Regional Approaches to Climate Change for Pacific Northwest Agriculture

REACCH Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Project Director: Sanford Eigenbrode, University of Idaho

Goals

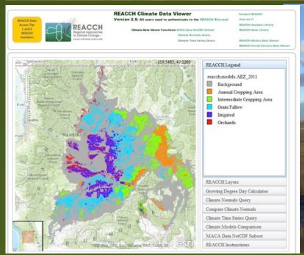
- Identify and implement management approaches and technology that
  - impart resilience to climate change
  - reduce greenhouse gas emissions
- Extend project information to producers and others
- Educate next generations: K-20
- 9 disciplinary and integrating objectives

Impacts

- Farmers and stakeholders more prepared to manage wheat under a variable climate
- New professionals prepared to serve agriculture in the public and private sector
- Capacity for continuing efforts to improve sustainability of Idaho wheat production
- Curricula for high school teachers on project themes
- Numerous resources that farmers and others

Approach

- Coordinated effort involving biologists, agronomists, climate modelers, economists, entomologists, sociologists, educators, extension educators
- Regional, with 3 universities and ARS
- >200 participants (PIs, students, others)
- Stakeholder input from inception
- 75:12:13, Research:Education:Extension



OSU Oregon State University

Washington State University

University of Idaho

USDA ARS

Outline

- Who we are
- Outputs
- Outcomes
- Partners
- Meeting Challenges
- Frontiers
- Futures

Who We Are

Who We Are

- ✓ Four institutions
19 PI's
- ✓ 12 academic units
- ✓ 29 Investigators
- ✓ 52 graduate students and postdocs
- ✓ 42 undergraduate research summer interns
- ✓ 20 technical and administrative staff
- ✓ 47 farmers participating in multi-year, longitudinal survey
- ✓ 4500 stakeholders participated in REACCH sponsored extension activities in Year 4

OSU Oregon State University · Washington State University · University of Idaho · USDA ARS

Where We Are

Where We Are

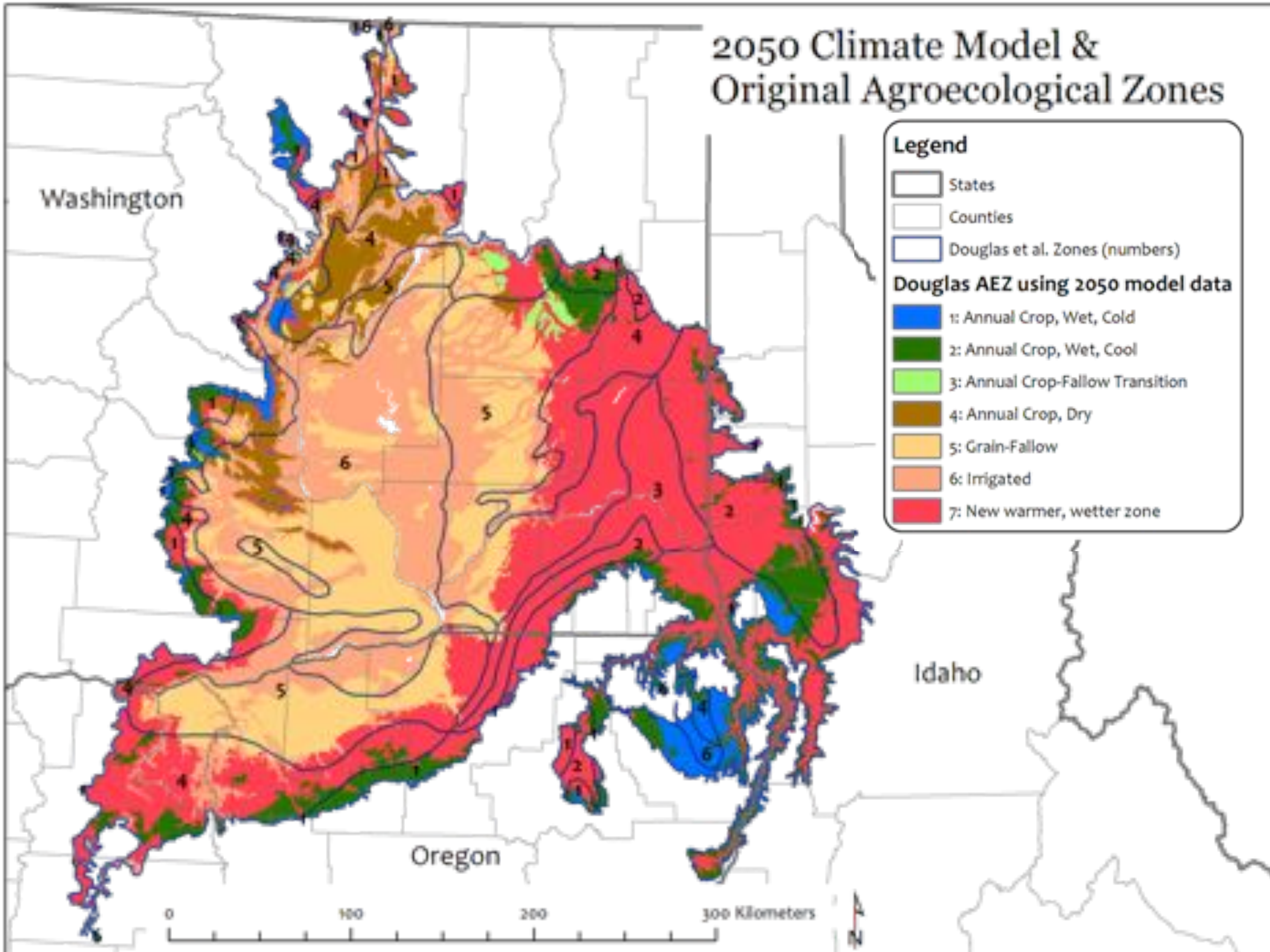
Where We Are

Where We Are

Erosion on the Palouse hills south of Colfax in early February, 2011. Photo by Kathleen Painter.

Where We Are

Where We Are


2050 Climate Model &
Original Agroecological Zones
Legend
States
Counties
Douglas et al. Zones (numbers)
Douglas AEZ using 2050 model data
1: Annual Crop, Wet, Cold
2: Annual Crop, Wet, Cool
3: Annual Crop-Fallow Transition
4: Annual Crop, Dry
5: Grain-Fallow
6: Irrigated
7: New warmer, wetter zone
Washington
Oregon
Idaho
0
100
200
300 Kilometers
N

Climate Change and PNW Agriculture

Vulnerabilities

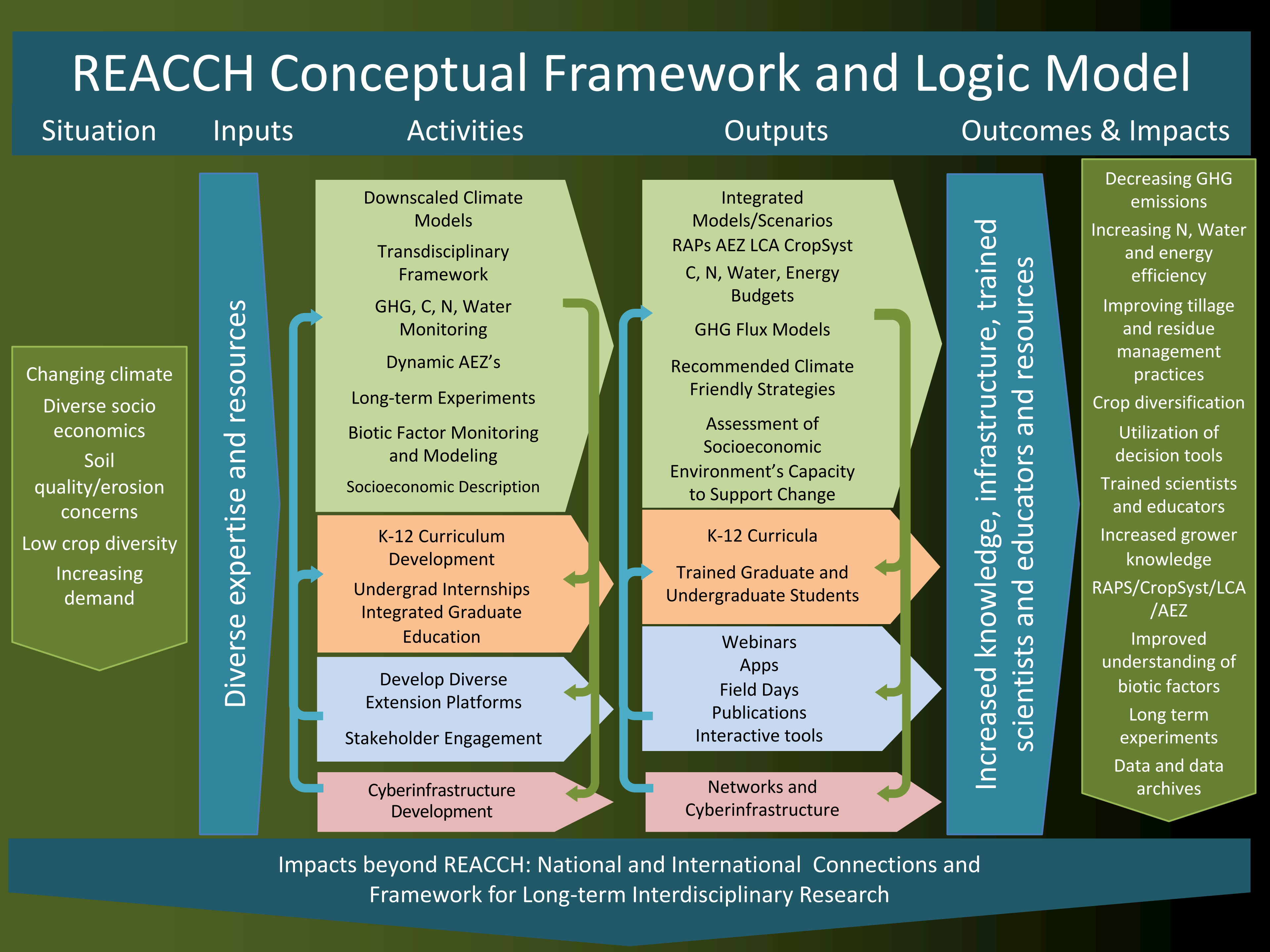
- Reduced summer precipitation
- Reduced precipitation as snow
- Increased episodes of extremely warm weather
- Increased demand for water with water shortages in some locations and years
- Changing weed, pest and disease pressure
- Needs for rapid adaptation by producers

Opportunities

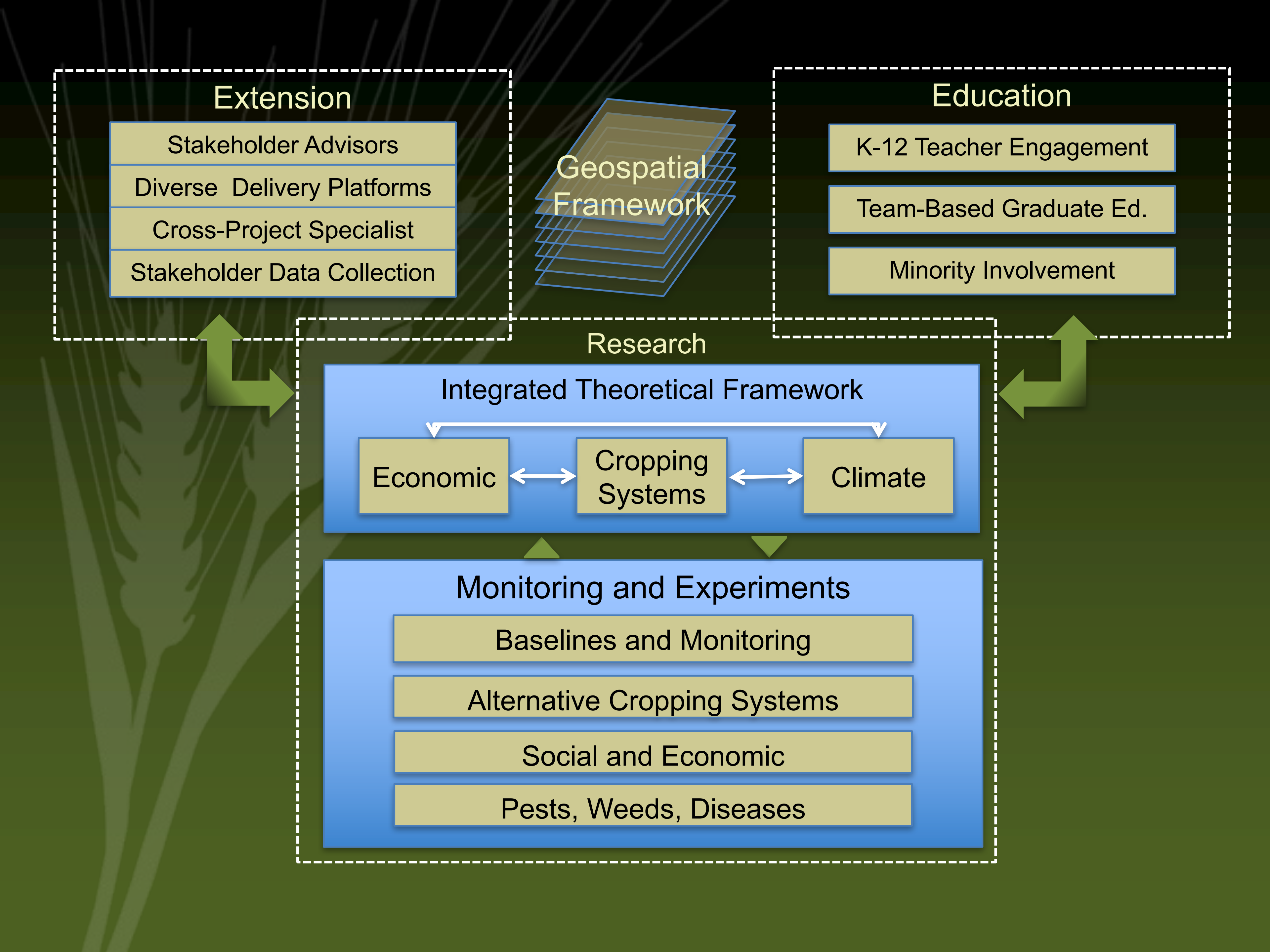
- CO_2 fertilization benefits
- Longer growing (frost-free) seasons
- Possibly more total water

Goals of REACCH

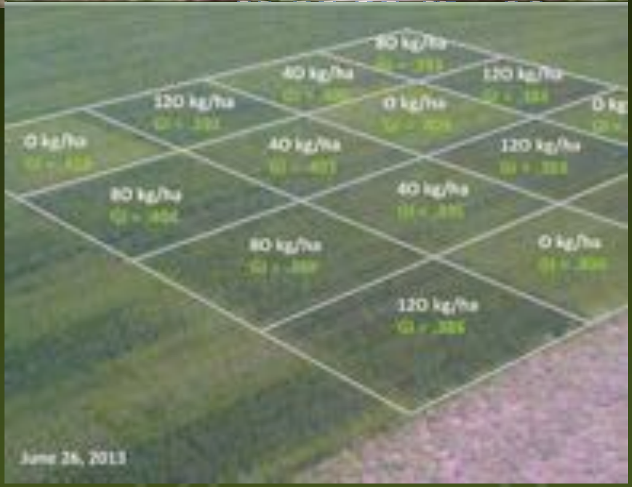
1. **ADAPTATION** - Develop and implement sustainable agricultural practices for cereal production within existing and projected agroecological zones throughout the inland PNW as climate changes.
2. **MITIGATION** - Contribute to climate change mitigation through improved fertilizer, fuel, and pesticide use efficiency, increased sequestration of soil carbon, and reduced greenhouse gas (GHG) emissions consistent with NIFA's 2030 targets.
3. **PARTICIPATION** - Work closely with stakeholders and policymakers to promote science-based agricultural approaches to climate change adaptation and mitigation.
4. **EDUCATION** - Increase the number of scientists, educators, and extension professionals with the skills and knowledge to address climate change and its interactions with agriculture.



REACCH Conceptual Framework and Logic Model
Situation
Inputs
Activities
Outputs
Outcomes & Impacts
Changing climate
Diverse socio economics
Soil quality/erosion concerns
Low crop diversity
Increasing demand
Diverse expertise and resources
Downscaled Climate Models
Transdisciplinary Framework
GHG, C, N, Water Monitoring
Dynamic AEZ's
Long-term Experiments
Biotic Factor Monitoring and Modeling
Socioeconomic Description
K-12 Curriculum Development
Undergrad Internships
Integrated Graduate Education
Develop Diverse Extension Platforms
Stakeholder Engagement
Cyberinfrastructure Development
Integrated Models/Scenarios
RAPs AEZ LCA CropSyst
C, N, Water, Energy Budgets
GHG Flux Models
Recommended Climate Friendly Strategies
Assessment of Socioeconomic Environment's Capacity to Support Change
K-12 Curricula
Trained Graduate and Undergraduate Students
Webinars
Apps
Field Days
Publications
Interactive tools
Networks and Cyberinfrastructure
Increased knowledge, infrastructure, trained scientists and educators and resources
Decreasing GHG emissions
Increasing N, Water and energy efficiency
Improving tillage and residue management practices
Crop diversification
Utilization of decision tools
Trained scientists and educators
Increased grower knowledge
RAPS/CropSyst/LCA /AEZ
Improved understanding of biotic factors
Long term experiments
Data and data archives
Impacts beyond REACCH: National and International Connections and Framework for Long-term Interdisciplinary Research

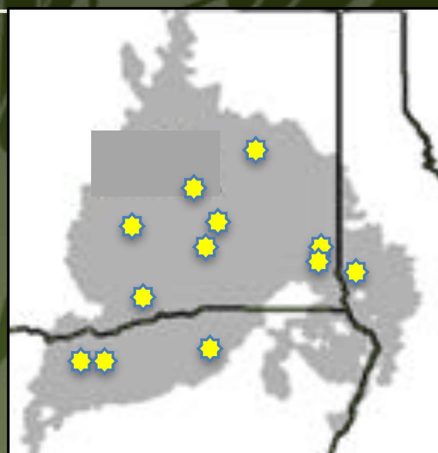

Extension
Stakeholder Advisors
Diverse Delivery Platforms
Cross-Project Specialist
Stakeholder Data Collection
Geospatial Framework
Education
K-12 Teacher Engagement
Team-Based Graduate Ed.
Minority Involvement
Research
Integrated Theoretical Framework
Economic
Cropping Systems
Climate
Monitoring and Experiments
Baselines and Monitoring
Alternative Cropping Systems
Social and Economic
Pests, Weeds, Diseases


a
b
c
d


80 kg/ha
40 kg/ha
120 kg/ha
120 kg/ha
0 kg/ha
0 kg/ha
40 kg/ha
120 kg/ha
80 kg/ha
40 kg/ha
80 kg/ha
0 kg/ha
120 kg/ha
June 26, 2013

Replicated Trials of Alternative Systems

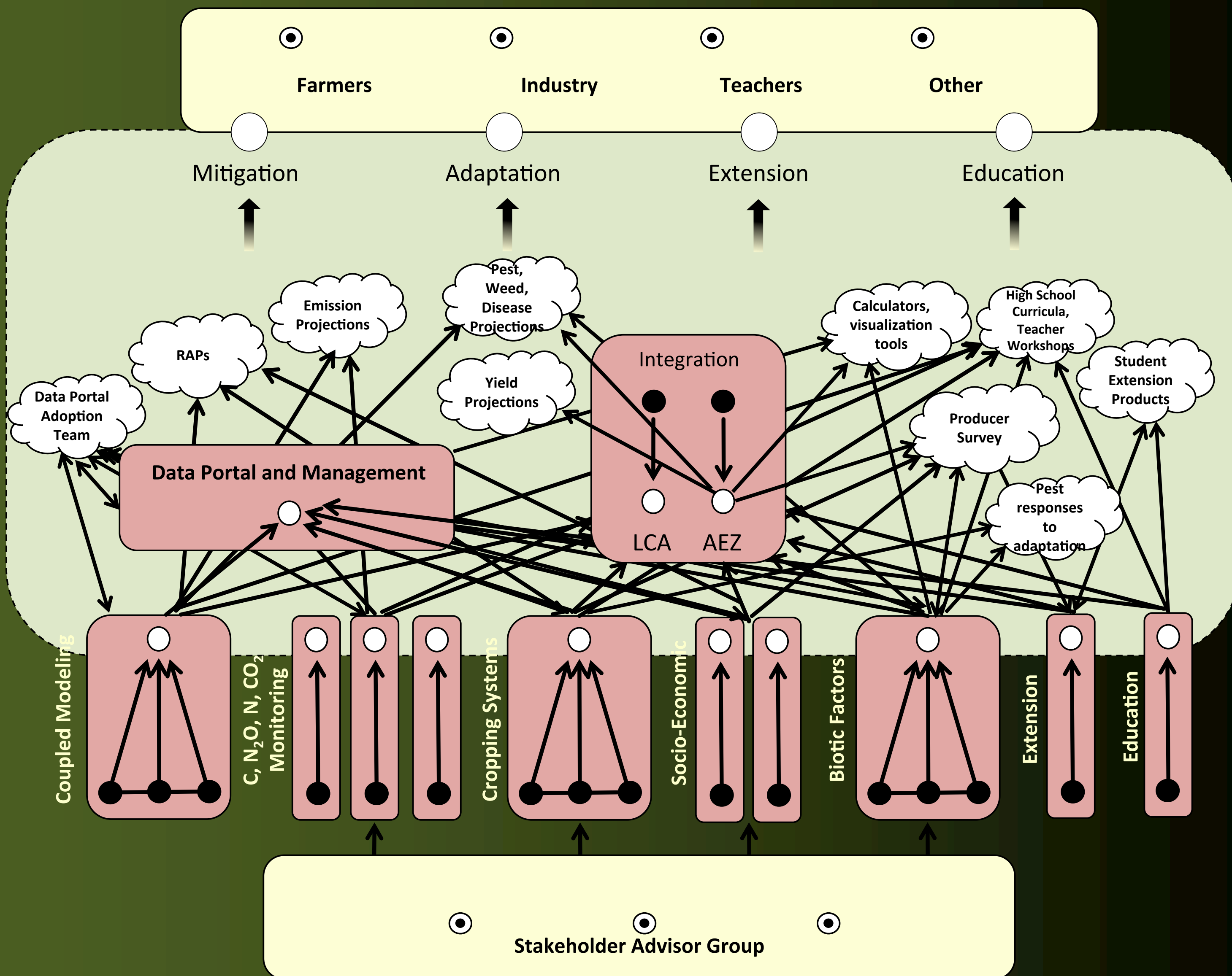
Long-term trials (15, including continued and newly established experiments)



	Wilke Farm	Cook Agronomy Farm	Palouse Conservation	Hennings Farm	Troutman Farm	Jariva Farm (Ritzville)	Kambitsch Farm	Prosser Station	Pendleton Station	Boyd Family Farms	Moro Station
Site specific N management											
Crop intensification/diversification											
Residue management											
Crop rotation											
Rotational N cycling and management											
Tillage											
N fertility, recycled C, N byproducts											

Crop residue long-term experiment at at Columbia Basin Agricultural Research Center, near Pendleton OR . Photo by Stephen Machado.

REACCH AAI 2014



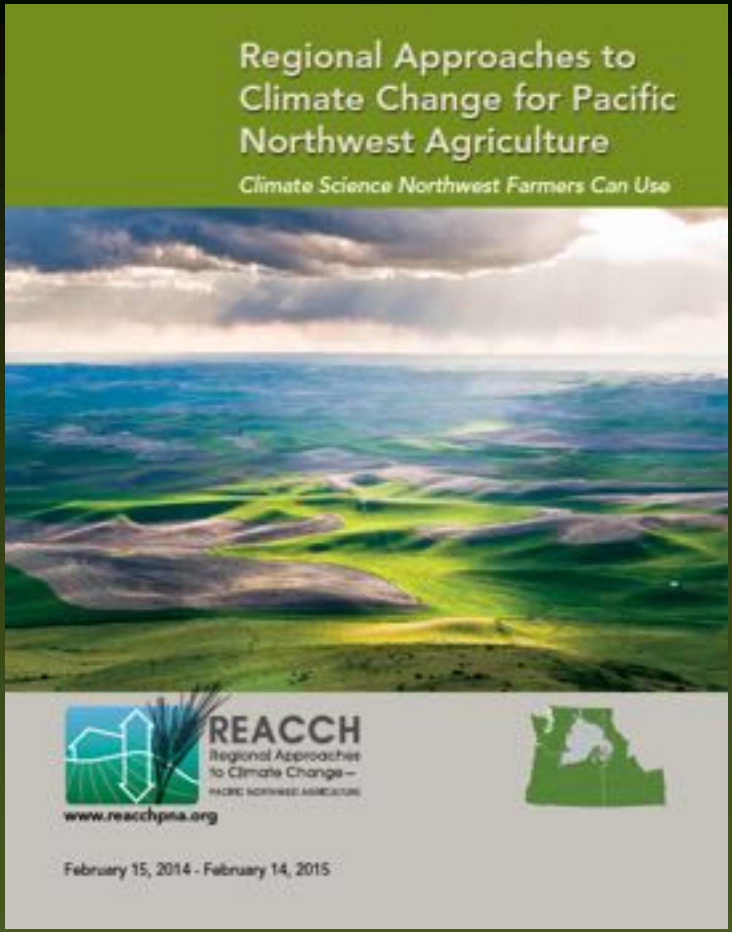
Wright-Morton, Eigenbrode, Martin, in prep

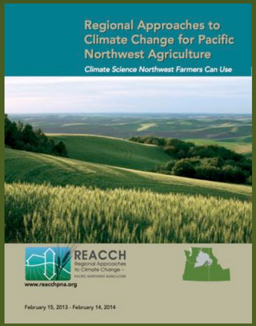
Outputs

64 stakeholder oriented videos on
https://www.youtube.com/user/reacchpna
> 800 datasets (35TB+ of data)
120 refereed publications and abstracts
225 presentations at professional meetings
227 presentations to producers
182 fact sheets, blogs and other extension products
Climate change x agriculture high school curriculum and annual teacher workshops
Web-based nitrogen efficiency calculator
Insect and weed management mobile applications

Outputs

4 Annual Reports
Year 4
64 articles across the project
Targeting Farmers, Policymakers, Educators, other Stakeholders
Guest articles: NW Climate Hub, LTAR, NWCCS, BioEarth, SCF





REGIONAL APPROACHES TO CLIMATE CHANGE FOR PACIFIC NORTHWEST AGRICULTURE
is a coordinated agricultural project committed to sustainability and building resiliency in cereal production systems.
Funded by National Institute of Food and Agriculture (NIFA).

Farmer-to-Farmer Case Studies

feature local growers introducing their innovative practices.
Learn more about Precision Nitrogen Application.

REACCH 4th Annual Meeting is coming up!

March 3-6th, University of Idaho, Moscow

Register to join us for the latest in science, outreach and collaboration

Get ready for the meeting by reading the REACCH 2015 Annual Report Available

Climate Science Northwest Farmers Can Use

Capital Ag Press covers REACCH findings

23 Jan, 2015| by erichs
Farmers have long taken a keen interest in a changing climate and potential effects, good and bad, on what they grow and how the…

Climate Change in Politics

22 Jan, 2015| by erichs
State of the Union 2015 address is followed by a Congressional vote on the veracity of climate change.

REACCH Annual Meeting Art and Science Exhibition

22 Jan, 2015| by erichs
REACCH-PNA (Regional Approaches to Climate Change – Pacific Northwest Agriculture) invites submissions from artists and scient…

2014 is the hottest year on record

22 Jan, 2015| by erichs
NASA and NOAA concur: the year 2014 ranks as

Get all the Climate and Agriculture news from the region. REACCH is one of the many authors.

