Graduate students are the nitrogen for growing REACCH's research

Edited by Leigh Bernacchi (lbernacchi@uidaho.edu) UI

REACCH graduate students are poised to be the leaders of research, extension, and education for the future of agriculture and climate change. As with most programs, they have trained within their disciplines, mentored by their major professors, Principal Investigators (PIs) on the REACCH project, to be adept at understanding and solving problems within their paradigm. Where REACCH students have gone above and beyond is in connecting through their objective teams and throughout the project to create enriching and creative representations of research, to meet multiple stakeholders through effective communication at field days, in classrooms, and in online videos, and to prepare for the greatest challenges yet to come.

IMPACT

Graduate students are at the core of our research program: they collect and analyze data, present their research to a wide variety of stakeholders, and serve as an interdisciplinary bridge through their extension and education projects. Most importantly, with their breadth and depth of knowledge, they will be the future leaders of climate change adaptation and agricultural sustainability.

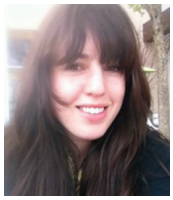
"Post-docs," PhD students, and master's students share in one another's accomplishments, and as we stride toward the end of the project, there is only more to celebrate: more defenses, graduations, grant awards, and jobs.

Mukhtar Ahmed (mukhtar.ahmed@wsu.edu)
WSU
Postdoctoral researcher, advised by Claudio Stockle
Multimodel approach to study the impact of climate variability on the productivity of wheat systems

As part of REACCH, we are using computer models to conduct a regional assessment of yields, water, and carbon footprint for baseline and future climatic conditions . We use gridded daily weather data (2.49×2.49 miles, 4x4 kilometers) for the period 1979 to 2010 and, for future weather, daily data projected by 14 global climate models (GCMs) for two representative concentration pathways (RCPs) of atmospheric carbon dioxide (CO_2) (4.5 and 8.5 parts per million), for a total of 28 future weather scenarios. An ensemble of five wheat growth models extracted

REACCH Scientific Advisory Panel (SAP) members (back row left) Karen Garrett, University of Florida new preeminence faculty in plant diseases, Phil Robertson, Distinguished Professor of Ecosystem Science at Michigan State University Kellogg Biological Station, and Senthold Asseng, University of Florida Department of Agricultural and Biological Engineering, with graduate students at the REACCH annual meeting in Richland, WA. Students discussed professional goals and research collaborations.

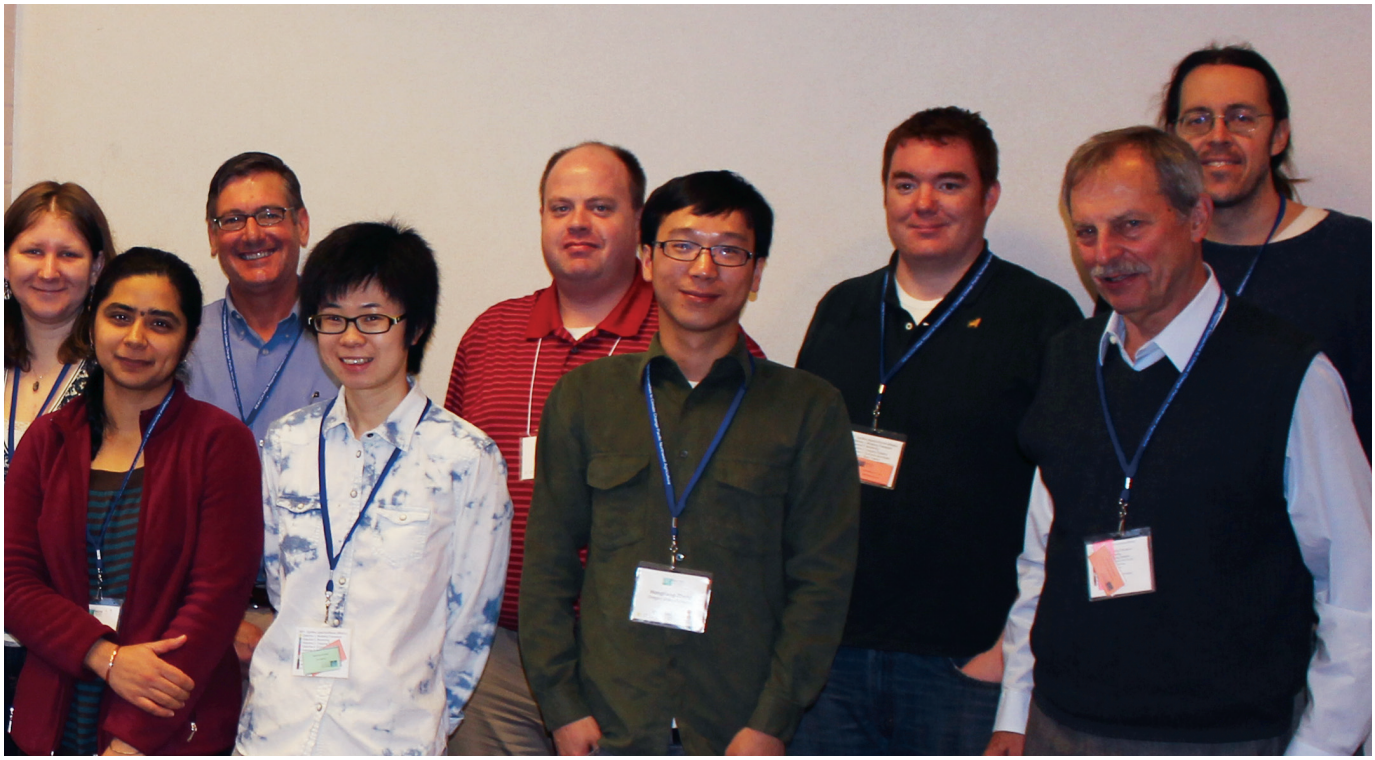
from CropSyst, APSIM-Wheat, CERES-Wheat, STIC, and EPIC are being coded to run under the platform of CropSyst. This platform will provide input/output operations and scenario creation capabilities (weather, soils, crop rotations, management) and will simulate hydrologic processes, including all components of the water balance, and nutrient cycling. The main objective of this multimodel study is to reduce the uncertainty associated with individual wheat growth models. Preliminary evidence has shown that the use of ensembles of crop growth models can be an effective way to reduce uncertainty.



