2017 REACCH Summer Internship Program
Research Projects Description

University of Idaho

Assessing Soil Health in inland Pacific Northwest Agroecosystems

Mentors: Jodi Johnson-Maynard (Soil Science, UI) and Kendall Kahl (REACCH, UI)

Increased demand for food and fiber crops must be met through methods that improve the long-term sustainability of our agricultural systems. Improvement and maintenance of soil health is an important consideration for creating a more resilient food system, especially considering climate change (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/). Farmers in the inland Pacific Northwest (IPNW) are interested in adopting new practices to improve soil quality, but are currently struggling to understand how to assess the impact of these practices. In addition, IPNW farmers are being encouraged to use relatively new soil tests (Haney et al., 2008; 2010) that have not been adequately tested in the region. In this project an undergraduate researcher will conduct research and extension to provide information to farmers interested in building soil health on their farms. Potential research questions include: How do results of new soil health tests compare to those from traditional methods? How well do soil health tests relate to crop health and yield? How do the results of soil health assessments vary from farm to farm? The researcher will learn the basic scientific principles behind the soil health concept, and the methodologies currently used to assess it.

Learning Objectives:

- Field and laboratory assessment of soil health.
- Knowledge of soil organisms.
- Management and climate influences on long-term soil productivity.
- Collaboration with stakeholders.

References:

Haney, R.L., E.B. Haney, L.R. Hossner, and J.G. Arnold. 2010. Modifications to the new soil extractant H3A-1: A multinutrient extractant. Communications in Soil Science and Plant Analysis 41:12:1513-1523.

Haney, R.L., W.H. Brinton, and E. Evans. 2008. Estimating soil carbon, nitrogen, and phosphorus mineralization from short-term carbon dioxide respiration. Communications in soil science and plant analysis 39:17-18:2706-2720.

Aphids as Crop Pests in Changing Landscapes

Mentor: Sanford Eigenbrode (Entomology, UI) and Jake Hennessey (Entomology, UI)

One of the most widespread and consistently challenging pests affecting cropping systems in the Pacific Northwest. These species are differently affected by changing climates. This internship will focus on aphid problems that have emerged because of changes in climate and other conditions. One experiment will be designed to assess the direct injury to wheat caused by a newly invasive species of aphid in the region. In surveys, *Metapolophium festucae cerealium,* an aphid native to the UK was found to be abundant throughout iPNW wheat systems (Halbert et al. 2013). Subsequent bioassays have shown that the aphid colonizes and reproduces on wheat, barley and oats, and on native grasses prevalent in natural systems in the region (Davis et al. 2014). We have also shown that it is potentially a serious pest (Sadeghi et al. 2016). The intern will contribute to data collection from a large field cage study to measure the injury this aphid can cause to wheat. A second issue involving aphids concerns those colonizing fall-sown pea crops. Under changing climates, more fall sown peas are being produced. It is not known how vulnerable these crops are to attack by aphids and transmission of disease causing viruses into the crop. Anticipating this, we are monitoring aphid pressure and virus incidence in fall sown peas, which are planted in October to overwinter and mature in summer. The intern will work within an ongoing effort to assess aphids and virus in these fall-grown peas. For the outreach portion, the student will work with the USA Dry Pea and Lentil Council to help communicate information about this study to producers throughout the region.

Learning objectives:

- Field sampling design and implementation.
- Crop health and yield measurements.
- Insect identification and curation.
- Basic analysis of insect abundance, crop yield and biomass data from different treatments.
- Approaches for web based delivery of information to producers.

References:

Davis, T. S., Y. Wu, S.D. Eigenbrode. (2014). Host settling behavior, reproductive performance, and effects on plant growth of an exotic cereal aphid, *Metopolophium festucae* subsp. *cerealium* (Hemiptera: Aphididae), *Journal of Economic Entomology,* 43:682-688.

Halbert, S.E., Wu, Y. & Eigenbrode, S.D. (2013) *Metopolophium festucae cerealium* (Hemiptera: Aphididae), a new addition to the aphid fauna of North America. *Insecta Mundi,* **0301,** 1-6.

Sadeghi, S. E., J. Bjur, L. Ingwell, L. Unger, N. A. Bosque-Pérez, and S. D. Eigenbrode. 2016. Interactions between *Metopolophium festucae cerealium* (Hemiptera: Aphididae) and *Barley yellow dwarf virus* (BYDV-PAV). Journal of Insect Science **16**:1–6.

