Transitioning Cereal Systems to Adapt to Climate Change

November 13-14, 2015 • Minneapolis MN, USA

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REACCH
Regional Approaches
to Climate Change –
PACIFIC NORTHWEST AGRICULTURE

Held prior to

Synergy in Science:
Partnering for Solutions
ASA • CSSA • SSSA • ESA
2015 MEETING
Nov. 15-18 | Minneapolis, MN

Welcome

On behalf of the organizing committee, I welcome you to "Transitioning Cereal Systems to Adapt to Climate Change." We are very excited to at last have you all convened here to work on the critical issues this conference targets. As you all are well aware, global food production must meet increasing demands for food production even while climates are changing. This challenge is severe for the semiarid regions that produce much of the world's staple cereals. Meeting it requires integrated efforts that transcend disciplines to allow developing science and technology and to affect producer behavior to maximize positive impacts on human society. You, the participants, represent many disciplines and experiences in the interdisciplinary collaboration required to meet this challenge. We are optimistic that during the next two days we can all learn a great deal and initiate new collaborations and approaches to support broader integration in our respective regions, and a more robust network among scientists working on these systems. We hope you will find it stimulating and memorable. Note that we will begin with presentations that provide overviews of issues regionally, transition to considering how disciplinary efforts can be strengthened and finish with working sessions to allow creative synthesis and to identify action steps to continue the collaborative momentum generated here. Thank you for participating and enjoy the meeting!
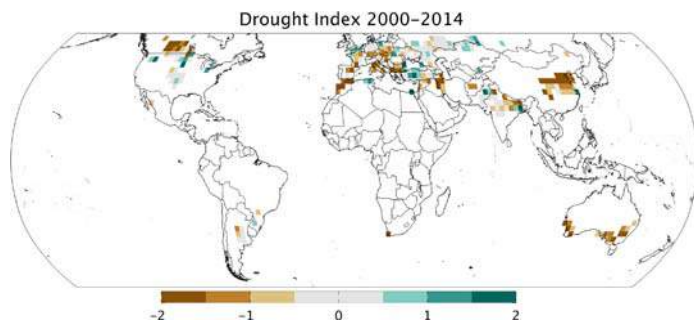

Figure 1: Mean self-calibrated Palmer Drought Severity Index (PDSI) from 2000-2014. Negative values indicate enhanced aridity, positive values indicate anomalously wet conditions relative to the 20th century. PDSI was acquired from the global data set of Dai (2011) using Penman-Monteith potential evapotranspiration. Land areas with less than 5% cover by wheat determined by Monfreda et al. (2008) are masked out.
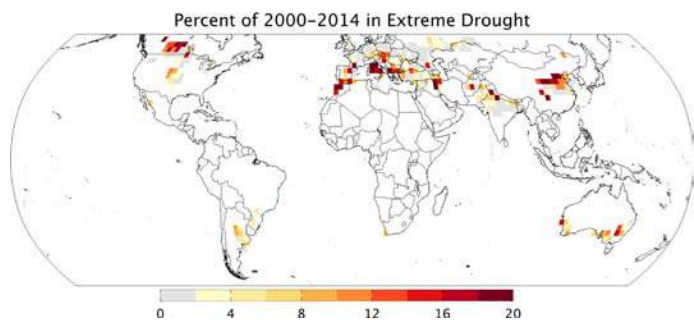
Figure 2: Percent of months from 2000-2014 where the self-calibrated Palmer Drought Severity Index (PDSI) was less than -4. Statistically, this would be expected to occur 2% of the time. PDSI was acquired from the global data set of Dai (2011) using Penman-Monteith potential evapotranspiration. Land areas with less than 5% cover by wheat determined by Monfreda et al. (2008) are masked out.

Table of Contents

Special Thanks to:

United States Department of Agriculture
National Institute of Food and Agriculture

REACCH
Regional Approaches
to Climate Change –
PACIFIC NORTHWEST AGRICULTURE

University of Idaho

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Conference Overview

This special conference is being held in conjunction with the annual meetings of the Entomological Society of America, the American Society of Agronomy, the Crop Science Society of America, and Soil Science Society of America, consistent with its interdisciplinary premise.

Global food production must continue to increase to meet demands at the same time as climates are changing. This challenge is particularly severe for semiarid regions that produce much of the world's staple cereals. Addressing this challenge requires integrated efforts that transcend disciplines to allow developing science and technology to affect producer behaviors to maximize positive impacts on human society.

This conference convenes representatives of large, collaborative projects, global initiatives and international agencies from around the world, and scientists from many disciplines to share and compare approaches to addressing this global challenge.

The conference themes draw attention to the major environmental factors that are being driven by global warming: increased atmospheric GHG's; increased temperatures of air, water and soil; altered or diminished water availability and season cycles; emergence of new pest and pathogen threats; rising incidence of extreme weather events; and dynamically changing vegetative and soil biodiversity. We then will challenge ourselves to discover how we can address these factors together, as we must, from a system-wide perspective to produce these outcomes.

Anticipated Outcomes

- Establish a global network of researchers addressing the effects of climate change on cereal systems in semiarid regions,

- Develop a plan for maintaining the vitality and utility of this network to ensure cross-fertilization and rapid dissemination of effective approaches,

- Establish a protocol for sharing approaches to integrated research, outreach, and policy to improve climate resilience of cereal systems in semiarid regions worldwide,

- Contribute to greater sustainability of cereal production systems in semiarid regions, and to global food security through the 21st century.

Conference Planning Committee

Sanford Eigenbrode[1], Patrick Binns[2], Dianne Daley Laursen[1], Paul Gessler[1], Jerry Hatfield[4], Hans Herren[5,] Chad Kruger[3], Bruce McCarl[6], Kate Painter[1], Roger Pulwarty[7], Phil Robertson[8], Claudio Stöckle[3], Von Walden[3], Corinne Valvidia[9]

[1]University of Idaho, [2]Westbrook Associates LLC, [3] Washington State University, [4] USDA National Laboratory for Agriculture and the Environment, Ames Iowa, [5] Millennium Institute, Washington D.C., [6] Texas A & M University, [7] USA National Oceanic and Atmospheric Administration (NOAA), [8] Michigan State University and Kellogg Biological Station, [9] University of Missouri

Transitioning Cereal Systems to Adapt to Climate Change

Thursday, November 12, 2015
Reception: 19:00-20:30, Millennium Hotel, Dome Room. No host bar, light refreshments.

Agenda   Friday, November 13, 2015

Stage and Scope: Plenary Session

08:00 Room 205	**Welcome and conference overview**
	Sanford Eigenbrode, REACCH Project Director, University of Idaho
	Welcome from **Phil Mulder**, President, Entomological Society of America

08:15	**Opening keynote address**
	How to transition cereal systems from problem to solution to the climate change challenge
	Hans Herren, President, Millennium Institute

08:45	**Opening keynote address**
	Transitions and transformations: Climate extremes, hotspots and adaptation in semiarid regions
	Roger Pulwarty, Director, National Integrated Drought Information System, NOAA

09:15	**Cereal system conditions, global challenges and opportunities for adaptation**
	Moderator: Sanford Eigenbrode, REACCH Project Director, University of Idaho
	Rapporteur: Bob Mahler, Professor, University of Idaho
	Adapting to increasing climatic risks in south Asian agriculture: opportunities and constraints
	Pramod Aggarwal, Regional Program Leader, CCAFS, New Delhi
	New findings for climate change and food security in China
	Xue Han, Research Assistant, IEDA, Chinese Academy of Agricultural Sciences
	Climate change and cereal cropping systems of South America: The sensitivity and adaptation of cereals in the sub-continent
	Daniel Calderini, Professor, Austral University, Chile

10:30	**Break**

11:00	Adapting cereal cropping systems to a changing climate in Australia
	Garry O'Leary, Senior Research Scientist, Department of Environment and Primary Industries
	Global challenges and opportunities for adaptation of cereal systems in sub-Saharan Africa
	Peter Craufurd, Strategic Research Team Leader and Senior Scientist, CIMMYT, France
	Cereal production systems in North America: Challenges for effective adaptation
	Jerry Hatfield, Laboratory Director, USDA-ARS, Ames, Iowa

12:30 Seasons Atrium	**Luncheon keynote address**
	A sustainable approach to climate-adapted agricultural production
	Ann Bartuska, USDA Deputy Undersecretary for Research, Education and Economics

Disciplinary Issues: Concurrent Sessions

13:30	Concurrent Session A

Room 210AB

Drought effects on water resources and crop production in semiarid regions
Moderator: Chad Kruger, Director CSANR and NWREC, Washington State University
Rapporteur: Erin Brooks, Research Scientist, University of Idaho

Adaptation to drought under climate change: A global perspective
Stefan Siebert, Senior Scientist, University of Bonn

Direct and indirect effects of climate change on cereal productivity in the Pacific Northwest region of the U.S.
Jen Adam, Director, BioEarth, Washington State University

Understanding the importance of managing climate risk in the restoration and conservation of natural capital in the dryland cereal systems
Anthony Whitbread, Research Program Director, ICRISAT, India

Room 212AB

Cropping system improvements and innovation
Moderator: Bill Pan, Professor and Extension Specialist, Washington State University
Rapporteur: Tai Maaz, Post Doc, Washington State University

Nutrient stewardship innovations for increased cereal system resilience
Paul Fixen, Senior VP, International Plant Nutrition Institute and 2016 ASA President

Innovations in Australian mixed cropping systems under climate change
John Kirkegaard, Senior Principal Research Scientist, CSIRO, Australia

Increasing productivity in rain fed, semiarid systems by analyzing and remediating limiting factors
Bram Govaerts, Associate Director, CIMMYT, Mexico

Room 205

Crop protection: Pests, weeds and pathogens
Moderator: Sanford Eigenbrode, Distinguished Professor, University of Idaho
Rapporteur: Hans Herren, President, Millennium Institute

From impact assessment to climate change adaptation: What do we need to know for invertebrate management in grains
Sarina Macfadyen, Ecologist, CSIRO Ecosystem Sciences, Australia

Managing disease in cereal systems
Karen Garrett, Preeminent Professor, University of Florida

Using weed germplasm as a means to adapt cereal crops to climate change and rising CO_2
Lewis Ziska, Research Plant Physiologist, USDA-ARS

The 'Push-Pull' farming system: Climate-smart sustainable agriculture for cereal-livestock production in Africa
Zeyaur Khan, Principal Scientist, ICIPE, Kenya

15:00	Break

Disciplinary Issues: Concurrent Sessions, *continued*

15:30	**Concurrent Session B**

Room 205 **Genetic improvement and integration**
Moderator: Sanford Eigenbrode, Distinguished Professor, University of Idaho
Rapporteur: Ian Burke, Associate Professor, Washington State University

Private sector breeding to prepare for changing climates
Edward Souza, Director, Global Wheat Breeding, Bayer Crop Science

Breeding for tolerance to heat and other climatic stresses for lower latitudes worldwide
Kulvinder Gill, Professor, Washington State University

Public sector breeding to prepare for changing climates
Jim Anderson, Professor Wheat Breeding and Genetics, University of Minnesota

Room 212AB **Identifying and assessing adaptation strategies**
Moderator: Kate Painter, Assistant Professor, University of Idaho
Rapporteur: Laurie Houston, Associate Professor, Oregon State University

What we know about public and private adaptation strategies
Bruce McCarl, Regents Professor, Texas A&M University

Improving models and data for developing pathways for cropping system adaption to climate change
Jim Jones, Distinguished Professor, University of Florida

Assessing how economic adaptations affect vulnerability to climate change
John Antle, Professor, Oregon State University

Room 210AB **Greenhouse gases: Monitoring and approaches to mitigation**
Moderator: Phil Robertson, Professor, Kellogg Biological Station, Michigan State University
Rapporteur: Brian Lamb, Professor, Washington State University

Greenhouse gas mitigation potential of dryland cropping systems in the U.S. Great Plains
Mark Liebig, Research Soil Scientist, USDA-ARS

Constraining soil-emitted GHGs from crop production on the Canadian semiarid prairies
Reynald Lemke, Research Scientist, Agriculture and AgriFood Canada

Is eddy covariance a suitable tool to establish greenhouse gas balance of cereals?
Marc Aubinet, Professor, University of Liege, Belgium

Nitrous oxide fluxes from cropping soils in a semiarid region in Australia: A 10-yr prospective
Louise Barton, Senior Research Fellow, University of Western Australia

Optimizing yield and reducing greenhouse gas emissions for resilient cropping systems in rain fed semiarid environments
Peter Grace, Professor, Queensland University of Technology, Australia

Poster Session

17:30 Seasons Atrium	**Poster Presentations**
	Session A: 17:30
	Session B: 18:00

18:30	**Reception**
	(Heavy hors d'oeuvres)

20:00	**Adjourn for Evening**

Saturday, November 14, 2015

Integration: Plenary Session

| 08:00 Room 205 | **Welcome and housekeeping issues** |

08:10 **Summaries of Concurrent Sessions A and B**
Moderator: Chad Kruger, Director CSANR and NWREC, Washington State University
Rapporteurs

| 09:40 | **Break** |

Integration: Concurrent Sessions

| 10:00 | **Concurrent Session C** |

Room 206AB **Cropping system models as platforms for integration**
Moderator: Jerry Hatfield, Laboratory Director and Plant Physiologist, USDA-ARS
Rapporteur: Claudio Stöckle, Professor, Washington State University

Utilizing crop models as integration platforms
Peter Craufurd, Strategic Research Team Leader and Senior Scientist, CIMMYT, France

Response:
Steve Peterson, Director of Sourcing Sustainability, General Mills, retired

Helen Greatrex, Post Doc, Intl. Research Institute for Climate and Society, Columbia U.