Liz Allen (lizb.allen@wsu.edu) WSU
PhD candidate, advised by Chad Kruger
Stakeholder engagement in environmental model development and science communication
My primary work is as a member of the communication and extension team of the WSU-based BioEarth regional earth systems modeling project. Within BioEarth, I'm involved in the design and evaluation of stakeholder engagement strategies. The BioEarth model will link hydrological, atmospheric, vegetation, and social/economic models, with the aim of producing outputs that are relevant to the needs of regional decision makers, especially in the agriculture and forestry sectors. We are looking at how scenario planning tools can use stakeholders' input and are tracking learning among researchers and stakeholders engaged in the research project. A key component of this research involves comparing approaches to interdisciplinary collaboration and stakeholder engagement across multiple regional-scale projects, including REACCH.

Iqbal Singh Aujla (iqbal.aujla@email.wsu.edu) WSU
PhD candidate, advised by Tim Paulitz
Impact of climate change on foliar and soil-borne pathogens of wheat in the Pacific Northwest region
Crops yields are affected to a large extent by diseases caused by various pathogens. Climate change will affect not only the distribution patterns of the fungal pathogens, but also their severity, depending upon the requirements of the fungi for soil moisture levels and temperature. Soil-borne fungi can actively grow and infect plants only when soil moisture is adequate and temperatures are optimum. Under extremely dry, cold, or hot conditions, fungi cease to grow and form resistant structures to survive until conditions are suitable. Thus, changes in climate may have a profound effect on the distribution of fungal diseases. The focus of this study is to analyze the impact of climate change on the distribution patterns of both foliar and soil-borne fungal pathogens of wheat in the Pacific Northwest (PNW) region.

Taylor Beard (taylor.beard@email.wsu.edu) WSU
Master's student, advised by Bill Pan
Introducing canola as an alternative crop in the Pacific Northwest
The main goal of my research as a graduate student was to understand the potential of canola and wheat residues to resist degradation and affect soil crusting. Arid and semiarid agronomic regions that have adopted



REACCH graduate students with SAP members, Matt Baker Dean of University College Texas Tech University (back second from left) and Richard Howitt (front right), University of California Davis, Professor emeritus agricultural and resource economics. Photo by Leigh Bernacchi.

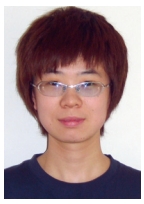
conservation management practices, such as reduced tillage, may be prone to soil crusting. Crusting can reduce water infiltration, enhance runoff and erosion, and interfere with seed germination. Structural components (e.g., hemicellulose, cellulose, lignin, and silicon (Si)) vary among crop types. Grasses such as wheat tend to have higher levels of Si and lower amounts of lignin when compared to oilseeds. When such residue is left on the soil surface, these components, specifically Si, may contribute to soil crusting. Therefore, it may be beneficial to consider crops with lower amounts of Si when planning rotations in areas where soil crusting can be an issue.

Leigh Bernacchi (lbernacchi@uidaho.edu) UI
Postdoctoral researcher, advised by J. D. Wulfhorst
Capacity for the public and wheat producers to respond to climate change
We surveyed wheat producers of the REACCH study area counties by mail and residents of ID, OR, and WA by phone on their perceptions of climate change, including risk and adpatation, and agriculture. Significant findings show that the general public has observed changes in weather over their lifetime (83%), but more than half of them attribute these changes to natural causes. Agricultural producers show varied levels of adaptability, depending on their current cropping practices: some have already adopted conservation tillage, and these are least likely to change their tilling again. The findings have implications for local planning and management by elucidating barriers and opportunities to effective climate adaptation and mitigation as well as community sustainability.

Prakriti Bista (prakriti.bista@oregonstate.edu) OSU-CBARC
Postdoctoral researcher, advised by Stephen Machado
Agronomic performance of cropping systems and crop modeling
I study cropping systems that promote biologically productive, economically profitable, and environmentally sound production practices. In the Pacific Northwest (PNW), the increasing climatic variability and degradation of soil resources have influenced crop productivity. Specifically, the loss of soil carbon and nitrogen in the form of greenhouse gases has influenced agricultural system sustainability in this region. My postdoctoral research involves monitoring and modeling the effect of traditional and conservation management practices on the agronomic performance and soil organic matter dynamics of dryland wheat-fallow systems in the Pacific Northwest. I am also evaluating the effect of cover crops on wheat yield, and on soil organic carbon and total nitrogen. I am involved in various types of extension work, including preparing a conservation handbook and helping write the State of the Region report.

Ryan Boylan (rboylan@uidaho.edu) UI
Master's student, advised by Erin Brooks
Modeling and monitoring sediment and nutrient transport from agricultural watersheds
Mitigation strategies to minimize the loss of soil carbon require a fundamental understanding of the dominant hydrologic flow paths, which drive runoff generation, soil erosion, and ultimately the quantity and quality of carbon exported from a landscape. We quantified temporal and spatial hydrologic carbon fluxes at three watershed scales (~10 hectares, ~25 acres ~5,000 hectares, ~12,355 acres; and ~900,000 hectares, ~2,223,948 acres) and under two tillage practices (conventional and no-till), using the Water Erosion Prediction Project (WEPP) model to simulate present and future field-scale variability in runoff and soil carbon erosion from a ~10-hectare field catchment managed under conventional tillage practices. Dissolved organic carbon concentrations were two times greater from the no-till catchment, while total organic carbon loads were 97% less than those observed at the conventional till catchment. Future climate predictions with the WEPP model indicate that sediment and loads will be equivalent to historic levels (>20 milligrams per hectare) and slightly higher than current rates for runoff and carbon.