Identifying the Impacts of Soil Acidification on Phosphorus Availability and Transport in Surface Runoff

Mentors: Erin Brooks (Hydrologic Modeling, UI) and Daniel Strawn (Soil Science, UI)

Over 60 years of application of inorganic nitrogen fertilizers is leading to widespread acidification in near surface soils in agricultural fields in the iPNW. Coincidently many growers have testified that phosphorus (P) fertilizer application in the region does not seem to be resulting in any crop yield benefit. Recent analysis of soil samples suggests that contrary to information provided in fertility guides, extractable P (i.e. plant available soil P) is increasing as soils are becoming more acidic. This increasing availability of soil P has major agronomic as well as water quality implications. In this project the student can explore the interaction between soil pH and soil P availability from an agronomic and or environmental impact perspective. Specific questions may include: How will the application of lime effect phosphorus availability? How are iron, aluminum, and calcium in these soils influencing the P response as these acidic soils? Is the increase in plant available soil P also resulting in increased soluble reactive P in surface runoff? What are the long term implications of lime application and climate change on P transport in this region?

Learning Objectives:

- Field methods for sampling soils.
- Laboratory methods used to measure different forms of soil P.
- Rainfall simulation/flume students to study P transport by surface water.

<u>Oregon State University</u>

Determining Labile Soil Organic Matter Pools Under Winter Wheat Cropping Systems

Mentors: Stephen Machado (Agronomy) and Rakesh Awale (Soil Science)
Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, OR

Soil organic matter (SOM), through its influence on nutrient holding and cycling, water availability, soil structure, erosion resistance, and soil biological processes, is central to soil health and sustained crop productivity. In addition, the buildup of SOM through enhanced C sequestration and N storage in soils reduces the potential for global warming by mitigating greenhouse gas emissions. Tillage and cropping systems alter the quantity, quality, and distribution of crop residue inputs in soil to influence SOM (Purakayastha et al., 2008). However, due to its large pool sizes and inherent spatial variability, changes in SOM usually take more than 5 years to manifest leading to late decision making and delayed remedial actions. On the contrary, labile SOM pools (such as microbial biomass C and N, potentially mineralizable C and N, permanganate oxidizable C, dissolved organic C and N, and particulate organic matter C and N) are much smaller in size and have shorter mean residence time in soils (rapid turnover rate) of weeks to months or few years compared with more recalcitrant pools. To this end, the labile pools are usually more sensitive and provide early signs of the effect of management changes when compared to SOM (Morrow et al., 2016). This project, therefore, aims to identify such SOM pools that can indicate early changes in SOM buildup or depletion across different tillage and cropping systems. Early identification of SOM changes will allow early management decisions and quick remedial action required to improve soil health and sustainability of wheat cropping systems. Specific research questions include: How do SOM pools differ with agricultural management practices? How does sampling procedure influence results of SOM-related analyses? How do SOM pools vary both spatially and temporally.

Learning Objectives:

- Soil sampling and conduct laboratory assessment of SOM pools.
- Data collection, management, and analysis.
- Writing report and presentation.

References:

Morrow, J.G., D.R. Huggins, L.A. Carpenter-Boggs, and J.P. Reganold. 2016. Evaluating Measures to Assess Soil Health in Long-Term Agroecosystem Trials. Soil Science Society of America Journal 80:450-462.

Purakayastha, T.J., D.R. Huggins, and J.L. Smith. 2008. Carbon Sequestration in Native Prairie, Perennial Grass, No-Till and Cultivated Palouse Silt Loam. Soil Science Society of America Journal 72:534-540.

Climate Zones for Hazelnut Production

Mentors: Laurie Houston (Applied Economics, OSU); Phil Mote and Nik Wisman (Oregon Climate Change Research Institute)

In the Willamette Valley of Oregon, the hazelnut industry has entered a phase of unprecedented growth, with more than 6,000 hectares of new orchards planted in just the last 5 years. With more growers, processors, agricultural professionals, and agricultural supply and companies entering the hazelnut industry, hazelnuts are an increasingly important element of the economy. Hazelnut orchards are not only profitable, but they are valued for being a low-input, stable land use that provides a sustainable source of protein and oil as well as ecosystem services such as carbon fixation. In this project, we will examine the sustainability of Oregon's unique hazelnut industry under climate change projections. We will also evaluate the potential to expand the cultivation of European hazelnuts to other parts of the Pacific Northwest under climate change scenarios.