Vara Prasad, Professor, Kansas State University

Senthold Asseng, Professor, University of Florida

Room 207AB **Collaborative translational science to address climate change in semiarid systems**
Moderator: Corinne Valdivia, Associate Professor, University of Missouri
Rapporteur: Isaac Madsen, Ph.D. student, Washington State University

Agro-ecological classification of farmer risk perceptions and climate adaptation
J.D. Wulfhorst, Professor, University of Idaho

Linking local and scientific knowledge: Challenges and opportunities
Jere Gilles, Director of Graduate Studies in Rural Sociology, University of Missouri

Perceptions and management of soil quality: A transitional approach
Peter Motavalli, Professor, University of Missouri

Agricultural systems that enhance translation
Karen Garrett, Preeminent Professor, University of Florida

Room 213AB **Data management to enable regional and global efforts**
Moderator: Cheryl Porter, Co-lead AgMIP IT Team, University of Florida
Rapporteur: Ed Flathers, Ph.D. student, University of Idaho

Wheat data management and sharing guidelines
Esther Dzale Yeuomo Kabore, Data and Knowledge Manager, French National Institute for Agriculture Research

Overview of CGIAR's open access, open data efforts
Medha Devare, Data and Knowledge Manager, CGIAR, France

Agricultural information supply chains – drivers and directions
Peter Fitch, Interoperable Systems Team Program Leader, CSIRO, Australia (video presentation)

Evolving an architecture for agricultural research data management in the US Pacific Northwest
Paul Gessler, Director, Northwest Knowledge Network, University of Idaho

Saturday, November 14, 2015

Action Planning

11:30 Seasons Atrium	**Luncheon Keynote Address** **An 80/20 approach to climate change adaptation in cereal systems** **David Lobell**, Associate Professor, Stanford University

12:30 Room 205	**Summaries of Concurrent Session C** Moderator: John Antle, Professor, Oregon State University Rapporteurs **Wrap-up and Outlook**

13:00	**Plenary Session: Synthesis and action to move beyond the conference ("The Solutions Room")** Facilitator: Michael Binder, Consultant, The Missional Network

14:30	**Break**

15:00	**Action step themed breakout working groups** Facilitator: Michael Binder, The Missional Network
Room 206A	**Enhancing, harmonizing and applying modeling efforts and data access to improve analysis and development of adaptation strategies for wheat and other cereals** Facilitator: John Antle, Professor, Oregon State University Rapporteur: Hongliang Zhang, Post Doc, Oregon State University
Room 206B	**Creating mechanisms to sustain the themes of the conference among ourselves and within our professional societies** Facilitator: Bill Pan, Professor, Washington State University Rapporteur: Rajan Ghimire, Assistant Professor, New Mexico State University
Room 207A	**Strengthening and contributing to existing U.S. and international partnerships and initiatives** Facilitator: Sanford Eigenbrode, Distinguished Professor, University of Idaho Rapporteur: Patrick Binns, Principal, Westbrook Associates LLC
Room 207B	**Building capacity and early career support efforts for graduate students working on resilient cereals challenges** Facilitator: Corinne Valdivia, Associate Professor, University of Missouri Rapporteur: Nicole Ward, M.S. student, University of Idaho
Room 213A	**Communicating with and informing farmers and food system stakeholders** Facilitator: Chad Kruger, Director CAANR, Washington State University Rapporteur: Prakriti Bista, Post Doc, Oregon State University
Room 205	**Ad hoc session(s): TBD by participants during the conference** Facilitator: Tim Paulitz, Research Plant Pathologist, USDA-ARS Rapporteur: Dianne Daley Laursen, REACCH Project Manager, University of Idaho

Plenary Session: Closing Remarks

16:15 Room 205	**Plenary Session: Working groups highlight reports** Facilitator: Michael Binder, Consultant, The Missional Network

17:00 Room 205	**Closing Remarks** **Sanford Eigenbrode**, REACCH Project Director, University of Idaho

Concurrent Sessions

Concurrent Session A

Title: Drought effects on water resources and crop production in semiarid regions
Scheduled: Day 1, 13:30, Room 210AB
Organizers: Chad Kruger and Erin Brooks
Purpose: To review the impacts of projected climate change on water availability in semiarid cereal production systems and approaches to improving water use efficiency through water management practices, cropping system design, tillage practices and other approaches.
Scope/focus: Global scope but focused on water use technologies at different scales, with an emphasis on modeling
Outcomes: Improve coordination of research strategies and ideas focused on various semiarid regions of the world.

Title: Cropping system improvements and innovation
Scheduled: Day 1, 13:30, Room 212AB
Organizers: Bill Pan and John Kirkegaard
Purpose: Review and compare approaches to diversifying wheat or cereal production systems with cover crops, rotational crops coupled with innovative management to improve resilience to climate change, improved nutrient and water use, and soil productivity.
Scope/focus: Cereal production systems globally, with examples of novel rotations and cover crops, their adoption by producers, metrics to assess the resilience they impart to production systems, needs for additional research.
Outcomes: Improve understanding of the potential for modifying wheat or other cereal production systems and successes in doing so worldwide. Delineation of a research agenda to continue developing such approaches. Discussion points for the remainder of the project concerning potential integration of the conference.

Title: Crop protection
Scheduled: Day 1, 13:30, Room 205
Organizers: Sanford Eigenbrode and Hans Herren
Purpose: Review the current research achievements and challenges for managing pests, weeds and diseases in semiarid cereals undergoing climate change.
Scope/focus: Gain an understanding of insect pests, weeds, diseases and their management within cereal cropping systems.
Outcomes: Identify research agendas going forward to address issues and ensure integration.

Concurrent Session B

Title: Genetic improvement anticipating climate change
Scheduled: Day 1, 15:30, Room 205
Organizers: Sanford Eigenbrode and Kulvinder Gill
Purpose: Assess the opportunities for genetic improvement to anticipate climate change related stresses and how best to integrate genetic technology into cropping system improvements.
Scope/focus: Wheat genetics and breeding in the context of a G x E x M framework.
Outcomes: Identified opportunities for improving wheat resilience to climate change related stresses while ensuring germplasm compatibility with emerging cropping system improvements and modifications.

Title: Identifying and assessing adaptation strategies
Scheduled: Day 1, 13:30, Room 212AB
Organizers: John Antle and Bruce McCarl
Purpose: Review potential and implemented public and private adaptation strategies, who might implement them and the public role, the interplay between biophysical and economic adaptations. The role of crop models, on farm data and economic models to address these issues will be emphasized.
Scope/focus: Global scope but focused on incorporating adaptation better into analyses, with an emphasis on modeling.
Outcomes: Improve climate change adaptation of cereals ultimately and in shorter term the identification of possible adaptations and their evaluation with ideas focused on various semiarid regions of the world.

Title: Greenhouse gases: Monitoring and approaches to mitigation
Scheduled: Day 1, 15:30, Room 210AB
Organizers: Phil Robertson and Brian Lamb
Purpose: Assess our current understanding of fluxes of the major greenhouse gases CO_2, N_2O, and CH_4 in semiarid cereal cropping systems, with particular attention to measurement and mitigation approaches.
Scope/focus: Gain an understanding of the soil, plant, environment, and management factors that govern the contribution of cereal cropping systems to atmospheric greenhouse gas concentrations at multiple spatial and temporal scales.
Outcomes: A summary description of the current state of the art, identification of key knowledge gaps, and a description of activities that could help to close these gaps in an integrated way.

Concurrent Session C

Title: Cropping system models as platform for integration
Scheduled: Day 2, 10:00, Room 206AB
Organizers: Jerry Hatfield and Claudio Stöckle
Purpose: Assess approaches for the integrated analysis of cropping systems with particular attention to the use of computer simulation models.
Scope/focus: Gain an understanding of the role of models as integrators of diverse scientific disciplines to produce comprehensive analyses of agricultural systems at multiple spatial and temporal scales.
Outcomes: A summary description of integrated analyses that can be accomplished with cropping system models detailing needs, limitations, and future developments.

Title: Collaborative translational science to address climate change in semiarid production systems
Scheduled: Day 2, 10:00, Room 207AB
Organizers: Corinne Valdivia and Chad Kruger
Purpose: This session addresses collaborative research approaches that connect the knowledge of local decision makers in small holder agriculture around the world, and scientific knowledge, in order to address key issues about learning in contexts of uncertainty and vulnerability.
Scope/focus: This session focuses on lessons about the role of perceptions, local and scientific knowledge in informing decisions, derived from participatory research and network analysis in Temperate and Tropical semiarid production systems. Session presenters integrate biophysical and social sciences approaches in soils, pests and diseases, farming practices, networks and landscapes, climate variability and change. Effectiveness of approaches, and the challenges and opportunities in the context of climate change are discussed drawing on experiences with research with farmers in the Inland Pacific Northwest and the Andean Mountain regions, to capture characteristics of developed and developing country contexts.
Outcomes: Exposure and learning on approaches in developing and developed countries' agriculture, focusing on adaptation to climate change. Participants will be part of a discussion on collaborative and interdisciplinary and participatory research experiences.

Title: Data management, interoperability and data sharing to support climate change science for agriculture
Scheduled: Day 2, 10:00, 213AB
Organizer: Paul Gessler
Purpose: Share information about agricultural data architecture, metadata, policies and opportunities for interoperability to support climate change science regionally and globally.
Scope/focus: Repositories for storing baseline and long-term agricultural data exist at various locations around the globe. Opportunities to share tools, applications and insights are evolving to use cloud and distributed computing resources. This session will provide examples from leading research teams and review of approaches we may test for open data to support open science.
Outcomes: A plan for leveraging existing efforts to test dynamic analysis tools using interoperability protocols between data repositories from around the globe. This will include discussion of funding opportunities to share data, applications and knowledge and expertise as secure and dependable networking capabilities evolve.

Saturday Synthesis Session

Title: Enhancement of modeling activities and data networks for improvement and utilization of wheat and other cereals
Scheduled: Day 2, 15:30, Room 206A

The efforts of AgMIP exist in a broader context including climate, crop, and economics modeler as well as agricultural researchers providing data sets for calibration and application of models. As a complement, data systems to support models, statistical meta-analyses, and other analytics are needed. How can we provide support and contribute to these efforts to increase the understanding of the interaction between dryland cereal systems and climate?

Title: Creating mechanisms to sustain the themes of the conference among ourselves and within our professional societies
Scheduled: Day 2, 15:30, Room 206B

After this conference, mechanisms will be needed to support continuing communication and collaboration by participants and others around themes we initiate here. What are these themes? Example themes include semiarid systems and climate change, crop protection in cereal systems in transition, designing improved resilient cropping systems. We will also need mechanisms to sustain them. Examples include moderated blog or blogs (Wikispaces or equivalent), one or more list serves, establishing or contributing to one or more ASA Communities of Interest (COI). One being entertained is a "Resilient Cereals Community of Interest." These communities can sponsor symposia at future Tri-Societies meetings.

Title: Strengthening and contributing to existing U.S. and international partnerships and initiatives
Scheduled: Day 2, 15:30, Room 207A

There are existing collaborative networks, agencies and initiatives in the U.S. and worldwide that include cereal system resilience and productivity in their agendas. Which of these might we coordinate with to carry on conference themes and how should this be accomplished? Examples include the International Wheat Initiative, international agencies (e.g. GAFSP, World Food Program, WOCAT), informal initiatives like System for Wheat Intensification, USDA 's LTAR sites where cereals are significant crops.

Title: Building capacity and early career support efforts for graduate students working on resilient cereals challenges
Scheduled: Day 2, 15:30, Room 207B

A community of scholars will be needed that is prepared for the collaborative, transdisciplinary efforts required to improve cereal systems and others. How can we better train graduate students and Post Docs for this type of work? How can we work together to ensure this is effort is international?

Title: Communicating with and informing farmers and food system stakeholders
Scheduled: Day 2, 15:30, Room 213A

Implementation of broader integration will depend on links to industry partners of various sectors including biotechnology, information technology, implements, breeding and genetics. What steps could be taken to identify and sustain these links?

Ad hoc session TBD by participants during the conference
**Scheduled:** Day 2, 15:30, Room 205

Keynote Speakers

Dr. Ann Bartuska

Ann M. Bartuska is Deputy Under Secretary for USDA's Research, Education, and Economics (REE) mission area. She came to REE in September 2010 from the USDA Forest Service, where she was Deputy Chief for Research & Development, a position she had held since January 2004. She served as Acting USDA Deputy Undersecretary for Natural Resources and Environment from January - October of 2009, and was the Executive Director of the Invasive Species Initiative of the Nature Conservancy from 2001-2004. Prior to this, she was the Director of the Forest and Rangelands staff in the Forest Service in Washington, DC.
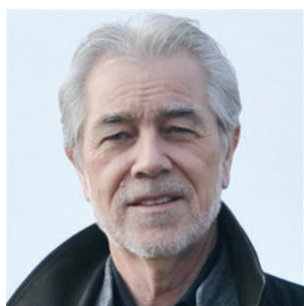
Dr. Hans Herren

Hans Herren's main research and development interests include achievements in holistic, integrated and sustainable agriculture and food systems. He has managed agriculture and bio-science research organizations and is now active at the policy development level. He has been President and CEO of the Millennium Institute USA since May 2005. Additionally: he has been the Chief Executive and Director General 1994-2004 of the International Centre of Insect Physiology and Ecology (ICIPE) Kenya; the Director Biological Control Program and Director Plant Health Management Division 1979 to 1994 at the International Institute of Tropical Agriculture (IITA) Nigeria; the Coordinator of the Agriculture chapter of the UNEP Green Economy Report, 2011; worked on UNEP Report on the Ecological Bases of Food Security, 2012; Co-Chaired the International Assessment of Agricultural Science and Technology for Development (IAASTD), 2003-2009. He received the Laureate of Right Livelihood Award 2013, the World Food Prize 1995, and the Tyler Prize for Environmental Achievement 2003.

Dr. David Lobell

David Lobell is an Associate Professor at Stanford University in the Department of Earth System Science, Senior Fellow at the Woods and Freeman Spogli Institutes, and Deputy Director of Stanford's Center on Food Security and the Environment. His research focuses on identifying opportunities to raise crop yields in major agricultural regions, and uses a combination of big data sets, statistics, and model simulations. He has been recognized with a Macarthur Fellowship in 2013, a McMaster Fellowship from CSIRO in 2014, and the Macelwane Medal from the American Geophysical Union in 2010. He also served as lead author for the food chapter and core writing team member for the Summary for Policymakers in the recent Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report. Dr. Lobell received a Ph.D. in Geological and Environmental Sciences from Stanford in 2005, and a Sc.B. in Applied Mathematics from Brown University in 2000.

Dr. Roger Pulwarty

Roger S. Pulwarty is the Senior Science Advisor for Climate, and the Director of the National Integrated Drought Information System (NIDIS) at the NOAA Office of Oceans and Atmospheric Research in Boulder, Colorado. Roger's publications focus on climate and risk management in the U.S., Latin America and the Caribbean. Throughout his career he has helped develop and lead widely-recognized programs dealing with climate science, adaptation, and services, including the Regional Integrated Sciences and Assessments, NIDIS and the Mainstreaming Adaptation to Climate Change project in the Caribbean. Roger is a lead author on the UN International Strategy for Disaster Reduction, the Intergovernmental Panel on Climate Change (IPCC) Special Reports on Water Resources and on Extremes, and a convening lead author on the IPCC Working Group II Impacts, Adaptation and Vulnerability. Roger has served on advisory committees of the National Academy of Sciences, provided testimonies before the U.S. Congress, and acts as an advisor on climate risk management and services to the Western Governors Association, the Caribbean Economic Community, the Organization of American States, the UNDP, the UNEP and the InterAmerican and World Banks, among others. He chairs the WMO Commission on Climatology Climate Services Information System. Roger's work has been featured in several media communications, including the New York Times and the BBC. Roger lectures at the University of Colorado and the University of the West Indies. He is a co-recipient of NOAA awards, Department of Commerce Gold and Silver Medals for integrating scientific research into decision-making, and the Gold Medal for Excellence in Applied Science and Technology from the Government of Trinidad and Tobago.

Plenary Speakers

Dr. Pramod Aggarwal

Pramod Aggarwal holds a Ph.D. in Life Sciences from the University of Indore, India, and a Ph.D. from Wageningen University, Netherlands. He leads the South Asia Regional Program for the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). He was an author for the IPCC 4th Assessment Report and a reviewer for the IPCC 5th Assessment Report. Previously, he was National Professor at the Indian Agricultural Research Institute, New Delhi, and Coordinator of the Indian network on climate change and agriculture. Aggarwal's research contributions include developing the concept of climate-smart villages (CSVs), crop growth models for the tropical environments, weather derivatives, adaptation strategies, inventories of greenhouse gases emissions, mitigation options, yield gap analysis, and crop yield monitoring systems. CSVs are now being replicated in more than 1500 villages in South Asia. His work on insurance has led to improved products with higher satisfaction of stakeholders and is being used by millions of farmers in India.

Dr. Peter Craufurd

Peter Craufurd is the Strategic Research Team Leader for Sustainable Intensification in Africa at the International Maize and Wheat Improvement Center (CIMMYT), based in Nairobi, Kenya. He has a more than 20 years' experience of working in the tropics both in Asia and Africa. A crop physiologist by training, his research interests have covered: crop improvement, especially screening for heat tolerance; climate change, especially modeling heat stress impacts; participatory action research; seed systems; and currently sustainable intensification in maize and wheat-based systems.