Tabitha Brown (tabitha_brown@wsu.edu) WSU
PhD candidate, advised by Dave Huggins
Impact of agricultural management practices on soil health, productivity, and nutrient use efficiency
Site-specific nitrogen fertilizer management has been reported as an important strategy to increase nitrogen use efficiency (NUE) in modern cropping systems. The Palouse region of eastern WA is characterized by complex soil fertility and crop productivity patterns, but cropping systems are typically managed uniformly. The overall research goals were to investigate relationships among winter wheat (*Triticum aestivum*) yield, water, and NUE across landscape positions that differ in soil properties and historical yield. I determined NUE components and indices based on soil and crop physiology and used them to develop performance classes for winter wheat to aid in site-specific nitrogen fertilizer and seeding rate management decisions for the region.



Jinshu Chi (jinshu.chi@wsu.edu) WSU
PhD student, advised by Shelley Pressley
Assessments of carbon and water dynamics in agriculture using eddy covariance
Global food demand is predicted to increase 100% by 2050, thereby increasing demands from ecosystem services, including agricultural production and natural resources. Future climate projections for the inland Pacific Northwest show a likely increase in temperature and significant reductions in precipitation that will affect carbon and water dynamics. This new scenario requires a comprehensive understanding of impacts of climate and management practices on carbon and water dynamics in agricultural ecosystems. My research mainly focuses on measurements of carbon and water fluxes using eddy covariance methods in the inland PNW region, in order to determine the best management practices for sustainable agriculture in the region in the future.

Seth Davis (thomasd@uidaho.edu) UI
Postdoctoral researcher, advised by Sanford Eigenbrode
The chemical and microbial dimensions of plant-insect interactions
I am investigating how environmentally mediated "ecological switches" drive disease dynamics in cropping systems, with efforts aimed at developing ecological models to describe how context-dependent pathogen-vector-host interactions promote pathogen retention in the landscape. I employ behavioral ecology and plant physiology approaches to investigate how aphid-vectored viruses mediate the response of plants to environmental stress. I have developed tractable methods for asking novel questions about the ecological drivers of pathogenesis, discovering that the consequences of virus infection for host plants span the pathogen-mutualism continuum relative to water availability. I am especially interested in elucidating the pathways by which elevated environmental stress may drive the origin of mutualistic interactions in pathosystems. Ongoing hypothesis testing is aimed at identifying an inheritable biochemical basis underlying plant responses to interactions between water availability and viruses in greenhouse and common garden experiments.

Hilary Donlon Davis (hilaryd@uidaho.edu) UI
Master's student, advised by Kate Painter
Longitudinal survey of wheat growers in the inland Pacific Northwest
This longitudinal survey is a four-year survey of growers and their wheat production practices, collecting information for the crop years 2011 to 2014. The survey is used to inform REACCH scientists about production practices in the four agroecological zones (AEZs). Data from this survey cover topics ranging from insects to economics. The survey collects the economics of each grower, and my primary focus is to compare economic variables between the AEZs. For each participant in the survey, an economic budget was made for each year of collected data. Another output from this collected data will be extension enterprise budgets for the three dryland AEZs.

Paige Farrell (farr8438@vandals.uidaho.edu) UI
Master's student, advised by John Abatzoglou
Climate change impacts on soil erosion in the inland Pacific Northwest
I used the Water Erosion Prediction Project (WEPP) model, which can account for various cropping practices, soil profiles, and geomorphology, to examine the potential impacts of climate change on soil erosion. I performed several sensitivity experiments to estimate the change in erosion due to changes in temperature, precipitation, and precipitation intensity. In addition to these sensitivity experiments, I applied downscaled data from climate projections to WEPP modeling and examined the projected impacts across the inland Pacific Northwest. These experiments will assist land management by identifying future erosion risks in a changing climate and potential efforts to mitigate detrimental impacts by modifying agricultural and land use practices.

Wenlong Feng (feng6701@vandals.uidaho.edu) UI
Master's student, advised by John Abatzoglou
Relationship between climate and winter wheat yields in the Columbia Basin
There is strong interannual variability in wheat yields across the Pacific Northwest that are spatially coherent, suggestive of large-scale climate drivers. In the moisture-limited area in the western Columbia Basin, cool-season precipitation positively correlated with wheat yield. In the eastern portion of the basin, growing degree days positively correlated with wheat yield. Spring to midsummer potential evapotranspiration had a significant negative relationship with wheat yields in the central portion of the basin, with insignificant or even positive correlation to wheat yields in areas with sufficient moisture. The July Palmer Drought Severity Index strongly correlated with wheat yields in most water-limited counties in the study region, suggesting a strong link between drought severity and wheat yield. These correlation coefficients between climate and wheat yields may supplement the process-based models to offer yield forecasts related to climate variation.

Edward Flathers (flathers@uidaho.edu) UI
PhD candidate, advised by Paul Gessler
Ecoinformatics—Data science
One of the challenges of modern science is being able to consume the deluge of different kinds of data coming from a multitude of sources and organize those data for analysis. My research is focused on collecting, managing, and analyzing "big" data using novel computational, statistical, and visual techniques. I emphasize open science methodology: publication of research data, computer code, and other materials that explicitly enable reuse and repeatability of research methods. By combining data that are produced though remote sensing systems such as satellites and aircraft, local monitoring systems such as flux towers and weather stations, field observations collected by people, and other sources, we can develop a more complete understanding of the world around us and the processes that make it work.