Check out AgClimate.net

REACCH's Art & Science Salon kicks off the annual meeting

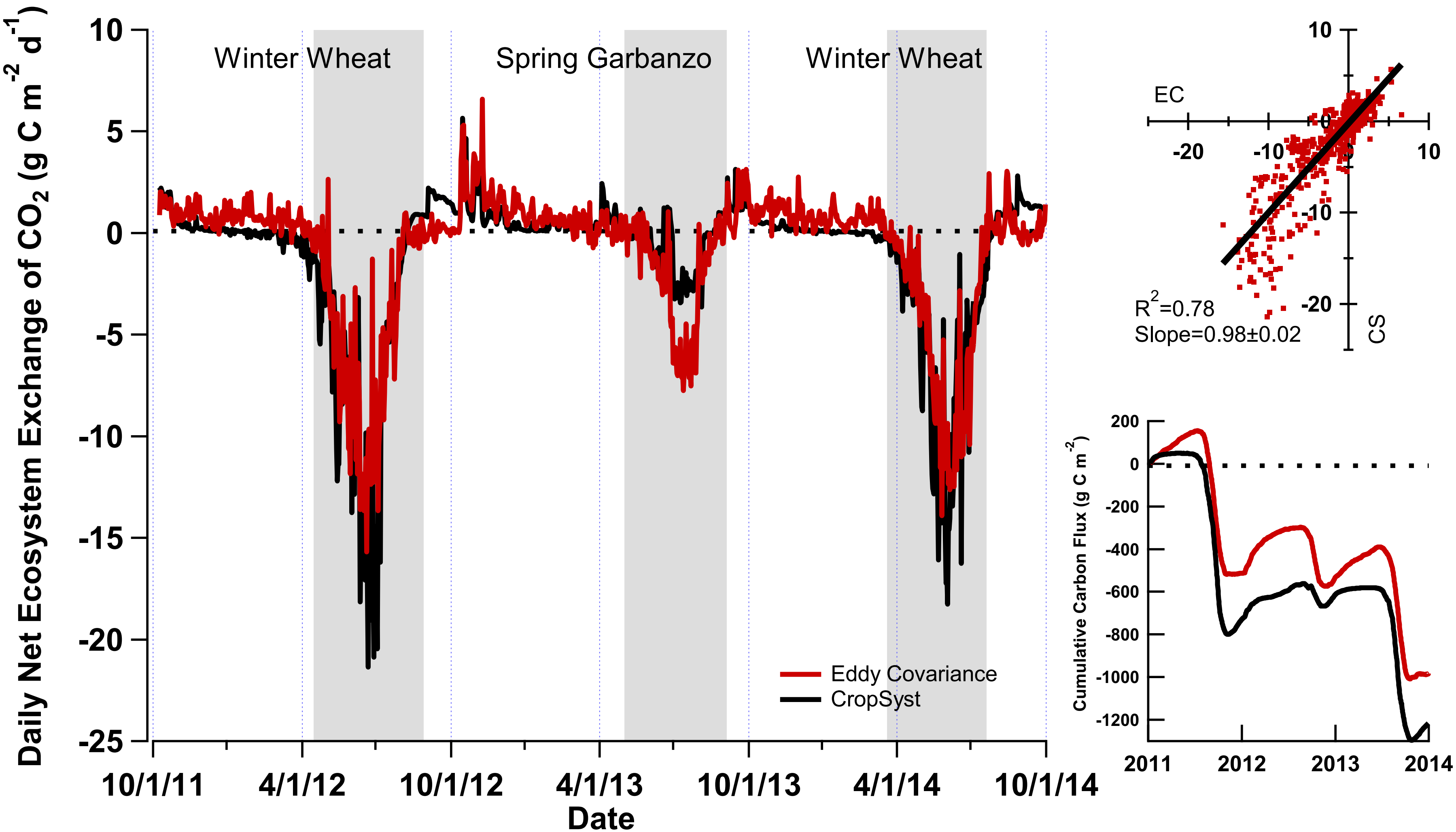
Come visit the exhibit this Tuesday 5-8pm and Wednesday 4-8pm

Some key findings

- Mitigation:
  - N_2O emissions dominated by winter spikes, exceed IPCC-based modeled expectations
- Adaptation:
  - Heterogeneity of outcomes substantial under most scenarios and cropping systems
  - Stripper header conserves soil moisture

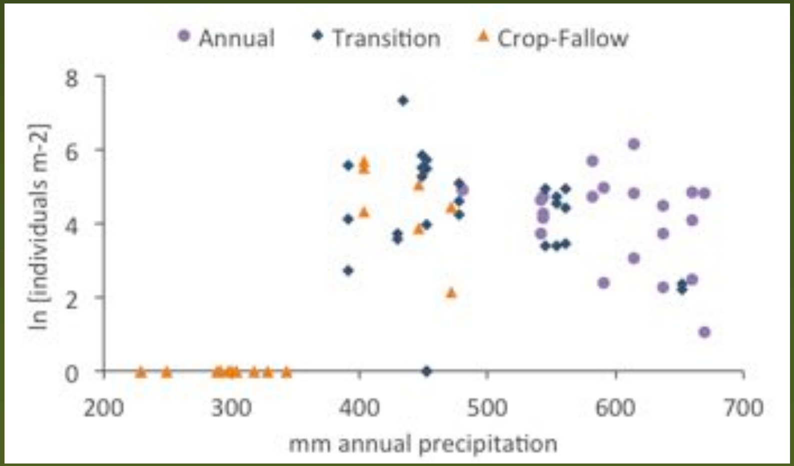
Highlights-1

Carbon and water fluxes measured continuously over five sites. Initial carbon and water budgets compiled and used for CROPSYST evaluation



Some key findings

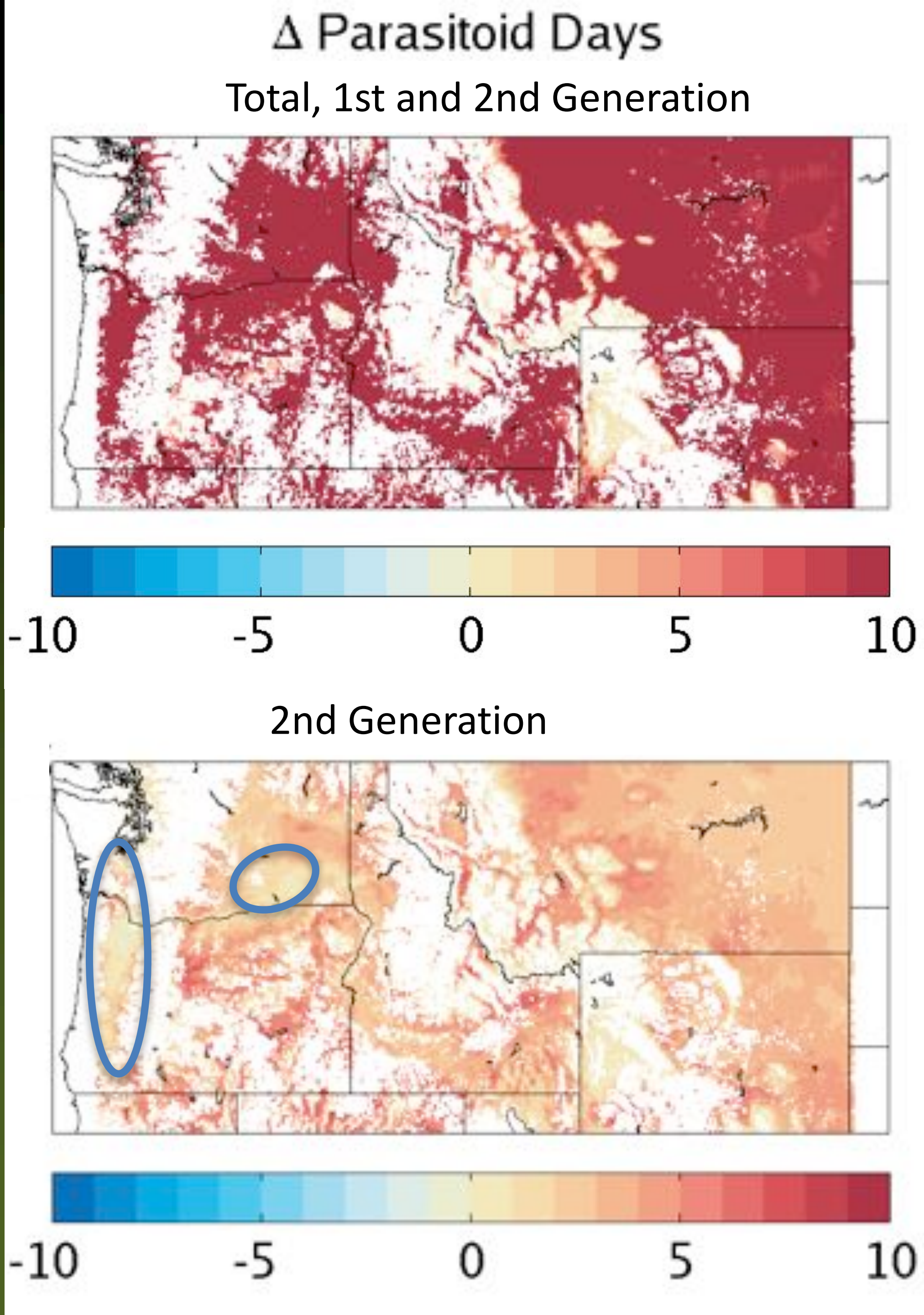
- Pest Weeds and Diseases:
  - New aphid sp.
  - Biological control of a key pest may weaken with CC
  - Aphid species differ in responses to climate drivers
  - Earthworm precipitation threshold



By mid 21st century…

Zero to substantial increases in overlap in 1st generation *T. julis* with CLB larvae

Small reduction to substantial increases in overlap in 2nd overlap in 2nd generation *T. julis* with CLB larvae

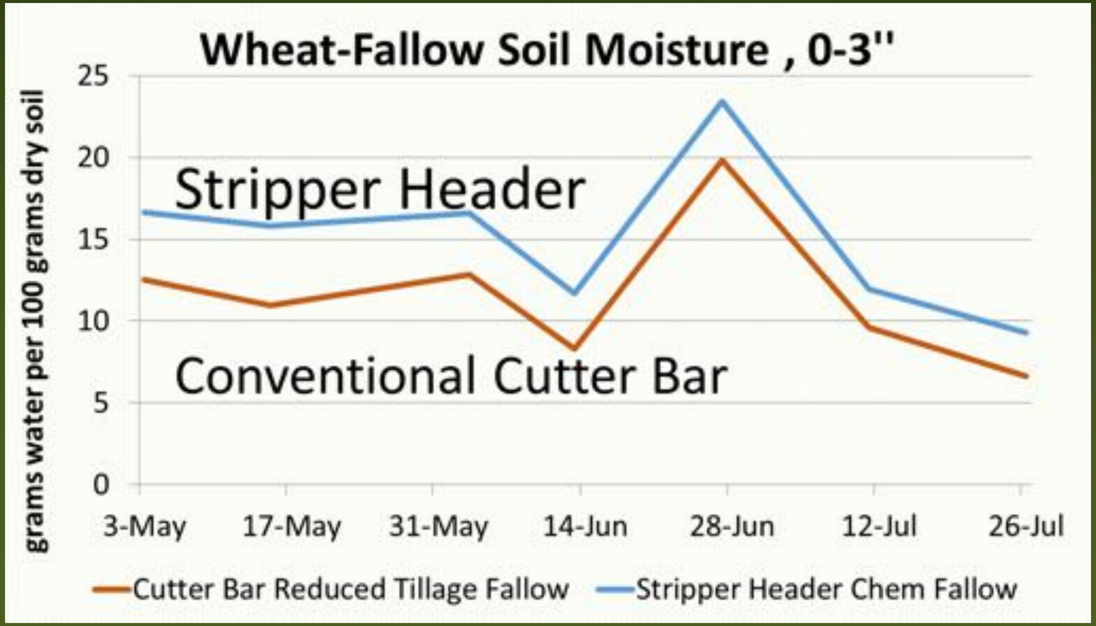


Some key findings

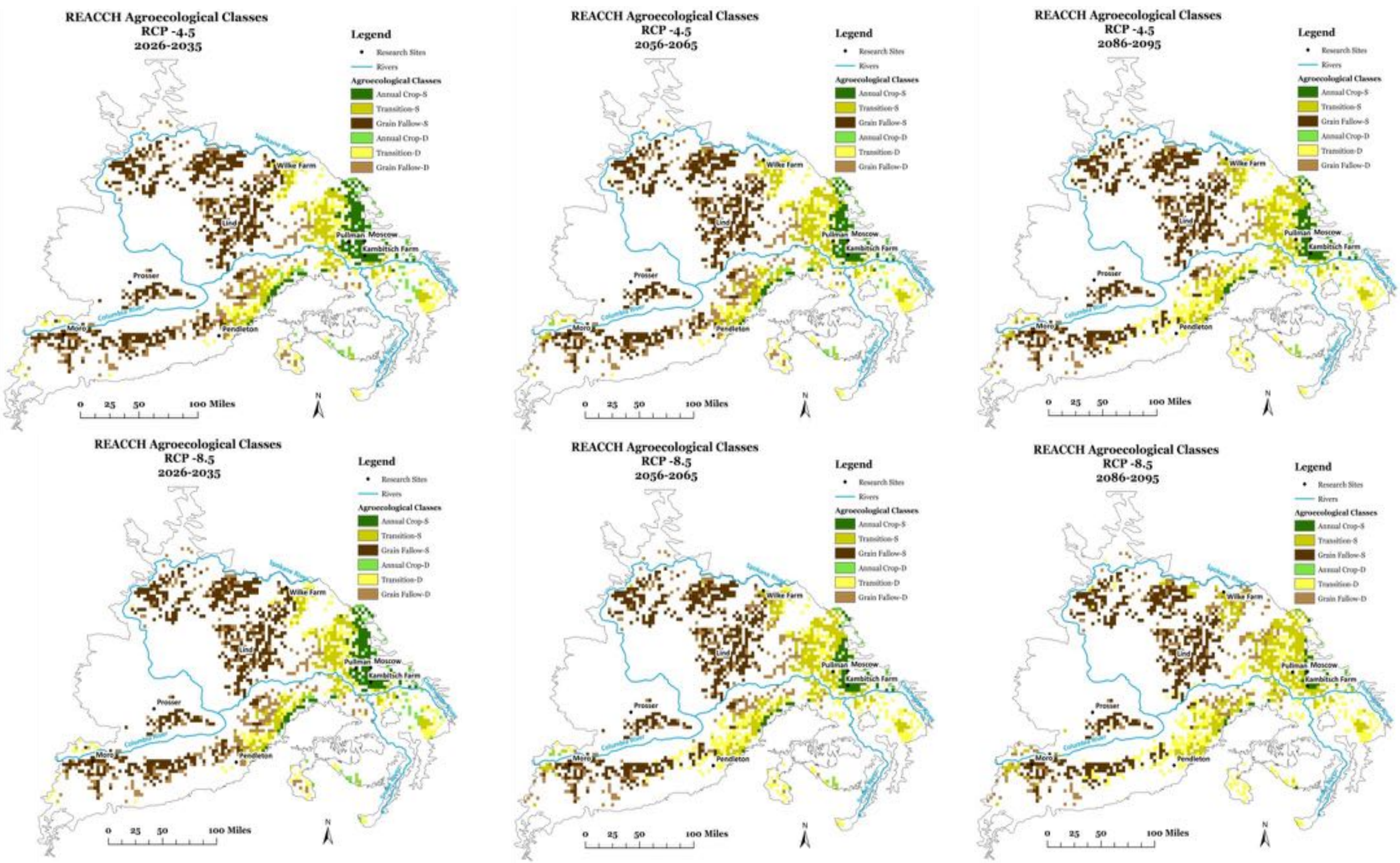
- Adoption
  - Most, but not all producers are skeptical about climate change and its human causes
  - The most progressive growers feel their systems are resilient to climate change
  - All are interested in precision technologies to improve N efficiency, and thus, potentially GHG mitigation
  - Empirical studies and modeling reveal dynamic, climate responsive regions in the landscape

Nimble, Flexible Systems: High Residue Farming

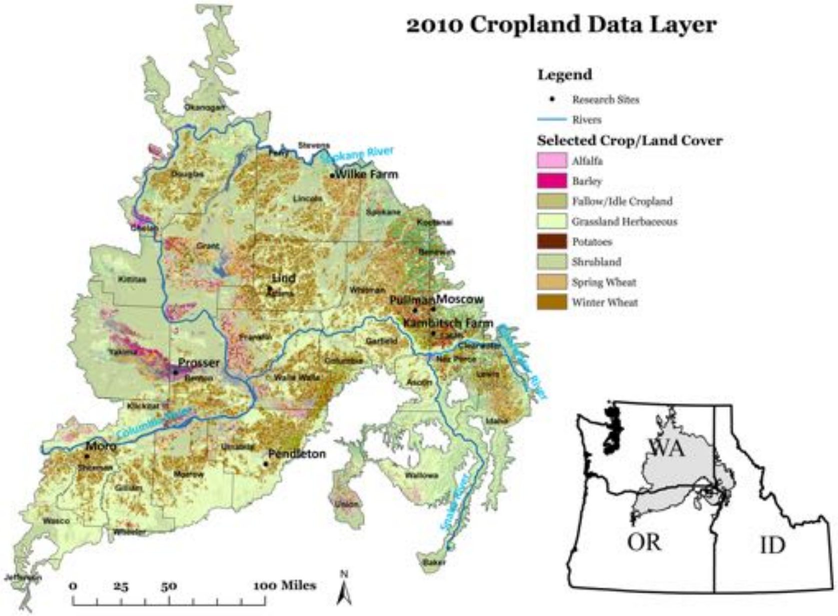
Port, Young, Roe, unpublished



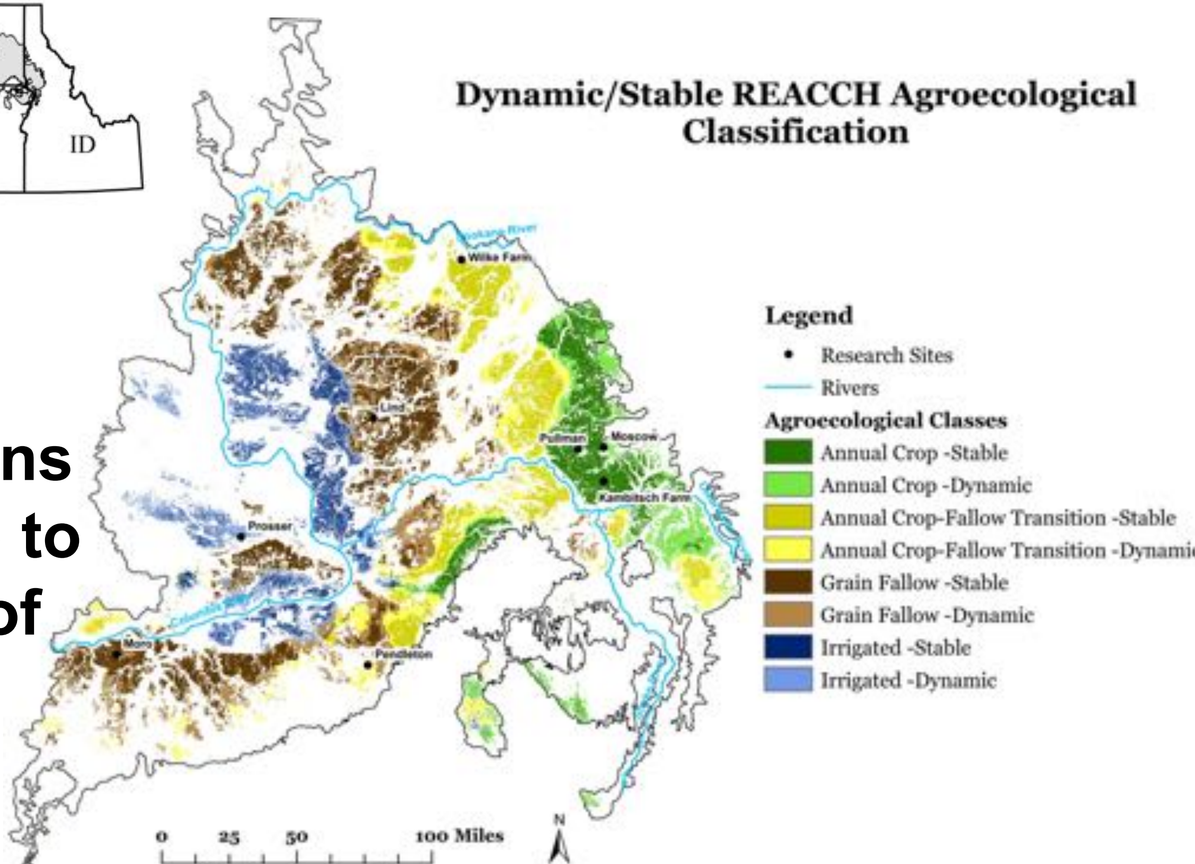
Prediction of AECs under different future scenarios



Highlights

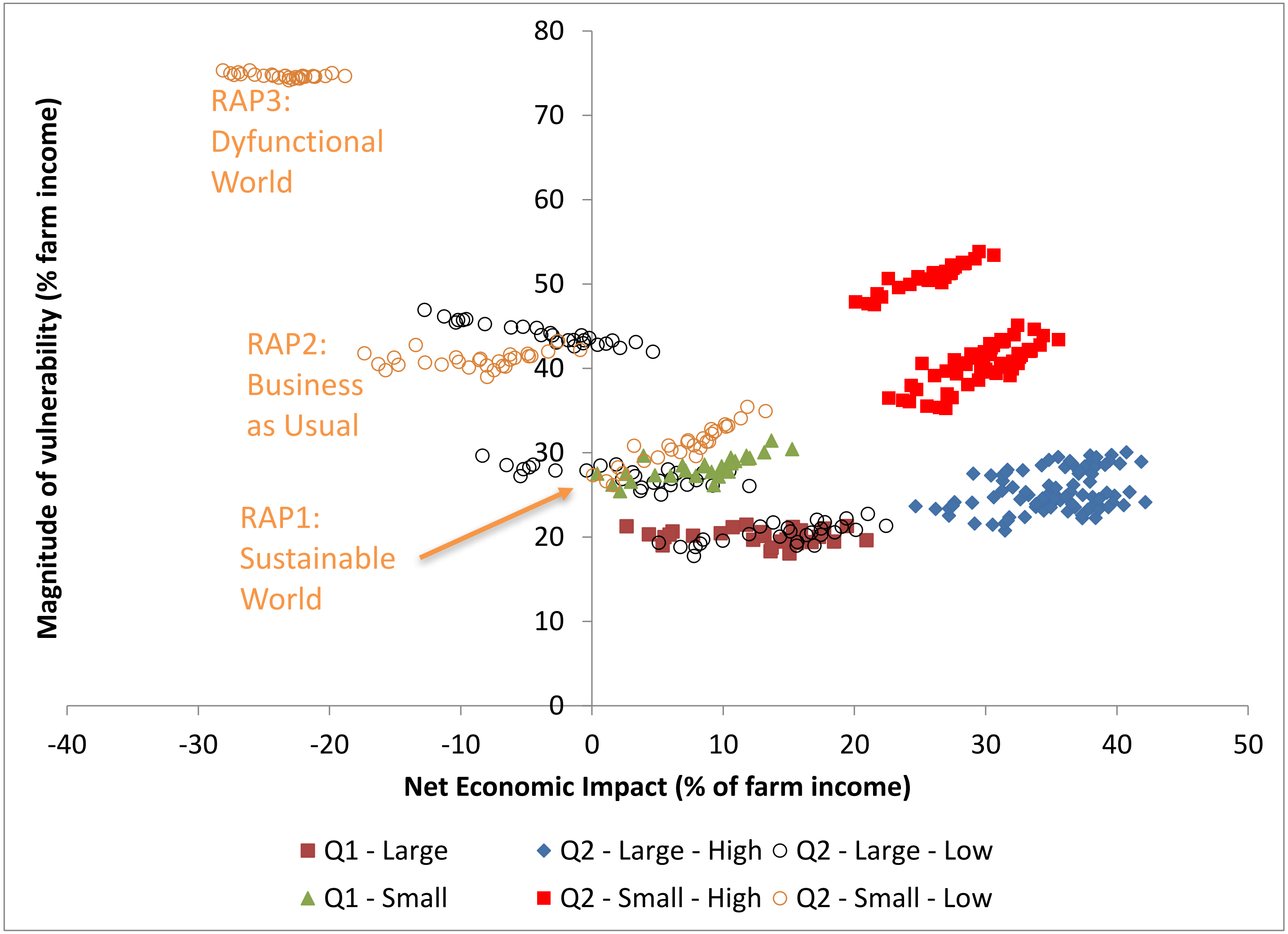


- **Dynamic Agroecological Classifications**



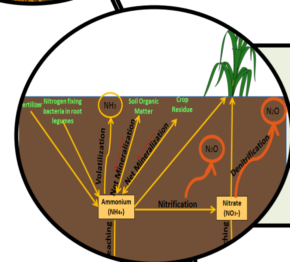
- **AECs used in many REACCH presentations (see Annual Reports) to aid characterization of REACCH study area**

Magnitude of CC vulnerability without adaptation: winter wheat – fallow

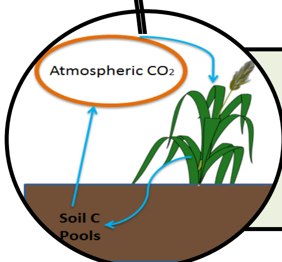


Results

Wheat Dryland Production : Evaluate the wheat production at PNW drylands under future climate condition and compare with current production



Nitrogen Budget Components : Evaluate the changes in N budget components (including N leaching, fixation, crop N uptake, net mineralization, ammonium volatilization and N_2O lost by nitrification and denitrification) under future climate condition and compare with current condition.



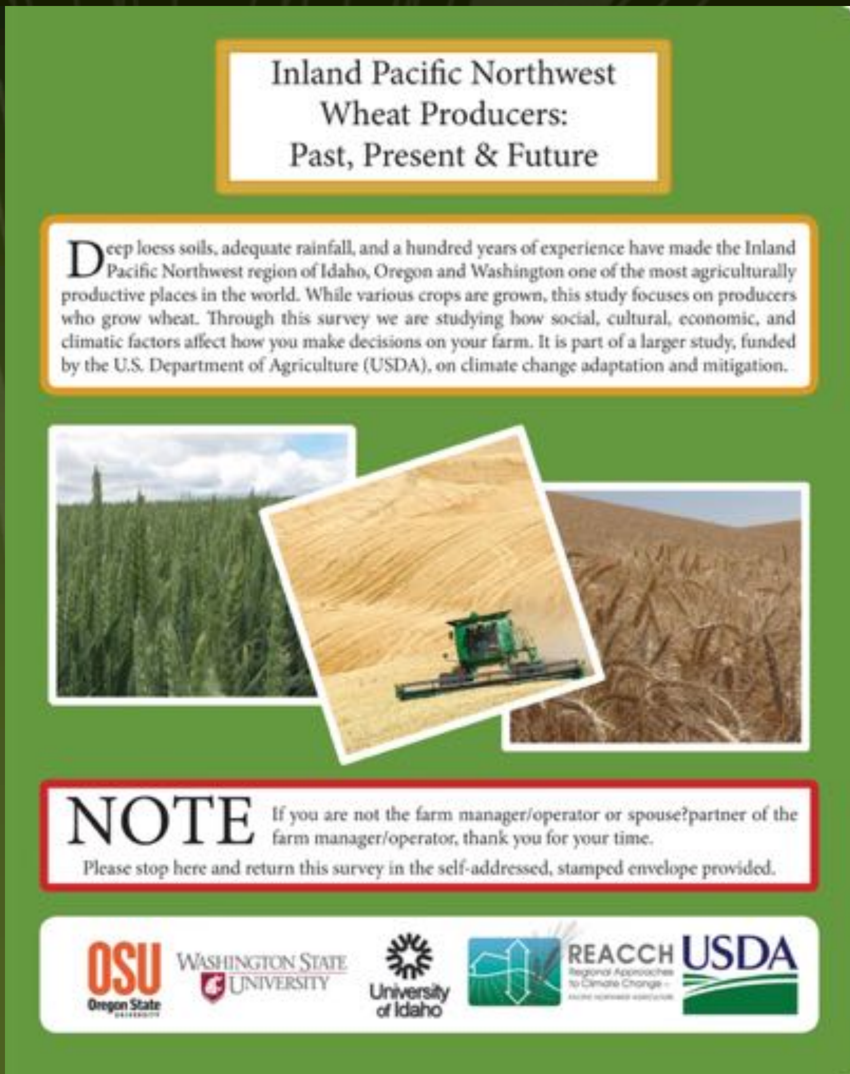
Soil Organic Carbon Changes : Evaluate the long term SOC changes under different cropping systems associated with agroecological zones in PNW, under current and future climate.

Total Carbon Footprint : Evaluate the total C footprint of different cropping systems and management associated with agroecological zones in PNW, under current and future climate. This will be done by looking at the N_2O emission (CO_2 equivalent), CO_2 emission and changes in SOM as a result of cropping systems, in addition to direct and indirect emissions with crop inputs and management

Effect of Different Tillage Intensity : Evaluate the effect of different tillage practices on soil water content during the growing season, N_2O emission, yield and total carbon footprint, at current and under future climate condition.

Socioeconomics

Administered by the University of Idaho Social Science Research Unit


Inland Pacific Northwest
Wheat Producers:
Past, Present & Future

Deep loess soils, adequate rainfall, and a hundred years of experience have made the Inland Pacific Northwest region of Idaho, Oregon and Washington one of the most agriculturally productive places in the world. While various crops are grown, this study focuses on producers who grow wheat. Through this survey we are studying how social, cultural, economic, and climatic factors affect how you make decisions on your farm. It is part of a larger study, funded by the U.S. Department of Agriculture (USDA), on climate change adaptation and mitigation.