Dr. Daniel Calderini

Daniel Calderini is a professor at the Institute of Plant Production and Health at the Austral University of Chile. His areas of study include physiology of crops and cereals. Dr. Calderini´s research focused on the impact of breeding on grain yield and associated traits of tempered cereals, environmental constraints to these crops (temperature, nitrogen, aluminium and UV-B) and physiological and molecular determinants of grain weight and grain weight-grain number interaction in cereals and oil crops. He was the head of the Graduate School of the Faculty of Agricultural Sciences (UACh) and is presently the head of the Doctorate Program. He was visiting scientist at CIMMYT, Mexico; CSIRO Plant Industry (Canberra); CNAP, University of York; CSIRO Plant Industry (Western Australia) and University of Lleida, Spain. He received the People's Republic of China Friendship Award. Dr. Calderini has led national and international projects, published over 60 refereed publications and co-editor of "Crop Physiology. Applications for genetic improvement and Agronomy."At the present is a member of the editorial board of international journals as Field Crops Research.

Dr. Xue Han

Xue Han is working in the climate change lab, Institute of Environment and Sustainable Development in Agriculture (IEDA), Chinese Academy of Agricultural Sciences (CAAS). Her research interests focus on soil-plant system responses to elevated CO_2 and farming management in Free-air Carbon dioxide Enrichment (FACE) experiments, as well as exploring potential adaptation options for agriculture. She was co-author of the 3rd national assessment report on climate change in China. She has participated in several international projects related with climate change, such as Sino-UK, Sino-Australian projects.

Dr. Jerry L. Hatfield

Jerry L. Hatfield is the Laboratory Director of the USDA-ARS National Laboratory for Agriculture and the Environment and Director of the Midwest Climate Hub in Ames, Iowa. His personal research focuses on quantifying the interactions among the components of the soil-plant-atmosphere system to quantify resilience of cropping systems to climate change. He represents agriculture on the National Climate Assessment, as a member of the IPCC process that received the 2007 Nobel Peace Prize, and on an IPCC Special report on the Effects of Climate Extremes. He is a Fellow of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America and Past-President of the American Society of Agronomy and member of the American Meteorological Society, American Geophysical Union and Soil and Water Conservation Society. He is a co-principal investigator on the Agriculture Model Intercomparison and Improvement Project (AgMIP) with other 700 international scientists.

Dr. Garry O'Leary

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Attendees

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Gopal Alagarswamy is a crop simulation modeler at the Center for Global Change and Earth Observations at Michigan State University. He received degrees in Crop Physiology (M.S., 1966) and Agricultural Sciences (Ph.D., 1972). Gopal uses crop simulation models to assess impacts of current and future climate on crops in mid-Western USA and in sub-Saharan Africa (SSA). He is a team member of a multi-disciplinary and multi-institutional project "Useful to Usable (U2U)" funded by the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA), designed to improve resilience and profitability of U.S. farms in the Corn Belt in a changing climate. In another USAID funded project in SSA region, his work involves assessing current and future climate impacts on maize production. He uses crop simulation models to explore plausible effects of a variable and changing climate on maize production and to assess crop management practices that are likely to offer resilience of production in changing landscapes. His work includes extensive collaboration with the national research scientists in East Africa. alagarsw@msu.edu

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Attendees

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Louise Barton is a soil scientist who has been researching nitrogen cycling in various land uses for the past 15 years. She is the Discipline Head for Geography, Environment and Soil Sciences in the School of Earth Environment at The University of Western Australia. Her current interests include quantifying nitrous oxide emissions from cropped soils in semiarid regions in Western Australia, and understanding the factors regulating these losses. In other field-based research, Louise has investigated nitrous oxide emissions from soils receiving agricultural and domestic wastewater. louise.barton@uwa.edu.au

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Erin Brooks is an Assistant Research Professor of Biological and Agricultural Engineering at the University of Idaho. His research focuses on landscape scale hydrologic processes as impacted by management, climate, soil, and topographic variability with the primary goal of improving management strategies in diverse ecosystems. Projects include identifying the dominant hydropedologic controls driving field scale variability in crop production and nitrogen movement for improving precision agricultural practices. He has also been heavily involved with developing spatial and management tools to target critical pollutant sources areas in agricultural and forest dominated landscapes. ebrooks@uidaho.edu

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Daniel Calderini is a professor at the Institute of Plant Production and Health at the Austral University of Chile. His areas of study include physiology of crops and cereals. Dr. Calderini's research focuses on the impact of breeding on grain yield and associated traits of tempered cereals, environmental constraints to these crops (temperature, nitrogen, aluminium and UV-B) and physiological and molecular head of the Graduate School of the Faculty of Agricultural Sciences (UACh) and is presently the head of the Doctorate Program. He was visiting scientist at CIMMYT, Mexico; CSIRO Plant Industry (Canberra); CNAP, University of York; CSIRO Plant Industry (Western Australia) and University of Lleida, Spain. He received the People's Republic of China Friendship Award. Dr. Calderini has led national and international projects, published over 60 refereed publications and co-editor of "Crop Physiology. Applications for genetic improvement and Agronomy." At the present is member of the editorial board of international journals as Field Crops Research. danielcalderini@uach.cl

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Nancy Cavallero is the National Program Leader in the Division of Global Climate Change at USDA NIFA. Her primary work involves directing the competitive grants programs in the areas of soil science, watersheds and water resources, and global/climate change research; shares leadership in explaining, planning, developing, promoting, and evaluating programs in these and related areas. ncavallaro@nifa.usda.gov

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Medha Devare is the Data and Knowledge Manager at the CGIAR Consortium. She has a rigorous scientific background (agronomy, microbial ecology, bioinformatics) but is equally comfortable in the data and knowledge management arena, and has expertise in agrisemantics. Medha works across CGIAR's fifteen Centers and Research Programs to coordinate a consistent approach to Open Access and Open Data, and facilitate good management and dissemination of CGIAR research outputs via FAIR principles (Findable, Accessible, Interoperable, Reusable). Prior to working at the Consortium, she was a Scientist and Knowledge Management Specialist at the International Maize and Wheat Improvement Center (CIMMYT) in Kathmandu, Nepal, where she led the USAID-funded Cereal Systems Intensification for South Asia initiative in Nepal. m.devare@cgiar.org

Attendees

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Paul Fixen is the International Plant Nutrition Institute's (IPNI) Senior Vice President, coordinates IPNI programs in the Americas and Oceana, and serves as IPNI Director of Research. Focus areas of Dr. Fixen's research include nutrient management as well as how low soil fertility and fertilizer use fit into the overall scheme of crop production systems and the environment. Dr. Fixen is a Fellow of the American Society of Agronomy (ASA), the Soil Science Society of America (SSSA), the American Association for the Advancement of Science, and the Fluid Fertilizer Foundation. He has served as Chair of Div. S-8, as Associate Editor of the SSSA Journal, as President of the North Central Branch of ASA and on numerous committees and boards such as the Planning Committee for the 18th World Congress of Soil Science and, for several years, the Science Advisory Committee of the International Nitrogen Initiative. He is currently a member of the Agronomic Science Foundation Board of Directors. pfixen@ipni.net

Edward Flathers is a Ph.D. candidate in the University of Idaho College of Natural Resources. His dissertation focuses on using data science techniques in the analysis of large ecological data sets. Data science techniques focus on "big data"—data that present analytical challenges due to large volume or other complexities—and are built on a combination of computer sciences, statistical sciences, and domain sciences. To address these foundational areas, Flathers has earned an undergraduate credential in computer science and a master's degree in statistics. Funded by the Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH PNA) grant, he also works closely with the Northwest Knowledge Network (NKN) to architect their data repository and various services that expose data for consumption by the research community at large. His goal at the U of I is to develop a thorough research-based grounding in data sciences in order to support his interest in ecological research into the future. flathers@uidaho.edu

Lisa Gaines, Ph.D. Environmental Sciences, Oregon State University, has more than 20 years of experience working with universities, government agencies, and NGOs to develop and manage multi-institutional natural resource and international development projects and programs. Within the Institute for Natural Resources at Oregon State University, she leads multi-institutional research and science review teams, facilitates planning and policy dialogues, develops and implements policy research, leads multi-institutional proposal development teams. As Director, Lisa is committed to INR's faculty and institutional integrity. She will work with the INR faculty to build partnerships with researchers, government agencies, non-governmental organizations, the private sector, and other stakeholders in Oregon and the Pacific Northwest to integrate science and policy to reframe and address the natural resource and environmental challenges we face. Her areas of interest and experience include the human dimensions of environmental risk, environmental policy and decision-making, citizen participation, evaluation, and international transboundary waters. lisa.gaines@oregonstate.edu

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Paul Gessler is Professor of Remote Sensing and Geospatial Ecology in the College of Natural Resources, and Director of the Northwest Knowledge Network (NKN) at the University of Idaho. He received degrees in Soil Science (B.S., 1986) and Environmental Remote Sensing (M.S., 1989) from the University of Wisconsin, and a Ph.D. in environmental modeling (Ph.D., 1996) from the Australian National University. Paul's research has involved soil-landscape modeling, remote sensing, and the geospatial characterization of soil patterns and processes via projects around the world. He is currently Co-PI of the $20M NIFA Coordinated Agricultural Project on Regional Approaches to Climate Change for Pacific Northwest Agriculture; Co-PI on a NOAA Climate Impacts Research Consortium involving pacific northwest research universities; and PI on a NSF cyberinfrastructure grant enabling improved network management of research data. NKN is a research data management, high performance computing, and cyberinfrastructure support unit. Paul is active in national and international scientific organizations evolving cyberinfrastructure for research. In 2014, the University of Wisconsin honored him as a distinguished scholar of Soil Science. paulg@uidaho.edu

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Kulvinder Gill received his B.S. Honors (Agronomy, 1981) and M.S. (Plant breeding, 1983) from Punjab Agricultural University, Ludhiana before joining Kansas State University to earn his Ph.D. in Genetics in 1990. After working as a post doc and then as a senior scientist, he became an Assistant Professor at the University of Nebraska, Lincoln in 1996. In 2002 he moved to WSU as the Vogel Endowed Chair professor. Currently he is serving as a professor and Director of the Climate Resilient Wheat Innovation lab at WSU. The main focus of his research is to improve crops by optimizing and utilizing modern tools and technology. Currently his lab is focused on: 1. Understanding chromosome pairing control in polyploids and its utility in crop improvement; 2. Develop alternate dwarfing gene systems to improve abiotic stress tolerance in wheat and other cereals; 3. Improve heat tolerance in wheat; and 4. accomplish quick, efficient, precise and targeted transfer of agronomically important genes. KSGILL@wsu.edu

Jere Gilles received his Ph.D. in Development Sociology from Cornell University and his currently the Director of Graduate Studies in Rural Sociology at the University of Missouri. His work focusses on developing multi-disciplinary approaches for solving problems of food security and natural resource management. For more than 30 years his research has looked at ways of linking scientific and local knowledge systems in order to speed up the development of "useful knowledge" for family farmers and livestock producers. He has conducted research and provided technical training on these issues in Peru, Bolivia, East Africa and Morocco. Most recently he has been involved in research on the potential contribution of GM maize to small holder agriculture in South Africa and in studies of farmer adaptation to climate variability and climate risk in the Altiplano region of Bolivia and Southern Peru. gillesj@missouri.edu

Bram Govaerts works currently as Associate Director of the Global Program of Conservation Agriculture of the International Maize and Wheat Improvement Center (CIMMYT). Most recently he was recognized with the 2014 Borlaug Field Award and its application, sponsored by the Rockefeller Foundation. Govaerts developed a vision to help poor producers to increase food production inspired by the creed of Dr. Norman Borlaug, Take it to the Farmer; this vision contributed substantively to form the great initiative with the Mexican Government called Sustainable Modernization of the Traditional Agriculture MasAgro, in June 2014 assumed the leadership of the entire program as well as the responsibility of coordinating the development of similar projects in Latin-America. b.govaerts@cgiar.org

Byju N. Govindan is a postdoctoral research assistant in the biotic team of USDA NIFA-funded project Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH). His interests are on the impact of anthropogenically induced changes in the agricultural cropping systems on the population and community ecology of insects, insect-pest and multi-trophic interactions, and their implications for the systems productivity. His current research interests are development and integration of pest (insect/disease/ weed) modules into existing agricultural cropping systems decision support tool. Integrated into CropSyst, he currently uses a crop-pest (winter wheat – cereal leaf beetle) simulation model to assess the impact of biotic stressors on crop growth and productivity to explain the gap between potential and actual yield under climate change scenarios, and plan adaptation strategies for integrated pest management and inform policies on global food security. byju.ng@wsu.edu

Peter Grace is Professor of Global Change and Theme Leader, Managing for Resilient Landscapes in the Institute for Future Environments at Queensland University of Technology (QUT) in Brisbane, Australia. He holds adjunct positions at the W.K. Kellogg Biological Station (Michigan State University) and the Earth Institute at Columbia University (NY). He is an agro-ecosystems scientist specialising in soil-plant-atmosphere interactions, soil carbon and nitrogen cycling, greenhouse gas emissions and sustainable agricultural production. He was previously Lead Scientist-Climate Change for the Consultative Group for International Agricultural Research (CGIAR) under the auspices of the World Bank and FAO and has worked throughout the Americas, Asia and Africa. He is currently the coordinator of the National Agricultural Nitrous Oxide Research Program in Australia and is an expert advisor (climate change) to both the Australian and New Zealand Governments. pr.grace@qut.edu.au

Helen Greatrex is a research scientist with a background in agrometorology and in decision making under climate uncertainty. The aim of her work is to research index insurance for developing countries, particularly how different sources of information might be used in insurance design and evaluation, for example from remote sensing data, crop simulation model outputs, farmer/local expert experience, and ground measurements. A large focus of her work is on how insurance might be used to enable the scale up of agricultural interventions such as drought resistant seed. Dr Greatrex also leads the insurance component of the CASCAID CCAFS Flagship 2 project, which is examining how insurance interacts with gender dynamics in Northern Ghana. greatrex@iri.columbia.edu

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Attendees

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Isaac Madsen is Ph.D. candidate in soil science at Washington State University. His research focusses on imaging root soil interactions at the single plant scale, nutrient recycling at the field scale, and research policy at the federal scale. He has been involved in efforts to image roots in toxic environments resulting from fertilizer placement and specializes in quantifying the impacts of fertilizer placement and rate on crop plants. At the field scale he has worked to develop nitrogen balances in irrigated cropping sequences in the absence and presence of cover crops. In addition, he has worked at the interface between science, science policy, and environmental policy. isaac.madsen@email.wsu.edu

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Jeff Melkonian received an M.S. in Agronomy in 1983, and a Ph.D. in Vegetable Crops from Cornell University. He is currently a Senior Research Associate in the Soil and Crop Sciences Section of the School of Integrative Plant Sciences at Cornell University. His main research areas are application of a dynamic simulation model for tracking maize growth, and nitrogen (N) uptake, N transformations and N and water fluxes in soil/crop systems, and using both statistical modeling and process modeling to examine the impact of high temperature and soil moisture stress on maize yield and yield components under current and projected temperatures and precipitation in the major maize production areas of the U.S. jjm11@cornell.edu

David Meyers With nearly 20 years of program evaluation experience in government and industry, I've helped design and implement appropriate evaluations for many public sector agencies, including the National Science Foundation, the US Department of Agriculture, the United Nations, state government, and non-profit foundations. My consulting work in the private sector has ranged from Fortune 100 companies to bootstrapped entrepreneurships. I am currently the outside evaluator for the Regional Approaches to Climate Change in Pacific Northwest Agriculture (REACCH). I believe evaluations should help decision-makers distinguish between what works and what doesn't. In my own small way, I aspire to make the world a better place by working with clients to build trustworthy evaluations that inform important decisions. david.meyer.email@gmail.com