Nathaniel Foote (foot2969@vandals.uidaho.edu) UI
Master's student, advised by Sanford Eigenbrode
Interspecific competion among cereal aphids as influenced by drought
The aphid *Metopolophium festucae* subsp. *cerealium* (MFC) is a recent invader in the Pacific Northwest (PNW) and has become an established pest attacking small-grain cereals throughout the Palouse. Potentially affecting its spread and pest status in the region are competition with other cereal aphid species, as well as certain climate-related factors that affect the insect herbivore community as a whole. We are using an experimental approach that employs a series of greenhouse studies to determine whether MFC actively competes with the historically established bird cherry-oat aphid (*Rhopalosiphon padi*), and whether water limitation of their shared host plant, wheat (*Triticum aestivum*), can alter the outcome of this competition. We aim to improve understanding of competitive interactions among co-occurring insect pests of cereal grains under projected

climate scenarios, in which drought may become a more prevalent condition affecting agriculture in the PNW.

Rajan Ghimire (Rajan.Ghimire@oregonstate.edu) OSU-CBARC
Postdoctoral researcher, advised by Stephen Machado
Soil organic matter dynamics in dryland cropping systems
Loss of soil organic carbon (SOC) and nitrogen from agroecosystems is a major challenge in sustainable crop production. Climate change and variability has posed additional challenges to agronomic, economic, and ecological efficiency of existing management practices. I am evaluating long-term trends in SOC, nitrogen, and crop yields, and monitoring seasonal and interannual dynamics of labile (less than a year turnover time) SOC and nitrogen pools in existing long-term experiments, as well as in recently established experiments. Addition of organic residue, including legume crops in rotation, and minimum soil disturbance increases SOC accrual and improves sustainability of winter wheat-based production systems in this dry region. Pendleton long-term experiments provided a great platform to understand the impact of historic changes in management practices, technologies, and production environments to shape the present-day agriculture and to postulate the future trends of dryland farming in the PNW.

Katherine Hegewisch (khegewisch@uidaho.edu) UI
Postdoctoral researcher, advised by John Abatzoglou
Statistical downscaling of global climate models
Global climate models (GCMs) are the primary tool used by regional planners to assess future climate impact on agriculture. Downscaling is the process of generating locally relevant data from the GCMs. I have downscaled outputs from 20 GCMs of the fifth phase of the Coupled Model Intercomparison Project (CMIP5), using two representative concentration pathways (RCP 4.5 and RCP 8.5), for the contiguous United States and for several meteorological variables (tasmin, tasmax, rhsmin, rhsmax, pr, rsds, uas, vas) for 1950 to 2099, using the Multivariate Adaptive Constructed Analogs (MACA) statistical downscaling method. These data can be accessed through either the REACCH data portal or the Northwest Knowledge Network (see http://maca.northwestknowledge.net). I have refined the original MACA method for better performance in correcting for biases inherent in climate models. The MACA data have been used by both REACCH teams and other organizations throughout the PNW for studying future hydrology , vegetation, and agricultural crops.

Jocelyne Helbling (jhelbling@vandals.uidaho.edu) UI
Master's student, advised by David Meyer and John Anderson
Social network analysis of interdsiciplinarity
Networks are implicit in a wide range of phenomena, including the social, biological, and physical. Network behavior is informal socializing that subtly reaffirms social and cultural values. Network analysis is a systematic, interdisciplinary methodology that uses empirical, mathematical, and computational approaches to measures and assess relational patterns across a broad range of individuals, groups, or entities to understand how interactions between individuals or entities give rise to large-scale patterns. These patterns can be seen in the overall structure of the network and in the emergent behaviors that characterize the system as a whole.

Tina Karimi (tina.karimi@email.wsu.edu) WSU
PhD student, advised by Claudio Stockle
Simulation of regional yields and greenhouse gas emissions under climate change in the Pacific Northwest
Using the CropSyst cropping systems simulation model and daily weather data, we downscaled to a 2.49-square-mile (4-square-kilometer) grid to assess the impact of possible climate change and management scenarios that cannot be experimentally evaluated. We considered typical conventional tillage and alternative conservation tillage practices for each zone. With this simulation setup, my research will evaluate (1) wheat production in Pacific Northwest drylands, soil water content (by considering water budget components), and nitrogen budget components, and (2) long-term soil organic carbon changes, nitrous oxide emissions, and total carbon footprint through life cycle assessment analysis, for current and future climate conditions by considering all scenarios in three agroecological zones.

Harsimran Kaur (harsimran.kaur@email.wsu.edu) WSU
PhD student, advised by Dave Huggins
Predicting for important bioclimatic variables for REACCH agroecological zones
Land use classification studies often rely on biophysical variables hypothesized to be key drivers or determinants of land use/cover. Weak relationships, however, can occur between delineated land use classification and actual land use. In contrast, classification based on land use/cover that has emerged as a consequence of determinants may be advantageous, as the actual land use can then be used to select important driving variables. Our expectation is that this approach can better select for those variables that have a major effect on the actual land use, and therefore, that the selected variables can eventually be used to predict future land use under different climate change scenarios.

Kedar Koirala (kedar.koirala@email.wsu.edu) WSU
PhD student, advised by Dave Huggins
Environmental air quality, environmental data analysis
A recent addition to REACCH, I will be conducting data analyses for the Cook Agronomy Farm to answer questions on precision agriculture such as spatial and temporal variability of crop yields. These analyses will aid the science-based development of field management zones relevant to precision agriculture.