NOTE If you are not the farm manager/operator or spouse?partner of the farm manager/operator, thank you for your time.
Please stop here and return this survey in the self-addressed, stamped envelope provided.

- Winter 2012-2013 mail survey
- Ian and Leigh
- Farm operations in WA, ID, OR study area w/ 50 or more acres of wheat
- Stratified random sample within 33 REACCH counties
- Dillman method with four mailings
- n = 900
- Response rate, 46%

Education Highlights

K-8

- workshop on agriculture and soil erosion for 40, 7-8th grade Native American students
- Developed weekly activities for a small group of Native American high school students

Education Highlights

Native Americans

- Developed weekly activities for a small group of Native American high school students

Education Highlights

9-12

Annual HS Teacher Workshop

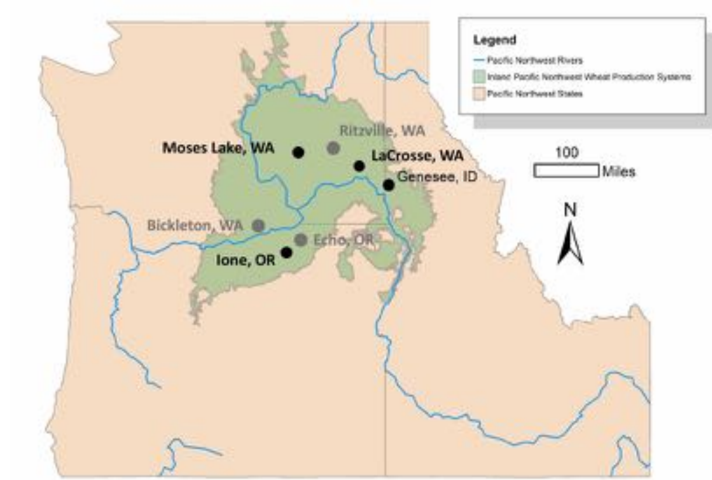
- Pendleton, Oregon July 2014 focused on Precision Agriculture, Economics and Spatial Thinking.
- 21 teachers, grades 6-12 science and ag. science teachers

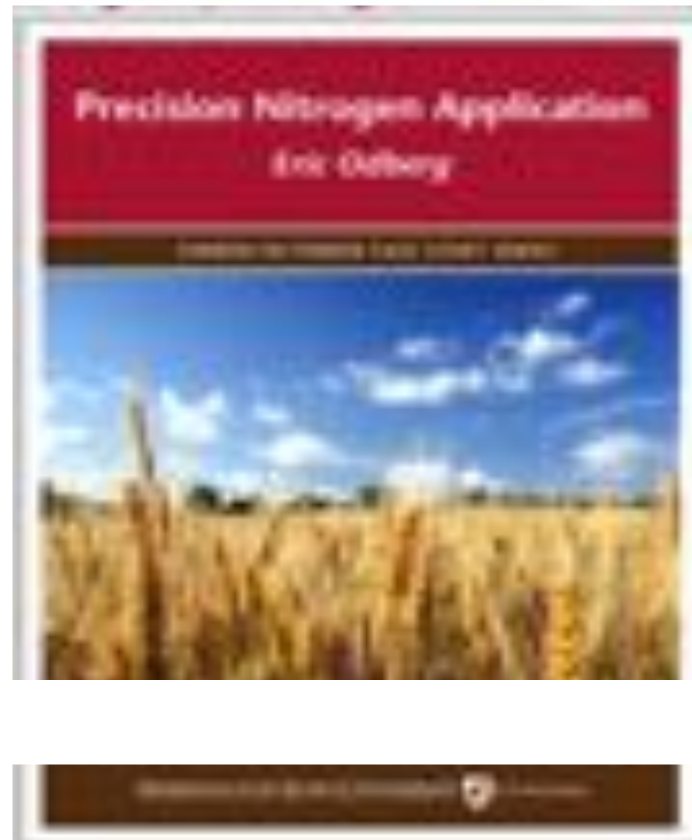
Education Highlights

- Undergraduate
  - 9-week summer internship program
  - Total of 60 interns by end of project
  - Immersion in Research, Extension, Integration

Extension Highlights

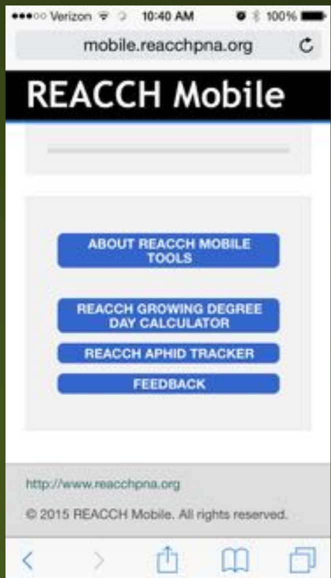
- Stakeholder outreach through partnerships
  - 4,500 people directly participated in a REACCH sponsored outreach activity or downloaded an outreach product in project Year 4.
- Funded 12 Extension Curriculum Grant Projects at $170,000 since 2013
- Hosted a Precision Agriculture Field Day at UI with 90 people in attendance in Year 4

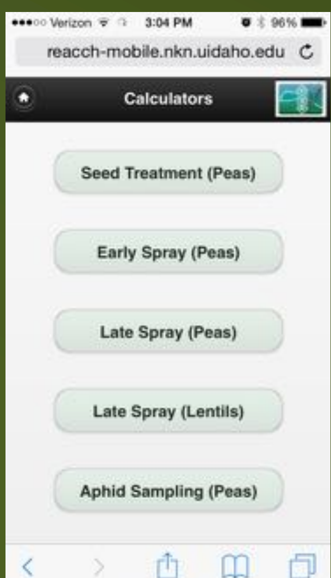


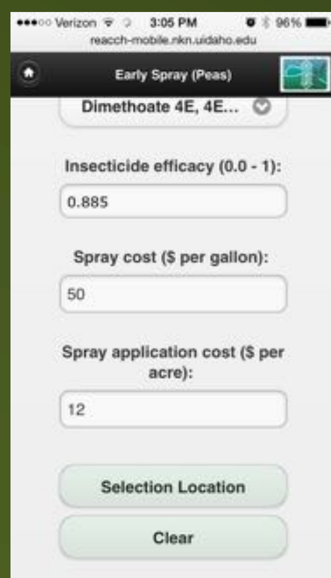


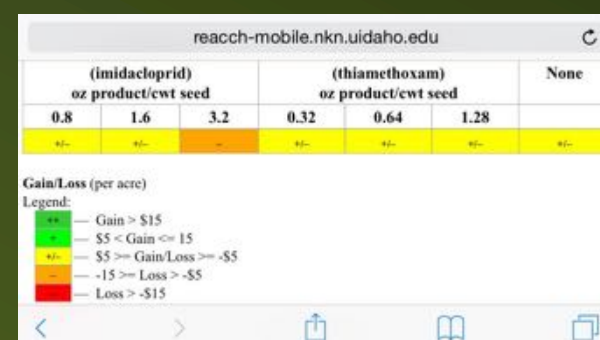
www.casestudies.reacchpna.org

Mobile Applications









AgBiz Logic

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Thank you for visiting the AgBiz Logic™ web site. This site is an economic, financial and environmental accounting decision tool to assist agribusinesses that grow, harvest, package, add-value, and sell agricultural products.
Learn More

Meeting Challenges

Integration Challenges

- Variety of virtual collaborative tools
- Frequent all-project integration calls
- Quarterly meetings of leadership
- “Toolbox” (MSU and UI) training and engagement
- Social Network Analysis
- Annual assessment survey and report
- Annual 2.5-day all-project meeting

Meeting Challenges

Stakeholder Challenges

- Farmers, with skepticism
  - Emphasize near-term needs for resilience to variability
  - Provide information and tools useful today, partnering
  - Stakeholder Advisory Committee
  - Emphasize “win-win” scenarios (reducing emissions makes economic sense)
  - Focus on early adopters
  - Conduct field tours, present to various venues

Meeting Challenges

Stakeholder Challenges

- Scientists
  - Publish widely and at high levels
  - Contribute to professional meetings
  - Organize symposia
  - Organizing international conference on climate change and arid production systems (2015)
  - Plan for special issue(s)

Meeting Challenges

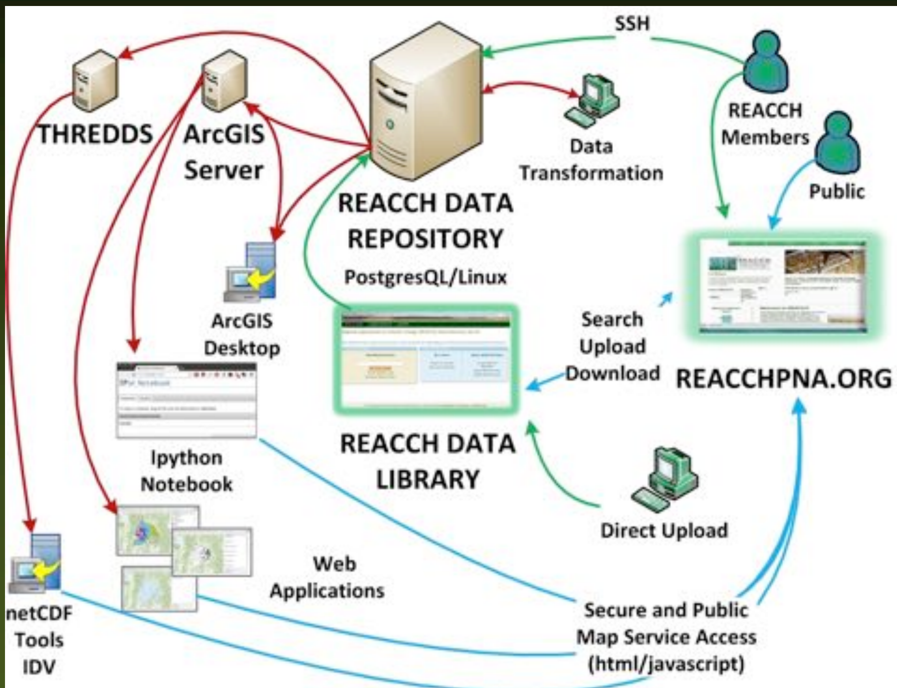
Stakeholder Challenges

- Policymakers and NGOs
  - Including on SAC
  - Develop targeted communication strategy
  - Involve NGO representatives as advisors
  - Provide public lectures to citizen groups

Addressing Challenges

Synthesis

Data Management



How the CAP experience can benefit NIFA

Lessons learned:

- CAPs and CAP leaders have common interests in maximizing impacts of the projects.
- Outcomes are affecting broad stakeholder profile
- We are gaining skills in achieving scientific "convergence" (NAS 2014) that could be transmitted to future awardees of foundational and coordinated projects.
- We have created legacy infrastructures: cultures of communication and collaboration, long-term experiments, regional baselines, integrated projections for our production systems.
- Data management systems in support of "Big Interdisciplinarity" that are extensible.

Action steps?

- Forthcoming NIFA RFA's could include opportunities to build on CAP themes, momentum, infrastructure.
- The Climate CAP directors are ready to assist in identifying best practices and methods for transmitting these to enhance collaboration within NIFA's portfolio during final years of these projects.

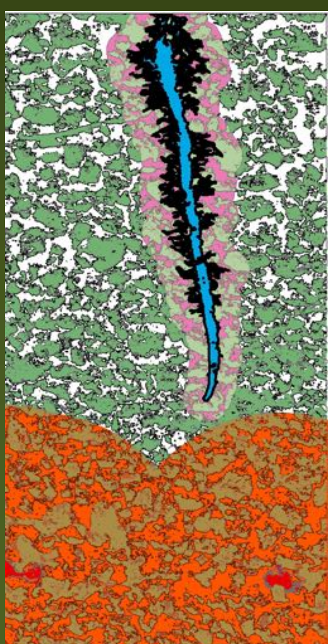
- Create more sustainable, resilient agroecosystems and rural communities for the region
- Contribute to climate change mitigation
- Build the required regional capacity for research, outreach and education
- Increase literacy concerning agriculture and climate change throughout the region
- Prepare a generation of scientists prepared for success in trans-disciplinary research, education and outreach

Frontiers

Frontiers

Curtis, D. J., N. Reid, and G. Ballard. 2012. Communicating ecology through art: what scientists think. *Ecology and Society* **17**(2): 3

ART 2015
SCIENCE
EXHIBITION



Futures

Partners in a Pacific Northwest Cereal Project

Climate Impacts Group (CIG)

<u>NSF-funded Projects</u>
- IGERT Projects
- EPSCoR
- FUTURE PROJECTS

USDA NW Climate Hub

<u>Private Industry</u>
- Commodity commissions
- Ag. service
- Farmer cooperators

USDOI GS NW Regional Climate Science Center

USDOI FWS LCCs

BioEarth

Climate Impacts Research Consortium (CIRC)

<u>USDA-LTARs</u>
- Cook Farm
- Great Basin

<u>Universities</u>
OSU
UI
WSU
UW
BSU

DOE/Universitie
s
Regional Data Management
Northwest Knowledge Network

<u>USDA NIFA-funded Projects</u>
- REACCH
- Site Specific Climate Friendly Farming
- FUTURE PROJECTS

Challenges

Integration

- Divides: geographic, institutional, disciplinary
- Diverse experience with integration
- Complexity and size of the project
- Scale: near term to decadal, within-field to regional
- Identifying and executing project-wide, integrating outputs

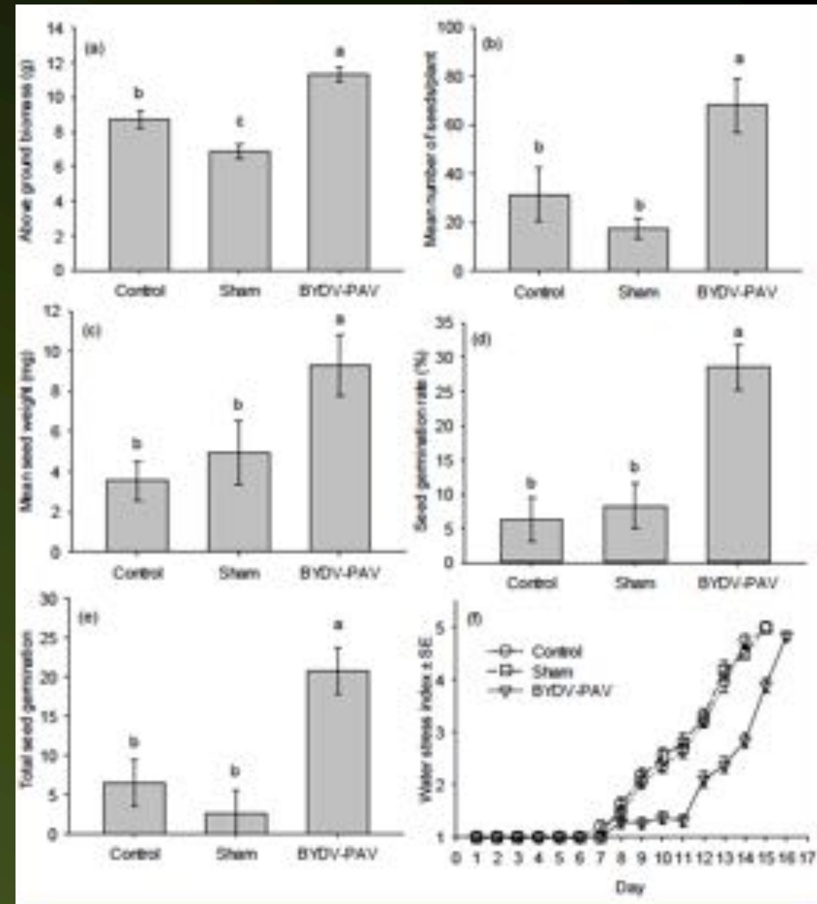
Diverse Stakeholders

- Farmers, some with climate change skepticism
- Policymakers
- NGOs
- Scientists

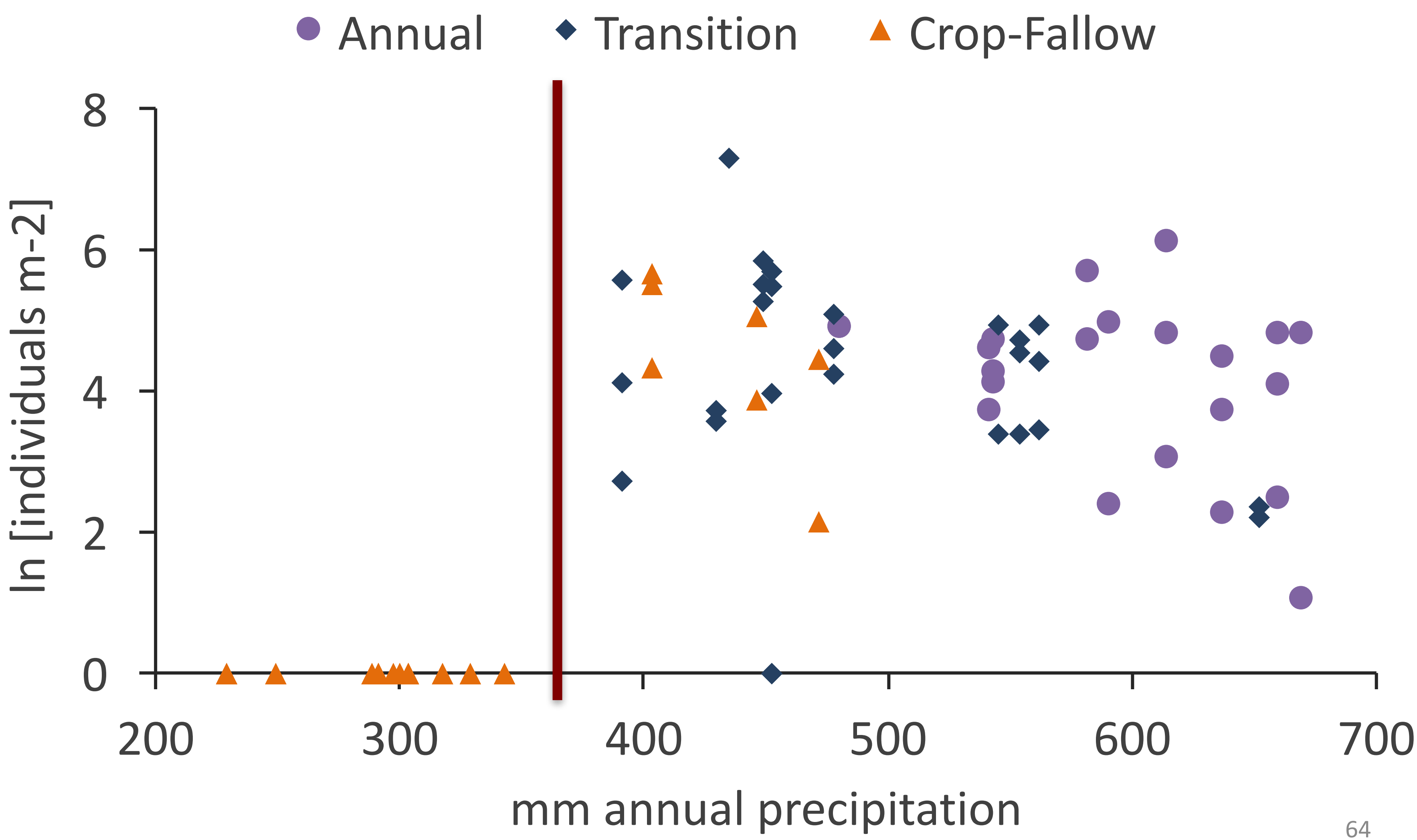
Projections

Example: Cereal leaf beetle (CLB), *Oulema melanopus*


BYDV-PAV
Sham


(a)
Above ground biomass (g)
Control
Sham
BYDV-PAV
(b)
Mean number of seeds/plant
Control
Sham
BYDV-PAV
(c)
Mean seed weight (mg)
Control
Sham
BYDV-PAV
(d)
Seed germination rate (%)
Control
Sham
BYDV-PAV
(e)
Total seed germination
Control
Sham
BYDV-PAV
(f)
Water stress index ± SE
Control
Sham
BYDV-PAV
Day

2011-2013 Densities at 32 regional sites



Incorporating Biological Control

- *Tetrastichus julis* (Walker) (Eulophidae)
- Successful biological control for CLB in North America.
- Released and well established in PNW (ID, WA, MT, UT) (Roberts et al. 2008)

Extension - Newsletters

The OutREACCH
A quarterly report by Regional Approaches to Climate Change
Pacific Northwest Agriculture

December 2013 — Vol. 2, Iss. 3
www.reacchpna.org

Director's Corner:

Getting the Word Out to Agribusiness

Sanford Eigenbrode, Project Director, UI

The Far West Agribusiness Association held its December 2013 Winter Conference on Dec. 9-11 in Pasco, Washington. Several REACCH scientists and students were in attendance to learn about the mission and concerns of the Association, build relationships with these stakeholders and make presentations about our work in the REACCH PNA project. The opportunity was ideal as we move into Phase II of REACCH, which will include a much greater emphasis on outreach, communicating our science and working to make sure it is relevant by considering feedback from all sectors of our stakeholder audience. The ten presentations by REACCH members were: *Precision Ma… Increase N Use Efficiency in Dryland W…* Huggins), *An Economic Forecasting To… Profitability of an Investment* (Clark Se… *System Intensification and Diversificati… Dryland Cropping Systems* (Bill Pan ar… *Cereal Aphids and Changing Climates* (Sanford Eigenbrode), *The Use of Diffe… Sensors for Assessing Crop Performar…* Magney), *What Do We Currently Know… Impacts of Climate Change on PNW C… Agriculture?* (Chad Kruger), *Soil Carbo… in Dryland Wheat-Based Cropping Sys…* Huggins), *The Cereal Leaf Beetle and… Climates in the Northwest* (Sanford Eig… Abatzoglou and Nate Foote), *Transition… Traditional Fallow to Chemical Fallow… Head* (Frank Young and Lauren Young… presentations included several with imr… to producers and agricultural professio… addressing longer-term issues pertaini… change and its impacts for agriculture t… beyond. All were well attended and we… helping enormously to educate stakeh… REACCH is and what we are doing. T… with other participants and opportunitie… invaluable. We are very grateful to Jim…

Executive Director at Far West Agribusiness Association, his planning committee and staff, especially Tara Smith, for encouraging our team to contribute to the conference and for organizing the event.
Look for more REACCH-related presentations this winter at meetings including the Idaho Cereal Schools, the Far West Agribusiness Association January Winter Conference, January 6-8 at the College of Southern Idaho in Twin Falls, ID, posters at Oilseed/Direct Seed conference January 21, 2014 at the Three Rivers Convention Center in Kennewick, Washington.

Extension on the Move: Upcoming Projects and Opportunities

Kristy Borrelli, UI

The OutREACCH
A quarterly report by Regional Approaches to Climate Change
Pacific Northwest Agriculture

August 2013 — Vol. 2, Iss. 2
www.reacchpna.org

2013 REACCH Summer Graduate Student Retreat Participants

Assessing Cropping Systems). REACCH investigators

The OutREACCH
A quarterly report by Regional Approaches to Climate Change
Pacific Northwest Agriculture

May 2013 — Vol. 2, Iss. 1
www.reacchpna.org

REACCH Newsletters

OutREACCH Newsletter - December 2013
OutREACCH Newsletter - August 2013
OutREACCH Newsletter - May 2013
OutREACCH Newsletter - November 2012
OutREACCH Newsletter - August 2012
OutREACCH Newsletter - May 2012

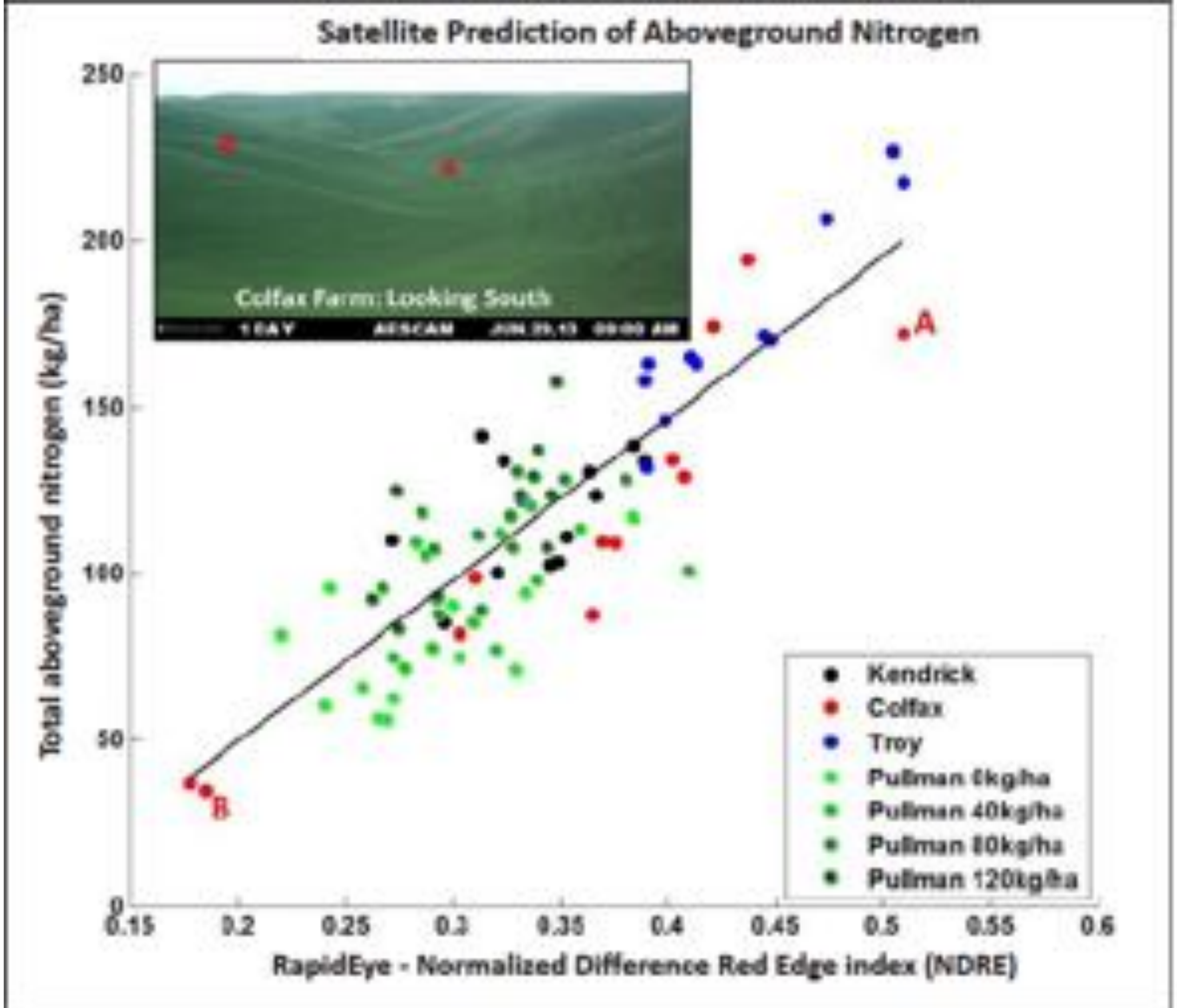


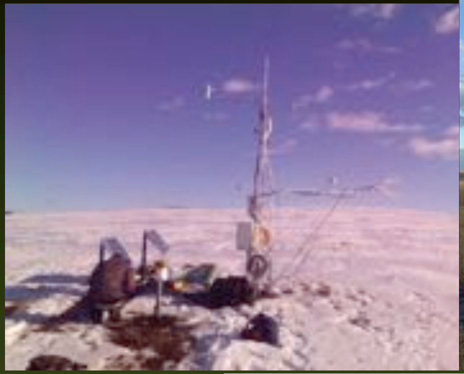
Figure 2. *Validation of the satellite-derived Normalized Difference Red-Edge Index (NDRE) in estimating total aboveground nitrogen. RapidEye satellite images were taken at peak biomass and compared with harvested total biomass multiplied by nitrogen concentration at four farms across the Palouse. Dots in different shades of green represent fertilizer treatments at study plots. (kilograms per hectare x 0.89 = pounds per acre)*

Update on milestones

- **M.7.1 Stakeholder Communication**
  - 44 presentations at various grower-related events
  - 1 REACCH hosted field day
  - 5-10 collaborative opportunities per year for other stakeholder-based meetings and workshops (many with 300+ people) – for example, PNDSA
  - Collaboration with objective 8 and NKN to design a website as a more effective outreach outlet
- **M.7.2 Develop Extension Products for Dissemination to Stakeholders**
  - Years 4 and 5 Annual Report
  - Case Study Videos
  - Webinar Series
  - Collaboration with Objective 8 – 8 mobile applications ready for demonstration (Demonstrated at ID Cereal Schools Feb 24 and 25)
  - Mini-grant projects (presentations later this afternoon)
  - 6 peer reviewed journal publications
  - 6 peer reviewed extension publications

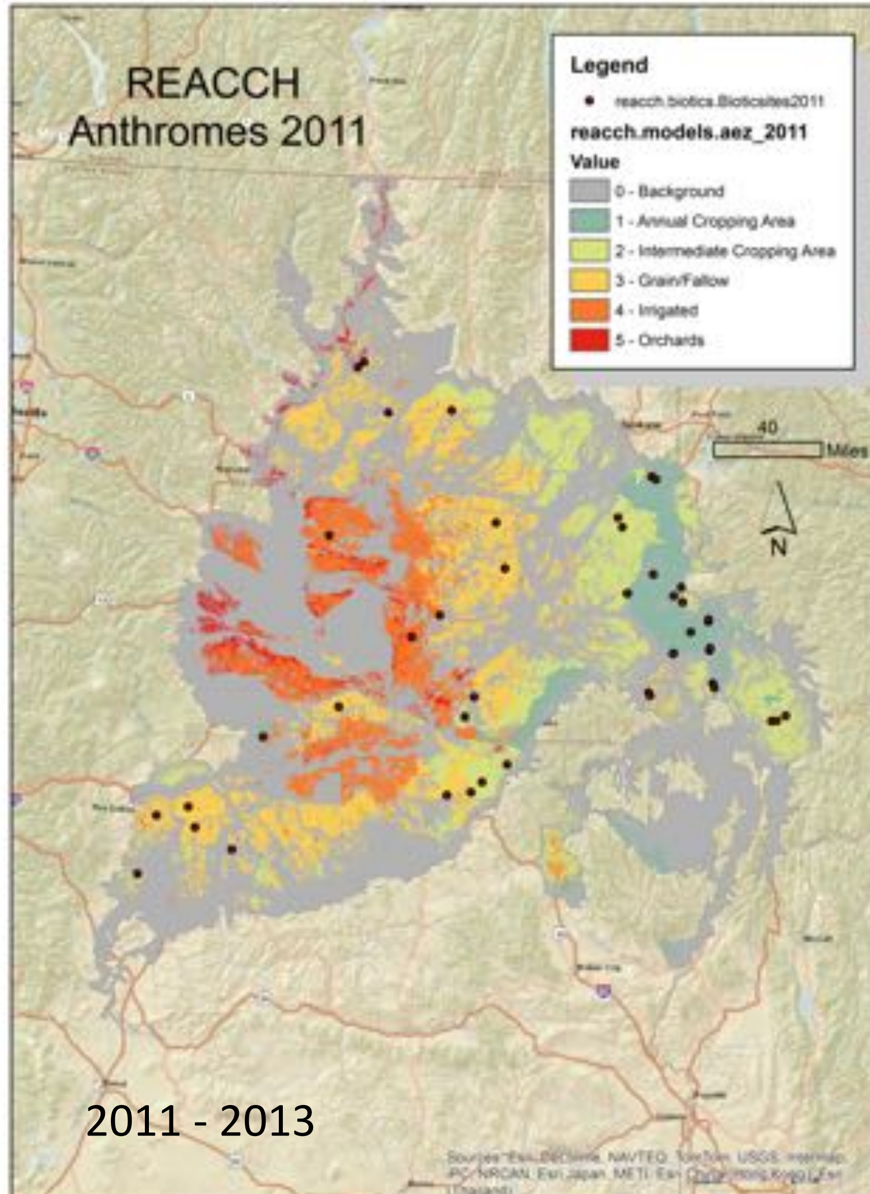
Monitoring GHG Emissions, Wind and Water Erosion

Flux towers, surface enclosure chambers, remote sensing, and wind and water erosion sampling.