The intern will work jointly with researchers in climate science, agricultural/natural resource economics, and horticulture to identify important weather and climate variables that influence hazelnut production in Oregon (where 99% of commercial hazelnuts produced in the US are grown). These variables will be used to create a suitability index for hazelnut production that will be applied on the landscape to identify how suitable hazelnut growing regions in the area may change under a changing climate, as well as identify desirable traits for future varieties of hazelnuts. The intern will also explore the relative advantages and disadvantages of growing hazelnuts as opposed to other crops that would also be suitable to the same locations, in order to examine the tradeoffs producers will face regarding crop choices. Specific research questions may include: What weather and climate variables are important in hazelnut production? How might climate change influence hazelnut production in the Willamette Valley? What type of management options may be used to mitigate impacts on hazelnut production? What crops do hazelnuts compete with in the Willamette Valley?

Learning Objectives:

- Gain first-hand experience applying basic statistical methods to large datasets
- Gain familiarity in creating visuals using observed and modeled climate data
- Understand the importance of the translation of science for management
- Build essential communication skills
- Gain experience working with and integrating diverse disciplines.

Qualifications: Working knowledge of R, matlab, or IDL programming language, ARC GIS. Coursework in climatology, economics, or horticulture is a plus.

Using Economic Frameworks to Study Climate Change Adaptation and Mitigation Alternatives

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

To assess the economic impacts of changes in climate and climate variability, researchers need frameworks that reflect how managers/growers will behave under changing climate and economic conditions, and how these impacts scale up to larger landscapes. Linkages between the potential for climate change and changes in water, food, and energy inputs and outcomes require blending economic research into an integrated approach, i.e. an interdisciplinary platform, for scientific assessments and policy design. AgBiz Logic provides such a framework for farmers, researchers, and policy makers.

The intern will learn how to use AgBiz Logic and be part of a team that is developing a climate module for the program. They will help integrate return and cost data from university budgets into the AgBiz Logic program. The intern will contact growers in the PNW to arrange and moderate focus groups that will be used to better understand what weather variables are important to producing a particular crop, assess grower’s attitude towards climate change, and identify potential adaptation strategies that may alleviate the impacts of climate change. **Specific research questions may include:** How do the uses of land and other natural resources change as sustainable management options limit the economic attractiveness of conventional technologies? How will changes in climate, both within seasons and over time, change farm management decisions? What are the economic and environmental tradeoffs of these decisions?

Learning Objectives:

- Gain first-hand experience with decision support tools and how they can be used to analyze linkages between climate change and the economics of agricultural systems
- Understand the role of uncertainty and how this influences on-the-ground management decisions
- Gain an appreciation for the role of economics in addressing the effectiveness of adaptation options
- Gain the importance of clear communications with stakeholders and policy makers

Qualifications: Economics or business, and senior level student interested in grad school.

Washington State University

Plant Root Stressors on Crop Water and Nutrient Use (2 interns)

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

Keys to agricultural adaptability to climate change will be to develop cropping systems that optimize subsoil quality. The inland Pacific Northwest produces abundant grain, oilseed and legume crops on modest amounts of winter precipitation. Productive crops with rooting depths of over 100 cm are reliant on rich, deep Palouse soils for stored moisture and nutrients. However, a century of continuous grain cropping and extensive tillage has created subsoil quality problems. These include soil compaction, deficiencies of nutrients that are immobile in soil, and poor soil structure and water infiltration. Reduced crop rooting, and poor water and nutrient use has resulted from these problems. In addition, seasonal stresses such as waterlogging in low lying landscape positions also constrain root growth and activity. The research question for this project is: What are the limiting factors that need to be addressed to optimize crop root development, soil water and nutrient use in dryland cereal-oilseed cropping systems?

Learning objectives:

- Field and lab methods to examine crop root responses to fertilizer management.
- Techniques in soil water and nutrient analysis, root sampling and digital imaging/analysis, field experimental design and characterization, data analysis and statistical evaluation.
- Natural history and soil formation of the Palouse region.
- Stakeholder interviews.

References:

Pan, W.L. I.J. Madsen, L. Graves, T. Sistrunk, R. Bolton. 2016. Ammonia/ammonium toxicity of root meristems and root hairs as influenced by inorganic and organic fertilizer sources and placement. Agronomy Journal 108: 2485-2492.

Pan, W.L., T. M. Maaz, W.A. Hammac, V.A. McCracken, R.T. Koenig. 2016. Mitscherlich-modeled, semi-arid canola nitrogen requirements influenced by soil N and water. Agronomy Journal 108: 884-894.