Nevin Lawrence (nevin.lawrence@wsu.edu) WSU
PhD candidate, advised by Ian Burke
Variation in downy brome development in the small-grain production region of the Pacific Northwest
Due to climate change, the Pacific Northwest PNW is projected to experience more frequent mild winters, which may speed up the development of many weed species compared to current observations. Enhanced knowledge of weed response to recent climatic trends can help growers adapt to climate change, and an understanding of the biological response in weed species could be used as an indicator of realized adaptation and climate change. I've chosen to assess the physiological and ecological response of *Bromus tectorum* L. (downy brome) to climate change. A current pest within the small-grain production regions of the PNW, downy brome is likely to remain a major weed of small grains in the region as the climate changes in coming decades.

Kirill Kostyanovsky (kirya.kostyanovsky@wsu.edu) WSU
Postdoctoral researcher, advised by Dave Huggins and Claudio Stockle
Seasonal and diurnal dynamics of N_2O and CO_2 emissions in no-till winter wheat systems in the Pacific Northwest
My research within the REACCH scope is on in situ instrumentation and monitoring of soil nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions with the static chambers via a portable flow-through system. We analyze isotopes of N_2O to discover the sources of N_2O emissions within the soil nitrogen cycle. The focus of my research is N_2O and CO_2 production in tillage and no-till wheat-based cropping systems, effects of dry-wet cycling and nitrogen application on N_2O emissions, and seasonal dynamics and the effects of freeze-thaw events. Another aspect of my research is quantification of availability, transport, and the effects of nitrogen and organic matter on net N_2O and CO_2 emissions.

Sihan Li (sli@coas.oregonstate.edu) OSU
PhD candidate, advised by Philip Mote
Superensemble regional climate modeling for improved projections
I have been working on a superensemble of regional climate modeling for the western United States, as part of a citizen science experiment called climateprediction.net. We use computer time contributed by tens of thousands of volunteers around the world to create superensembles to perform regional climate modeling. I am looking at the dominant model parameter changes and how they relate to the major regional scale prognostic variables; that is, I am trying to relate the macroscopic variation in regional climate response to the subgrid scale parameterization. To fully deal with uncertainties in regional climate modeling, the systematic bias—that is, irreducible error—must be considered directly within the analysis. By thoroughly looking into and quantifying different sources of uncertainties in regional climate modeling, we can make more meaningful and accurate projections of the future climate.

Tai McClellan Maaz (tai.mcclellan@wsu.edu) WSU
PhD candidate, advised by Bill Pan
Nitrogen use efficiency and cycling in no-till cropping systems that feature canola, peas, and wheat
Indigenous soil nitrogen supply is often not factored into nitrogen use efficiency (NUE) equations, despite its large contribution to plant nitrogen nutrition and its role in nitrogen cycling. My research includes greenhouse, laboratory, and field experiments to determine (1) differences in soil nitrogen uptake and partitioning in wheat (*Triticum aestivum* L.), field pea (*Pisum sativum* L.), and canola (*Brassica napus* L.) and (2) the effects of crop and fertilizer on net nitrogen mineralization and nitrogen carryover. In laboratory studies, I have linked the partitioning of carbon and nitrogen into structural and soluble cell components to the effects of crop residues on soil mineralization/immobilization potential. Findings from my field study have related residual nitrogen carryover and crop residue nitrogen to the availability of nitrogen for subsequent crops, with multiyear nitrogen balances capturing the effects of fertilization and the inclusion of legumes on rotational NUE. My research will help inform growers participating in the expansion of canola production within WA's wheat-based cropping systems.

Isaac Madsen (isaac.madsen@email.wsu.edu) WSU
PhD student, advised by Bill Pan
Nitrogen loss from irrigated cropping systems
Research conducted at the Irrigated Agricultural Research and Extension Center in Prosser, WA, is designed to examine the impacts of cover cropping and reduced tillage on nitrate soil profiles in a potato-corn-wheat rotation. Potato, corn, and wheat are field crops often grown in rotation in the Columbia Basin. Potatoes in particular are intensively managed with high levels of fertilizer and pesticides. Determining the uptake of fertilizers and developing and evaluating conservation practices such as cover cropping and reduced tillage are important aspects of agricultural sustainability in the Columbia Basin. Preliminary data show cover crops reducing nitrate levels in the 2nd, 3rd, and 4th feet.

Troy Magney (tmagney@uidaho.edu) UI
PhD candidate, advised by Lee Vierling and Jan Eitel
Remote sensing of crop structure and function
My research focuses on the development, testing, and application of remote sensing instruments to monitor the temporal, spatial, and mechanistic dynamics of plant structure and function. These remote sensing instruments include ground-based radiometers (reflectance based), LiDAR instruments (laser based), time-lapse digital cameras, and satellites. Using information from these different types of instruments enables the mapping of patterns associated with crop stress, nutrient uptake, and productivity. By looking through different lenses (slices of the electromagnetic spectrum), we can learn new information regarding the wide variability of field productivity to help establish management zones.

John Merickel (meri8103@vandals.uidaho.edu) UI
Master's student, advised by Bahman Shafii
Aphid population modeling
By using the data from the Idaho suction trap network, we can gain a better understanding of the population dynamics of four cereal grain pest aphid species through statistical modeling. We used nonlinear regression models to describe the intraannual accumulation of aphids. We then used climate data to group the 12 Idaho suction trap sites into similar environments through clustering processes. Finally, we developed individual models for each species, specific to each environment, using nonlinear regression and incorporating an autocorrelation structure to model interannual population variation. These models have the potential to help the cereal grain producers of Idaho and the region better forecast aphid populations in order to optimize their harvest yield.

Ashutosh Misra (ashutosh.misra@wsu.edu) WSU
Postdoctoral researcher, advised by Claudio Stockle
Estimation of weather variables for crop growth modeling, risk quantification for crop insurance programs
The vulnerability of agriculture to weather and climate fluctuations makes these fluctuations an important part of the crop production system, but we usually do not have complete weather time series for crop production modeling. To cope with this, we are trying to identify suitable techniques for (1) parameterizing and evaluating solar radiation, relative humidity, and wind speed as compared to observations using estimated parameters from available neighboring stations and (2) comparing the results of crop growth simulations using observed and estimated weather. The outcome of the study will help quantify risk in different crops, making it useful in designing and developing crop insurance products.