Pests, Weeds, Diseases

Current Baselines



Update on milestones (cont.)

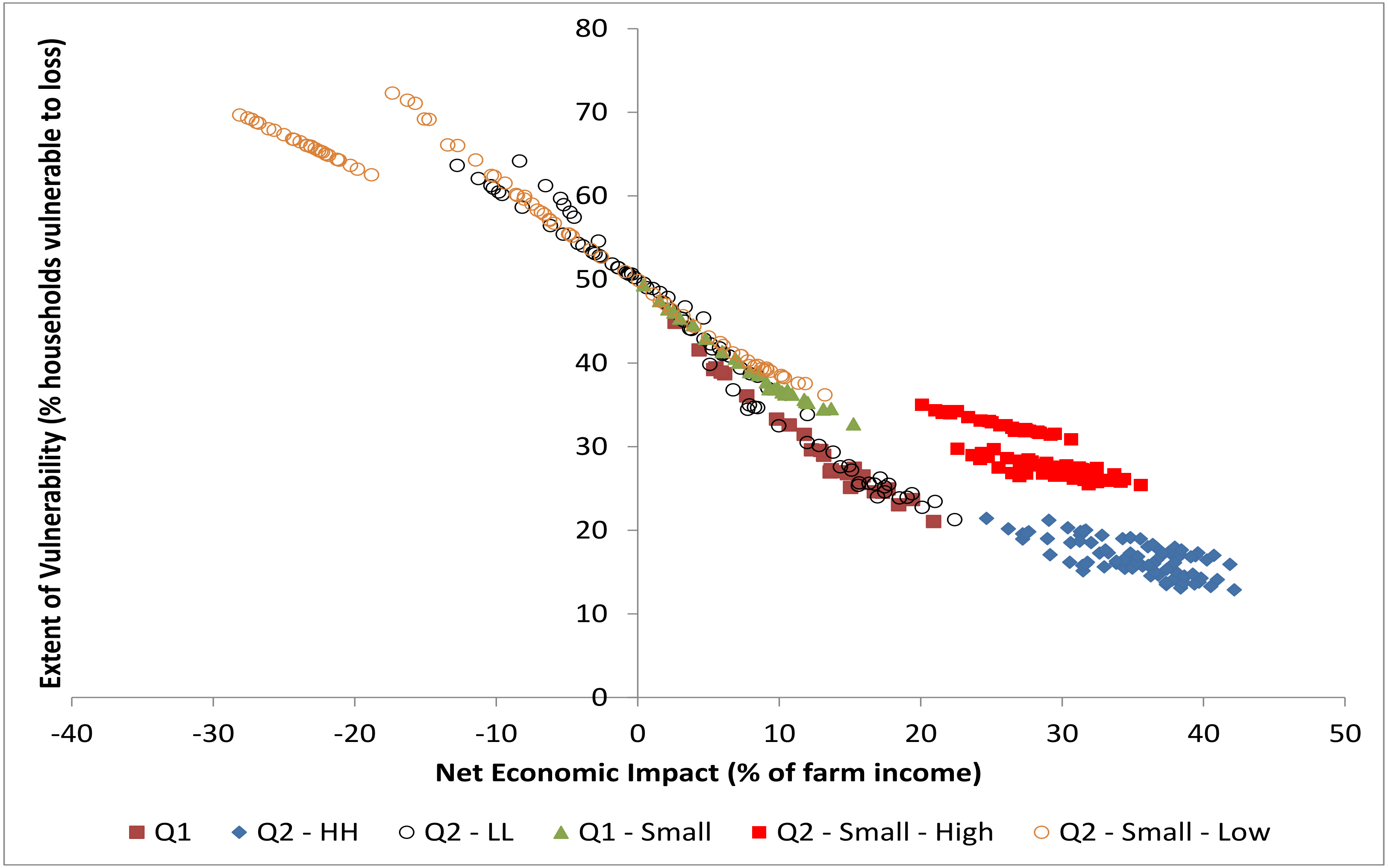
Develop REACCH Extension Educator Network

- AgClimate.net launched
- REACCH Extension Curriculum Grants – developed specifically to enhance our network
- Participation with USDA Climate Hub, LTAR groups and NKN
- Continued collaboration with established university, agri-business and grower-based groups – provide them a gateway to regional climate information

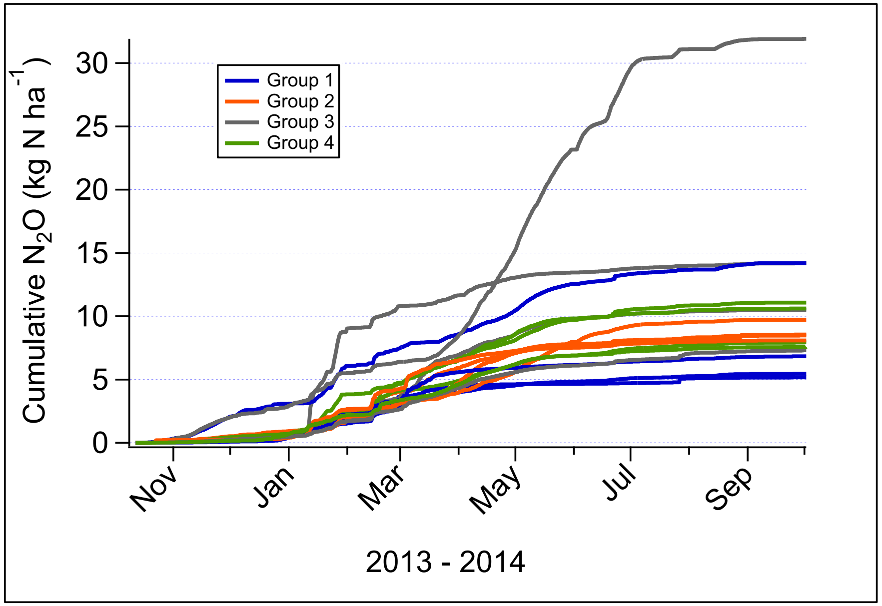
Synthetic Outputs for Year 5

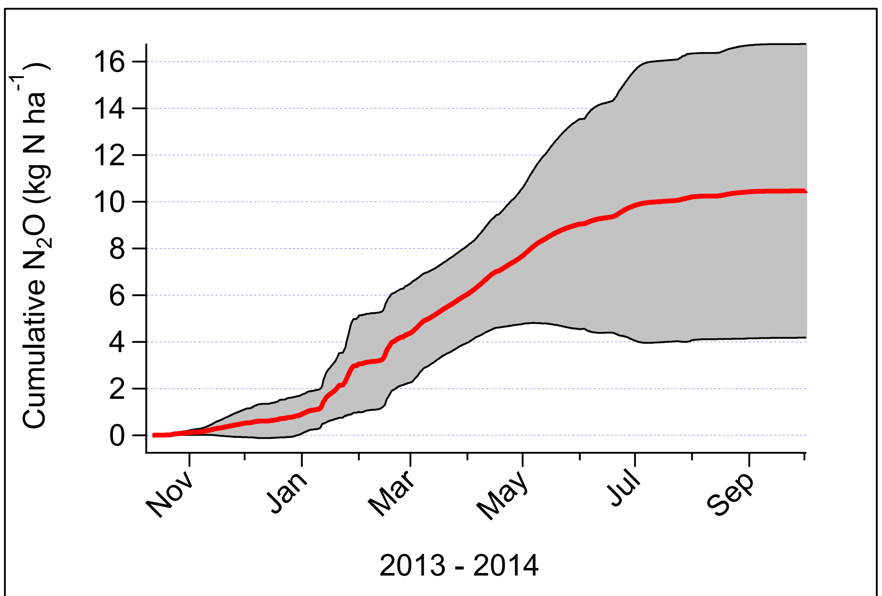
1) REACCH Conservation Ag Handbook
2) Continued development of mobile applications and communication outlets
3) AgClimate.net content
4) NW Climate Hub programmatic development

Extent of CC vulnerability without adaptation: winter wheat – fallow



Highlights-2: N2O Emission Monitoring





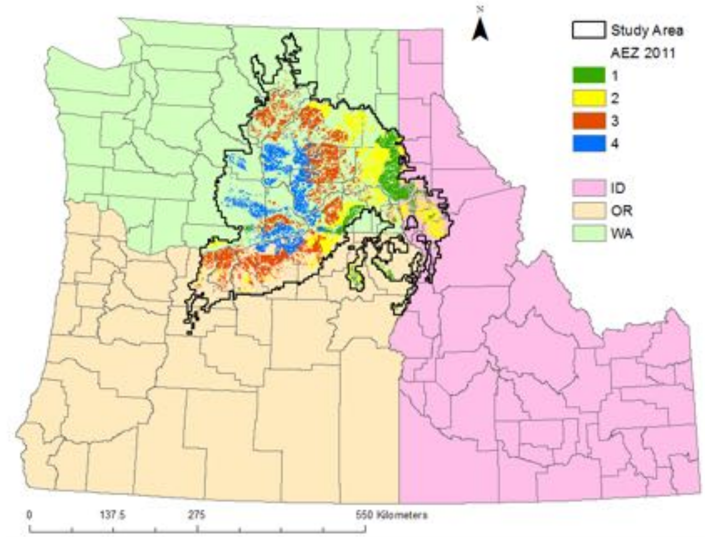
New hybrid chamber/gradient tower method for N2O fluxes

Continuous measurements from Nov-2013 at Cook Farm No-till and from June-2013 at Cook Conventional-till

Average fluxes are higher than IPCC default estimates

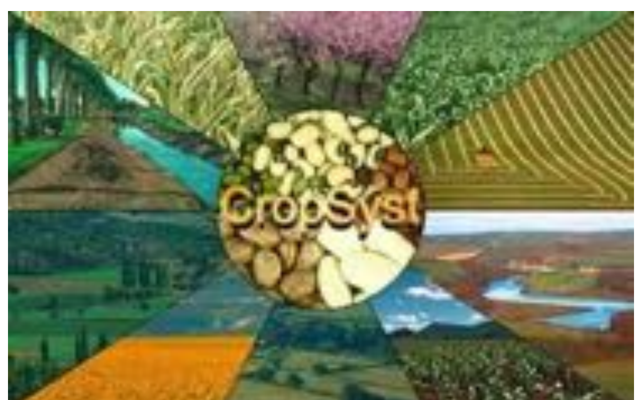
Evidence for N2O elevated emissions during wintertime freeze-thaw cycles

Regional simulations for Agro Ecological Zones in PNW



- Agroecological zones in REACCH study area
- Corresponded cropping systems in each zone, considering different tillage intensity
- Gridded daily weather data (4x4 km) for the period 1979 – 2010 (baseline simulations)
- Downscaled daily weather data projected by 14 GCMs that are part of the 5th phase of the Coupled Model Inter-Comparison Project (CMIP5)
- Two representative concentration pathways (RCP) of atmospheric CO_2 (4.5 and 8.5). These are respectively an approximate radiative forcing of 650 and 1370 ppm CO_2 equivalent by 2100
- The USDA-NRCS STATGO soil data was used to extract averaged soil data required by CropSyst for each pixel
- CropSyst
- OpenLCA

Rainfall Zone	Conventional and Conservation Cropping systems
3	Winter Wheat – Summer Fallow
2	Winter Wheat – Spring Wheat – Summer Fallow
1	Winter Wheat – Spring wheat – Spring Peas



openLCA Framework

How are we different in answering these questions?

Biggest differences:

- Perceived productivity
- Face-to-face time (Objective area)
- Objective-area productivity

	SD	Mean
Project has improved my research productivity (i.e., data, methodologies, modules, publications, and other products)	**1.1**	3.9
Adequate face-to-face meeting time with others within my objective area team	**1.1**	3.8
Group meetings within my objective area(s) are productive	**1.1**	4.0
Team's ability to capitalize on strengths of different researchers	**1.0**	4.1
Project has improved the quality of my research	**1.0**	3.9

Most agreement:

Trust items and working styles accommodations

Trust Scale	**0.7**	4.3
Collaboration Satisfaction w/Project Scale	**0.7**	3.7
I respect the REACCH team members	**0.7**	4.6
I trust other REACCH team members will not exploit or otherwise misappropriate ideas or information I share	**0.8**	4.4
Ability to accommodate the different working styles of team members	**0.8**	3.9
I am comfortable showing limits or gaps in my knowledge to REACCH team members	**0.8**	4.2

REACCH Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Multi-model Comparisons

SPECIFIC TASKS

- Multimodal comparisons for wheat growth, development and yield in the US Pacific Northwest
- Multimodal ensembles to improve accuracy and consistency in simulating winter wheat growth and yield
- To design management/adaptation strategies for cereal-based farming in the Pacific Northwest to mitigate climate change impact on wheat productivity

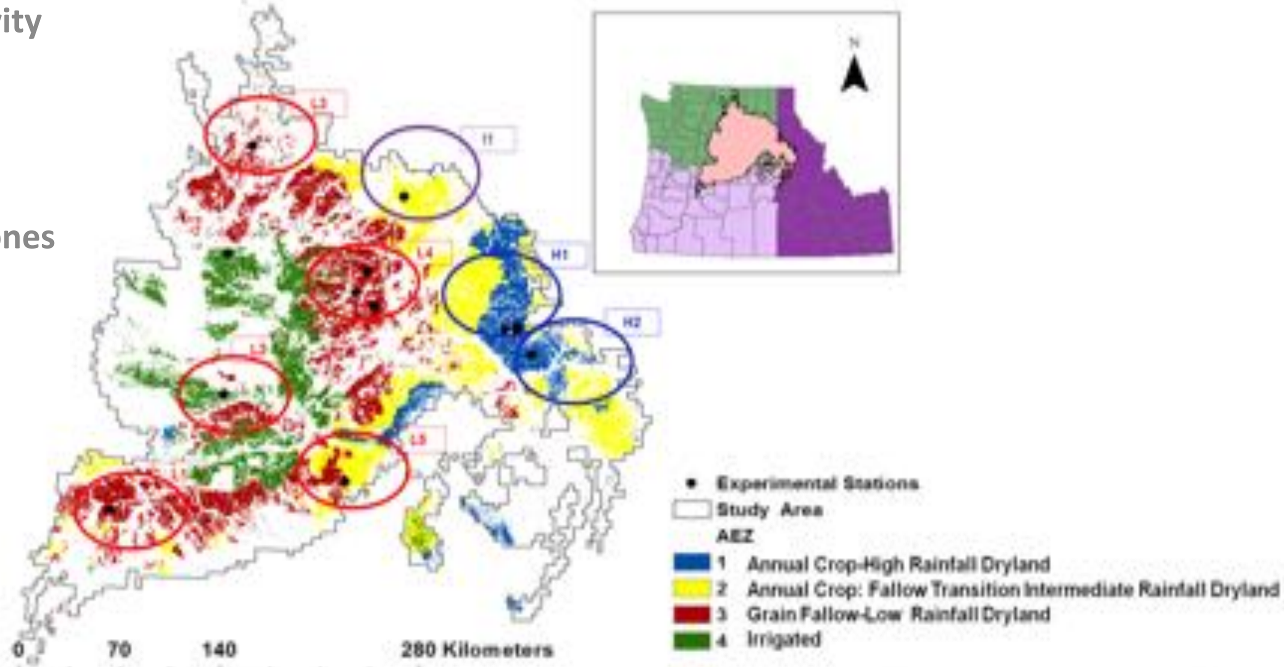
<u>STUDY SITES</u>

4 agro-ecological zones (AEZ)

- Low precipitation zones
- Intermediate precipitation zones
- High precipitation zones
- Irrigated

<u>CROP MODELS</u>

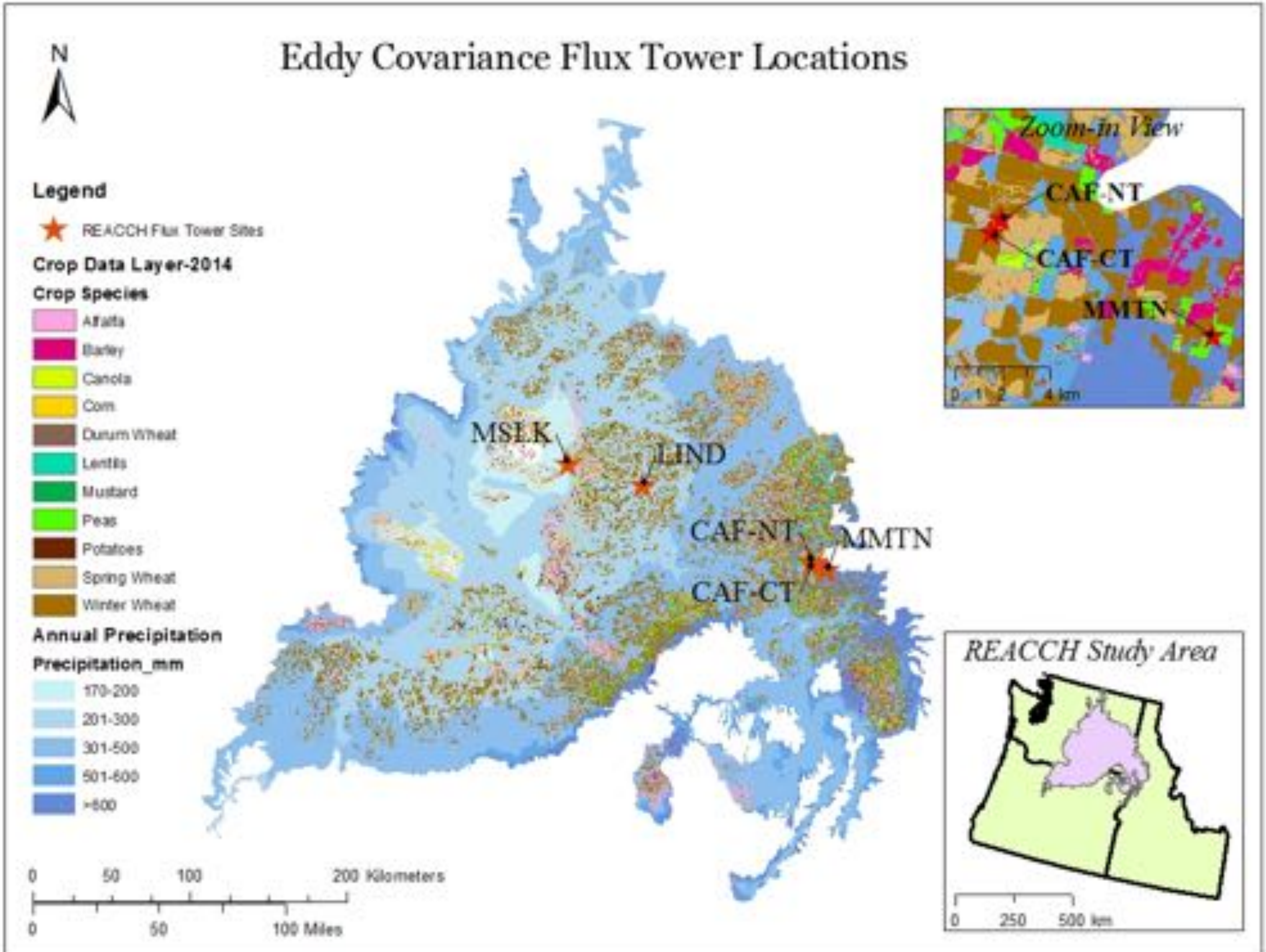
- CropSyst
- APSIM
- STICS
- DSSAT
- EPIC



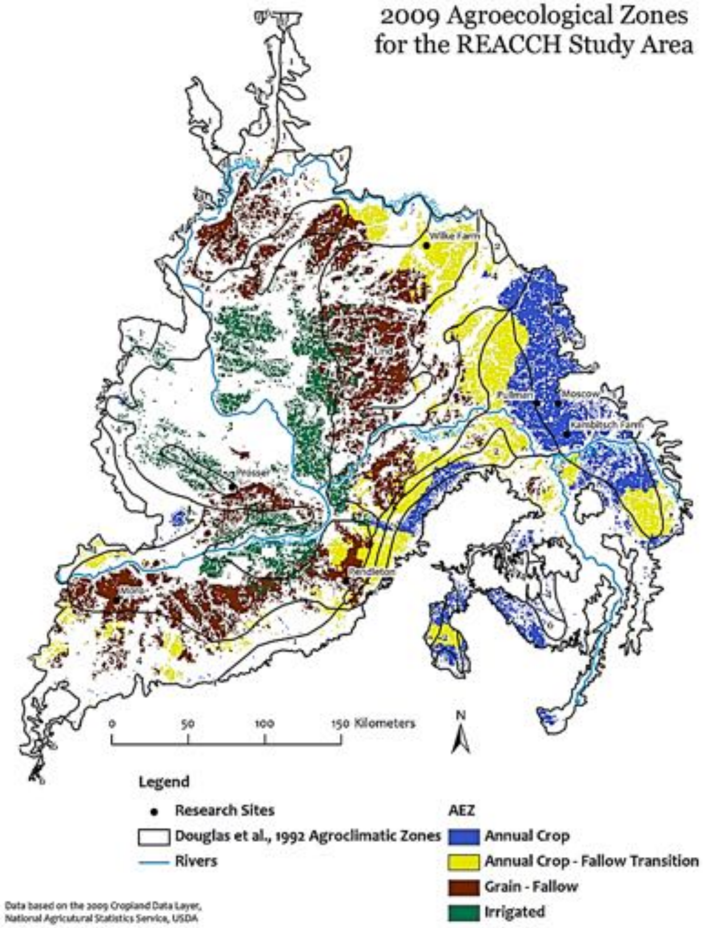
Low rainfall sites (L1 – L5)	Intermediate rainfall sites (I1)	Irrigated
1.Sherman County	1.Lincoln County	1.Grant County
2.Benton County	**High rainfall sites (H1 – H2)**	
3.Douglas County	1.Whitman County	
4.Adams County	2.Fremont County	
5.Umatilla County		

Socioeconomics

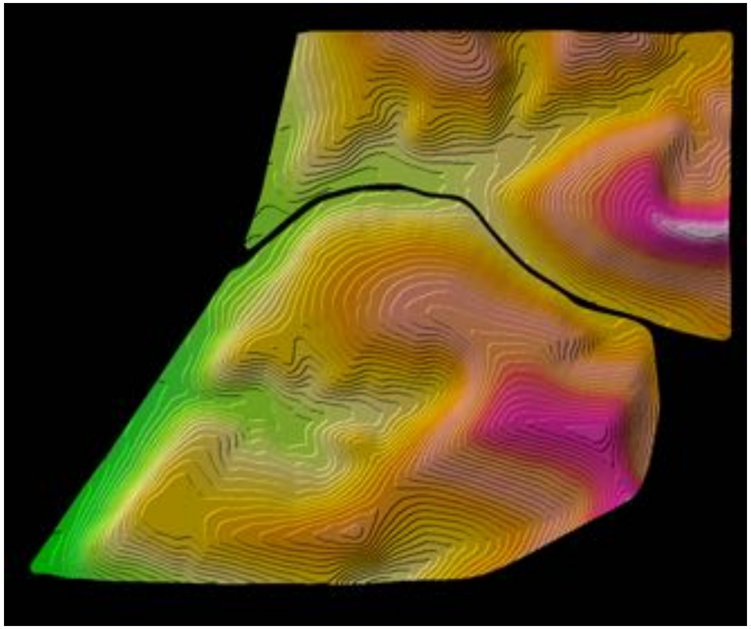
- Longitudinal Survey
  - 40 participants
  - Annual interviews
  - Enterprise budgets
  - Production practices


Eddy Covariance Flux Tower Locations
N
Legend
REACCH Flux Tower Sites
Crop Data Layer-2014
Crop Species
Alfalfa
Barley
Canola
Corn
Durum Wheat
Lentils
Mustard
Peas
Potatoes
Spring Wheat
Winter Wheat
Annual Precipitation
Precipitation_mm
170-200
201-300
301-500
501-600
>600
MSLK
LIND
CAF-NT
MMTN
CAF-CT
0 50 100 200 Kilometers
0 50 100 Miles
Zoom-in View
CAF-NT
CAF-CT
MMTN
0 1 2 4 km
REACCH Study Area
0 250 500 km

Long-term Agro-ecosystem Research (LTAR)



R.J. Cook Agronomy Farm



Creation and funding of an LTAR that will build on REACCH efforts

Goals of REACCH

1. **ADAPTATION** - Develop and implement sustainable agricultural practices for cereal production within existing and projected agroecological zones throughout the inland PNW as climate changes.
2. **MITIGATION** - Contribute to climate change mitigation through improved fertilizer, fuel, and pesticide use efficiency, increased sequestration of soil carbon, and reduced greenhouse gas (GHG) emissions consistent with NIFA's 2030 targets.
3. **PARTICIPATION** - Work closely with stakeholders and policymakers to promote science-based agricultural approaches to climate change adaptation and mitigation.
4. **EDUCATION** - Increase the number of scientists, educators, and extension professionals with the skills and knowledge to address climate change and its interactions with agriculture.