Maaz, T., W.L. Pan and A.H. Hammac. 2016. Influence of soil nitrogen and water supply on canola nitrogen use efficiency of canola. Agronomy Journal 108: 2099-2109.

Pan, W.L., FL Young, S. C Hulbert, D. R. Huggins, T.M. Maaz. 2016. Canola Integration into semi-arid wheat cropping systems of the inland Pacific Northwestern USA. Crop and Pasture Science 67(4) 253-265

Exploring the Effects of Predators on Aphids and Aphid-Transmitted Viruses

Mentors: David Crowder (Entomology, WSU) and Ben Lee (PhD student, WSU)

The Crowder lab at Washington State University is seeking a student intern to work on a project examining the impact of natural enemies (predators such as lady beetles) on the spread of aphid-transmitted viruses to legume crop plants. Aphids are key pests of cereal and legume crops in the Pacific Northwestern United States, primarily because they can vector pathogens (viruses/bacteria) that infect crop plants. Natural enemy species could influence aphid populations through various mechanisms. By consuming aphids natural enemies can reduce vector densities and potentially cause reductions in disease spread. However, predators can also stimulate aphid movement as aphids try to escape predation. This increased movement under threat of predation could actually increase the rate of disease transmission through crop fields. The research question for this project is: How do specific natural enemies affect aphids and the spread of disease?

Learning Objectives:

- Design of field experiments to explore these various mechanisms by which natural enemies can affect aphids and ultimately disease spread.
- Field and laboratory methods used to study aphids and other organisms of interest.
- Collection and analysis of data.

Greenhouse Gas Flux Measurements of Agricultural Systems

Mentors: Brian Lamb (Atmospheric Science, WSU), Shelley Pressley (Atmospheric Science, WSU) and Eric Russell (Atmospheric Science, WSU)

Part of the Regional Approaches to Climate Change in Pacific Northwest Agriculture (REACCH PNA) program involves continuous monitoring of greenhouse gas (GHG) fluxes to establish a baseline for carbon sequestration and N_2O emissions for current crop management practices and to investigate how GHG fluxes change for selected management alternatives. The approach is to use micrometeorological methods to directly measure CO_2/H_2O/N_2O fluxes over representative fields within the region. Over the past 5 years, measurements have been made at 5 locations (Chi et al, 2016; Waldo et al., 2016). Washington State University (WSU) now has the opportunity to establish a long term agricultural research station (LTAR) on the WSU Cook Agronomy Farm. Four of the original 5 towers are currently being relocated to the LTAR site, while one of the five sites remains in Lind, WA. Sites have been identified for the 4 micrometeorological tower sites, cement bases have been poured, and it's anticipated that towers and instrumentation will be deployed before spring 2017. Figure 1 illustrates two of the sites monitoring GHG fluxes.

Figure 1. Photographs of the Lind (left) and Cook Farm (right) flux tower sites.

The REACCH summer undergraduate student will work closely with both faculty and a post doc during this project and be involved in all aspects of the study including 1) Site installation and/or maintenance, 2) instrument calibration, 3) collection of associated biological data, 4) data analysis of GHG fluxes, and 5) interpretation of data to address the scientific objectives of the study. Specifically, data from each of the sites will be analyzed for patterns associated with management events and meteorological conditions including seasonal differences and cross-site variability. The data will also be compared to small scale enclosure chamber measurements collected at one of the tower sites.

Learning Objectives:

- Experience working with scientific instruments.
- Collection of samples and data for a long-term monitoring program.
- Data analysis following specified standards and protocols.
- Micrometeorological measurement techniques (i.e. eddy covariance).

References:

Chi, J., Waldo, S., Pressley. S., O'Keeffe, P., Huggins, D. R., Stöckle, C., Pan, W. L., Brooks, E., and Lamb, B. K. (2016): Assessing carbon and water dynamics of no-till and conventional tillage cropping systems in the inland Pacific Northwest US using the eddy covariance method, Agriculture and Forest Meteorology 218-219, 37-49, doi.org/10.1016/j.agrformet.2015.11.019.

Waldo, S., Chi, J., Pressley. S., O'Keeffe, P., Pan, W. L., Brooks, E., Huggins, D. R., Stöckle, C., and Lamb, B. K. (2016): Assessing carbon dynamics at high and low rainfall agricultural sites in the inland Pacific Northwest US using the eddy covariance method, Agriculture and Forest Meteorology 218-219, 25-36, doi.org/10.1016/j.agrformet.2015.11.018.