videogateway.cgi/id/23020?recordingid=23020

Schillinger, W.F., A.C. Kennedy, D.L. Young. 2007. Eight years of annual no-till cropping in Washington's winter wheat-summer fallow region. Agriculture Ecosystems and Environment 120:345-358.

The effect of insects and disease on biological nitrogen fixation

Mentors: David Crowder (Entomology, WSU) and Paul Chisholm (Entomology, WSU)

Nitrogen is a critical nutrient that most plants obtain from the soil. However, legume crops such as pea, lentil, and garbanzo bean are unique in their ability to "self-fertilize" by taking nitrogen from the air and converting it to soil-based forms accessible to plants of all kinds. But legumes can't do this on their own, they need the help of microscopic, soil-inhabiting bacteria called Rhizobia to make it happen. This symbiotic relationship makes legumes key components of many cropping systems. Surprisingly, we know little about how a plant's life events may influence its ability to fix atmospheric nitrogen in this way. Over a growing season, plants experience a wide range of stressors, including insects and disease, which may affect their ability to self-fertilize. Our project seeks to understand how biotic plant stressors, namely insect pests and plant viruses, may influence nitrogen fixation. Students will design and implement a controlled ecological experiment in an outdoor, field-based setting examining how insects and disease affect nitrogen fixation in peas.

Learning objectives: Students will become familiar with the challenges facing farmers growing peas in northern Idaho/eastern Washington. They will rear and maintain colonies of insects, and will plan and execute an independent field experiment. Although not a core component of the project, students will also have to the chance to learn and perform various molecular-level techniques, such as the 15-N isotope labeling method used to measure biological nitrogen fixation. This interdisciplinary project will provide broad exposure to the fields of ecology, plant pathology, entomology, and soil science.

Unraveling the Diversity in Downy Brome Seed Dormancy

Mentors: Ian C. Burke (Weed Scientist, WSU), and Amber L. Hauvermale (Associate of Research, WSU).

Downy brome (*Bromus tectorum* L.) is one of the worst invasive weed species in both agricultural and rangeland environments in the United States (Morrow and Stahlman, 1984; Novak et al., 1993). Also known as cheat grass, downy brome adapts to changes in resource availability and environment, and interferes with the growth of other established plants. In the inland Pacific Northwest (PNW) downy brome is highly competitive in small grain production systems because it emerges throughout a growing season due to extensive variability in seed dormancy (Rydrych and Muzik, 1968; Stahlman and Miller, 1990; Blackshaw, 1993). Screening of PNW downy brome populations indicates that at least 4 distinct seed dormancy scenarios persist in the region and may even occur within the same field! Currently deployed rotational management strategies do not consider downy brome seed dormancy scenarios, and may not adequately address specific infestation types within a field or a region. To address this need, important dormancy, germination, and emergence studies will be conducted to look at how dormancy scenarios can be manipulated to ensure effective management and rotation based on weed biology, rather than herbicides. Potential research questions that students may work on include: How do growth inhibitors or stimulators effect dormancy scenario? How is downy brome seed dormancy impacted by current management practices? What will the best management practices be to control this weed in the future?

Learning objectives: The student will learn how to: 1) conduct weed ecology studies in both the field and greenhouse, 2) measure seed dormancy, weed growth parameters, and analyze data, and 3) assess if/how dormancy scenarios may be manipulated by changes in management practices.

References:

Blackshaw, R. (1993). Downy Brome (*Bromus tectorum*) Density and Relative Time of Emergence Affects Interference in Winter Wheat (*Triticum aestivum*). Weed Science 41: 551-556.

Morrow, L.A., and Stahlman, P.W. (1984). The History and Distribution of Downy Brome (*Bromus tectorum*) in North America. Weed Science 32: 2-6.

Novak, SJ, RN Mack (1993) Genetic variation in *Bromus tectorum* introduced populations. Heredity (Edinb) 71:167–176.

Rydrych, D.J., and Muzik, T.J. (1968). Downy brome competition and control in dryland wheat. Agron. J. 60: 279-280.

Stahlman, P, S Miller (1990) Downy brome (*Bromus tectorum*) interference and economic thresholds in winter wheat (*Triticum aestivum*). Weed Sci 38:224–228.