Update on milestones

Accomplished

- D6.1 Teacher Survey analyzed
- M6.2 K-12 Teacher training
- D6.2b Formation of interdisciplinary teams
- D6.2 Multi-institutional course
- D6.3a Classroom activities developed
- D6.4 Graduate level course on spatial statistics

Pests, Weeds, Diseases

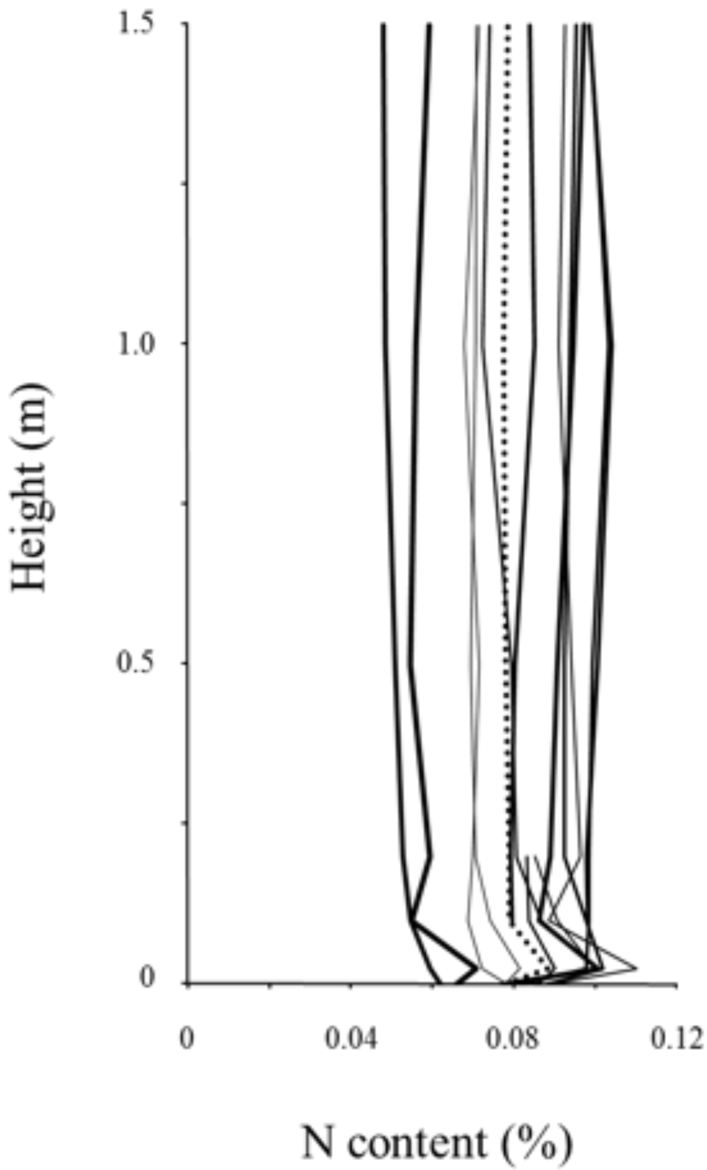
Baselines, Modeling

Responses to Alternative Management

Schotzko, UI

OSU

Highlights-3: C,N loss due to Wind Erosion



- Loss of N in windblown dust during singular high wind events represented from 0.2 to 3.2% of the applied N and averaged 0.5 kg/ha across events.

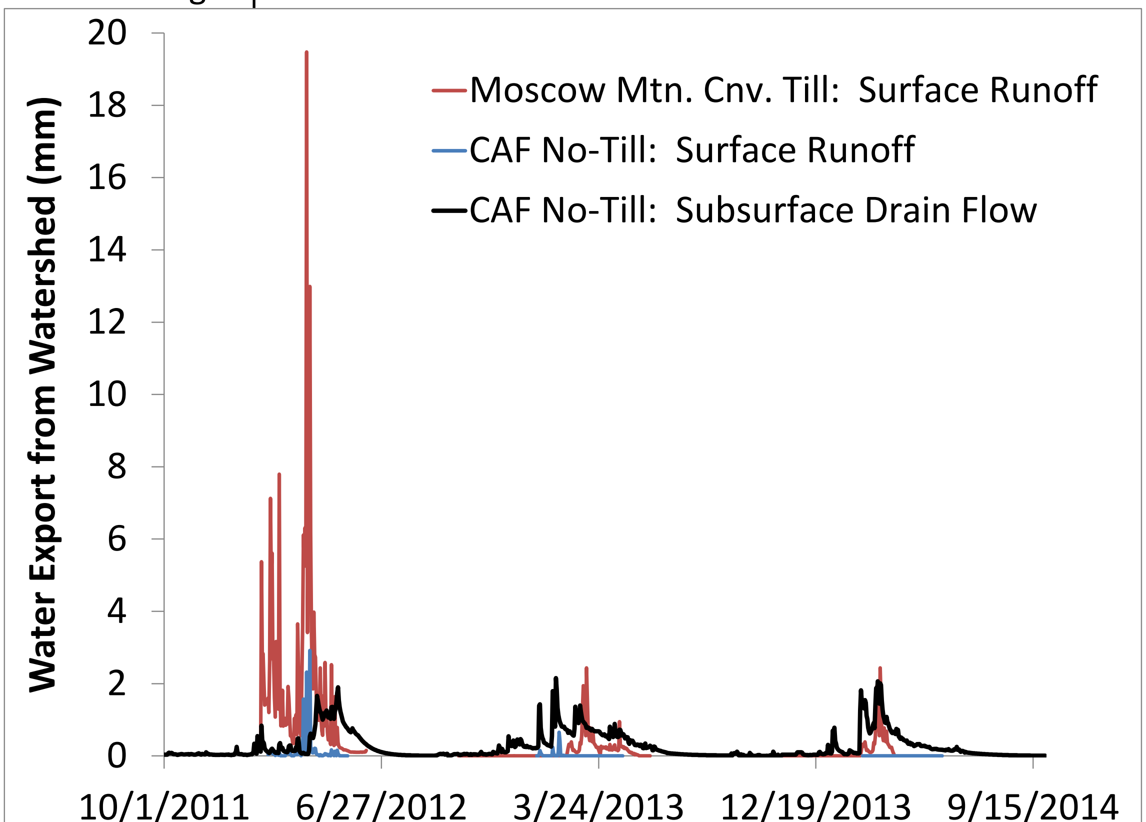
- Annual N loss due to wind erosion could exceed 5 kg/ha or about 10% of N applied as fertilizer.

- average C loss per erosion event of 4.1 kg C/ha . Thus, C loss is about 10 times that of N loss.

Highlights-4: C, N water erosion

Annual Surface Runoff and Subsurface losses of Water (mm/yr)

Year	CAF: Subsurface Drain	CAF: Surface Runoff	Moscow Mtn: Surface Runoff
2012	90.0	13.1	228.0
2013	113.4	1.9	30.0
2014	86.4	0.0	21.0
2012-2014 Average =	**96.6**	**5.0**	**93.0**

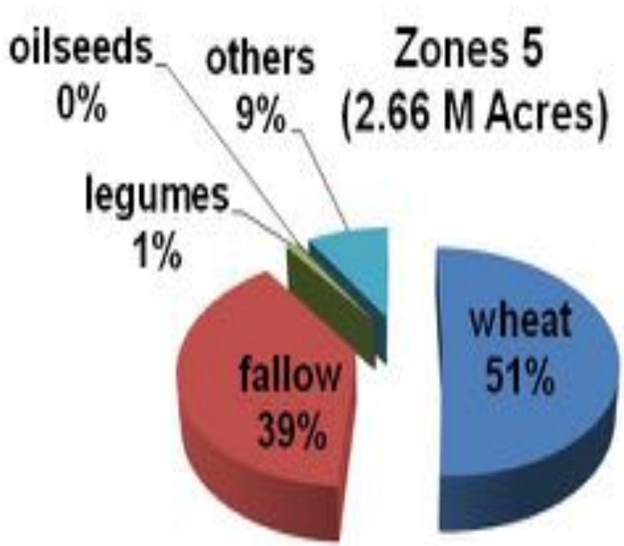


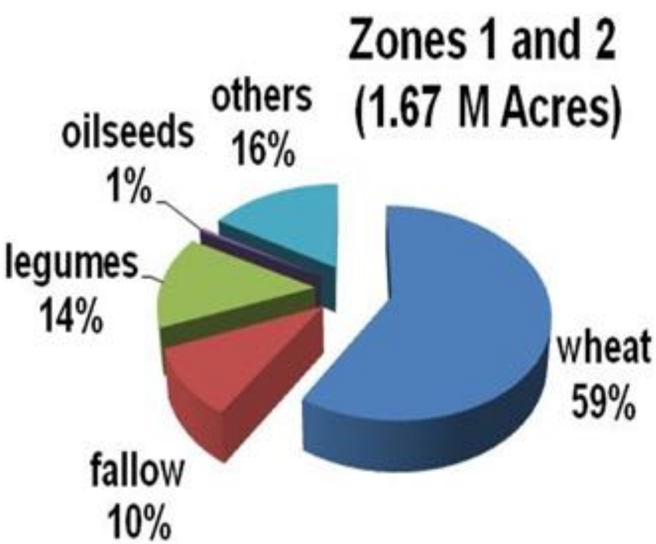
- Surface runoff losses at the conventional tillage site are 20x greater than at the no-till site
- When water loss from artificial subsurface drainage is considered, there is **more** water loss from the no-tillage site than the conventional tillage site
- Annual sediment and carbon losses from conventional tillage site 100x greater than no-tillage site
- Model simulations suggests soil erosion will increase in the future

2011 Resource Inventory

Google Maps Tour

- ❑ Inventory field expts
- ❑ ID conv. & alternatives
- ❑ Soil C,N fractionation
- ❑ Soil, crop analysis
- ❑ Integration questions
- ❑ Win-Win-Win





2012 Alternative Management Mitigation of Greenhouse Gasses

TP

Current

10% ↑ DS > Canola > NUE > Biosolids

<u>1,550K Mg CO2e</u>
Yr, **but for only 10 yr**

<u>78K Mg CO2e</u>
Yr (↑ 10% NUE)

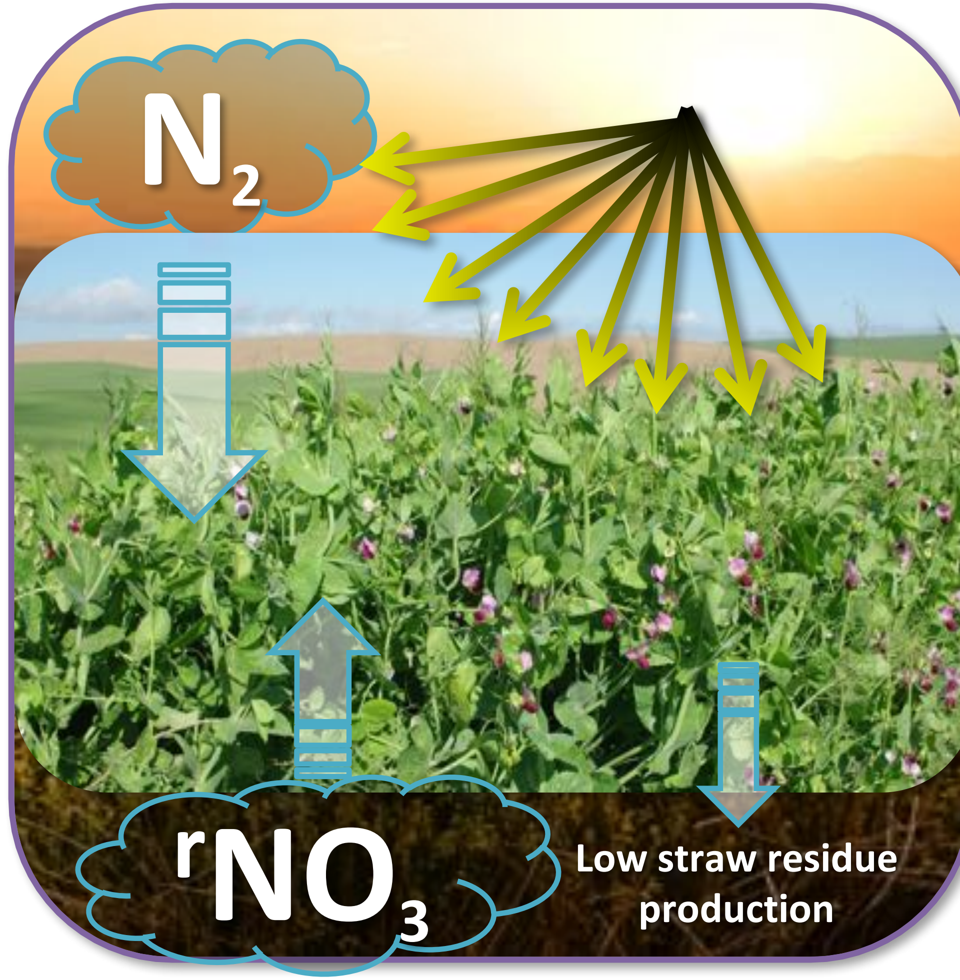
<u>50K Mg CO2e</u>
Yr (50K dT)

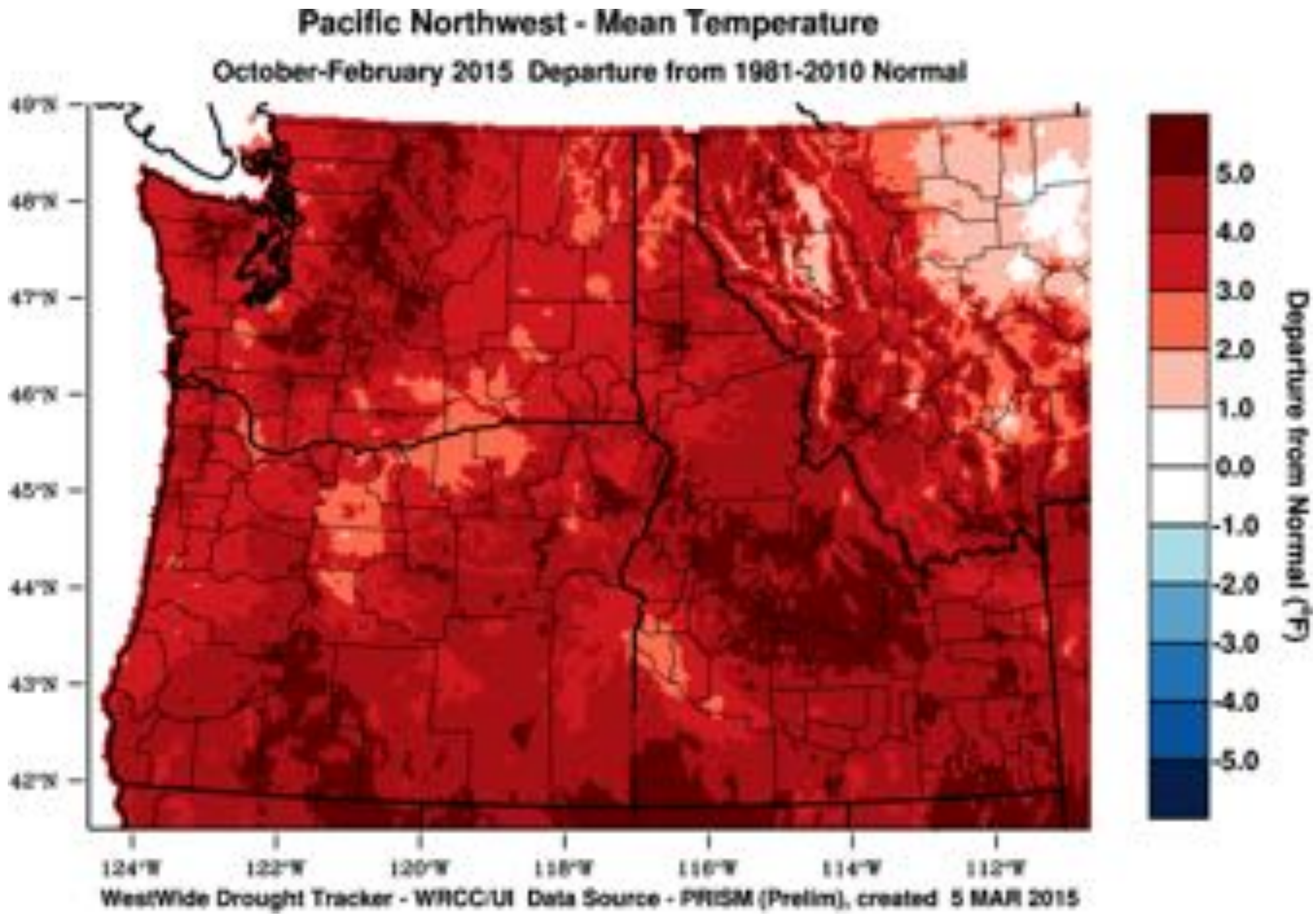
<u>150K Mg CO2e/</u>
10,000,000 gallons biodiesel. 100,000 acres.year

2013

Westward winter & spring legumes transition zone

(Machado, Schillinger)





climateinw.wordpress.com—Abatzoglou 2015

REACCH Social Science Research

- 2012: General Public Survey
  - ID, OR, WA residents, rural-urban strata (n=1300, 25% response rate, 40% cooperation rate)
- 2012-2013: Agricultural Producer Survey
  - Survey of Wheat Producers in REACCH region (n=900, 45% response rate)
  - Climate change perceptions, farming practices, location
- 2013-2014: Crop Consultant qualitative research based on mini-grant
  - n=8, mostly eastern half of reacch, includes crop insurance specialist and one chem manufacturer, independent and company
- 2014: mapping, weighting, analyses
- 2015: analyses, data-display and integration

Producers have observed weather changes, but Don't Believe it's Human Caused

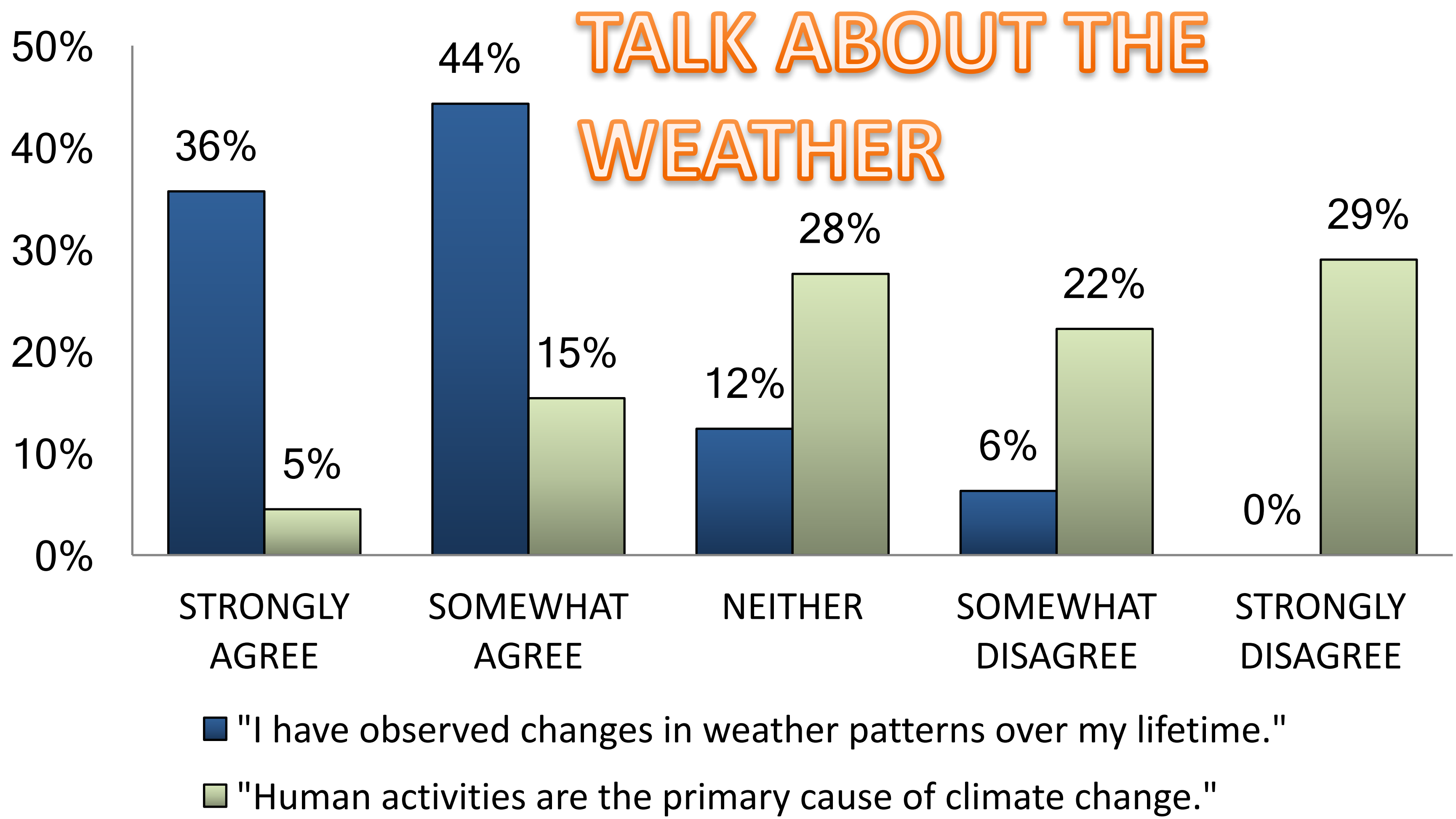


Figure 1. Metopolophium festucae cerealium, *a newly arrived aphid affecting wheat in the Pacific Northwest. Photo by Brad Stokes.*

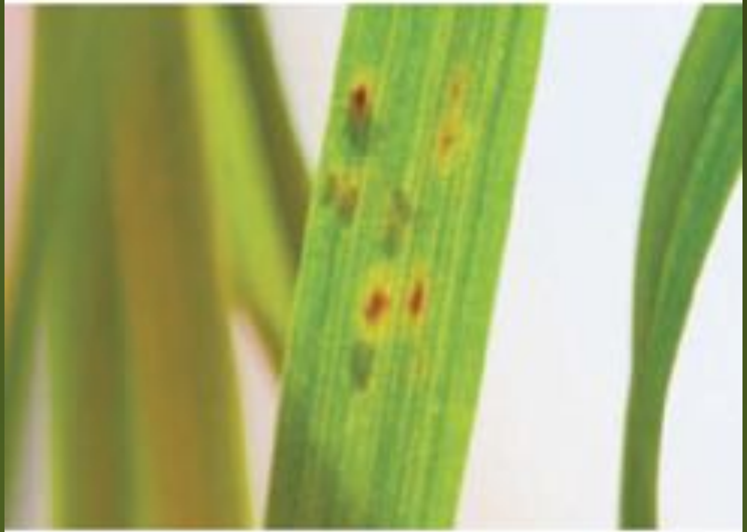
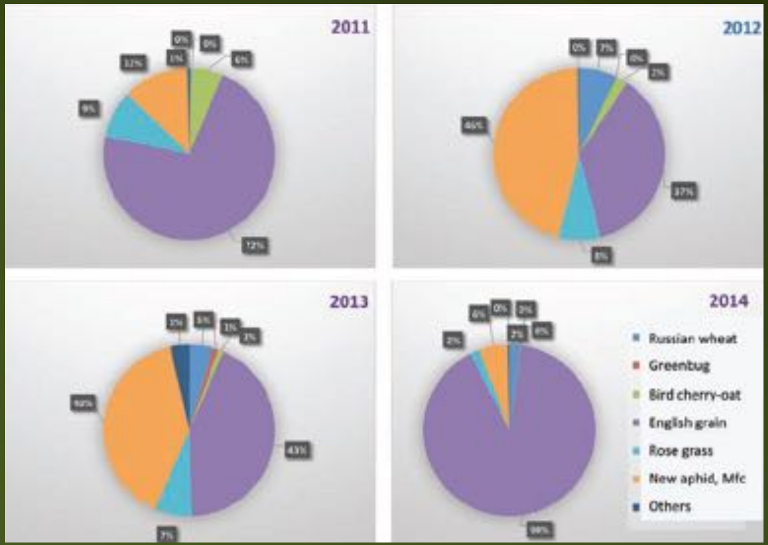
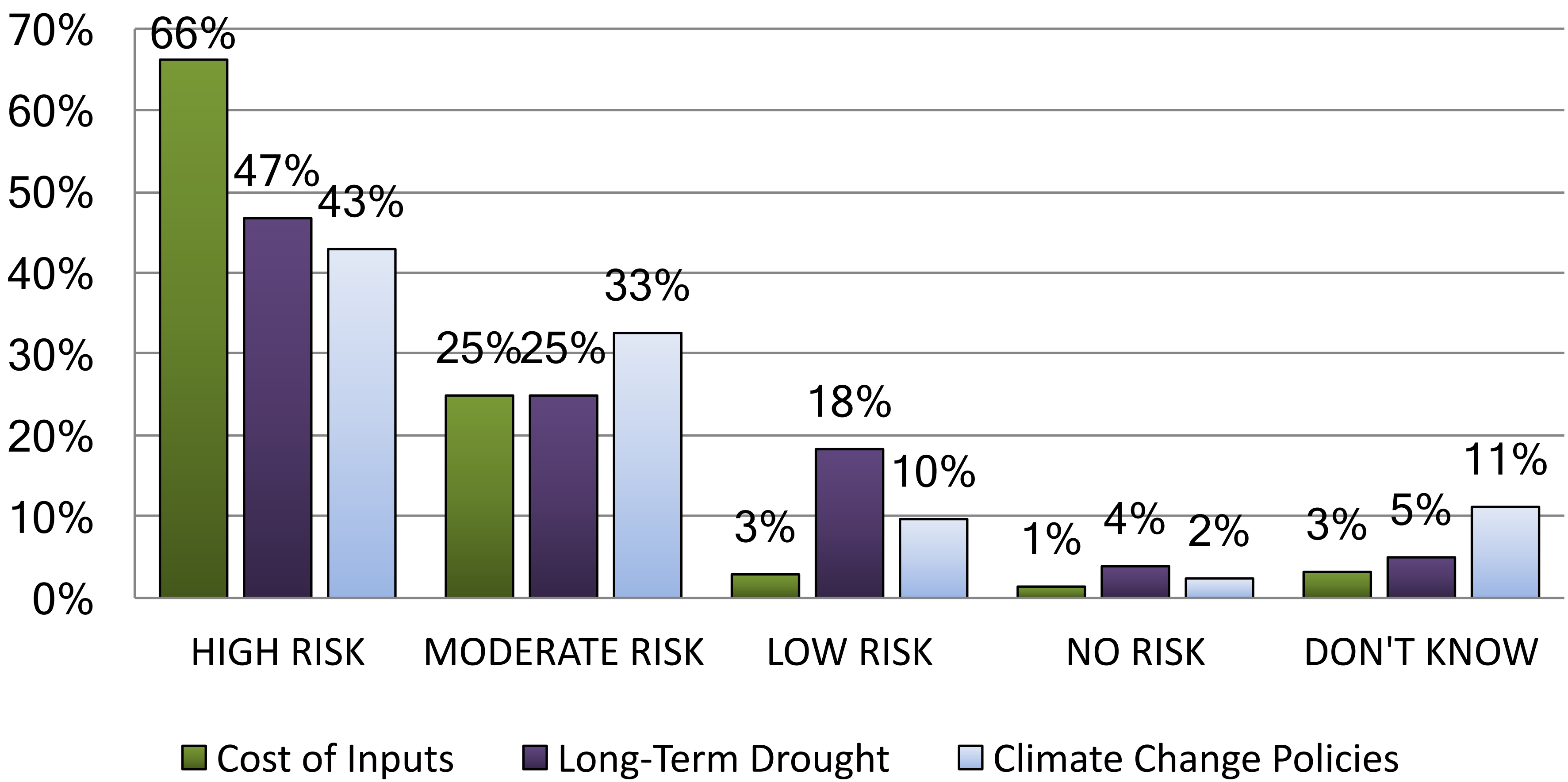