Jason Morrow (jason.morrow@email.wsu.edu) WSU
Master's student, advised by Dave Huggins
The influence of climate and management on surface soil health within the inland Pacific Northwest
Surface soils influence ecosystem health through their role in nutrient cycling and decomposition, gas exchange, water infiltration, and erosion. Soil organic matter (SOM) is critical to soil functioning and subsequently to soil and ecosystem health. Both the hydrolyzable and nonhydrolyzable fractions of soil organic carbon were equally sensitive to climate, indicating no relationship between chemical recalcitrance and climate sensitivity. Permanganate oxidizable carbon (POXC) was representative of SOM stabilization, while one-day carbon mineralization was representative of microbial activity and SOM mineralization. Both POXC and mineralization potential may be increased by cropping diversification, and stabilized inputs such as compost, along with no-till, may increase POXC. Plant-available nutrients displayed varying correlations with soil carbon and nitrogen properties, management, and climate factors. Overall, POXC and carbon mineralization were shown to be important indicators of surface soil health.

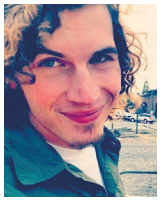
Jianhong Mu (jianhong.mu@oregonstate.edu) OSU
Postdoctoral researcher, advised by John Antle
Economics of climate change impacts on crop yields, land use, and agricultural production systems
We modeled adaptation following the way farmers make decisions: short-term allocations (within system) nested within long-term allocations (choices between systems), and found substantial potential for adaptation. Under climate change impacts, cropland, pastureland, and rangeland use could change by 6% to 15%, –2% to 5%, and –14 to –5%, respectively, under a lower-emission scenario (RCP 4.5) and by 5% to 20%, –5% to 5%, and –15% to 3%, respectively, under a high- emission scenario (RCP 8.5). These results show that the effects of climate change could be substantially different under alternative plausible future representative agricultural pathways and scenarios. They indicate the types of uncertainties we need to discuss when assessing climate change impacts.

Byju Nambidiyattill Govindan (byju.ng@wsu.edu) WSU
Postdoctoral researcher, advised by Claudio Stockle and Sanford Eigenbrode
Development of biotic modules for integration into the cropping system model
The cereal leaf beetle (CLB) is one of the pests with the potential to cause increased crop damage with warming temperatures. Elevated temperatures will cause faster developmental rates in insects by increasing their metabolism rates in a nonlinear fashion, increase the winter survival rate of different life stages of pests, disrupt their synchrony of emergence with natural enemies, and increase the risk of damage to crops. Development of a nonlinear temperature-dependent population model is expected to help predict the population growth potential of CLB and link the relative abundance of CLB to the feeding damage potential to wheat under future climate scenarios in the various agroclimatic zones of the PNW. The outcomes from the project are expected to help researchers plan adaptation strategies for integrated pest management in a changing climate and inform policies on global food security.

Lauren Parker (lparker@uidaho.edu) UI
PhD student, advised by John Abatzoglou
Spatial coherence of precipitation extremes
Extreme precipitation events across the PNW, although rare, affect the region by causing increased runoff, flooding, damage to infrastructure, and loss of life and property. Using data from the National Weather Service Cooperative (COOP) and the Natural Resources Conservation Service Snow Telemetry (SNOTEL) stations, I examined three-day precipitation accumulations exceeding the 95th percentile over the past two decades. I used simple metrics to show the relationship between distance and the probability of synchronous occurrence of extremes between station pairs, the regional representativeness of each station, and the preferential direction for coherence. Initial results show that the

spatial coherence of extremes between stations decays with distance. The role of Pineapple Express events in producing extreme precipitation exhibits clear spatial patterns across the region, and Pineapple Express storms do result in regional extreme events of both high and low coherence.

Qiuping Peng (qiuping.peng@wsu.edu) WSU
PhD candidate, advised by Dave Huggins
Carbon and nitrogen dynamic and cycling under different crop rotation systems
My research interests are carbon and nitrogen cycling in soil. Monitoring carbon and nitrogen dynamics under different crop rotations and tillage management would show how the soil responds to anthropogenic activities, would offer clues that could lead to practical and meaningful solutions for sustainable agriculture development, and would be beneficial to food productivity and environmental protection.



Alexander Peterson (pete5506@vandals.uidaho.edu) UI
Master's student, advised by John Abatzoglou
Bioclimatic changes in false springs across the United States
Crop species receptive to thermal accumulation during the spring may break dormancy and begin developing earlier in the year; however, advances in phenological timing may leave early-stage vegetation growth vulnerable to cold damage when hard freezes follow green-up, resulting in a false spring. I modeled spatiotemporal patterns of green-up dates, last spring freezes, and false springs across the contiguous United States from 1950 to 2099, using downscaled climate projections. Results indicate widespread advancement in the timing of green-up and last spring freeze dates over the period, with last spring freezes trending earlier in the year relative to green-up. Although regionally variable, these changes result in an overall reduction in false springs across the United States.

Megan Reese (megan.reese@wsu.edu) WSU
Master's student, advised by Bill Pan
Winter canola water use
Winter canola can introduce diversity into the traditionally winter wheat-fallow rotations of WA's intermediate-rainfall and low-rainfall zones. However, this crop is relatively new, and best agronomic practices are still evolving. I initiated an on-farm winter canola seeding date trial in 2013 in Ritzville, WA. In addition, I established winter canola variety trials in Pomeroy, Asotin, and Okanogan in 2014. At each site, I measure soil water content biweekly via gravimetrically analyzed cores and a neutron probe. In addition, I collect biomass samples. I will quantify nitrogen and water use efficiencies, extraction depths and patterns, and total water usage and relate them to growing degree day progression. Very little research has focused on winter canola water use, and the information garnered from this study has the potential to guide production management decisions.