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Michelle Miller is Associate Director at the Center for Integrated Agricultural Systems, the sustainable agriculture research center on the University of Wisconsin-Madison campus. She works as a practicing economic anthropologist engaged in participatory research. She holds degrees from the UW in landscape architecture (emphasis: regional planning and restorative ecology), and on sustainable development (emphasis: agriculture and food). Fresh out of school, Michelle worked for World Wildlife Fund in the Great Lakes states and provinces on agricultural pollution prevention. For the last 15 years she has worked with fruit growers to assist them in their efforts to reduce pesticide risk and build regional markets. Current projects focus on agriculture of the middle and regional food economies, food transportation, supply chains, labor and land tenure, resiliency and climate change. Recent papers: "The power of story for motivating adaptive response–marshaling individual and collective initiative to create more resilient and sustainable food systems" (with Jeremy Solin) and "Metropolitan Foodsheds: A Resilient Response to the Climate Change Challenge?" (with Laura Lengnick and Gerald Marten), Journal of Environmental Studies and Sciences. mmmille6@wisc.edu

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Terry Nipp is the Vice President for Research at Agricultural and Environmental Geographic Information Systems (AEGIS, Ltd). At AEGIS, Dr. Nipp is the Project Director for an NSF supported project to develop new tools that integrate genomics and crop modelling to help plant breeders accelerate the adaptation of cereal crops to changing climatic conditions. Dr. Nipp also serves as the Executive Director of the Sun Grant Association, which provides leadership for the Grant Initiative (SGI) - a collaborative effort of the nation's agricultural colleges at land grant universities that supports bioenergy research and education. The SGI engages in research that addresses the full bioenergy production chain, from feedstock development and production, through harvest and logistics, to conversion and product development. tlnipp@ilioco.com

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William Pan is a professor of crop and soil sciences at Washington State University. Pan graduated from University of Wisconsin with a B.S. in biochemistry, plant and soil sciences, followed by an M.S. Agronomy at University of Missouri and Ph.D. in soil science at North Carolina State University. Over 31 years, Pan has focused his research, teaching, and outreach on nutrient cycling and rhizosphere ecology as it influences root development and soil management. He has taught several soils courses while employing and advising over 150 undergraduate students, while advising 30 graduate students, and serving as department chair from 2002-2008. In 2008-2009 Pan co-developed and co-coordinated dryland agronomy modules conducted in the middle East and U.S. as part of USDA funded Iraq Agriculture Revitalization Project. He currently coordinates the Washington Oilseed Cropping Systems Project and the PNW cropping system research focused on adaptation and mitigation of climate change under the USDA CAP project, REACCH. wlpan@wsu.edu

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Attendees

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Margaret Smith joined the Cornell University College of Agriculture and Life Sciences' Department of Plant Breeding and Genetics in 1987 as a maize breeder. She currently serves half time as Associate Director of the Cornell University Agricultural Experiment Station and half time doing plant breeding research and extension. Her research emphasizes breeding maize for productivity and local adaptation, improving insect and disease resistance, adapting varieties to more sustainable production systems, and breeding for organic systems. Margaret does extension education on crop varieties, seed, and plant genetic engineering. Before Cornell, Margaret worked as a plant breeder at the Tropical Agriculture Center for Research and Teaching in Turrialba, Costa Rica, and as a maize breeder at the International Maize and Wheat Improvement Center in Texcoco, Mexico. The focus of her work in both positions was on improving crop varieties for small-scale and subsistence farmers in the tropics an interest she maintains to date. She currently serves on the Subcommittee for Independent Advice of the CGIAR Research Program on Dryland Cereals. mes25@cornell.edu

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Corinne Valdivia is an Associate Professor at the University of Missouri in the Department of Agricultural Economics, Division of Applied Social Sciences. Her research focuses on understanding the mechanisms that lead to sustainable livelihood strategies, in the context of transformational changes. She leads multi-faceted projects that require collaboration across disciplines, engaging with local decision makers and stakeholders at multiple scales, in Temperate and Tropical contexts. Dr. Valdivia has received several awards, most recently the inaugural Brady J. Deaton Fellow in International Agriculture. She is a member of several international associations, such as the International Association of Agricultural Economics, the Association for International Agriculture and Rural Development, and the Agricultural and Applied Economics Association. valdiviac@missouri.edu

Gerard W. Wall is a global climate change scientist with USDA-ARS. He received degrees from SUNY at Stony Brook (B.S., 1979) and Kansas State University (M.S., 1982; Ph.D., 1986). He has lead research groups in multidisciplinary broad-based investigations on the response of agronomic crops to ambient and enriched CO_2 and O_3 (Free-air CO_2 Enrichment [FACE]), and natural and artificially imposed thermal regimes (Temperature Free-air Controlled Enhancement [T-FACE]). His work has focused on thermal tolerance of crops to biotic and abiotic stresses. He has demonstrated versatility in both experimental work and in the development of physiological-based algorithms designed to simulate plant response to global change. He has contributed experimentally derived data sets, which are routinely utilized by international crop growth modeling consortia such as AgMIP, GCTE-IGBP, GRACEnet and ICASA. gary.wall@ars.usda.gov

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Anthony Whitbread is the Director of the Resilient Dryland Systems Program, ICRISAT, since 2014. This team of 30+ scientists, work with smallholder farming communities across south Asia and sub-Saharan Africa in a research for development mode to better manage climatic risk, soil fertility and identify market led innovation. This role was preceded by a 20 year research career - after earning a Ph.D. from UNE, Armidale in 1997 Anthony worked for CSIRO in the crop-livestock systems of semiarid Australia and Africa. In 2011 he became Professor of Crop Production Systems in the Tropics at the Georg-August-Universität in Göttingen, Germany- a continuing role. His work has been recognised with the 2014 CSIRO medal for 'Impact from Science' for having profound impact on the adoption of water use efficient practices in the Australian Grains Industry. He has authored more than 50 journal articles and book chapters and many conference and industry publications. a.whitbread@cgiar.org

Jeff White joined USDA in 2003 and is a research plant physiologist with the US Arid Land Agricultural Research Center in Maricopa, AZ. His research concerns crop adaptation to climate change and uncertainty with emphasis on genetic adaptation to heat and drought. He uses ecophysiological models to test hypotheses related to crop responses and to assess potential impacts of climate on productivity. Recognizing that access to high quality data is essential for model evaluation and improvement, he is a strong proponent of efforts to improve management of research data sets via data standards and supporting software tools and to strengthen field research via proximal sensing. Previous to coming to USDA, Dr. White worked over 20 years variously at CIMMYT, CIAT and CIP (the International Potato Center). jeffrey.white@ars.usda.gov

Attendees

J.D. Wulfhorst works as a rural sociologist conducting research on integrated projects focusing on natural resources management and agricultural landscape challenges in the western United States. His research emphasis areas have covered nuclear waste management, water resources, rangelands conflicts, and conservation adoption in large-scale agricultural settings. As a social scientist within the REACCH project in the Pacific Northwest, he has conducted data collection and analysis among producers and stakeholders about their perceptions of impact and expected behaviors as the region adjusts to climate change effects. jd@uidaho.edu

Liujun Xiao is a first-year Ph.D. student in Nanjing Agricultural University. He is the class leader of National Engineering and Technology Center for Information Agriculture. His major is agricultural informatics and his works mainly on agronomy/crop modeling under extreme weather events. He has completed all the courses of Ph.D., and the weighted average score is 91.41. He is skillful in R language and application of different models, including DSSAT-wheat, APSIM-wheat and Wheat-grow. Currently, he is writing a paper about cold stress and yield impact in winter wheat of China. 291468254@qq.com

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Lewis Ziska is a Plant Physiologist with the USDA's Agricultural Research Service in Beltsville, Maryland. After graduating from the University of California, Davis, he began his career as a Smithsonian fellow, and then took up residence as the Project Leader for global climate change at the International Rice Research Institute in the Philippines before joining USDA. Since joining USDA, Dr. Ziska has published over 100 peer-reviewed research articles related to climate change and rising carbon dioxide that address: (1) Agriculture and Food Security; (2) Weeds and weed management; (3) Invasive species; (4) Plant biology and public health. l.ziska@ars.usda.gov

Speaker Abstracts

Speaker	Title	Abstract
Aggarwal, Pramod	Adapting to increasing climatic risks in South Asian agriculture: Oppotunities and constraints	Agriculture and food security in South Asia have always been affected by climatic risks. IPCC reports and other studies predict increased probability of extreme weather events in the region, leading to greater instability in food production and threatening livelihood security of millions of farmers. Many studies indicate a probability of 10-40% loss in crop production in India and South Asia by 2070-2100 unless steps are taken to increase our adaptive capacity. Several technological, institutional and policy interventions can help South Asia adapt to climate change and to current and future weather variability. Adaptation strategies include modifying planting dates, bridging yield gaps, deploying adverse climate tolerant genotypes and diversified land use systems, using solar irrigation, assisting farmers by providing value-added advisory services and crop/weather insurance, and improving land and water use policies. Most of the proposed adaptation options, if implemented scientifically, also have mitigation co-benefits. CCAFS is scaling out the Climate-Smart Villages (CSVs) model in South Asia to promote climate-smart agriculture (CSA). Climate Smart Villages are sites where a portfolio of the most appropriate technological and institutional interventions, determined by the local community, are implemented to increase food production, enhance adaptive capacity and reduce emissions. A critical analysis of recent data indicates that these strategies have reduced the impact of rainfall deficits and temperature increases on an aggregated scale, although significant problems persist at local/sub-national levels. While most of these interventions have shown increased production, resilience and even mitigation, efforts are needed to increase their coverage. This requires understanding the adaptation domains of CSA practices, their linkages with demand and supply of food grains, and appropriate 'business models' to scale them out. Efforts are simultaneously needed to address the complex problems of widespread poverty, poor governance, weak institutions, and human capital to realize the full potential of CSA practices.
Antle, John	Assessing how agronomic and economic adaptations affect vulnerability to climate change	Adaptation to climate change can occur through both agronomic and economic changes in management and other factors that affect agricultural system performance. This presentation introduces a framework for adaptation and vulnerability assessment that shows how both bio-physical and economic adaptations can be incorporated. Examples from REACCH and AgMIP studies in the U.S. and Africa will be presented.
Aubinet, Marc	Is eddy covariance a suitable tool to establish greenhouse gas balance of cereals?	Eddy covariance is a tool that allows trace gas exchanges (water vapor, carbon dioxide, methane, nitrous oxide, VOCs) between terrestrial ecosystems and atmosphere to be measured. The method provides measurement with a high time resolution (half hourly) and for long periods (several years). This makes it a relevant tool to study greenhouse gas exchanges by cereals and to establish their carbon balance. We took example from our experiments developed at the Lonzée Terrestrial Observatory (Belgium), where an eddy covariance system installed since 2004 above a crop rotation provided continuously measurements of carbon dioxide exchanges, allowing the establishment of the carbon budget of a five year rotation (two years of winter wheat, potato, sugar beet). In addition, the method allowed evaluation of the impacts of climate and of cultural activities on the CO2 exchanges.
Barton, Louise, D. V. Murphy and K. Butterbach-Bahl	Nitrous oxide fluxes from cropping soils in a semiarid region in Australia: A 10 year perspective	Western Australia's wheatbelt includes 7 million hectares of arable land producing up to 40% of Australia's grain exports. The region has a semiarid climate with winter-dominant rainfall and hot, dry summers; also described as a Mediterranean-type climate. Cropping is confined to the winter months with soils fallow at other times of the year. The soils are derived from highly weathered materials, generally coarse-textured, and low in soil organic carbon (SOC) and nutrients. Nitrogen fertilizer (mainly urea; up to 100 kg N ha^{-1} per year) is applied as split applications at seeding and during the growing season depending on crop requirements. Ten years of *in situ* measurements from various sites have confirmed nitrous oxide (N_2O) fluxes are small (0.04–0.27 kg N ha^{-1} yr^{-1}) and represent <0.12% of applied N fertilizer. Including grain legumes in cropping rotations has not enhanced soil N_2O fluxes in the growing season or post-harvest. Increasing SOC elevated soil N_2O fluxes, but losses represented <0.12% of the N fertilizer applied. Developing strategies for mitigating N_2O fluxes from cropping soils in our region is challenging as losses occur post-harvest, when there is no active plant growth, and in response to summer rainfall rather than N fertiliser additions. Strategies that control soil N supply from nitrification following soil wetting, or immobilise excess inorganic N via soil microbial or plant uptake, would be expected to decrease the availability of N for subsequent N_2O losses. We have demonstrated that increasing the efficiency of the nitrification process, by increasing soil pH (via liming), can decrease N O fluxes from sandy, acidic soils following summer rain. Accurately accounting for N_2O fluxes in our region has refined Australia's national greenhouse gas inventory and demonstrated that on-farm greenhouse gas emissions represent a low proportion of the total emissions from grain production.

Speaker	Title	Abstract
Bartuska, Ann M.	A sustainable approach to climate-adapted agricultural production	At the United States Department of Agriculture (USDA), much of our work is focused on finding solutions to the unprecedented challenges facing the global food and agricultural system. These challenges include producing enough safe and nutritious food for a growing population, adapting to a changing climate, building the bioeconomy, and conserving our natural resources. We recognize that healthy and safe food and water depend on healthy and safe agriculture and natural resources. Agriculture and natural resources are at the crossroads of the world's most critical problems. The food system in the United States is critical infrastructure and relies on climate-adapted agricultural production. The increased extreme weather events in the U.S. have forced farmers to actively attempt to grow crops under hotter, drier climate regimes and protect their crops from damage during extreme weather events. Farmers are dealing with seasonal changes in precipitation; increased variation in temperature and precipitation; both among and within years; changes in weather patterns in season; and an increase in temperature and precipitation extremes. Our approach to dealing with the complexities of a sustainable food and agriculture system recognizes investments need to be made in new and emerging technologies, and promotes open access to data even while accelerating efforts in animal and plant genomics. All of this must be done at a global scale, even as we enhance our domestic efforts. Matching global monitoring of agriculture (e.g. GEOGLAM) and linking to agricultural productivity models that incorporate climate change response (e.g. AgMIP) are important tools for accomplishing our objectives. USDA continues to make great strides in understanding the effects of climate on agriculture and developing climate-smart agricultural varieties and practices. The Department's scientific research and technology investments directly support sustainable intensification, or what some call the 'triple win concept' of increasing productivity and maintaining resilience, while achieving mitigation.
Calderini, Daniel, D.J. Miralles, A. del Pozo, G. García	Climate change and cereal cropping systems of South America: The sensitivity and adaptation of cereals in the sub-continent	In South America, cereals such as maize (97.2 M t y-1), rice (24.3 M t y-1), wheat (21.1 M t y-1) and barley (4.3 M t y-1) are key crops for food and feed uses. This subcontinent has huge variability through agroecosystems, from the tropics to cold areas and from very productive to bare soils. This complexity means that the climate change will affect the cereals cropping systems in different ways. Present scenarios estimate the temperature increase between 1 and 4°C for 2050 in South America; however, changes of 4-4.5°C are expected, for example, in maize areas of Brazil. The forecast accuracy of rainfall is affected by the influence of El Niño SO in South America. Remarkably, contrasting rainfall scenarios were predicted for bordering countries like Chile and Argentina since decreasing rainfall is expected for Central-South Chile, while western semiarid Argentina will be beneficiated by higher rainfall. Consequently, cereal systems of Chile started to move southern and the wheat sowing area of semiarid Argentina increased. Several studies highlighted the negative impact of climate change on cereals but positive impacts are also expected, even in summer crops regarding that maize yield would increase 30% or more in some temperate/cool areas. The main effect of higher temperature on C3 cereals will be the shortening of the crop cycle without impact on either interception efficiency (k) or RUE. On the other hand, higher environmental CO_2 concentration could balance the negative impact of temperature (improving WUE under water shortage); however, the trade-off between temperature and CO_2 could be over-compensated by temperature in environments of South America. A key for assessing the impact of climate change on cereal cropping systems will be the differential sensitivity of the crop phenophases and the management strategies to mitigate the climate change conditions, e.g., grain setting and grain filling.
Craufurd, Peter and Kindie Tesfaye	Global challenges and opportunities for adaptation of cereal systems in sub-Saharan Africa	The IPCC has concluded that the mean annual temperature has increased over Africa and that further increases are very likely. Changes in current rainfall patterns are less clear, but consensus projections indicate that all regions will be wetter, except for southern Africa where a drying trend is anticipated. Increased frequency and severity of extreme climatic events such as severe storms, flooding and droughts are also very likely. Maize, sorghum, millet, wheat and rice are all important cereals in SSA, with maize being the dominant food security crop. Meta-analyses suggest that cereal yields, with the exception of rice, will decline by 5-20% on average by 2050 with regional and mega-environment differences. The risk of hunger is likely to increase significantly in East and Southern Africa where calorie consumption is low. Maize for example, which makes up 70% of the cited IPCC studies, is predicted to show positive to neutral impacts in high and upper mid-altitude mega-environments, as well as negative impacts in dry mid-altitude and lowland environments. Areas suitable for production are also likely to change, with some gains but more losses. Simulation studies also suggest that maize losses will be higher at higher nitrogen rates. In terms of adaptation, both short and longer duration varieties will be needed. For example, in the savannas of West Africa, local photoperiod-sensitive varieties will fare better than improved varieties. In maize and rice, where heat stress at flowering is a major threat, heat tolerant lines have been identified. Drought tolerant lines have also been identified and are being released and transgenes are ready for testing. The fact remains, however, that in SSA adaptation is, and will likely continue to be, affected by policy and institutional options that limit access to technological innovations.