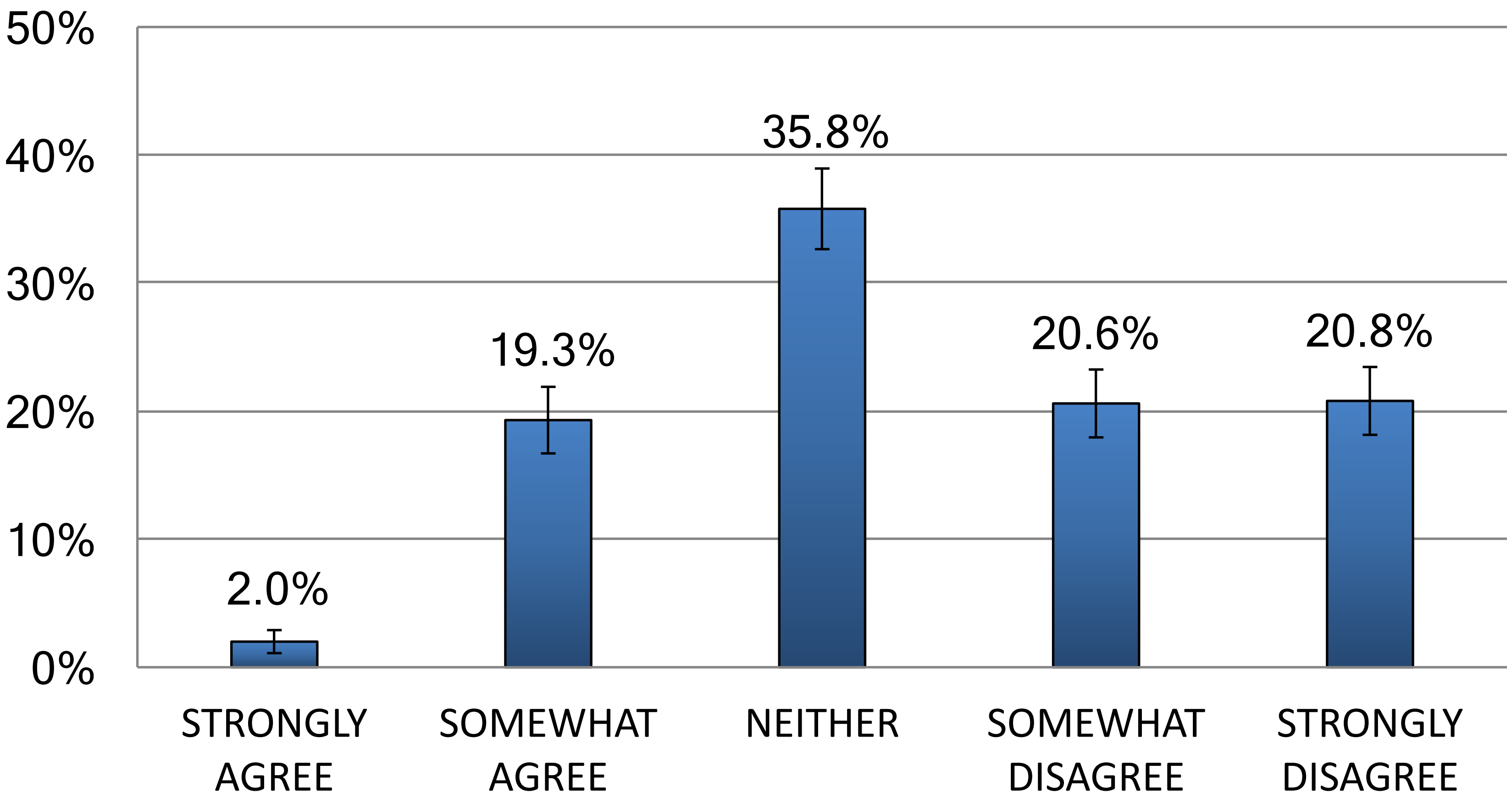
Figure 2. *Example of feeding injury caused by this aphid; on some hosts it can cause a red staining, as shown here. Photo by Brad Stokes.*



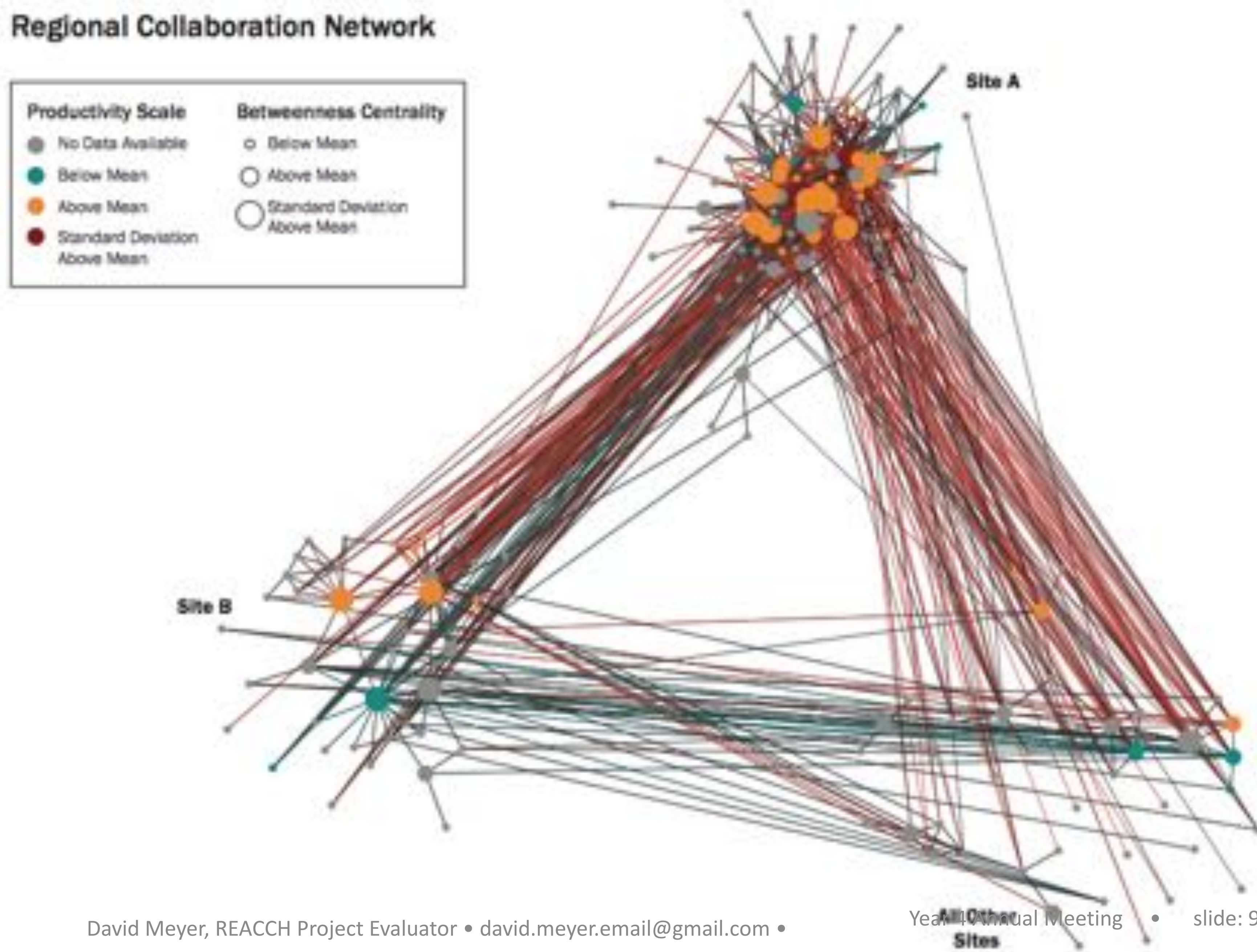
Producers' Risk Perceptions



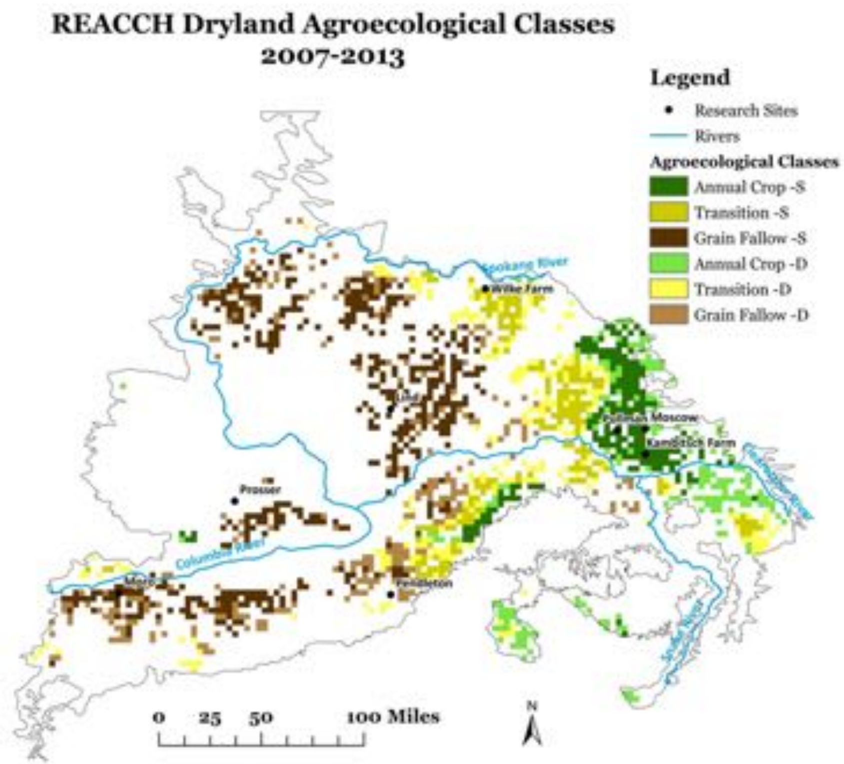
I will need to make changes to my production practices DUE TO climate change



Network Type: “Collaboration” **Centrality Measure**: Betweenness **Masse Scale:** Productivity



Highlights



Weather and AEC data

Weather layers (Abatzoglou, 2012) (4 × 4 km) used to calculate 38 bioclimatic variables; Conversion of AECs converted to 4 × 4 km scale

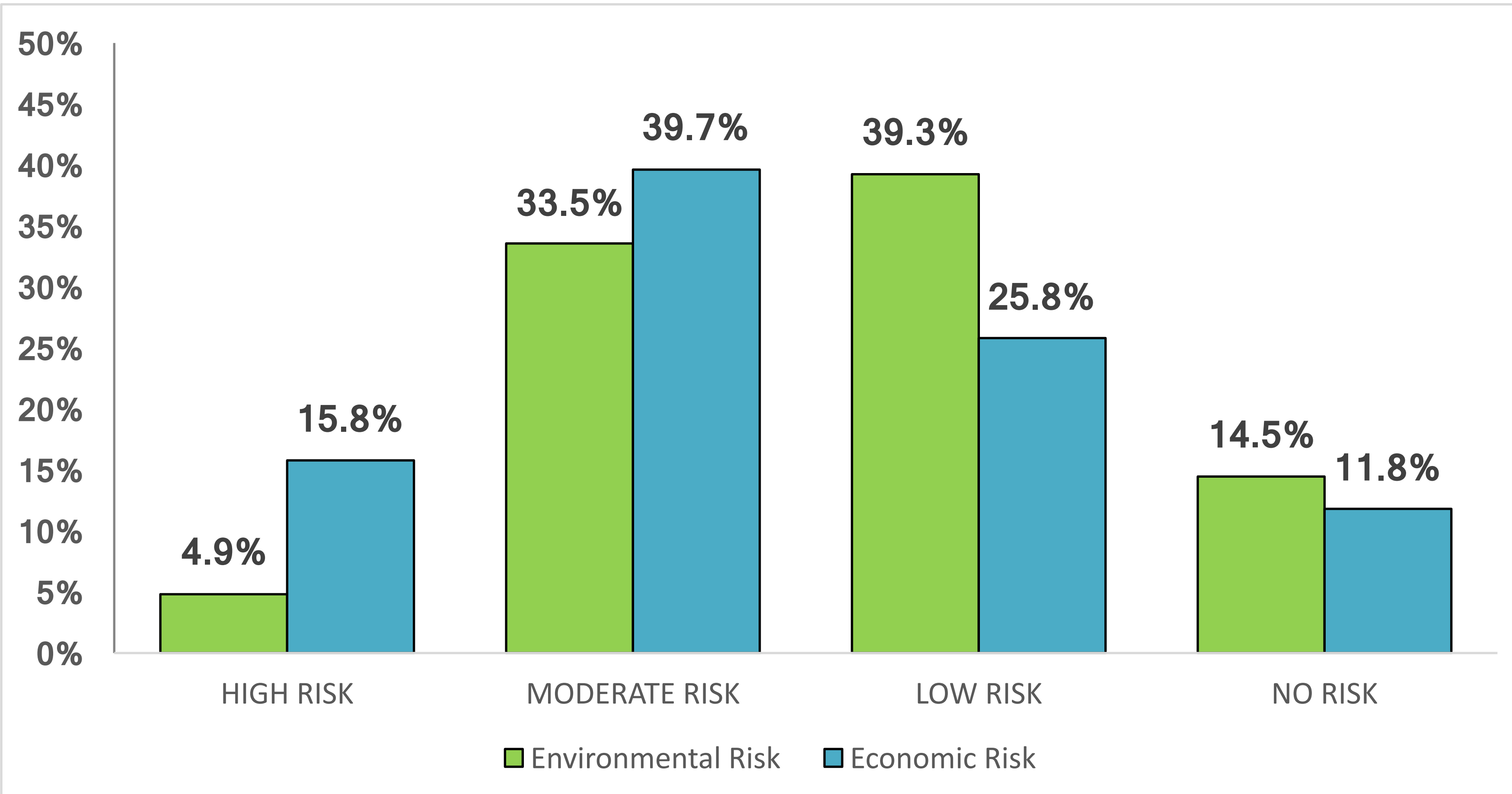
Statistical Analysis in "R"

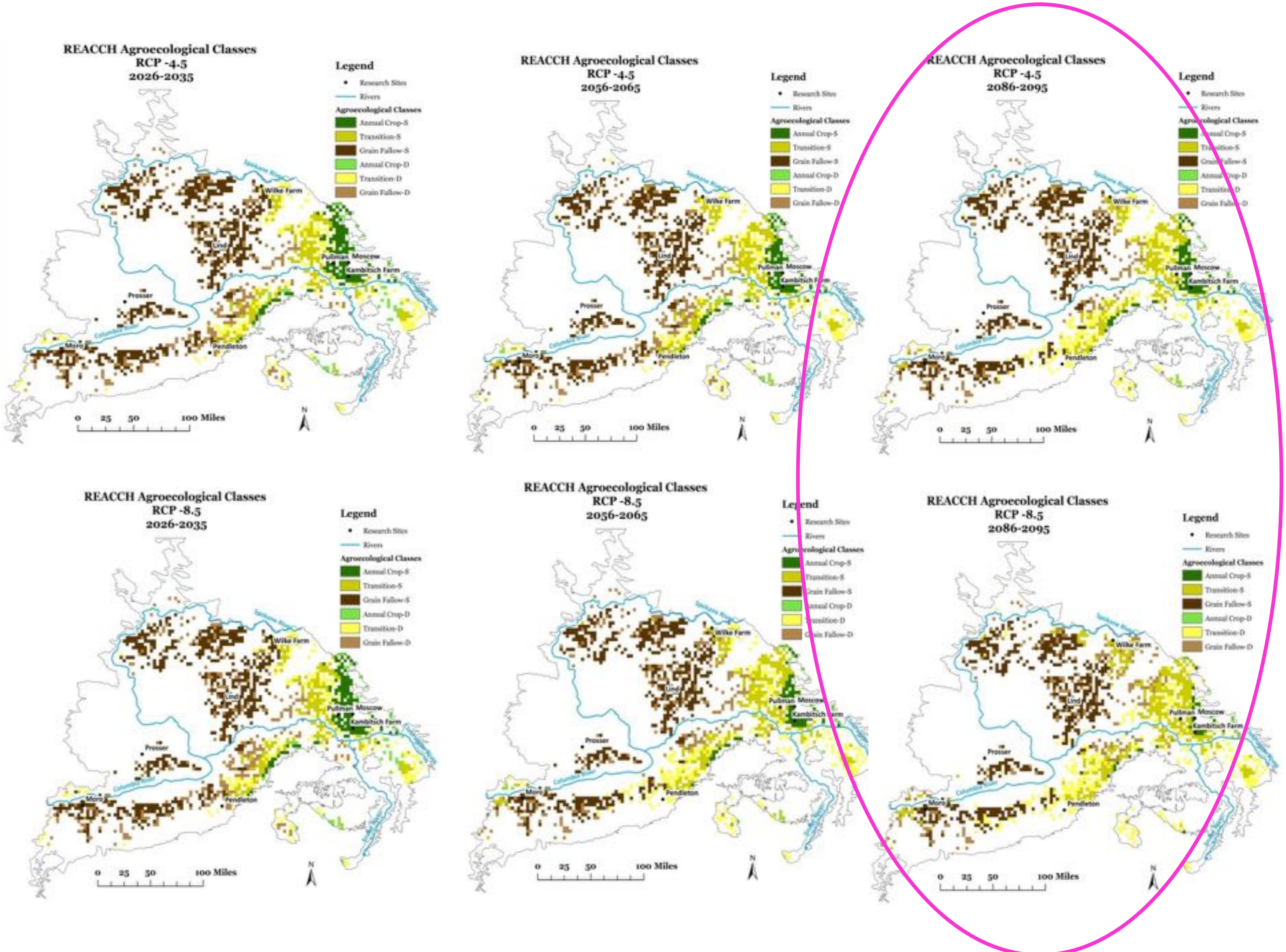
Variable selection using "Recursive Feature Elimination", training random forest on selected predictors (5 bioclimatic variables)

Future climate data extraction

Future climate data from 14 different Global Climate Models used to calculate the identified variables for three different time periods (2026-2035, 2056-65 and 2086-2095) and two different climate change scenarios (Representative Concentration Pathway) RCP 4.5 and RCP 8.5 (Abatzoglou and Brown, 2012)

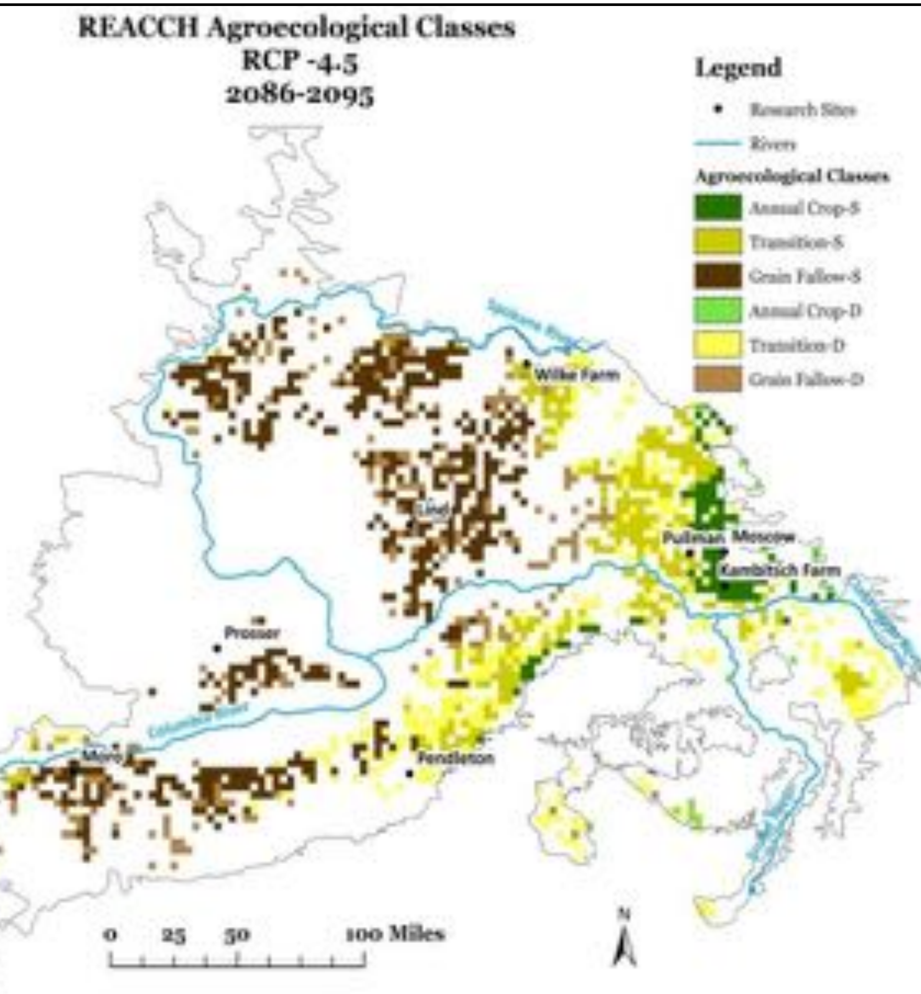
Risk of Climate Change Scenario on Personal farm

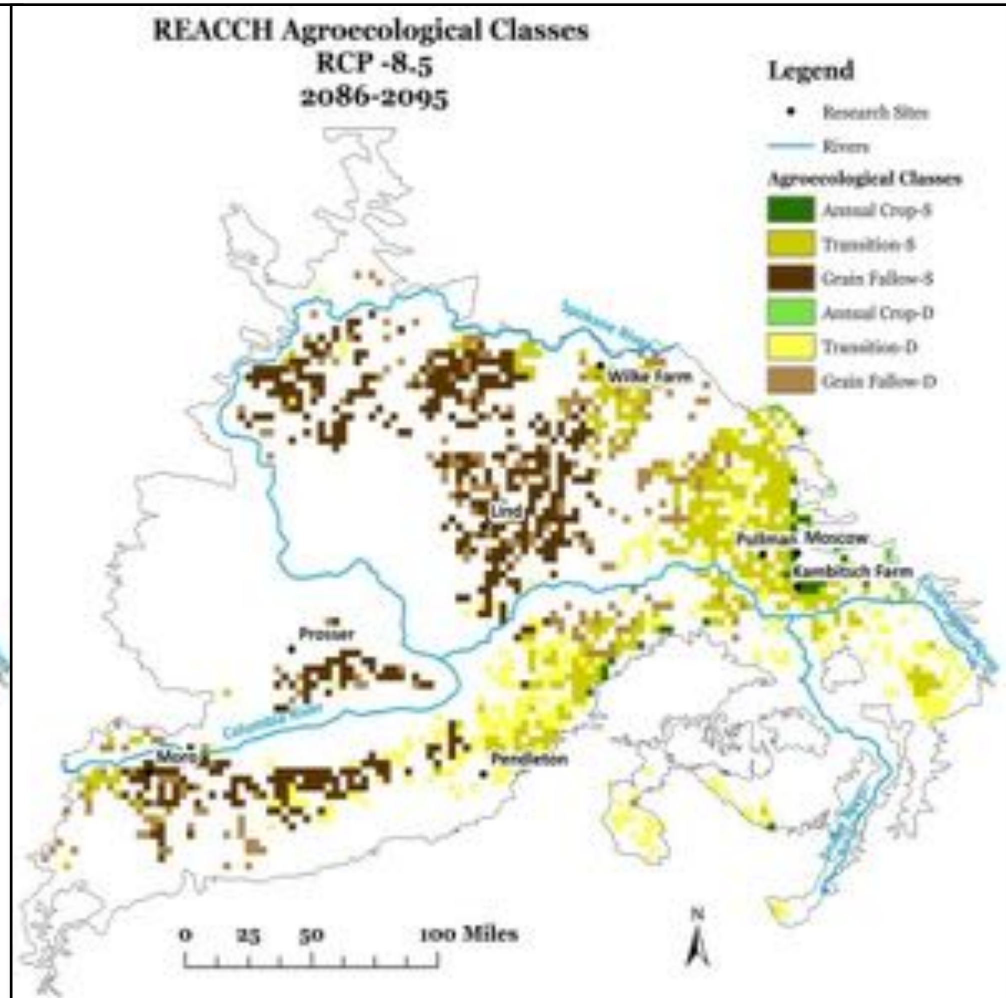




Kaur et al., in preparation

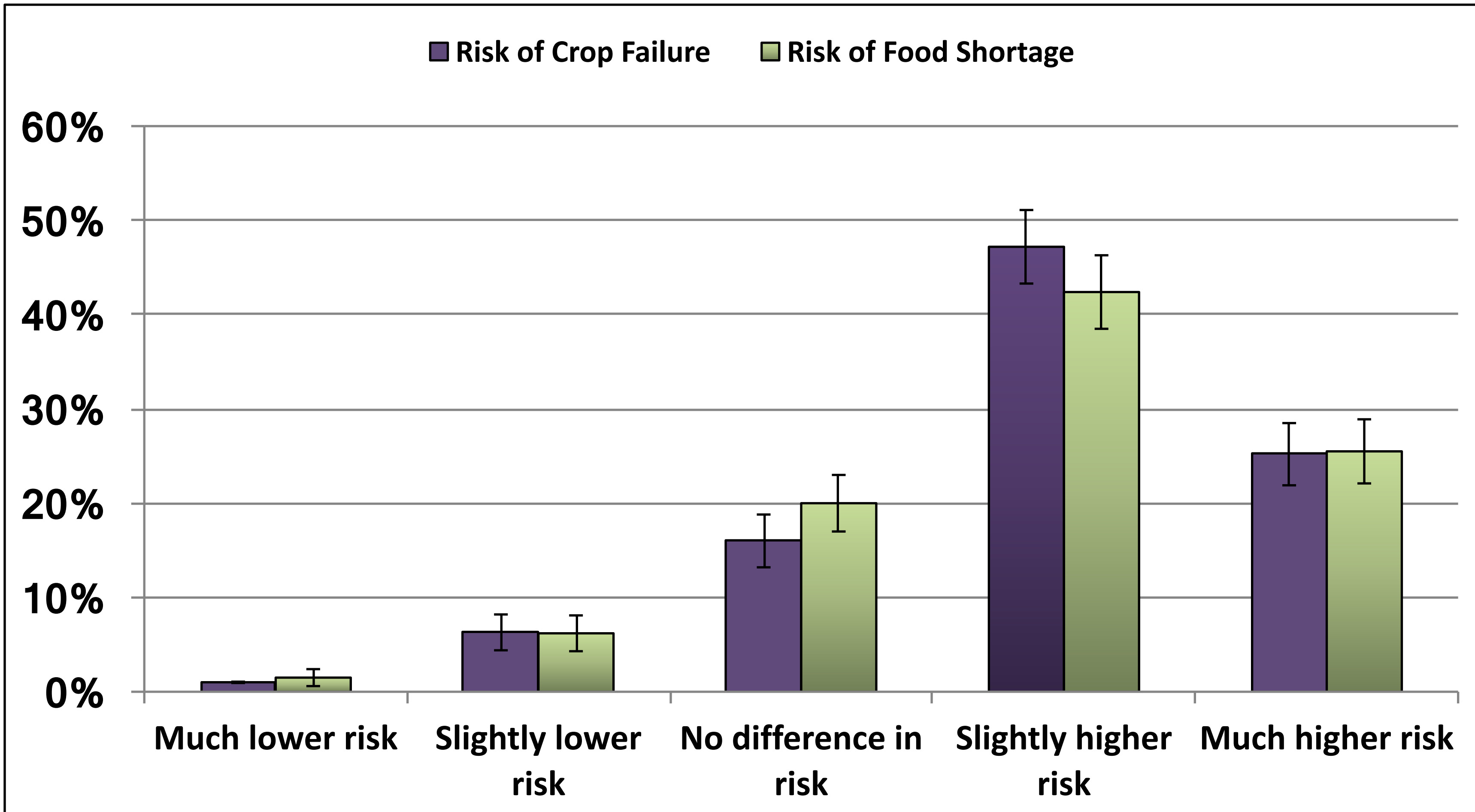
NOT SO DISTANT FUTURE: TWO CHOICES



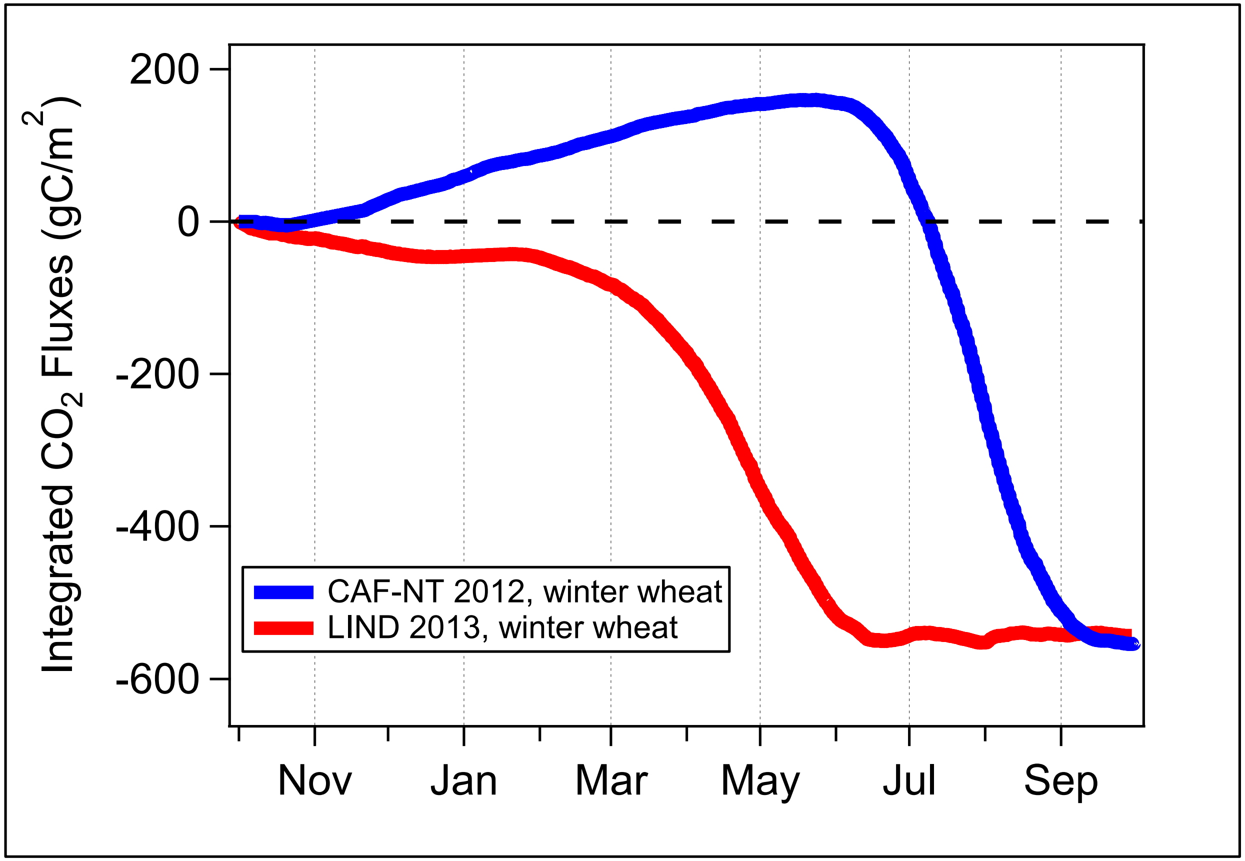


Under climate change pressure, HOW CAN WE CONNECT GROWERS WITH EATERS?