Seyed Ebrahim Sadeghi (ebrahims@uidaho.edu) UI
Postdoctoral researcher, advised by Sanford Eigenbrode
***Effect of climate change on aphid vectors of* Barley yellow dwarf viruses**
The majority of cereal aphids in the region are vectors for the *Barley yellow dwarf virus* (BYDV). Our objective is to test the hypothesis that this new aphid is a good vector for BYDV (PAV, SGV, and MAV serotypes). After obtaining evidence of BYDV transmission by the aphid, we will study its vector capacity for the virus. Meanwhile, we will compare life table parameters of aphids on healthy and BYDV-infected plants and two different temperatures in controlled chambers.The second priority in my work is to analyze data concerning population densities of different aphid species collected during 2011 to 2014. These data have been collected at 119 collecting sites distributed over 32 municipalities in ID, WA, and OR. The data will be analyzed to find out the relationship between climatic factors and the population density of the aphid species under study.

Erich Seamon (erichs@uidaho.edu) UI
PhD student, advised by Paul Gessler
Ecoinformatics applications for modular scientific investigation
My current research interests are working with geospatially enabled data sets—from metadata organization to analytical tool and data mining techniques. I am currently exploring how evapotranspiration varies in relationship to crop yield for the inland PNW, and how this approach could be integrated with advanced data dissemination techniques, as well as extension of analytics to farm management systems.

Lia Shrewsbury (c/o dhuggins@wsu.edu) WSU
Master's student, advised by Dave Huggins
Spatiotemporal variation of denitrification drivers
I identified the environmental and biological drivers of denitrification at different topographical positions and seasons within an agricultural field. I took soil environmental measurements and used them as possible explanatory variables. The predictive power of both possible and potential denitrification models was improved when spatiotemporal variation was considered, and it was improved further when nitrite reductase gene (nirK) abundance was considered. Modeling spatiotemporal variation is needed to predict denitrification rates and thus more accurately predict soil nitrous oxide emissions.

Alan Smith (smit6736@vandals.uidaho.edu) UI
Master's student, advised by John Abatzoglou
Microclimates in the inland Pacific Northwest
I am examining microclimatology using data collected from meteorology sensors on Moscow Mountain in ID to analyze the effects of microscale topographic influences. In addition, a new micrometeorology sensor will be deployed will be deployed at the Cook Agronomy Farm north of Pullman to analyze microclimatology in minor hilly terrain.

Stephen Taylor (stephen.e.taylor@wsu.edu) WSU
Master's student, advised by Dave Huggins
Developing decision support systems for farmers using precision nitrogen management technologies
My research is focused on developing science-based decision support systems for farmers using precision nitrogen management technologies in wheat. I will use variable-rate technologies, as well as differing prescription mapping technologies, to strengthen the way farmers make site-specific management decisions. General goals are to improve farming economics by lowering fertilizer inputs and maintaining yields, as well as decreasing the environmental impacts of chemical fertilizers.

Rachel Unger (rachel.unger@wsu.edu) WSU
PhD candidate, advised by Dave Huggins
Field-scale cropping system nitrogen use efficiency after 10 years of continuous no-tillage
Evaluating nitrogen use efficiency (NUE) for a longer time period that represents the cropping system may provide an improved assessment of NUE. In addition, cropping system NUE may vary spatially across heterogeneous landscapes and soils. Our overall objective was to use a niitrogen mass balance approach to better understand how terrain, no-tillage, and the implementation of multiple crop rotations influence cropping system NUE. Crop rotations initiated in the fall of 2000 and the spring of 2001 consisted of six different three-year rotations of spring wheat, winter wheat, and alternative crop (spring or winter plantings of barley, canola, lentils, or peas). We monitored all nitrogen inputs from fertilizer applications and nitrogen output from harvested grain at each of the georeferenced locations. Site-specific, field-scale assessments of NUE for each cropping system will be presented.

Sarah Waldo (sarah.waldo@email.wsu.edu) WSU
PhD candidate, advised by Brian Lamb
Measuring the emission and uptake of greenhouse gases over agricultural fields
Agricultural soils are an important source of nitrous oxide (N_2O), a greenhouse gas (GHG) with 300 times the warming potential of carbon dioxide (CO_2) per molecule. At the same time, agricultural fields can be a sink for CO_2 if the right management practices are employed. My research uses micrometeorological techniques (eddy covariance and flux gradient) to measure the exchange of these two GHGs over agricultural fields in the inland Pacific Northwest. The results will provide a baseline GHG budget for cropping systems in this area. The results will also be used to inform models such as CropSyst, which will improve larger-scale estimates of the GHG budget of agriculture in the region.

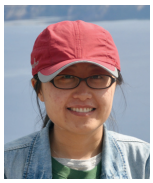
Chelsea Walsh (wals9279@vandals.uidaho.edu) UI
PhD candidate, advised by Jodi Johnson-Maynard
Earthworm distribution, activity, and effects on nitrogen cycling
Greenhouse experiments have shown that, under ideal soil conditions and high population densities, earthworms have the potential to increase crop yields by improving nutrient cycling, water infiltration, and soil structure. In reality, environmental thresholds limit the distribution of earthworms and the period of the growing season during which they remain active. This research aims to connect laboratory studies of earthworm thresholds and impacts to real world conditions, climate variation, and regional distribution by combining broad and focused approaches. This information will contribute to modeling the effect of earthworms on nitrogen cycling in the inland PNW.