Speaker	Title	Abstract
Devare, Medha	Overview of CGIAR's Open Access, Open Data efforts	In its first phase (2015), CGIAR's Open Access and Open Data initiative focuses on assessing current Open Access/Open Data (OA/OD) resources, practices, and needs across Centers, strengthening collaboration and coordination around tools and approaches within CGIAR and external communities, developing a framework for prioritizing data to be initially made open, and for impact assessment. The second phase envisioned for 2016 and 2017 will build on this work to render CGIAR outputs standards-based and interoperable, and ensure that they are discoverable and accessible via integrated and contextualized views across Centers and CRPs, type (e.g., publications, data, etc.), and discipline (e.g., genetic/genomic; agronomy; breeding; natural resource management; socioeconomic; geospatial, and other sectors). Most Center repositories represent silos whose contents are not generally easily discoverable or inter-linked where appropriate and useful (e.g., agronomic trial data with socioeconomic or adoption data in the same geography). In the absence of such interoperability-mediated discovery, "open" is of very limited utility. The overall objective, then, is to make CGIAR's trove of research data and associated information completely accessible for indexing and interlinking by a robust, demand-driven cyberinfrastructure for agriculture, ensuring that research outputs are open via FAIR principles – that is, Findable, Accessible, Interoperable and Re-usable to enhance innovation, impact, and uptake. Creating a strong data-sharing culture, addressing data quality issues through interventions throughout the data life cycle, and developing the technical infrastructure to enable this goal are key focus areas for CGIAR's OA/OD activities in the immediate future. This talk will provide an overview of the status quo and planning for the next phase of OA/OD across CGIAR.
Dzale, Esther Yeumo Kabore	Wheat data management and sharing guidelines	The Wheat Initiative (WI) (www.wheatinitiative.org) aims to reinforce synergies between bread and durum wheat international research programs to increase food security, nutritional value and safety, taking into account societal demands for sustainable and resilient agricultural production systems. In 2012, the WI conducted a survey highlighting the wide diversity of wheat-related data formats and the lack of standardization. Research on wheat can and must make optimum use of currently available data to feed the growing global population. Increased computing power allows for more sophisticated analyses with 'mega databases". The Wheat Data Interoperability (WDI) working group, within the umbrella of the WI, was endorsed by the Research Data Alliance (RDA) in 2014. The 15 active members include wheat scientists, data and metadata technologists from national and international organizations: CIMMYT, CSIRO, INRA, FAO, IRD, Bioversity, ACPFG, Planteome, Agro-Know.

The WDI aims at building common framework to foster the reuse and interoperability of wheat data. The WDI use the EIF definition: An interoperability framework is an agreed approach to interoperability for organizations that wish to work together towards the joint delivery of public services. Within its scope of applicability, it specifies a set of common elements such as vocabulary, concepts, principles, policies, guidelines, recommendations, standards, specifications and practices.

The deliverables include: recommendations on data exchange formats; data description best practices (consistent use of vocabularies, consistent use of external database cross references, etc.); and data sharing best practices. The WDI portal gathers wheat-related vocabularies and ontologies and makes them accessible through APIs. The expected benefits are: bioinformaticians and data managers who will find relevant information on existing data and metadata standards, avoiding duplicating efforts; and integrated wheat information systems using computation and modelling tool designers who will be able to easily discover access, interpret, aggregate, and analyze data from different sources. |
| Fitch, Peter, Simon Cox, Peter Lemon, and John Kirkegaard | Agricultural information supply chains: Drivers and directions | Interest in better use of agricultural information is exploding. The drivers for this explosion are many and varied and include technological drivers such as improvement to computers, sensors, smartphones, emergence of the cloud, better analytics and so on. At the same time there is pressing need for enterprises to be more productive, more profitable, look after the land and water resources used for production, whilst becoming more resilient to a changing climate and to resilient to market shocks.

Opportunities for use of information abound, the information age is finally making its presence felt in agriculture. On many farms today crop yield information is automatically and routinely collected and stored on the cloud. It is combined with other information such as soil nutrient and climate forecasts and a range of management products are created, which can be downloaded directly to the enterprise for use. A custom prescription for your farm can be quickly generated and used, resulting in significant on-farm benefits.

This talk reviews the current ways in which agricultural information is transferred, accessed and shared across the agricultural information landscape. We identify that one major issue is that often this data is commercially sensitive and needs to be managed accordingly. We also identify the need for open standards and interfaces to access and use data and identify where work in other domains such as water, can be helpful. |
| Fixen, Paul | Nutrient use analytics for climate-adaptable nutrient management strategies | Management of cropping systems under changing climatic conditions will likely benefit from evidence-based approaches to input decisions and the assessment of system performance. In the case of nutrient management, nutrient use analytics have a key role to play in guiding decisions concerning nutrient stewardship and system performance. Meaningful nutrient use analytics cannot be limited to efficiency measurements, but must include assessment of the effectiveness of nutrient use in obtaining intended outcomes. Scalability is highly desirable where the same metric can be applied at an individual field or farm scale as well as at a watershed, state or national scale. Many exciting new technologies and decision support tools are entering the agricultural scene that can enable the kind of site-specific management that will be essential for proper response to changing climatic conditions and inform farmers about nutrient source, rate, time, and place decisions. Scalable performance metrics can facilitate adoption of these technologies by farmers and offer science-based guidance to policy makers in developing programs to accelerate that adoption. |

Speaker	Title	Abstract
Garrett, Karen	Managing disease in cereal systems	The risk of crop losses to disease is strongly tied to weather, so climate and climate change are key risk factors. Crop breeding for resistance to pathogens and herbivores is one of the most important tools for adaptation to climate change, and breeding strategies also must address climatic variability. Impact network analysis (INA) is a framework for evaluating information and technology impacts through linked socioeconomic and biophysical networks, identifying system strengths and vulnerabilities. It can be used to assess the likely or realized impacts of strategies for adaptation to climate change and climate variability. Two key examples of such impact networks are system-level management of new invasive diseases, and crop breeding networks that determine how limited pools of disease resistance genes are deployed across landscapes.
Garrett, Karen	Agricultural systems that enhance translation	Participatory research offers the potential for improved system outcomes, such as resistant varieties and other IPM strategies better matched to stakeholder needs. Including a participatory research component generally requires additional investment, so it is useful to know under what circumstances the investment is rewarded and how participatory research can be optimized. Impact network analysis (INA; introduced in abstract above) provides a framework for evaluating the likely benefit of including participatory system components. Key factors determining the effects of including a participatory component include the degree of farm heterogeneity, the effects of which can be better understood through wider participation, and the degree of mismatch between the perceived priorities of farmers and scientists. Optimization strategies can be devised to efficiently address these factors.
Gessler, Paul, E. Seamon, E. Flathers, S. Eigenbrode, C. Stöckle, L. Sheneman, and D. Vollmer, D. Huggins	Evolving an architecture for agricultural research data management in the US Pacific Northwest	The Pacific Northwest of the US has an estimated $US 21 billion agricultural sector critical to the economic well-being of the region. The USDA NIFA funded Regional Approaches to Climate Change for Pacific Northwest Agriculture project (REACCH) has stimulated the development of a research data management framework to store and enable interactive analysis of data from regional land grant universities, state experiment stations, and USDA ARS research units. REACCH contributes to a growing number of research data sets managed collaboratively by the Northwest Knowledge Network, which further provides support systems and applications, as well as connections and interoperability with other national and international research data management efforts. These data and systems, collectively, represent critical assets accumulated from funded research and a wealth of information for understanding potential changes and impacts to agriculture and society in the region. They also serve as the basis for new science based on data exploration, analytics, and data mining using these multi-disciplinary and multi-scale spatiotemporal data. This talk will overview the development of this network of resources and data along with the cyberinfrastructure, data policies and funding mechanisms aimed at sustaining access to these critical data assets. The ongoing development of new data interoperability techniques and analytical methods requires that our systems continually evolve to take advantage of new portal capabilities, data collection technologies, and analytical techniques that can operate over a diverse set of distributed data repositories. We will also discuss ongoing efforts for the establishment of a national agricultural data management network as well as other initiatives that are providing alternatives for data access and analysis.
Govarets, Bram	Increasing productivity in rain fed, semiarid systems by analyzing and remediating limiting factors	In semiarid, rain fed production systems, water is the principal factor limiting crop productivity. To achieve sustainable intensification in these systems, innovation systems approaches have to support the development of innovations that optimize rainfall use efficiency to cope with both heavy rainfall events and prolonged drought. Optimizing rainfall use efficiency will make it possible to further increase productivity by addressing other limiting factors in the system like nutrient deficiencies. The presentation will show examples from long-term experiments and component technology trials with maize and wheat in the Mexican highlands that evaluate conservation agriculture and fertilization to sustainably increase productivity. Conservation agriculture is based on minimizing soil movement, crop rotation and retaining permanent soil cover through crop residues or cover crops, and has been shown to improve soil quality. In the studied long-term experiments conservation agriculture especially increased soil physical quality compared to conventional practices involving tillage, and zero tillage with residue removal. Improved parameters include soil aggregate stability, direct infiltration and soil water content during dry periods. Conservation agriculture also increased yield compared to conventional practices, and more so in more diverse crop rotations. We compared the application of N fertilizer at different moments to a zero N application control under conservation agriculture and conventional tillage. Under conventional tillage, yields were low and similar with and without N fertilizer application, whereas with conservation agriculture yields were higher than in the conventional practice without N fertilizer, and there was an additional yield increase with fertilizer application. The results show that conservation agriculture should be the base for sustainable intensification of rain fed semiarid cereal systems, in order to fully seize the benefits of other technologies such as optimized fertilization. In order to reflect these scientific insights, innovation systems approaches will connect the scientific knowledge with farmer innovation while fostering multi-sectorial public private partnerships.

Speaker	Title	Abstract
Grace, Peter	Optimizing yield and reducing greenhouse gas emissions for resilient cropping systems in rain fed semiarid environments	The paucity of greenhouse gas emissions data that exists in semiarid climates makes it difficult to outline generalized agronomic and economic decisions which maximize crop productivity and at the same time provide significant mitigation potential. The value of traditional site specific agronomy trials in combination with greenhouse gas monitoring can be greatly enhanced through the use of simulation models which combine soil, crop and atmospheric processes. Data from a high temporal resolution automated global greenhouse gas monitoring network with multiple treatments focusing on N2O reduction has been used with a selection of simulation models to develop robust mitigation strategies which take into account nitrogen management, crop rotations and climate variability. These examples provide confidence in the ability of simulation models to develop regional strategies for improved food security and reducing greenhouse gas emissions.
Greatrex, Helene D.E.O. Osgood, J. Hellin, J.W. Hansen	The role of index insurance in semiarid cereal systems	There are many solutions posed to the challenges facing cereal farmers in semiarid regions, not least new varieties of seed and/or alternative management practices. However, the risk of severe drought or another climate shock can limit the uptake of these innovations. The risk of loss in a 'bad year' is often too great for a farmer to be able to invest in an otherwise productive opportunity. Weather based index insurance and other financial tools have recently been promoted as a way to help farmers manage their climate risk, and subsequently, to invest in inputs and technology that can increase their yields and income. For example, insurance has been shown to be useful in enabling farmers to access credit to purchase improved seed and other inputs, or to cover specific components of risk that existing safety nets cannot cover. There are now many insurance programs active in the world, some operating as pilots and some reaching thousands, or millions of farmers. This talk examines some of the features that an index insurance program might need in order to scale and the multiple roles agronomists and other actors can play in this process. It also reports on new research in insurance design and delivery, utilising tools such as crop simulation models, livelihood mapping and economic research games.
Han, Xue; Erda Lin, Wei Xiong	New findings for climate change and food security in China	After the releases of IPCC AR5 and China Second National Assessment Report for Climate Change, some suggestions were proposed based on new findings for food security. Warming was notable since 1980 in China, coinciding with widespread yield stagnation. Warming has been blamed as a driver for past yield stagnation, but the effects of warming largely cancelled out in different latitudes showing a small net effect of warming on China's food production. Increased pollution was another important player for reducing crop yields over past decades. Adaptation to warming could improve food production, and still had huge potential impacts. A large potential exits for production, if climate-smart agriculture is applied. To answer whether China's food production can deal with a 2°C warming world, a current assessment suggests a 2°C warming has limited effects (less 5%, even without CO_2 effect) on China's total food production. Current adaptation can utilize this small warming and turns it with more inputs with as there may be more opportunities to increase production but uncertain picture under a 4°C warming. Water could be one big barrier for future food production. More concerns will be focused on international food trade trends.
Hatfield, Jerry L.	Cereal production systems in North America: Challenges for effective adaptation	Cereal production in North America is located primarily in rain fed climates and show large variation in production among years due to soil water availability. Adaptation to an increasing variability in precipitation during the year requires increasing attention to water management to meet crop water demands. Effective adaptation strategies will have to include quantifying the risk to the potential exposure to extreme temperatures and variable precipitation regimes. Cereal production can be enhanced through linking climate adaptation with improved genetic resources and agronomic management.
Herren, Hans R.	How to transition cereal systems from problem to solution to the climate change challenge	Cereal based systems worldwide are of crucial importance to food and nutrition security on a global scale. Their importance however in the contribution to Climate Change has grown exponentially, not only with greater surfaces, but also because of the farming practices that accompanied their global spread. To over reliance on a growing amount of cereal commodities of a fewer number of species and genetic diversity in all cereal producing areas has led to a number of challenges that need to be addressed urgently, at the root causes, should we tackle the multiple challenges posed by this steady move towards simplified and reductionistic systems. There are many great solutions to many of the challenges as we will see and hear about in this symposium. The main issue will be to give a close look at how to implement these solutions respecting the need to address the three dimensions of sustainable development, the environment, society and economy. The trend to simplify and increase the efficiency in the production process has left a trail of problems that a world which has moved beyond many off the planetary boundaries can no longer afford. The vital ecosystem services, upon which our production bases depends, has been replaced by unsustainable, subsidy fueled business options and a reversal of this trend is an urgent necessity to assure the medium and long term production of food, feed and fiber. One will note the absence of the word energy, that is with purpose. As main mechanism to induce and carry out a full transformation, at global scale, of cereal systems, and the linked consumption patterns that have been fueling the present unsustainable production pathways, full cost accounting is seen as the best leverage point. Time is now to introduce regenerative, agroecological agriculture practices across the board, and without delays, the ice is melting, the seas are rising; climate change is knocking at the door, to ignore it would at best be irresponsible, at worst criminal. We have truly sustainable solutions, we have choices, lets make the correct ones, now.