In the Pacific Northwest over the next 30 years, do you think climate change will cause:



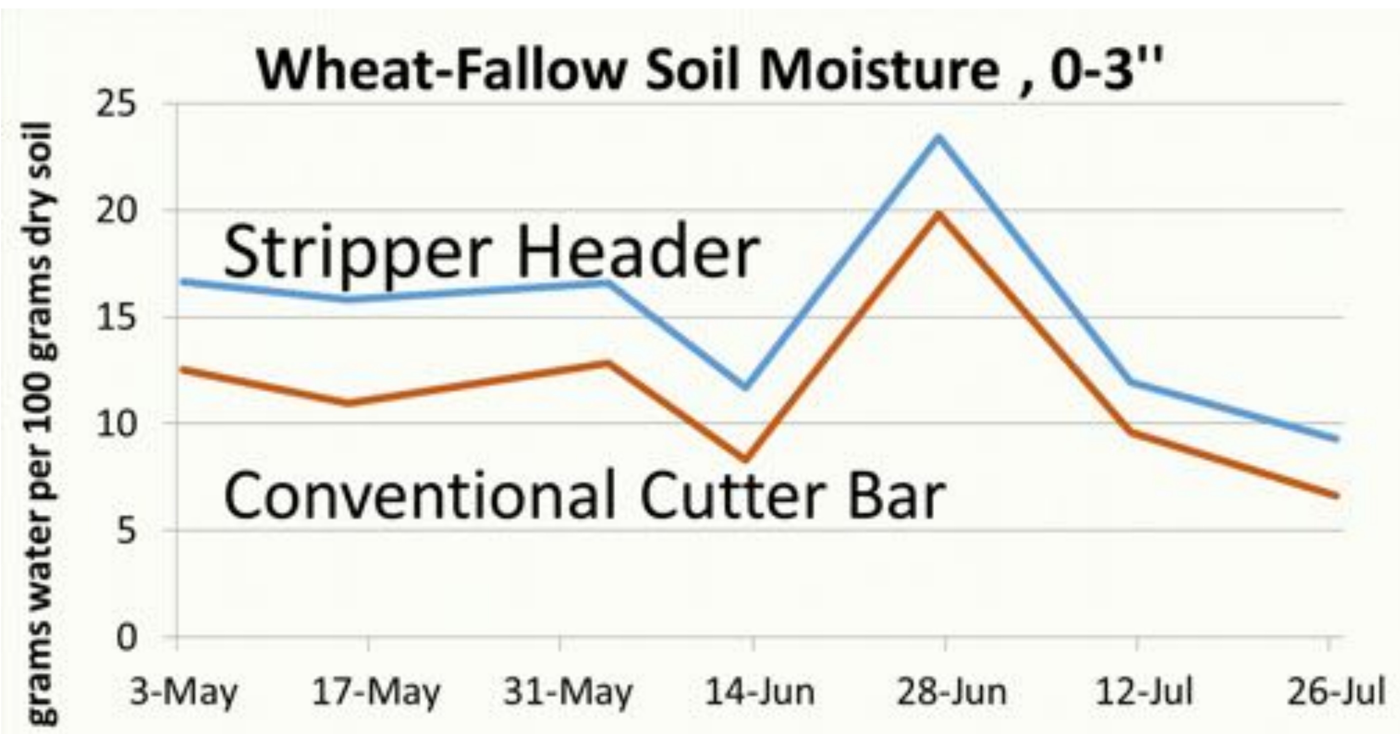
Annual net ecosystem exchange measured by flux towers



2014 Developing Nimble and Flexible Systems

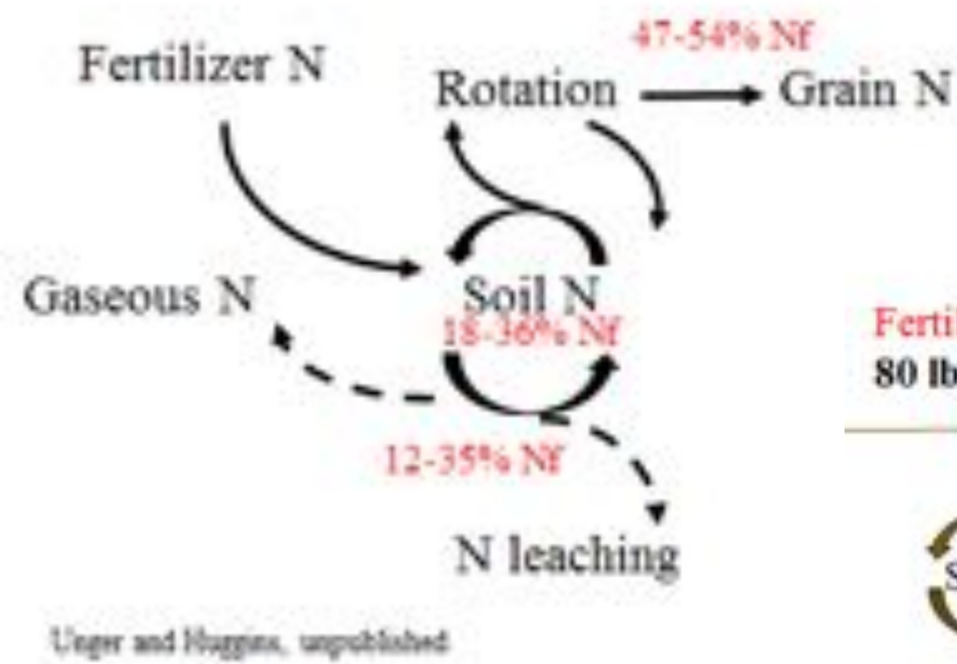
High Residue Farming

Port, Young, Roe, unpublished



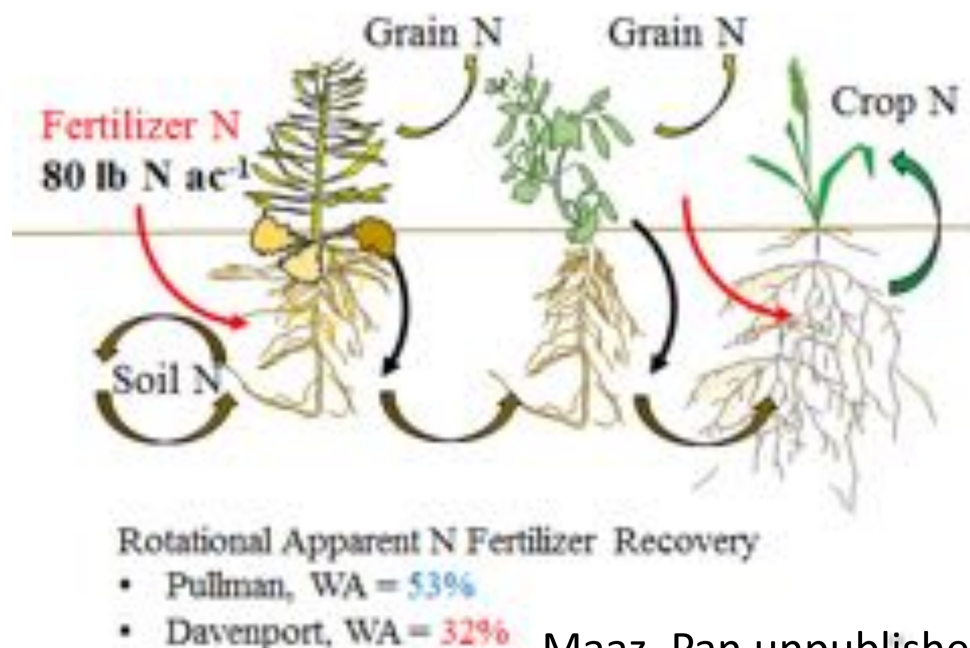
Rotational N fertilizer recovery vs. Rotational N Supply Recovery

N (Nf) fertilizer recovery in a 10 year study



rNUpE=58-75%

3 Crop Sequence

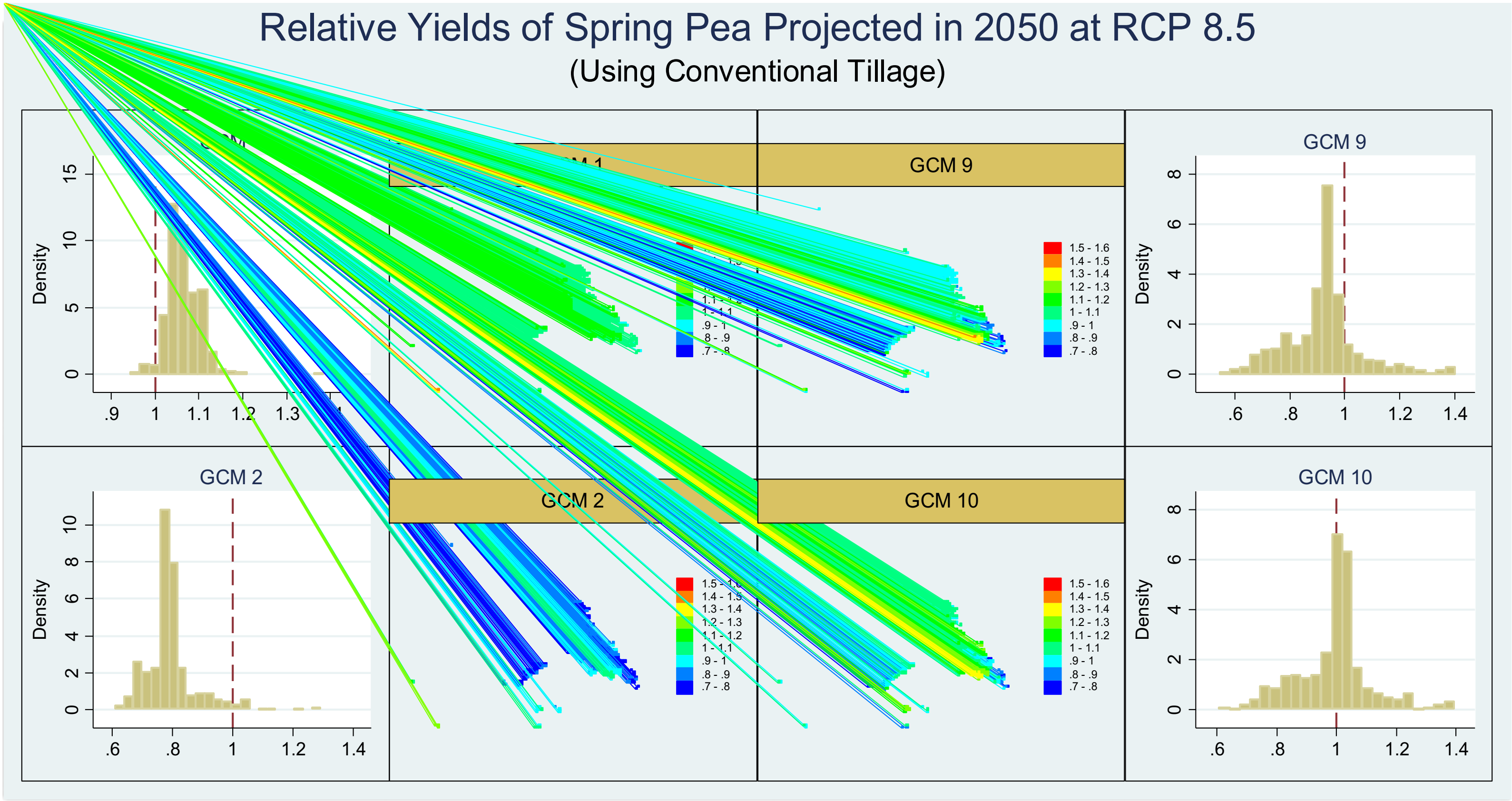


Maaz, Pan unpublishec

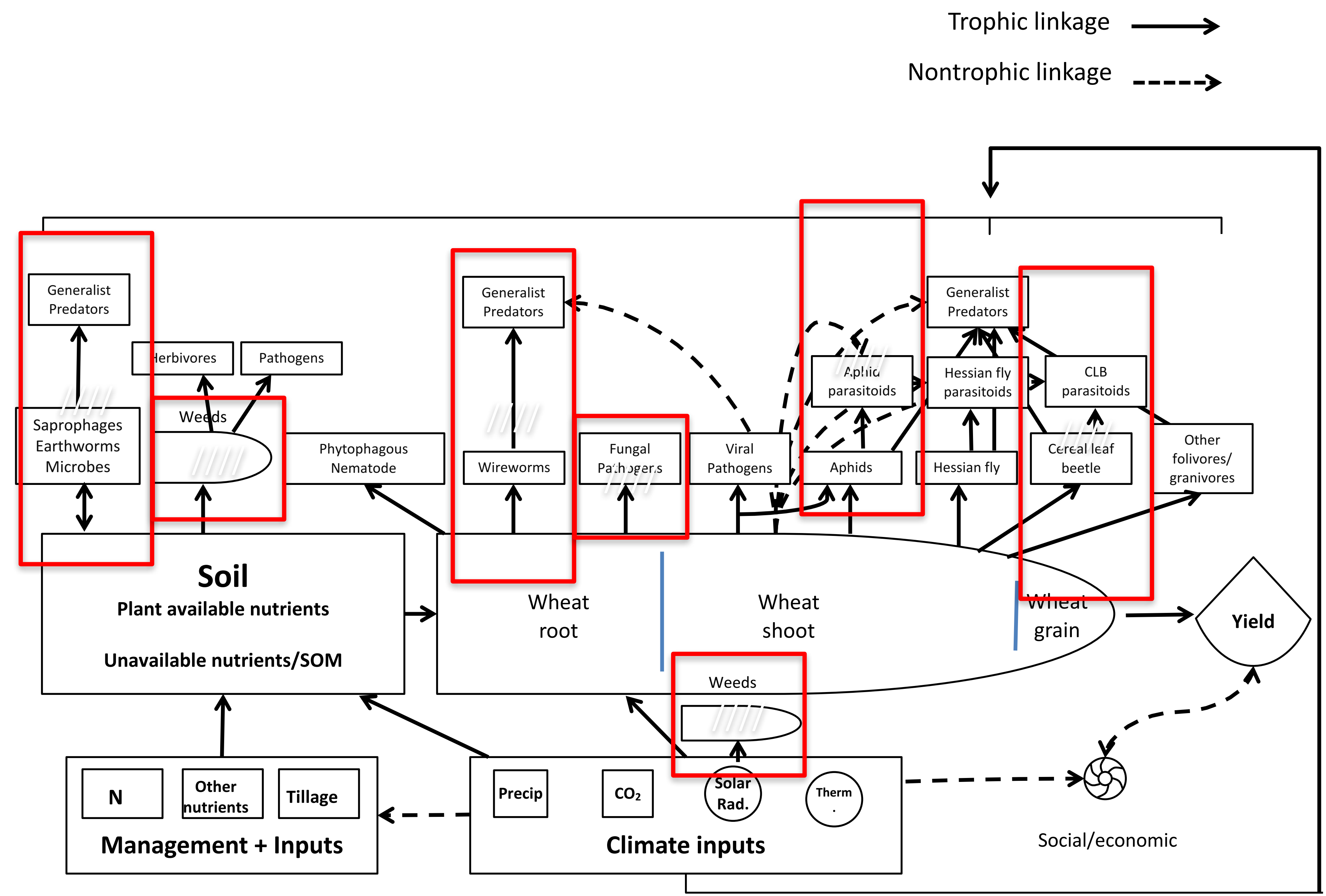
Impact assessment approach

- *Question 1*: what is sensitivity of current systems to climate change?
- *Question 2*: what are impacts of climate change under plausible future technological and socio-economic conditions?
- *Question 3*: what are benefits of alternative or climate-adapted systems under current or future climate and socio-economic conditions?

Relative yield distributions: *linking bio-physical and economic models to represent heterogeneity and vulnerability*



Largest View – Biotic Team, Wheat Fallow System in the Inland PNW



Results: Simulated Phenology of CLB

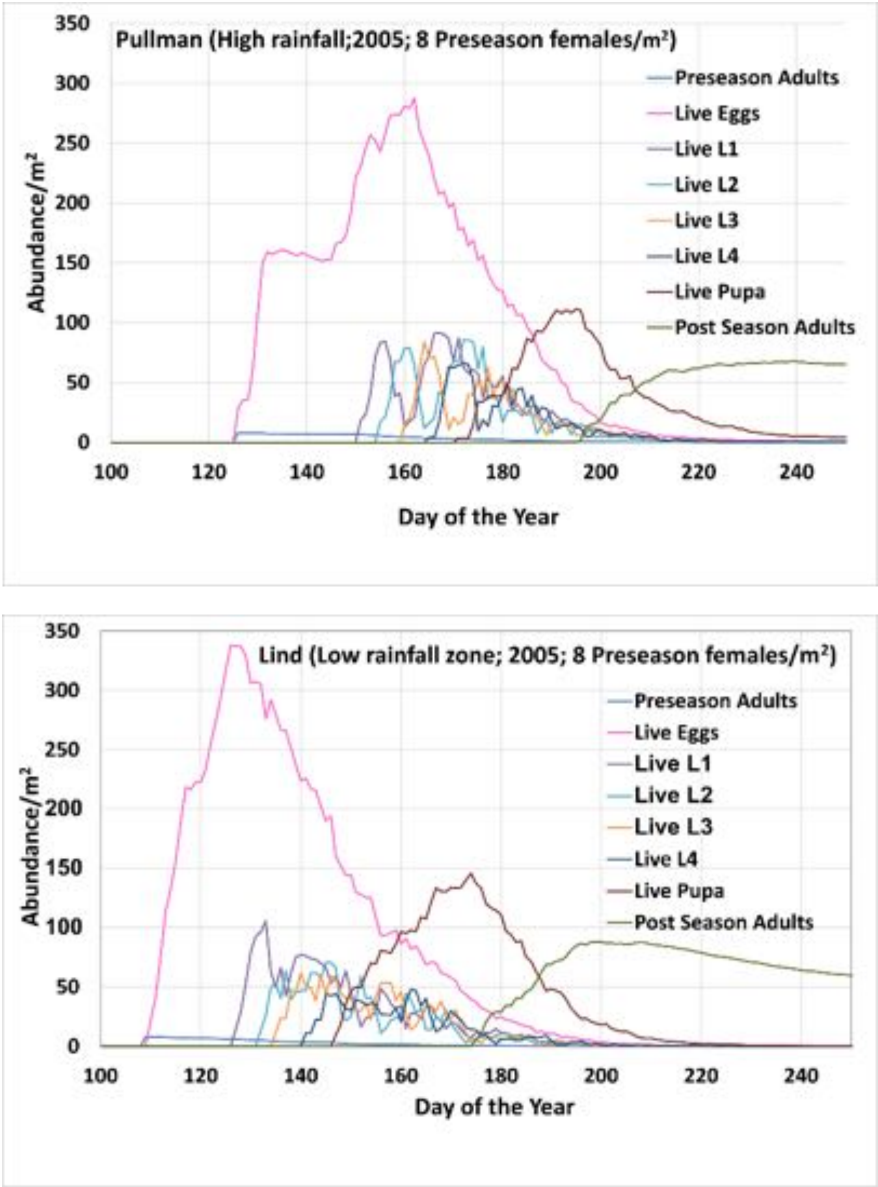


Figure 1: Simulated Phenology of CLB

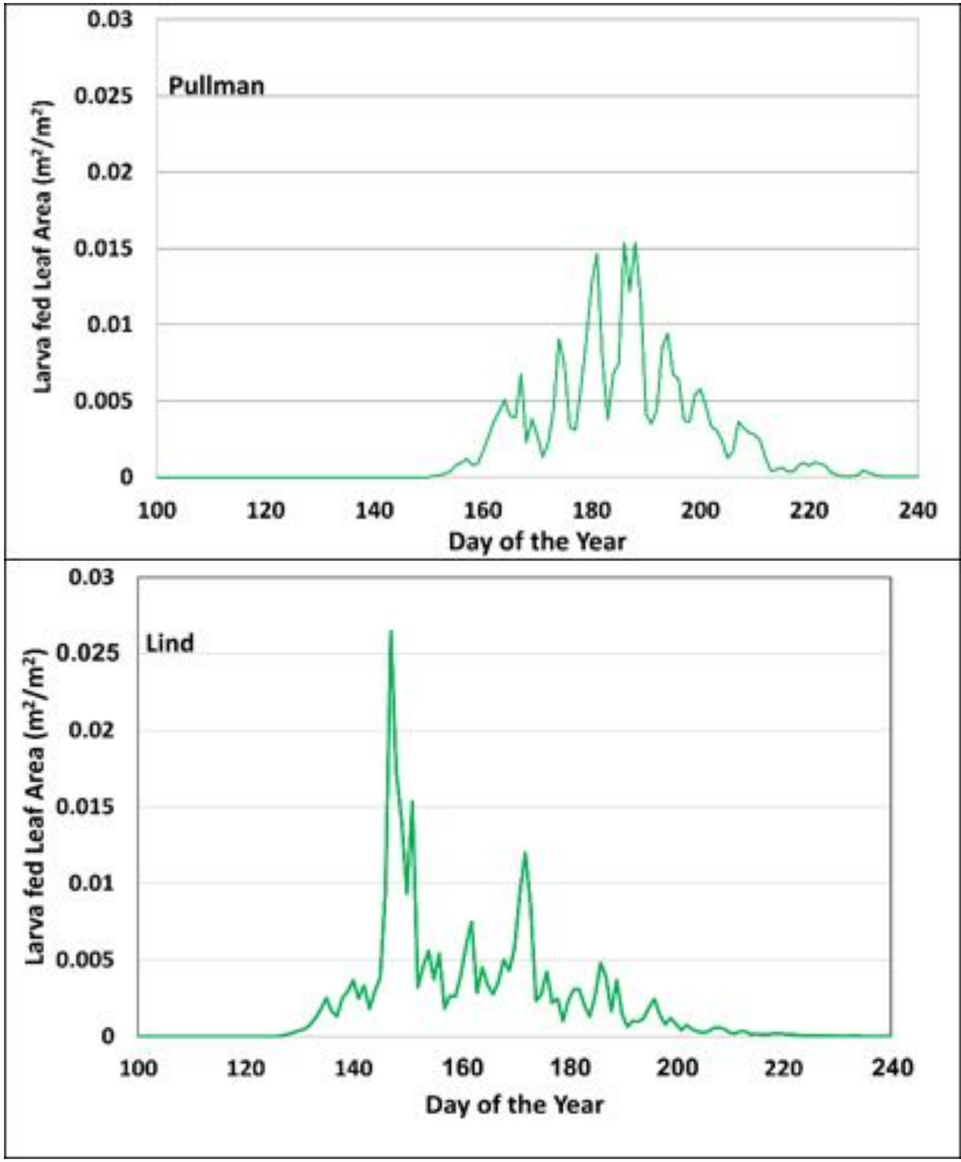


Figure 2: Simulated Feeding Dynamics of CLB

Objective 2: Illustrate the capabilities of the coupled model by simulating wheat yield loss by all four larval instars at below or above economic threshold levels (ETL) of CLB infestation