Nicole Ward (ward5576@vandals.uidaho.edu) UI
Master's student, advised by Erin Brooks
Improving agricultural nitrogen management through policy incentivized practices
Precision agriculture, which focuses on applying variable inputs, including nitrogen, to match the field variability of crop needs, has been identified as a promising strategy to decrease the environmental harm due to excess nitrogen while maintaining high yields. Cost-share programs, created through Farm Bill legislation, are meant to provide incentives for the adoption of precision agriculture. This study will use an advanced cropping systems model, CropSyst-MicroBasin, to examine field-scale nitrogen management with an understanding of how economic policy incentives affect farm profitability and management practices by (1) assessing the impact of policy incentives on the profitability of adopting nutrient management practices, (2) quantifying changes in nitrogen export to the environment, and (3) evaluating how effectively the conservation policy incentives address nutrient management issues in the region.

Jenna Way (wayj@onid.orst.edu) OSU
Master's student, advised by Clark Seavert
Evaluating environmental and economic trade-offs in agriculture.
We are developing an environmental module, called AgEnvironment™, in AgTools™ for agricultural producers to measure environmental impacts at the farm level. AgTools™ is a decision-making tool for agricultural producers that analyzes the profitability and feasibility at the individual farm level of different cropping systems and management decisions. AgEnvironment™ will capture changes in climate and allow users to evaluate adjustments in yields, cropping systems, inputs, and environmental impact, providing the opportunity to evaluate environmental and economic trade-offs. Currently, we are researching tools to measure the impact of practices and inputs on the environment and farm-level sustainability, such as energy use, fertilizer and pesticide use, soil erosion, and greenhouse gas emissions.

P. Troy White (pwhite@uidaho.edu) UI
PhD candidate, advised by Kattlyn Wolf
Inclusion of climate change in secondary education
My research focuses on the integration of climate science into the science and agriculture curriculum of secondary teachers in the PNW. Specific objectives include monitoring teacher perceptions relating to climate change and teaching of controversial science topics in their classes. The study uses both teacher workshops and REACCH-developed curriculum resources to train teachers on climate science and agriculture and then monitors their perceptions relating to climate change using a modified version of the Global Warming's Six Americas survey. In addition to the teachers' perceptions, we are collecting student content and attitudinal data to measure the impact of the curriculum and teaching resources on their knowledge and attitudes toward climate change and agriculture. This research improves climate literacy and examines teaching effectiveness.

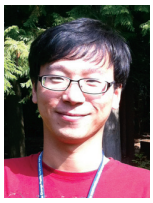
Lauren Young (leyoung@wsu.edu) WSU
Master's student, advised by Frank Young
High-residue no-till using a stripper header to conserve soil moisture for planting of oilseeds
Growing winter triticale and a tall variety of winter wheat has increased residue production at the Ralston project by at least 35% when compared to crop years with semidwarf winter wheat. Using a stripper header for harvest leaves the crop residues standing, creating a different microclimate than when a conventional cutter bar header, which leaves shorter residue, has been used. The stripper header stubble results in decreased soil temperatures and decreased wind speeds at the soil surface, which contribute to soil moisture differences between stubble treatments. The stripper header no-till system conserves more moisture during the fallow year and can reduce the loss of soil to wind erosion.



Jialing Yu (yujia@onid.oregonstate.edu) OSU
PhD candidate, advised by Junjie Wu
Impact assessment of the federal crop insurance program
Agricultural production faces risks from various sources, such as weather conditions, pests, natural disasters, management errors, diseases, and price fluctuations. The federal crop insurance program has become a major risk management tool for the government. It is important to understand the effects of the program's policies and how changes in policy will affect these impacts.

Crop insurance is a voluntary program, which makes program participation a critical issue for the government in delivering the program and also for researchers in correctly assessing the program's impacts. The government has increased premium subsidies several times over the life of the program to encourage participation. Yet not all producers participate in the program. It is essential to understand the participation process, in that it selects the population that will be affected and therefore determines the distribution and magnitude of policy impacts. Farmers making participation decisions based on potential outcomes give rise to the selection problem in policy evaluation.

This study applies the Tradeoff Analysis Model for Multi-Dimensional Impact Assessment (TOA-MD) to the selection issue in the impact assessment and analyzes how policy changes may affect the program participation rate and thus the outcome impacts. TOA-MD is a population-based approach that links policy changes to participation and simulates distributional policy impacts, accounting for self-selection and counterfactual issues. It emphasizes the heterogeneity of the population, which affects the participation rate, and heterogeneous policy outcomes. The study focuses on regions with different characteristics and levels of heterogeneity, namely the Pacific Northwest, the Corn Belt, and the Great Plains, to understand the role that heterogeneity plays in program participation and impacts.



Hongliang Zhang (zhangh@onid.oregonstate.edu) OSU
PhD candidate, advised by John Antle
Climate change impacts on agricultural systems
My research focuses on assessing climate change impacts on agricultural systems and evaluating conservation tillage as a potential strategy for adapting to climate change . The study region is the East Cascades in the PNW, including the REACCH region. I use two different methodologies: statistical approaches and process-based approaches. I assess the vulnerability of agricultural systems under future climate scenarios based upon the estimated distribution of outcomes. Also, I investigate factors that drive the use of conservation tillage and evaluate the effects of conservation tillage on crop yields and production risk.

Xiaojuan Zheng (xiaojuanjudy@gmail.com) OSU
PhD candidate, advised by Jeff Reimer
Integrating representative agriculture pathways into the commutable general equilibrium model
My research study is trying to introduce representative agricultural pathways and scenarios (RAPS), which describe narratives and trends in key drivers at a regional or global scale, into a computable general equilibrium economic model. I estimate key economic relations econometrically using historical data, including a foreign export demand decision model and a PNW wheat output supply model. The general objective is to provide confidence intervals concerning economic variables of interest to development of the Pacific Northwest wheat sector over the next few decades.

REACCH students and team members gather for a discussion with Sonny Ramaswamy, USDA NIFA Director, at the University of Idaho, July 2014. Photo by Leigh Bernacchi.