Speaker	Title	Abstract
Jones, James W.; C. E. Vallejos, Melanie Correll, Salvador Gezan, Cheryl Porter, Chris Hwang, and Kenneth J. Boote,	Improving models and data for developing pathways for cropping system adaption to climate change	Cropping system models are widely used to study climate change impacts and adaptation of cropping systems globally. However, a number of studies have recently shown considerable uncertainty in current crop models relative to their abilities to simulate production when they are carefully compared with each other, and these uncertainties increase under high CO_2 levels and high temperatures. These studies, conducted by contributors to the Agricultural Model Intercomparison and Improvement Project (AgMIP), clearly point out that model improvements are needed to increase their effectiveness in research on transitioning crop production to adapt to climate change. We discuss two critical areas in which the agricultural science community must advance in order to achieve the next generation of models for these purposes. The first critical area involves developing a culture for preserving research data over time and space and tools for harmonizing data so that anyone wanting to evaluate or improve models will have access to data from varying environments and management systems. Existing crop models have been developed by using data from only a few environments and few cultivars. Another critical area is a need to better represent the genetic diversity of crop responses to environment and management factors. This is needed to enable virtual research with crop and economic models to estimate the combinations of genotypes and management that best fit within current and future climate conditions. In this paper, the authors will describe recent developments in gene-based modeling of cropping systems that are needed for next generation crop models and an approach for harmonizing typically-collected data in crop research trials that promises to considerably increase data discovery, access, and use by models and other quantitative analysis methods.
Khan, Zeyaur	The 'Push-Pull' farming system: Climate-smart sustainable agriculture for cereal-livestock production in Africa	The climate-smart 'push-pull' system (www.push-pull.net) effectively controls serious biotic constraints to cereal production in Africa (insect (stemborers) and striga weed) while improving soil health and biodiversity. The companion cropping system makes smallholder farms more resilient often with a tripling of yields. It involves attracting stemborers with trap plants (pull) whilst driving them away from the main crop using a repellent intercrop (push). Chemicals released by intercrop roots induce abortive germination of the noxious parasitic striga weed. The companion plants provide high value animal fodder, facilitating milk production. Furthermore, soil fertility is improved due to the nitrogen fixing intercrop and soil degradation is prevented. To date climate-smart push-pull has been adopted by over 42,000 smallholder farmers in eastern Africa.
Kirkegaard, John A., James R. Hunt, Julianne M. Lilley, Susan J. Sprague, Lindsay W. Bell, Clive A. Kirkby, Mark B. Peoples, Andrew L. Fletcher, Therese M. McBeath, Rick Llewellyn	Innovations in Australian mixed cropping systems under climate change	Australia's broad-acre cropping occurs in mixed crop-livestock enterprises with phases of wheat-based cropping sequences rotated with legume-based pastures grazed by sheep. The biophysical and economic elements of such "ley-farming" systems have been considered some of the most sustainable worldwide. The recent intensification of cropping systems at the expense of pasture area has involved a 50% reduction in sheep numbers and an intensification of cropping under no-till farming systems, with the inclusion of oilseed (canola) and grain legume break crops. Changes in climate are already evident with drier autumn planting periods, more variable rainfall and warmer temperatures and changes in the occurrence and severity of damaging frosts. Despite these challenges, new cropping system innovations and flexible crop-livestock options are maintaining crop productivity increases with a focus on system water-use efficiency and management of risk. Recent national research initiatives on whole-farm water-use efficiency, integration of dual-purpose (grain-graze) crops, strategic tillage, increased adoption of break crops, inclusion of perennial plants and consideration of intercropping have all addressed aspects of system resilience. Features of the research that improve the likelihood of adoption include the use of crop and whole-farm simulation in the analysis of risk, and the close interaction between growers and researchers in local field-based research to embed social and economic imperatives from the outset. We discuss recent research highlights and whole-of-system synergies that generate significant improvements in resource-use efficiency and productivity in the face of this farming system evolution and a changing climate.
Lemke, Reynald	Constraining soil-emitted GHGs from crop production on the Canadian semiarid prairies	Agricultural soils are a significant contributor to anthropogenic greenhouse gas emissions and approaches to reduce these emissions must be identified. Concurrently, the human population's food requirement is projected to double from present levels by 2050. Consequently there is an urgent need to identify cropping practices that will not only improve yields but also minimize GHG emissions. The first step towards addressing these seemingly mutually exclusive requirements is to ensure a clear understanding of the sources, sinks and drivers of the greenhouse gas emissions associated with crop production. The preponderance of greenhouse gas research on the Canadian prairies has focussed on spring seeded wheat (Triticum aestivum); however the selection of crops grown by producers in this region has expanded remarkably in recent years. This paper will provide a brief overview of the current state of understanding of greenhouse gas emissions from the Canadian semiarid prairies and then present data generated from recent studies targeted towards understanding the impact of more diverse crop sequences on soil-emitted greenhouse gases. An evaluation of these cropping systems based on yield-scaled metrics will be considered, as well as discussion regarding how the information may point towards potential opportunities to constrain emissions from cropping systems in the region.

Speaker	Title	Abstract
Liebig, Mark	Greenhouse gas mitigation potential of dryland cropping systems in the U.S. Great Plains	The U.S. Great Plains contain significant expanses of agricultural land dedicated to dryland cropping. Dryland cropping systems in the region that sequester soil organic carbon (SOC) and minimize nitrous oxide (N_2O) emissions can serve to reduce the greenhouse gas (GHG) balance of U.S. agriculture. This presentation will summarize effects of dryland cropping on SOC dynamics and N_2O flux in the U.S. Great Plains, and discuss outcomes in the context of anticipated climate change. Among cropping practices, continuous cropping combined with no-tillage management appears most effective at sequestering SOC. Accrual of SOC in these systems has accompanying benefits to agroecosystem performance through increased crop productivity and improved soil quality. Assessments of N_2O flux in the region are limited, but suggest low-to-moderate emission rates under most cropping systems. Anticipated changes in climate are projected to vary considerably across the region, making blanket recommendations for GHG mitigation difficult. Projections suggest adaptive, multifaceted management approaches will be needed to minimize the GHG footprint of dryland cropping systems in the U.S. Great Plains.
Lobell, David	An 80/20 approach to climate change adaptation in cereal systems	Much of what is required to improve cereal systems in the face of climate change are the same things that we'd need even if the climate was not changing. These include general needs such as robust breeding and agronomy research capacity, and more specific needs such as improved drought tolerance. Thus, a large fraction (say, 80%) of "adaptation" resources aimed at improving agriculture should focus on these things, as they often represent the most cost-effective investment strategies. At the same time, climate change opens up some unique risks and opportunities -- things we could safely ignore if the climate was not changing. Effective adaptation involves not pitting old needs vs. new needs, but rather identifying the right investments to make in each category. One way to achieve this balance is to focus modeling and experimental work on identifying investments that have significantly higher or lower value in future vs. current climate. Some examples of this type of work will be presented.
Macfadyen, Sarina	From impact assessment to climate change adaptation: What do we need to know for invertebrate pest management in grains	Extensive research has shown that climate change will have a range of direct and indirect impacts on invertebrate pests of broad-acre crops. However, much less attention has been placed on translating these likely changes in pest outbreak risk into practical management options for growers. Using climate change projections for major pests of Australian grain production systems as a case study I will highlight areas for future research that will provide knowledge that will lead to improved management in the short-term, but also facilitate adaption to climate change in the long-term.
McCarl, Bruce	What we know about public and private adaptation strategies	McCarl will draw on IPCC reports and his work to identify possible adaptation strategies, and who might implement them, including arguments about public goods and a needed public role. He will also review findings on what adaptations have been observed and the relative value of multiple actions.
Motavalli, Peter	Perceptions and management of soil quality: A translational approach	Development of sustainable land use practices and systems are urgently required because of widespread soil degradation from poor land use practices and the negative effects of climate change in some regions. Soil quality has been described conceptually as an assessment of the soil's capacity to support a particular function, such as serving as a medium for plant growth, and scientific approaches, such as the soil management assessment framework, have been developed for soil quality evaluation. In this presentation, the importance of assessing local perceptions of soil quality and community feedback on appropriate soil quality indicators and tests in the development, adoption and monitoring of sustainable land use practices and systems will be addressed.
O'Leary, Garry J., and David J. Connor	Adapting cereal cropping systems to a changing climate in Australia	Since the introduction of mechanization crop production in Australia has undergone significant adaptation resulting in increased productivity. This adaptation exceeds what could be attributed to changing climate over the last 100 years. The early analyses of the historical climate in Australia reveal high variability with extended wet and dry periods. Lack of water is the major limitation to productivity. Despite these serious challenges Australian agriculture remains efficient and productive and the idea that cropping systems will need continuing adaptation to climate change, as well as to technology and prices, is not new. According to climate change projections, typical declines without adaptation by 2030 are estimated at around 8% for wheat in the temperate south and over 12% for sugarcane in the sub-tropical and tropical north. Beyond 2030 greater losses around 12% are projected for wheat. FACE experiments and other studies show that such losses might easily be compensated by the greater atmospheric CO_2 concentration in some locations, but additional uncertainty is introduced because of lower grain quality and the yet-to-be-established response of crops to higher temperatures. The technical solutions will involve closer monitoring of soil water, water conservation strategies and multiple sowing times using different crops to reduce risks. The management of pests and disease will be an added burden especially in higher rainfall areas. Advancement will be incremental, always with the aim of increasing productivity and/or efficiency. Technical solutions alone are, however, insufficient to affect a sustained adaptation to significantly different environments. Social, economic and regulatory constraints will also determine the course of adaptation and these will require careful consideration and implementation. We argue that crop production can be increased for an increasing world population in the face of climate change but do not underestimate the challenge and the need for wide participation from farmers, society and government.

Speaker	Title	Abstract
Pan, William	Flexible cropping system design is required for climate and social change and fluctuation	Climate change forecasts stress long term, trending changes in mean precipitation and temperatures, while not being as capable of predicting the degree of annual and seasonal fluctuations. Similarly, there are long term trends in markets of farm inputs and products, but also seasonal and annual fluctuations governing these markets. Farmers flexibly react to these fluctuations to make cropping system adjustments on-the-go. Designs of future systems will require general frameworks for design, but they will also require an integration of flexibility components that will allow these real-time adjustments. A few examples of potential flexible systems in the Inland Pacific Northwestern U.S. will be discussed.
Pulwarty, Roger S. and Douglas Kluck	Transitions and transformations-climate extremes, hotspots, and adaptation, in semiarid regions	All aspects of food production and security are affected by climate. As the IPCC notes, projected impacts vary across crops, regions, and adaptation scenarios. For major crops (wheat, rice, and maize), climate change without adaptation will have negative impacts, although individual locations may benefit. A range of adaptation options exists. However, many analyses assume a fixed or "changed" climate without accounting for changes in extremes as these evolve to 2050 and beyond. Systems, and equilibrium assumptions, may change faster than models can be recalibrated, and projections may be most unreliable at the time when they are most desired. Key factors are intra-seasonal (extremes) to decadal variability effects on quantity, quality, and access, including crop migration, storage and utilization. There remains limited understanding of impacts and adaptation options for non-production elements. We will address the factors driving a changing climate, sources of knowledge and uncertainty in characterizing hotspots in the U.S. and elsewhere, impacts on productivity, and adaptation priorities. We argue that immediate needs are to; acknowledge the cross-scale nature of climate, of early warning information and of climate-resilient strategies affecting food production and security, including critical interdependencies derived from water and land resources; recognize that communication is a necessary but limited framing-as important, is an understanding how particular lessons become socialized into practice over time; craft an acceptable, fundable, collaborative framework between research-management.
		Key factors determining success in the above dimensions, include; food production assessments linked with food security assessments; information services to support adaptation in changing environments; and empirical evidence on the effectiveness of technological interventions and social adaptations at all levels of the food system. Most critical will be development of sustained networks across institutions to ensure that lessons being learned, as risks and opportunities emerge, become embedded in practice and inform the choice of pathways for resilience.
Wulfhorst, J.D.	Agro-ecological classification of farmer risk perceptions and climate adaptation	The presentation will focus on perceived risk of changing environmental conditions from climate variability such as long term drought, less reliable precipitation, and fewer days with frozen soils. Agro-ecological class designations are used to delineate geographic and social community variability for risk perceptions. Data for the analysis were generated from a 2012 survey of 900 Inland Pacific Northwest farmers who participated in a social survey as part of a large regional Coordinated Agricultural Project focused on climate change.
Ziska, Lewis	Weeds, rice and climate change: A new paradigm?	Among global cereals, rice is recognized as a primary source of calories for approximately one-third of the global population. Weed induced losses in rice cultivation can be severe, resulting in 100% loss if weeds are not controlled. Climate change, including rising CO_2 levels, warmer temperatures and precipitation extremes (drought, flooding), will differentially affect rice and associated weeds. To date, published studies indicate that red rice, recognized as a ubiquitous weed in rice systems, is likely to respond more to recent and projected CO_2 levels than cultivated rice, with additional crop losses. Weed management in turn is also likely to be impacted. For example, diminished water supplies are affecting traditional flooding-transplanting weed control, and increasing reliance on herbicides. In addition, increasing CO_2 is facilitating greater genetic outcrossing (and diminished chemical control) in herbicide resistant rice cultivars such as Clearfield. While there is an urgent need for additional information, the data to date indicates that weed-rice interactions and weed management in rice systems are likely to be negatively impacted by climate change with subsequent consequences for global food security.

Poster Abstracts

Bold indicates presenter name. Posters are listed by session, in alphabetical order.