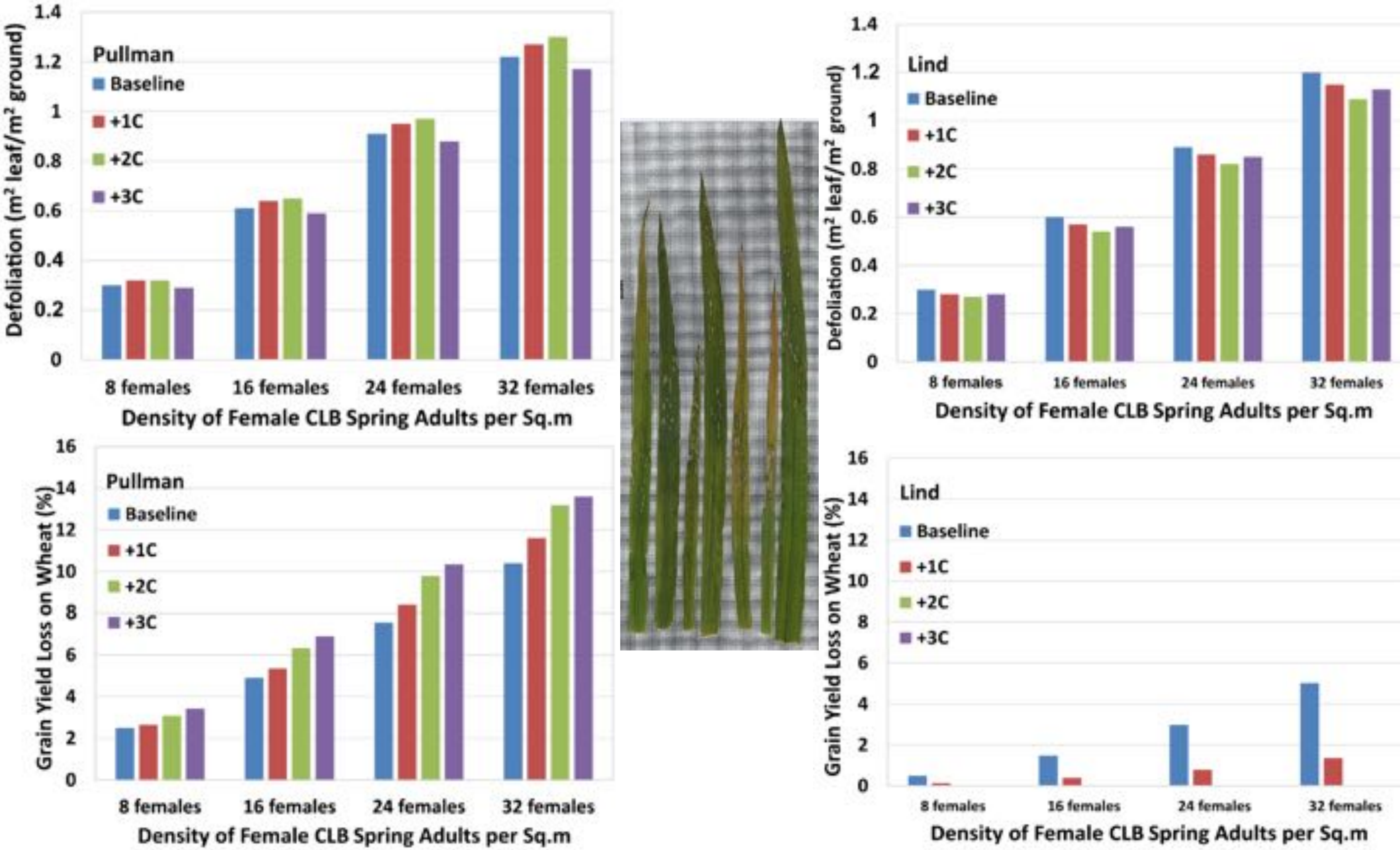
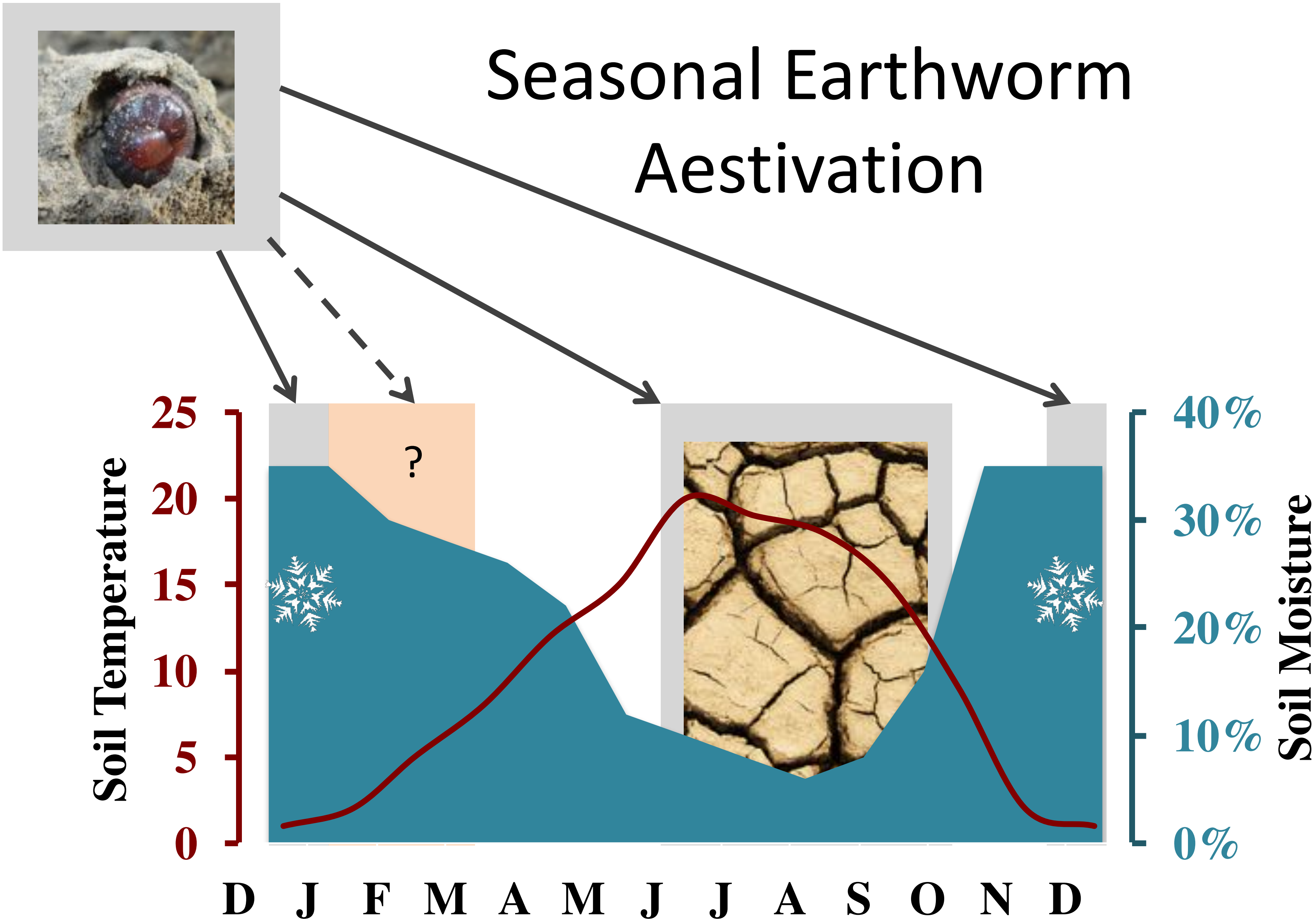
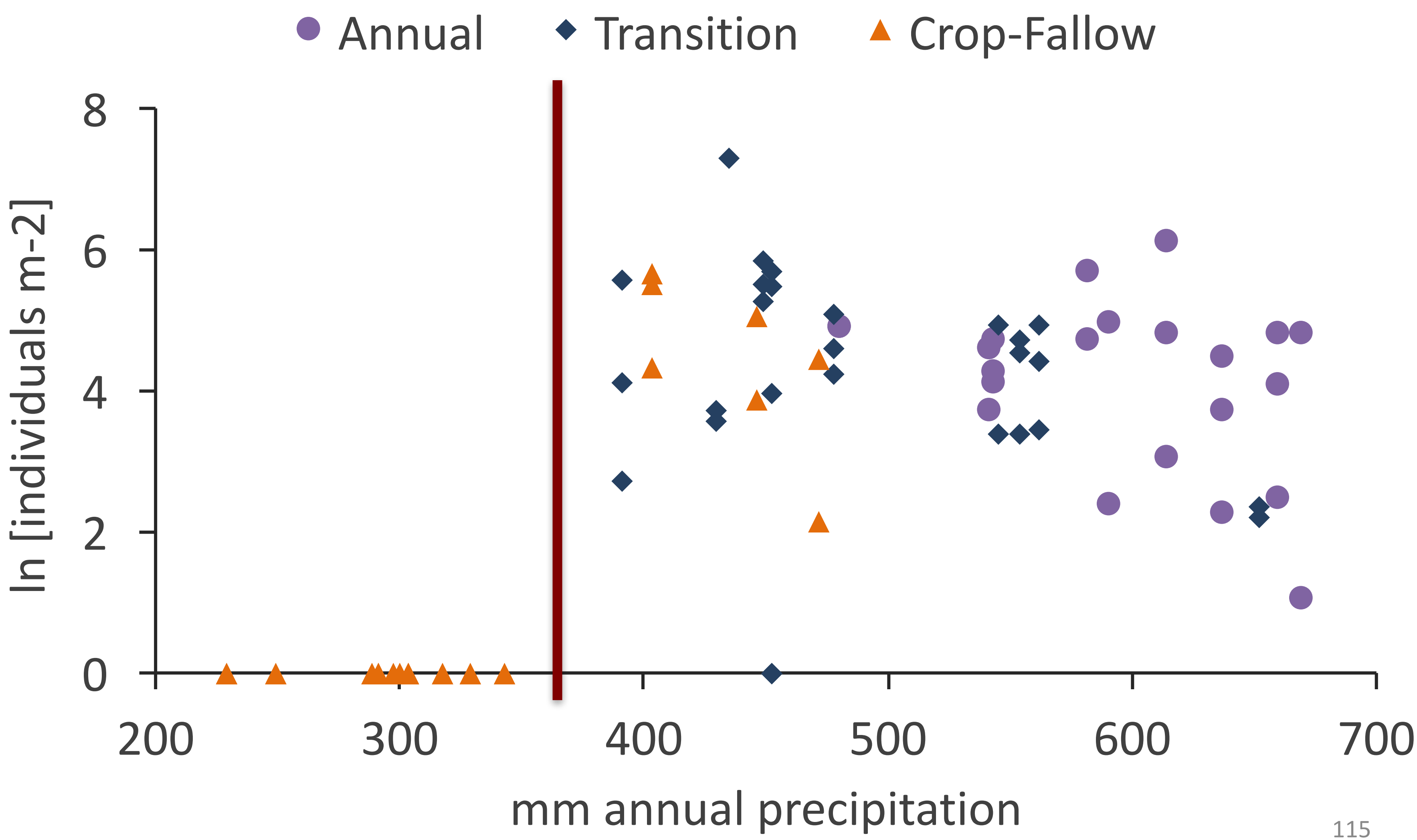


Figure 3 & 4 : CLB defoliation and resultant yield loss

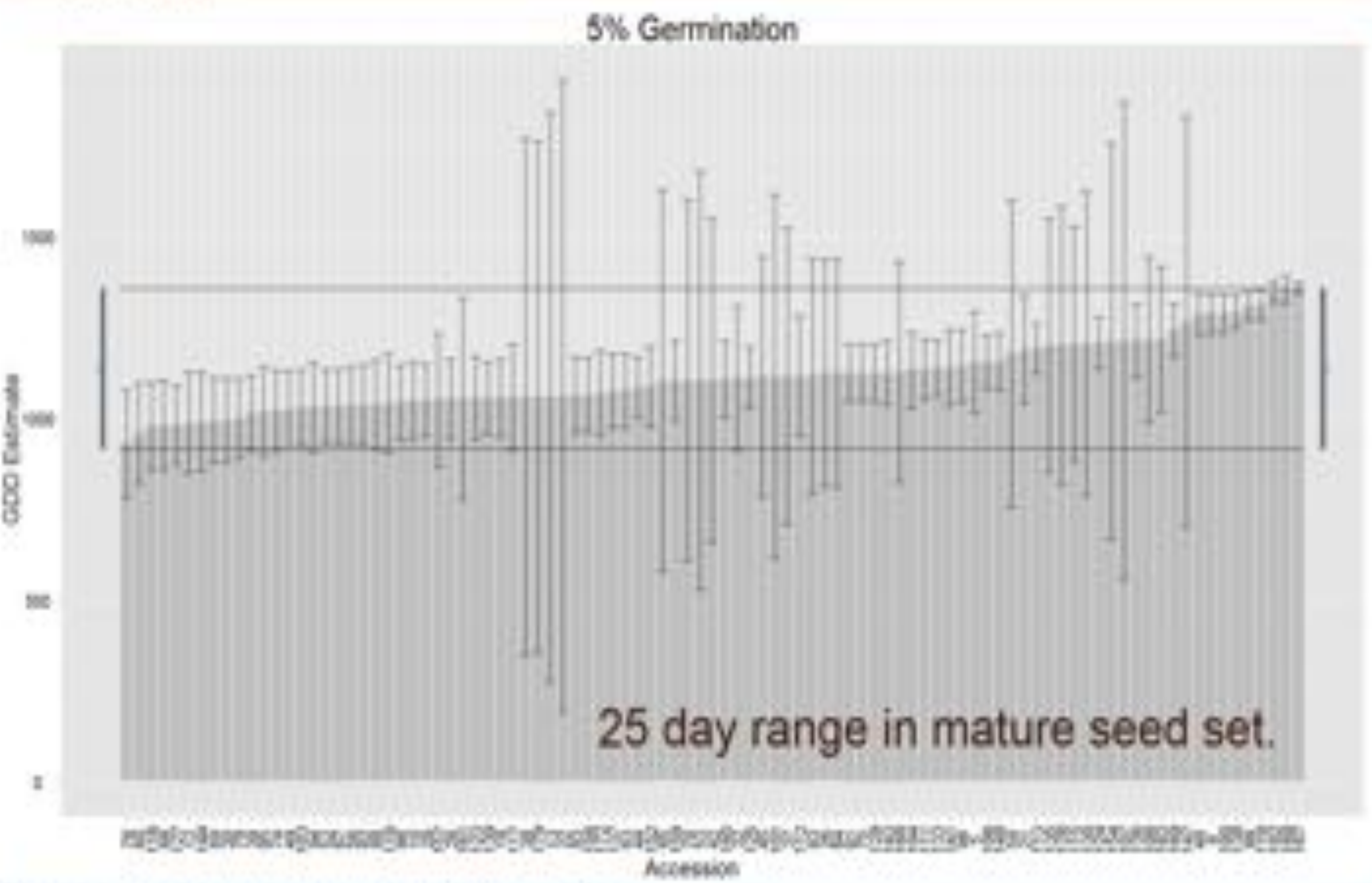
Seasonal Earthworm Aestivation

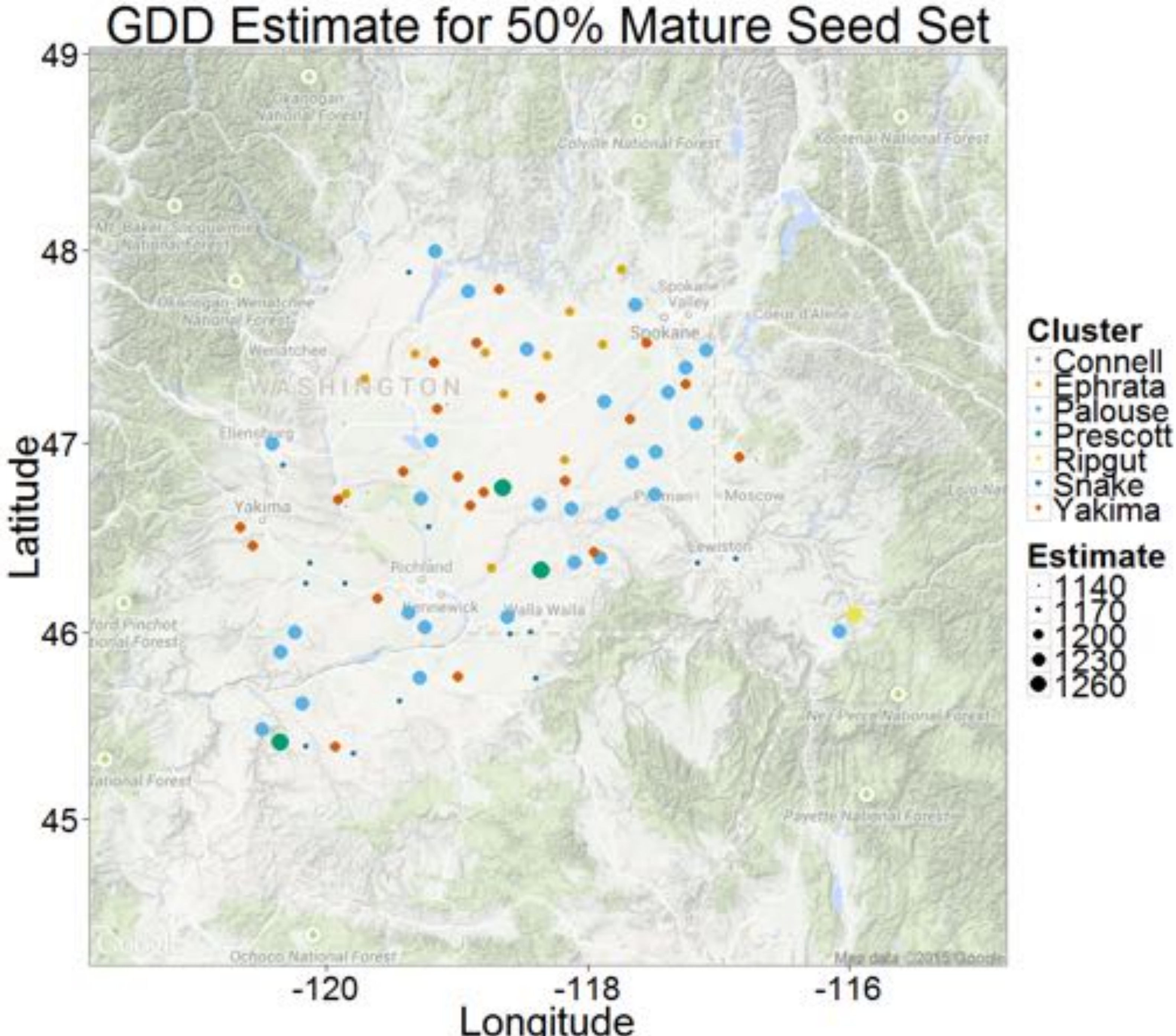


2011-2013 Densities at 32 regional sites



Vern requirements for downy brome genotypes



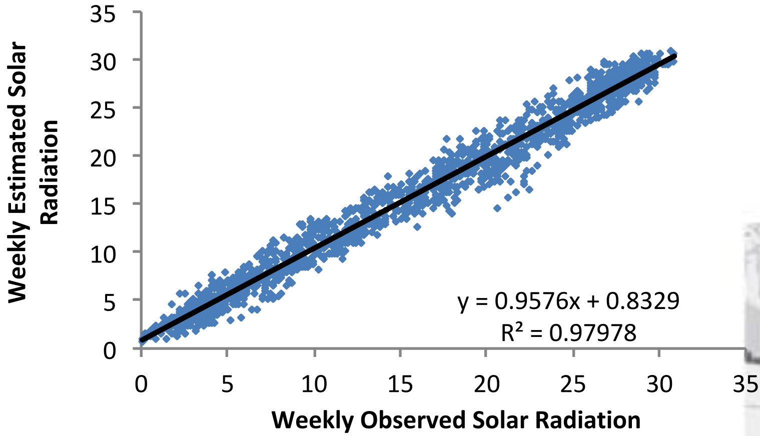

GDD Estimate for 50% Mature Seed Set
Latitude
Longitude
49
48
47
46
45
-120
-118
-116
Cluster
Connell
Ephrata
Palouse
Prescott
Ripgut
Snake
Yakima
Estimate
1140
1170
1200
1230
1260
Map data ©2015 Google

Highlights

- Data system implemented and being used for interactive data access (THREDDS, Web services, mobile apps)
- Mobile App Development – integration of biotics with data management system
- 15 presentations and engagement in national and international efforts for research data management

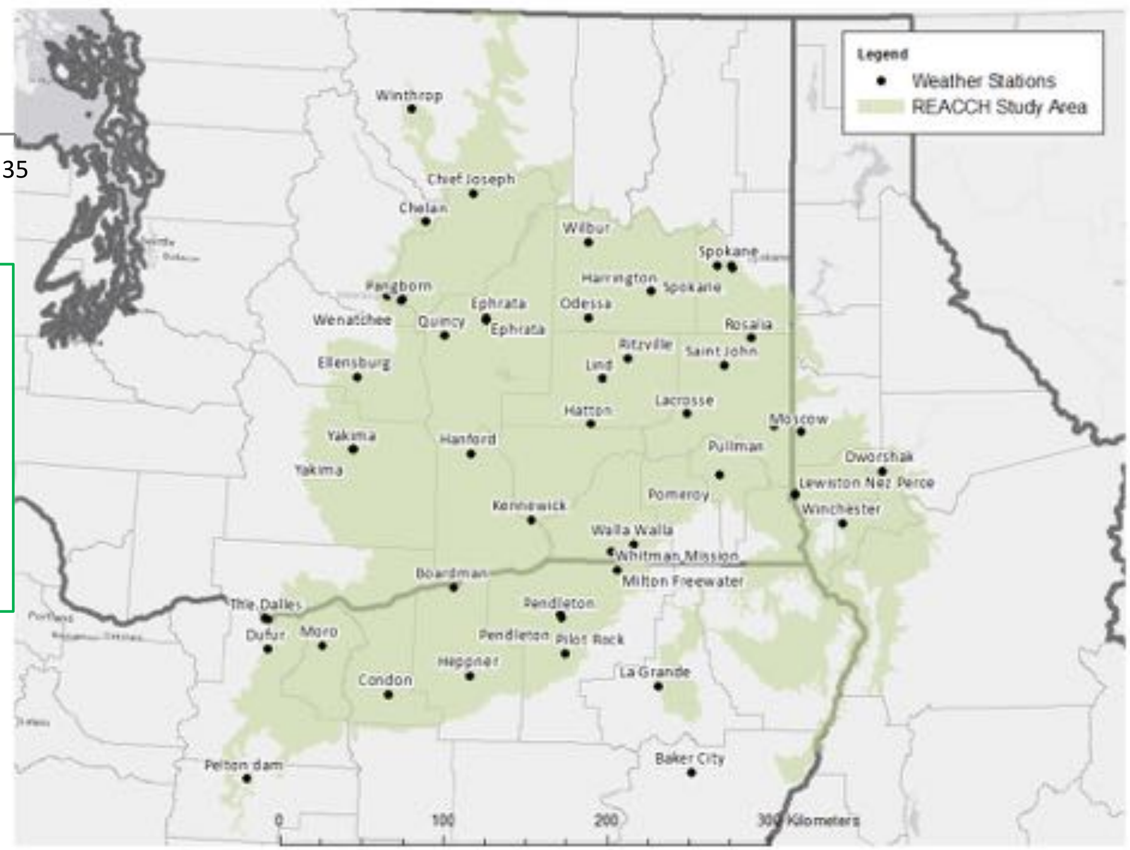
Identifying biases in gridded weather data

Estimated weather using ClimGen

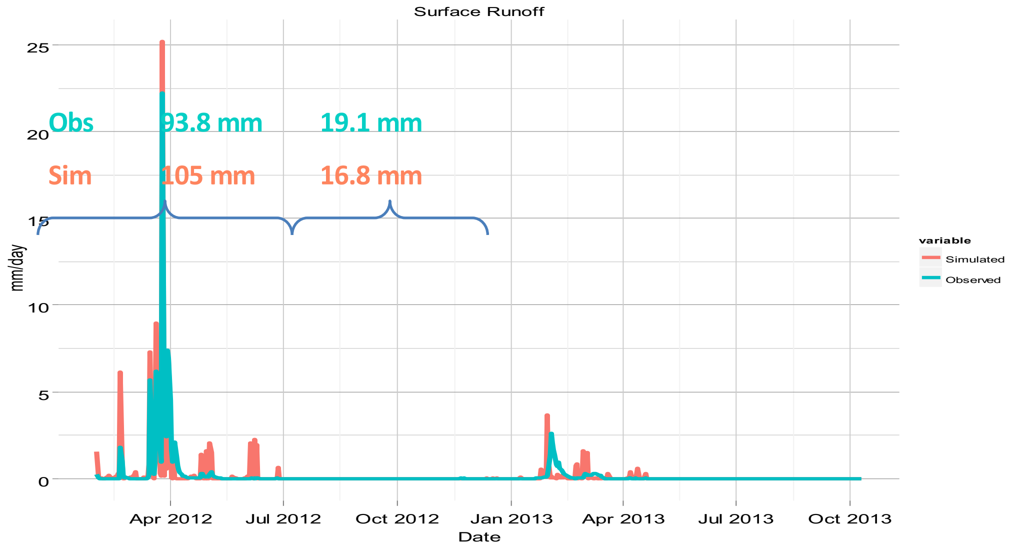


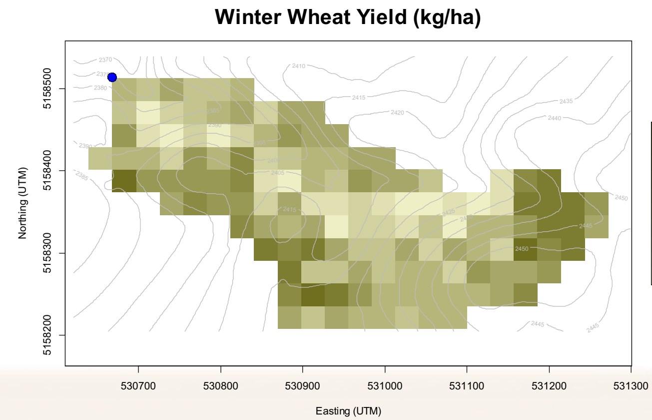
Observed weather

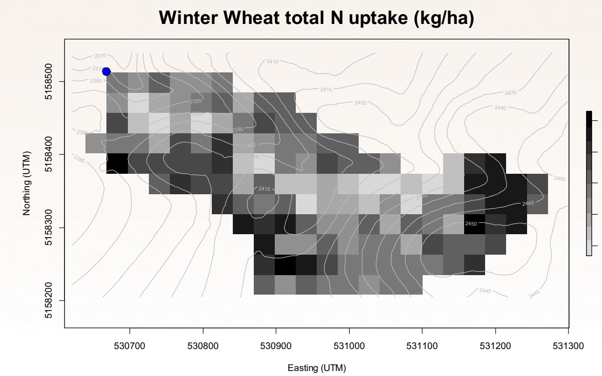
- WSU AgWeatherNet
- Agrimet
- Thermo-pluviometric

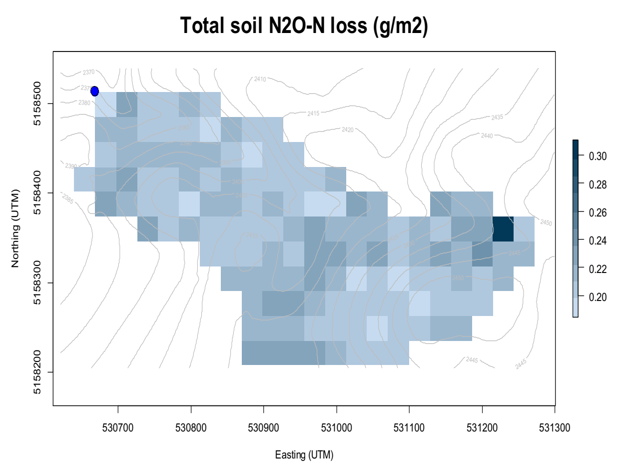


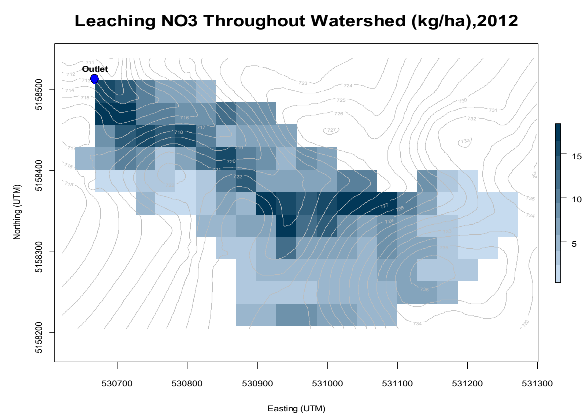
Basin Lendand (Wolff, ID)



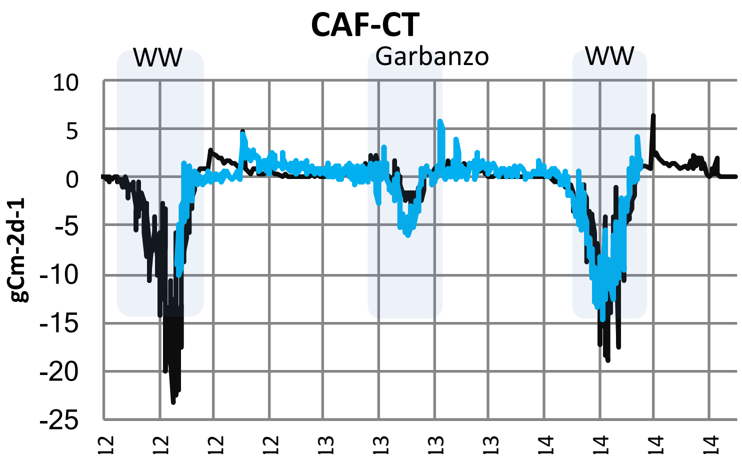


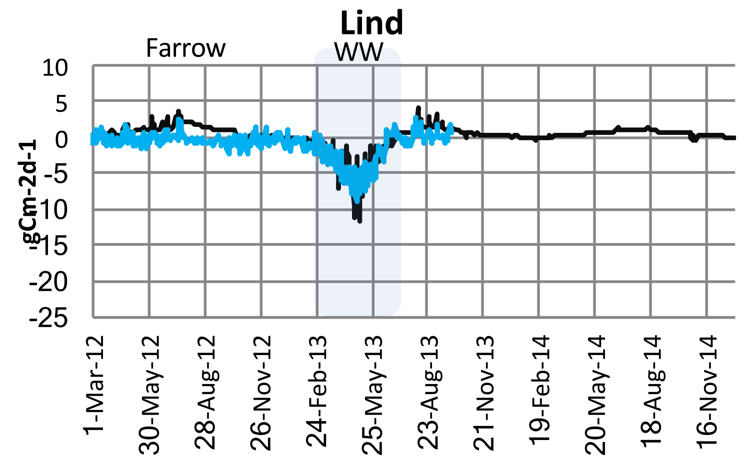


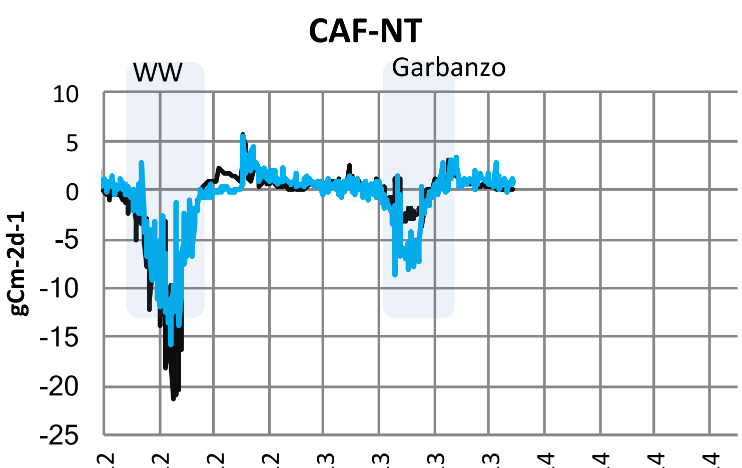


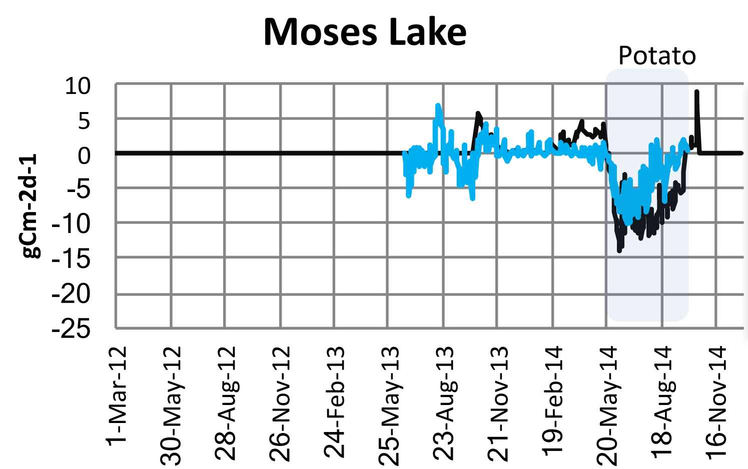


NEE-Tower flux sites









MicroBasin CS   Tower Flux