Collaborative translational sciences to address climate change in semiarid production systems

Authors	Title	Abstract	
Kirti Rajagopalan, **Chad Kruger**, Nicholas Potter, Von Walden, Georgine Yorgey	An agricultural producer learning tool for the Columbia River Basin	A primary factor affecting risk management for agricultural producers is weather and its variability. At key decision points throughout the year, producers use the information available to them to make the best possible decisions in spite of uncertainties. Decision support tools can help producers make better informed short-term decisions about their operations, such as what to plant, when to plant and how to manage crops under variable weather conditions. Such tools can be adapted to be used as learning tools. Learning tools can help producers evaluate past operational decisions, or explore the possible future impacts of long-term strategic decisions before they are actually made. For example, drawing on historical and future climate projections, a producer might explore what the future climate normal and extremes might be, look at historical analogs for a specific scenario, or explore adaptation strategies. A prototype learning tool has been assembled for the Columbia River Basin in the Pacific Northwest US. The goals are: Visualize historical climate and crop yield data in a format that is relevant for producers. Provide access to short-term and seasonal weather forecasts that can be viewed in the context of historical data. Provide a learning tool that gives producers the flexibility to evaluate what if scenarios with respect to operational decisions made in the recent past. Provide a learning tool for producers to visualize what future climate projections look like, identify historical analogs and evaluate adaptation alternatives. Although the current prototype focuses on weather and climate-based visualizations, the framework can be expanded to include other aspects that impact producer decisions. There is also potential to integrate what we learn through on-going regional earth system modeling partnerships in the Columbia River basin to enrich the toolkit and help producers make informed decisions that prepare them to adapt to a changing climate.	**A1**
Kathleen Painter, Georgine Yorgey, Kristi Borrelli, Erin Brooks, Chad Kruger, Nicole Ward	A grower case study approach for transdisciplinary integration and technology transfer	Large interdisciplinary projects face many challenges, from encouraging the necessary interaction among scientists to achieve transdisciplinary interaction, to stakeholder engagement, to farm-level technology transfer. Focusing on one grower's farm at a time using a case study approach has provided a successful platform for these needs. Twelve growers were asked to participate in case studies for the Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH) project, based on a number of criteria, including focal practice, location of farm, applicability to others, and grower personalities. Participants were identified based on their unique practices or approaches to topics of interest. The process began with a phone call to the grower(s) to describe the process and discuss the project. Next, in-person on-farm interviews were conducted with a small team that included a videographer and two or three REACCH scientists. A scripted set of questions was prepared for each interview, although the interviews were allowed to follow their own dynamics. The final product from these interviews included a video presentation and an accompanying multi-university bulletin. The process of creating this multi-media output was lengthy. Each interview was fully transcribed for reference. The focal topic was addressed within the bulletin as a story featuring a farm, a family, and a specific place. Additional topics were addressed in a transdisciplinary manner as sidebars. For example, one sidebar provides details on hydrological monitoring, including soil electrical conductivity measurements and infrared imagery, and explains potential farm-level implications. Another sidebar provides details on fertilizer cost savings using precision ag tools. Each case study includes inserted video segments, interactive photos and about six sidebars. These case studies are popular features at regional ag conferences. The video segments pique interest in the written bulletin, and the story-line approach is educational while also accessible to diverse audiences.	**A2**

Authors	Title	Abstract
Sanford D. Eigenbrode, John Abatzoglou, Ian Burke, John Antle, Erin Brooks, Susan Capalbo, Paul Gessler, David Huggins, Jodi Johnson-Maynard, Chad Kruger, Brian Lamb, Stephen Machado, Phil Mote, Kathleen Painter, William Pan, Steven Petrie, Timothy Paulitz, Claudio Stöckle, Jonathan Velez, Von Walden, J.D. Wulfhorst and Kattlyn Wolf,	Regional approaches to climate change for Inland Pacific Northwest cereal production systems	The long-term environmental and economic sustainability of agriculture in the Inland Pacific **B2** Northwest (northern Idaho, north central Oregon, and eastern Washington) depends upon improving agricultural management, technology, and policy to enable adaptation to climate change and to help realize agriculture's potential to contribute to climate change mitigation. To address this challenge, three land-grant institutions (Oregon State University, the University of Idaho and Washington State University) (OSU, UI, WSU) and USDA Agricultural Research Service (ARS) units are partners in a collaborative project - Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH-PNA). The overarching goal of REACCH is to enhance the sustainability of Inland Pacific Northwest (IPNW) cereal production systems under ongoing and projected climate change while contributing to climate change mitigation. Supporting goals include; Develop and implement sustainable agricultural practices for cereal production within existing and projected agroecological zones throughout the region as climate changes; 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 the 2030 targets set by the USDA National Institute for Food and Agriculture (NIFA); Work closely with stakeholders and policymakers to promote science-based agricultural approaches to climate change adaptation and mitigation; Increase the number of scientists, educators, and extension professionals with the skills and knowledge to address climate change and its interactions with agriculture. The poster provides an overview of the specific goals of this project and activities that are being pursued to achieve them. More information about the project can be found at: http://reacchpna.org.

Crop protection: Weeds, pests and pathogens

Nevin Lawrence, **Ian C. Burke**	Adaption of downy brome to climate change within the small-grain production region of the Pacific Northwest	Downy brome (*Bromus tectorum* L.), a common weed in the Pacific Northwest (PNW) of the **A3** United States, was selected to model physiological and ecological response to climate change. To phenotype downy brome phenology, ninety five downy brome and one ripgut brome (*Bromus diandrus* Roth.) accessions were transplanted as seedlings to common gardens located near Central Ferry, WA and Pullman, WA in November of 2012 and 2013. Panicles were collected from each replicate weekly at the onset of flowering. Seeds were removed from panicles and planted in a greenhouse to determine if seed was physiologically mature. Germination of downy brome seeds was regressed against cumulative growing degree days (GDD) (base 0 C) at time of collection using a two-parameter log-logistic model to estimate GDD required to produce mature seed. Phenology differed at each common garden location but was negatively correlated to temperature, with mature seed set occurring earlier when winter temperature was colder. Accession were clustered together into groups of similar genotypes for analysis based upon variation in single nucleotide polymorphisms. Population clusters matured, relative to each other, in the same order at each study location, suggesting a strong genetic control of phenology. As downy brome growth stage can influence the efficacy of herbicides, variation in phenology between population clusters may have management implications. Utilizing 14 climate models that adequately captured the historical characteristics of the PNW climate, the calendar date at which 50% of seeds were physiologically mature was reached from 1950-2005 was compared to the projected mean calendar date from 2031-2060. Projected date that 1,000 GDD was reached occurred 10-30 days earlier in the year. The interaction of earlier downy brome development and increased spring moisture may interfere with ability of growers to make timely applications of spring applied herbicides under future climate projections.
Iqbal Aujla, **Timothy Paulitz**	How temperature and water potential affect the growth of *Fusarium* and *Rhizoctonia* pathogens of wheat	Climate change is projected to shift the temperature regimes and type of winter precipitation in **A4** the Pacific Northwest region of the United States. Temperature and moisture are two major factors influencing the activity of soil-borne pathogens like *Fusarium culmorum*, *F. pseudograminearum*, *Rhizoctonia solani* AG-8 and *R. oryzae* causing crown and root rots of wheat respectively, in the dryland wheat production area. This study has been undertaken to decipher the influence of temperature and water potential on the biological activities of these wheat pathogens. These pathogens were grown on potato dextrose agar, potato dextrose broth, and wheat straw or toothpicks adjusted to different osmotic and matric potentials (-0.13 to -10 MPa) with sodium chloride, potassium chloride, and polyethylene glycol (PEG-8000), and incubated at temperatures ranging from 4 to 35°C. Fusarium spp. grew optimally at 20 - 25°C and -1 to -3 MPa. A decline in growth rate was observed at lower water potentials, but growth rates were 0.07 - 3.34 mm/day even at -9 MPa. *Rhizoctonia solani* AG-8 was more restricted for optimal growth at 20-25°C and -0.13 MPa. The optimal growth of *R. oryzae* occurred at 30°C and -0.13 MPa, but the growth rate declined less compared to AG-8 with lower water potential and temperature. *R. oryzae* was the only pathogen to grow at 35°C where the optimum water potential was -2 MPa, compared to -0.13 MPa at temperatures lower than 35°C. The effect of water potential was independent of salt composition. This study contributes to the knowledge of the biology and epidemiology of these pathogens, and will be used in predicting their potential distribution under future climate scenarios.

Crop protection: Weeds, pests and pathogens

Authors	Title	Abstract	
S. Ebrahim Sadeghi, S. Thomas Davis, Ying Wu, B. Sahfii, J. Abatzoglou, S. D. Eigenbrode	Impact of climatic factors on cereal aphid population density in the Pacific Northwest USA	Direct and indirect damages from aphids to crops are limiting factors for cereal crops in the Pacific Northwest region of the United States (PNW-USA) as well as worldwide. At least ten aphid species have been known to occur in cereal crops and on perennial and annual grasses within the region. The development of sustainable integrated pest management (IPM) programs are needed to inform ecosystem management approaches across spatial large scales. This study aimed to evaluate climatic factors impact on four main cereal aphids in the PNW-USA. Aphid samples were collected weekly by sweep net in 108 Regional Approaches to Climatic Change (REACCH) sites from May to July 2011-2014. Statistical analyses to evaluate correlation structure between climate variables and aphid densities were conducted using SAS (9.4). Cumulative degree (CDD) and cumulative precipitation (CP) were calculated for each of the sampling sites. Significant correlations were detected among densities of aphid species and daily climatic factors (temperature, relative humidity), CCD, and CP within each year as well as for the data pooled across all years. We found a trend of significant positive association between daily temperature and CDD with densities of individual aphid species, as well as total aphid densities. Conversely, a significant trend of negative association was observed between daily relative humidity and CP with aphid densities. The significant correlations between CDD and aphid population densities suggest that CDD can be used as a tool for cereal aphid IPM and prediction of inter-annual aphid abundances in cereal fields in the Pacific Northwest regions of USA. It will be necessary to calculate CDD in multiple ecological zones across the seasonal phenology of each aphid species to expand our current understanding.	A5
Byju N. Govindan, Sanford D. Eigenbrode, Claudio O. Stöckle	Interactive effects of CO_2 and warming on cereal leaf beetle dynamics and winter wheat yield in the Pacific Northwest USA	Agricultural cropping system models used as a decision support tool to predict crop growth and yield under different soil, climate and management scenarios most often ignore the crop loss due to pests. Coupling crop models with pest modules can help explain the gap between potential and actual yield. Using annual weather data for selected sites in Washington, we simulate the phenology and feeding by cereal leaf beetle (CLB), *Oulema melanopus* (L.) (Coleoptera: Chrysomelidae) in R 3.1 freeware and couple that output to a daily time-step winter wheat – fallow model simulated in CropSyst. Specifically, we apply linear or nonlinear models to explicitly model the temperature-driven physiological processes of development (Sharpe–Schoolfield–Ikemoto model), mortality, and reproduction as well as feeding rates of different instars, for CLB on wheat. The model was parameterized using CLB development data from published temperature-controlled experiments, and CLB consumption data from our own experiments. We demonstrate the utility of this model to capture phenological dynamics and feeding behavior of CLB to explain the gaps in predicted crop yield under ambient (400 ppm) and elevated (950 ppm) CO_2 levels in the Pacific Northwest. Cumulative yield loss by all four larval instars of CLB in the coupled model is also compared with control (no CLB) and also at levels below or far exceeding the economic threshold. Our approach could be used to evaluate production systems response to a range of global warming scenarios for any foliar feeding insect pest species of any crop and consequent yield loss.	B3
Elnayer H. Suliman, Hanan A. Salman, Imad-eldin A. Ali, Lutfie A. Yousif	Selected technologies for sorghum protection to reduce pest losses under rain fed conditions in Gedarif State, Sudan	Sorghum is attacked by various field pests throughout its growth stages and has been described by different workers. Different insect pests species were listed; Soil diseases and different weeds also recorded. The most serious is probably the central shootfly, *Atherigona soccata* (Rondani), head covered smut, *Sphacelotheca sorghi* and *Striga hermenthica.* The experiments were conducted at Northern area, Gedarif State, viz., University Farm (Twawa) during the 2010/2011 and 2011/2012 seasons. The objective of this research is to test selective technologies for reducing field pests losses on dry land sorghum. The sorghum varieties Wad Ahmed (late maturing) and Arfa Gadamak (early maturing) were sown. Gaucho 70 WS and Raxil 2 WS insecticides seed-dressings for controlling Covered smut and central shootfly control. Two selective herbicides for controlling broad leaves weeds e.g., (2.4.D and Glean) were applied to control *Striga hermenthica* and other broad leave weeds. Hand weeding was carried out two times on for sub-plots viz., untreated control. Urea fertilizer 1N was applied during sowing time. Regular surveys were carried out weekly after crop emergence to record pest damage and insect population, where 25 plants of sorghum were randomly selected from each plot and the numbers of dead-heart caused by the larvae of *A. soccata* were assessed. Mean number of weed/mÂ² and % weed ground cover 4 weeks after sowing also recorded. During the harvest time disease incidence and yield were recorded. Results obtained on mean number of dead heart recorded on Arfa Gadamak variety significantly different between treatments when compared with untreated control. Treatments treated with Raxil 2 WS and Gaucho 70 WS did not record any dead heart, disease incidence and % damage during the season. Treatment (Hand weeding + Gaucho 70 WS + Raxil 2 WS) recorded lowest % weed ground cover compared with others treatments. The highest yield was obtained by treatment (2.4.D + Glean 75 + Gaucho 70 WS + Raxil 2 WS) (3932.2 Kg/ha.).	B4

Cropping system improvements and innovations

Authors	Title	Abstract
Md Abiar Rahman, Masakazu Tani, SM Asik Ullah	Climate change and food production scenarios in the Teknaf Peninsula of Bangladesh	Bangladesh is one of the vulnerable countries to climate change. The coastal area of Bangladesh is more prone to climate change, where agricultural production is low. The Teknaf peninsula is situated in the corner of Bangladesh, where both forest and marine ecosystems are found in a narrow area. High population, poverty, and climate variability are some problems. The aim of this study is to investigate the climate change and food system in the Teknaf peninsula of Bangladesh. Weather data were collected from Bangladesh Meteorological Department, while agricultural information were collected from the Department of Agricultural Extension. Long-term (1984-2013) weather data shows that annual rainfall (around 4000 mm) does not change remarkably, but its distribution has been changed. Therefore, frequent drought is being observed. According to land distribution data, drought is a common event that covers 23% of landmass. **A6**
Ram A Jat, M.C. Chopda, R. K. Mathukia	Climate change and variability, and farmers' response in Saurashtra Region of Gujarat, India	The Saurashtra region of Gujarat, India comes under a typical arid and semiarid type of climate. Groundnut-wheat is the major cropping system followed in the region. Farmers in the region were surveyed to ascertain the adoption of climate change adaptation strategies. The survey revealed that the farmers in the region are well aware about the changes in rainfall and temperature patterns in the region over a period of time. Realizing the crop losses due to changing rainfall and temperature pattern a regular phenomenon, the farmers have started to adapt by following various coping strategies like-- harvesting of rain water through check dams (with community efforts and the help of developmental agencies) and open wells (individual farmers); use of micro irrigation systems for supplementary irrigation; frequent interculturing to reduce moisture losses through evaporation and weeds; use of growth retardants; growing groundnut as a climate resilient crop during rainy season; intercropping; diversifying crops; introducing pigeonpea as a strategic relay crop in groundnut; changing crop geometry; use of responsive varieties; furrow irrigation to establish wide spaced crops (e.g., cotton); mulching, farm mechanization for timely field operations, diversifying with other farm enterprises like cattle farming and agro-forestry, etc. In the last couple of years, as an adaptation strategy, farmers are widely shifting to underground PVC irrigation pipes from unpaved surface irrigation channels to reduce conveyance losses of water. Many farmers are following paired row system (two or three rows most common) in groundnut to facilitate interculturing, conserve rain water, and introduce relay crop of pigeonpea or castor. Diversification, putting area under different crops like groundnut, cotton, castor, cereals. etc. during rainy season, and wheat, coriander, cumin etc. during winter season, has been identified by farmers as an important strategy to reduce climate variability and market fluctuations related losses. **A7**
Barbara Kyampeire, Ruth Kabanyoro, Immaculate Mugisa	Farmers willingness to adopt intercrops for soil fertility management in the Lake Victoria Crescent Agro-Ecological Zone (LVCAEZ) of Uganda	Intercropping, particularly with legumes, is a food security and soil fertility management strategy of small-holder, resource-poor farmers in sub-Saharan Africa. Understanding the extent of and factors affecting farmer's willingness to adopt intercropping practices is central to decisions to promote this practice. We assessed the socio-economic factors affecting the farmer's choice to adopt an emerging rice intercrop technology in the Lake Victoria Crescent Agro-ecological Zone (LVCAZ) of Uganda. A household survey was conducted with 171 rice farmers in Kiboga, Kayunga and Luwero districts. Logistic regression analysis was used to model the willingness of farmers to adopt the rice intercrops. Results show that approximately 60% of the farmers are willing to adopt the practice. The willingness to adopt is higher with higher level of education of household heads, contact with extension agents and training, ease of access to rice seed and membership to farmer groups. On the other hand, farmer experience with rice cultivation negatively affects willingness to adopt the technology. The implication of our findings is that extension agents, especially the National Agricultural Advisory Services, should work with farmer groups to create awareness of the benefits of rice intercrops, link them with research institutions such as the National Agricultural Research Organization to enable them access seed. The Participatory Market Chain Approaches that have already shown success in potato value chains should be promoted so that commercial rice farmers have alternative markets for secondary crops from the intercrops. Further studies into the economic and social and environmental benefits of these practices are required to shed light on their sustainability **A8**

Cropping system improvements and innovations

Authors	Title	Abstract	
Elnayer H. Suliman, Abdalla H. Mohamed, Dafalla A. Dawoud, Osama M. A. Elhassan, Shadia A. Salih, Adil Y. Yagoub	Integrated technologies for sorghum-legume production system to improve livelihood and adaption to climate change in Gedarif State, Sudan	Sorghum, grown as a single crop by large scale farmers, is sometimes inter-cropped with legumes by small scale farmers to provide the protein that supplements carbohydrates and starch in sorghum. Rural families derive food, animal feed, cash and other benefits including improved soil fertility through in situ decay of root residues and legume leaves. Field work was conducted at 6 environmental zone locations: Northern (dry area), Central (semi-dry area) and Southern (wet area) in Gedarif State during 2011/2012 and 2012/2013. Production technologies were evaluated by (1) improved sorghum variety (AG8 for low rainfall areas and Wad Ahmed for relatively high rainfall areas), (2) intercropping with legume (cowpea for low rainfall areas and groundnuts for relatively high rainfall areas), (3) water harvested by cross ridging against the slope and tied to ridges every 10 m, and (4) low micro dose of nitrogen fertilizer (15 kg urea/ha applied with the seeds at sowing). These improved production techniques were compared with farmer practices and showed excellent performance on grain yield and forage (increased sorghum, cow pea, and groundnuts), resulting in improved productivity in the whole semiarid system. Sorghum grain yield increased to 2500 kg/ha in the southern area compared with traditional farmers (500 kg/ha), in the central area, sorghum productivity increased to 1728 kg/ha compared with traditional farmers production (225 kg/ha), and in the northern area productivity of sorghum crop increased from 180 kg/ha to 1080 kg/ha. Data recorded on sorghum Stover yield was significantly different between production technologies and traditional farmer's practices (17.5, 10.8 and 6.7 ton/ha) in southern, central and northern areas, respectively. Groundnuts and cowpea recorded the highest yield compared to traditional farmers yield (1500 and 1152 kg/ha) and 500 and 432 kg/ha, respectively.	A9
Isaac J. Madsen, Megan E. Reese, Taylor M. Beard, Tai M. Maaz, Lauren E. Port, Myra L. Nunez, Jacqueline C. Huettenmoser, William L. Pan	Subsoil accessibility and nutrient availability in three rainfall zones in the Pacific Northwest	A greater focus on the availability of subsoil resources will became increasingly important to crop production as climate change leads to warmer drier summers and wetter winters. Crop species, root architecture, and soil impedance to root growth are important factors that influence the ability of crops to access and take up nutrients from deep in the profile. Water drawdown data in soil profiles was collected in conjunction with field trials at different rainfall locations across the Inland Pacific Northwest. A significant portion of total water use occurred during the spring regrowth of winter canola (90% in low and 75% in intermediate precipitation zones). Drawdown occurred throughout the entire 5 foot profile, with more than 50% reduction of total water content in 3-5 feet between March and harvest. Soil pits were dug in mature canola fields in three distinct precipitation zones, within which root densities, soil physical characteristics, and nutrient profiles were spatially recorded. A restrictive layer characterized by high bulk density, resistance, and silt content was observed in the lowest rainfall zone. At all sites, more than 65% of roots were distributed in the subsoil beneath the first visual pan layer. Root density was strongly and positively spatially correlated with K and OM, but strongly and negatively spatially correlated with Na, Mg, EC, and Ca. The relationship between root density and nutrient distribution is an important factor when assessing late season nutrient availability. Our findings highlight the importance of subsoil quality and accessibility across different rainfall zones within a changing climate.	B5
Robert L. Mahler	The impact of water, soil fertility and conservation on sustainable cereal production in the dryland region of the Inland Pacific Northwest	Five surveys conducted between 1997 and 2014 have evaluated grower attitudes and perceptions toward water use, soil fertility and conservation practices in the Inland Pacific Northwest. In general growers equate the surveyed attitudes and practices to sustainable cereal production. Most farmers support both water conservation and soil conservation practices. More than two thirds of growers have actively implemented these practices in significant components of their production systems.	B6
Rajan Ghimire, Prakriti Bista, Stephen Machado	Warming effects on soil carbon and nitrogen mineralization in dryland cropping systems in the Pacific Northwest	Climate change will influence soil organic carbon (SOC) and nitrogen (N) dynamics through their effects on mineralizable and easily decomposable fractions of soil organic matter (SOM). We evaluated the effects of soil warming on SOC and N mineralization in a winter wheat (*Triticum aestivum* L.)-based production systems in the Pendleton long-term experiments (PLTEs). Soil samples were collected from 0- to 10-cm and 10- to 20-cm depths of selected treatments of crop residue, tillage fertility, and wheat-pea LTEs established in 1931, 1941, and 1964, respectively. Undisturbed grassland, which has not been cultivated since 1931 was considered as a reference for these comparisons. Approximately 20 g soils with moisture at field capacity were incubated in 20°C and 30°C temperature. Soil C and N mineralization was monitored for 10 weeks. Repeated tillage, wheat-fallow system, and warming accelerated soil C and N mineralization. Mineralizable C and N contents were greater under reduced- and no-tillage systems than under the conventional system. Reducing or eliminating fallow through maintenance of perennial grasses and wheat – pea (*Pisum sativum* L.) rotation can increase SOC accumulation. Increasing nutrient supply through manure and N fertilizer addition can complement to the effects of reduced and no-tillage management to improve SOC and N accumulation and improve sustainability of winter wheat-based production systems in the Pacific Northwest in the projected climate change.	B7

Cropping system models as platforms for integration

Authors	Title	Abstract
Nicole K. Ward, Fidel Maureira, Erin Brooks, Matt Yourek, Claudio Stöckle	CropSyst-Microbasin model as a tool to inform variable-rate nitrogen management and dryland farm profitability	Precision fertilizer management is a promising method to maintain high agricultural yields while **A10** using less fertilizer inputs in the highly heterogeneous Palouse region. This study assessed the use of CropSyst-Microbasin at a tool to inform fertilizer management practices. A highly-instrumented field site was used to parameterize CropSyst-Microbasin. The model accurately simulated spatial and temporal changes in soil water content, total surface runoff, and average crop yield. Fertilizer management scenarios were conducted with an analysis of total nitrogen loss, crop yield, and farm profitability. Simulated yields were analyzed with local costs of production and varying crop, fertilizer, and fuel costs to examine the sensitivity of profitable fertilizer management to varying market conditions. Hillslope scenarios demonstrate the capacity of CropSyst-Microbasin to simulate the contribution of lateral redistribution of nitrogen to down-slope yields. Field catchment (roughly 10 hectare) simulations demonstrate the unique capacity of CropSyst-Microbasin to simulate agricultural production on highly heterogeneous landscapes, capturing spatial and temporal variability. Simulations and field sites were examined in conjunction with other types of production measurements, such as NDRE-based N uptake predictions, to explore field-scale spatial and temporal drivers of production and risk to inform precision fertilizer management on the Palouse.
Hussain Sharifi, Robert J. Hijmans, Matthew Espe, Bruce A. Linquist	Optimal estimation of phenological crop model parameters for rice (*Oryza sativa*)	Crop phenology models are important components of crop growth models. Typically only a few **B8** parameters of phenology models are calibrated and default cardinal temperatures are used which can lead to a temperature-dependent systematic phenology prediction error. Our objective was to evaluate different optimization approaches in the Oryza2000 and CERES-Rice phenology sub-models to assess the importance of optimizing cardinal temperatures on model performance and systematic error. We used two optimization approaches: the typical single-stage (planting to heading) and three-stage model optimization (for planting to panicle initiation, panicle initiation to heading, and heading to physiological maturity) to simultaneously optimize all model parameters. Data for this study were collected over three years and six locations on seven California rice cultivars. A temperature-dependent systematic error was found for all cultivars and stages, however it was generally small (systematic error < 2.2). Both optimization approaches in both models resulted in only small changes in cardinal temperature relative to the default values and thus optimization of cardinal temperatures had very small effect on systematic error and model performance. Compared to single stage optimization, three-stage optimization had little effect on determining time to panicle initiation or heading but significantly improved the precision in determining the time from heading to physiological maturity. The RMSE reduced from an average of 6 to 3.3 in Oryza2000 and from 6.6 to 3.8 in CERES-Rice. With regards to systematic error, we found a trade-off between RMSE and systematic error when optimization objective set to minimize RMSE or systematic error. Therefore, it is important to find the limits within which the trade-offs between RMSE and systematic errors are acceptable, especially in climate change studies where this can prevent erroneous conclusions.
Prakriti Bista, Stephen Machado, Rajan Ghimire	Soil organic carbon dynamics in a dryland wheat-fallow system: DAYCENT model simulations	Agricultural management practices that contribute to soil organic carbon (SOC) sequestration can **B9** improve soil health and agricultural sustainability. We used DAYCENT model to simulate the impact of crop residue and nutrient management practices on SOC content, and grain and residue yield in a long-term (80 years) winter wheat (*Triticum aestivum* L.)-summer fallow (WW-SF) systems in Pendleton, OR. Treatments included fall burning of crop residue (FB0), no burning of cop residue with 0 (NB0), 45 (NB45) and 90 (NB90) kg N ha^{-1}, and addition of cattle manure (MN) and pea vines (PV). Model performance was evaluated by comparing modeled and observed data from 1931 to 2010. The model was reasonably accurate with R2 values of 0.93, 0.95 and 0.99 for the mean of observed and modeled grain yield, residue yield and SOC, respectively. The paired t-test results showed the significant bias between observed and modeled SOC five out of six treatments. The model show highest rate of SOC decrease in FB0 (24.4 g C m^{-2} yr^{-1}) and an increase in MN (9.69 g C m^{-2} yr^{-1}) from 1931 to 2010. DAYCENT projected that SOC loss was between 866 to 2192 g C m^{-2} in different WW-SF systems except MN, where is showed SOC gain of 496 g C m^{-2} SOC by 2080. However, with conversion to no-tillage from 2011onwards, all treatments are projected to gain SOC. DAYCENT results revealed that conversion to no-till can minimize the SOC loss by 17 to 47% under different treatments besides MN where SOC gain can be increased by more than 300%. Our study suggested adaption of no-tillage system along with addition of organic amendments can increase SOC sequestration, mitigate climate change and improve the long-term sustainability of dryland WW-SF systems.

Authors	Title	Abstract
Muhktar Ahmed, Claudio O. Stöckle, Roger Nelson, Stewart Higgans	Uncertainties in the prediction of winter wheat response to climate change with crop-climate models	Simulations of crop yield under climate variability are subject to uncertainties, and quantification **B10** of such uncertainties is essential for effective use of projected results in adaptation and mitigation strategies. In this study we evaluated the uncertainties related to crop-climate models using five crop growth simulation models (CropSyst, APSIM, DSSAT, STICS and EPIC) and 14 general circulation models (GCMs) for 2 representative concentration pathways (RCP) of atmospheric CO_2 (4.5 and 8.5 W m-2) in the Pacific Northwest (PNW), USA. The aim was to assess how different process-based crop models could be used accurately for estimation of winter wheat growth, development and yield. Firstly all models were calibrated for high rainfall, medium rainfall, low rainfall and irrigated sites in the PNW using 1979 to 2010 as the baseline period. Response variables were related to farm management and soil properties, and included crop phenology, leaf area index (LAI), biomass and grain yield of winter wheat. All five models were run from 2000 to 2100 using the 14 GCMs and 2 RCPs to evaluate the effect of future climate (rainfall, temperature and CO_2) on winter wheat phenology, LAI, biomass, grain yield and harvest index. Simulated time to flowering and maturity was reduced in all models except EPIC with some level of uncertainty. All models generally predicted an increase in biomass and grain yield under elevated CO_2 but this effect was more prominent under rain fed conditions than irrigation. However, there was uncertainty in the simulation of crop phenology, biomass and grain yield under 14 GCMs during three prediction periods (2030, 2050 and 2070). We concluded that to improve accuracy and consistency in simulating wheat growth dynamics and yield under a changing climate, a multimodel ensemble approach should be used.

Data management to enable regional and global efforts

Suzan M. Shahin, Rahaf M. Ajaj, Mohammed A. Salem	Climate change and food security: Bridging the interaction gaps for future integrity	Climate change and global warming has become a real threat to global food security, by affecting **A11** the agricultural capability and productivity. Global population is expected to continue to increase, thus, the world will be facing a food and hunger crisis. Food-insecure populations will be enlarged, especially in low-income countries. The extent and diversity of climate change, make regional long-term strategies for climate change adaptation, mitigation and impact assessment an impossible task in the absence of the cross regional collaboration and international strategic planning. Consequently, there is a crucial need to bridge the interaction gaps between farmers, households, scientists and decision makers, among major hot spots including: climate information services, seasonal forecasting, farming practices, tolerance of emerging pests and diseases, agricultural intensification, action policies and integrated research projects. Bridging such gaps is urgently needed in order to guarantee the future global sustainability and integrity.
Erich Seamon, Paul Gessler, Edward Flathers, Luke Sheneman	Developing an agriculturally-focused data management system for climate assessment, adaptation, and mitigation: regional approaches to climate change for Pacific Northwest Agriculture (REACCHPNA)	Over the course of the last five years, the REACCHPNA data management effort, a cyberinfrastructure **A12** component of REACCHPNA, a USDA funded coordinated agricultural project (USDA Award #2011-68002-30191), has had a focus to develop modular, sustainable, and extensible systems/processes that would allow for the collection, storing, and analyzing of REACCH-related data and content. In support of this strategy we have built out four core systems to implement this approach. Our http://www.reacchpna.org portal; REACCH data and analysis libraries for data discovery, analysis, and metatagging; a THREDDS data catalog, for climate data subsetting and aggregation; and an interactive python notebook server, to facilitate collaborative data science efforts. Supporting these four core areas is a developed architecture that includes a three-tier server environment (data, applications, web), a metadata cataloging server (a customized version of ESRI's Geoportal Server), a geospatial web server environment for web mapping services (ArcGIS Server), and a geospatial enterprise database (PostgresQL) all interconnected to an LDAP server for unified user logins across systems. In addition, all data is replicated/mirrored at Idaho National Laboratories (INL). Preliminary results of the data management complication include over 1000 discrete data entries (data, surveys, publications), with approximately 30 map services outputting dynamic, REST-enabled urls. In addition, over 40TB of climate data has been assembled for aggregation and subsetting purposes, that can be integrated with other non-raster based data thru REST and javascript applications.

Authors	Title	Abstract
Edward Flathers, Paul Gessler, Erich Seamon	Implementing a free, open-source data repository to support distributed interdisciplinary science	The science data management system as a framework for collaboration and integration is a **B11** relatively new tool in the interdisciplinary project toolbox. Historically, these repository systems have been established as silos: each research lab might establish their own, proprietary model for data management with little effort at interoperability. With the emergence of open standards for data organization and data access services, repositories can be linked across labs, institutions, and disciplines across the world to help enable a new, open science based upon data sharing and remote collaboration. In the past, one of our challenges with monolithic, prepackaged data management solutions is that customization can be difficult to implement and maintain, especially as new versions of the software are released that are incompatible with our local codebase. Our solution is to break the monolith up into its constituent parts, which offers us several advantages. First, any customizations that we make are likely to fall into areas that can be accessed through Application Program Interfaces (API) that are likely to remain stable over time, so our code stays compatible. Second, as components become obsolete or insufficient to meet new demands that arise, we can replace the individual components with minimal effect on the rest of the infrastructure, causing less disruption to operations. The modular approach also leads to other advantages in both IT and science goals for the repository. In this poster, we illustrate our application of the Service Oriented Architecture (SOA) design paradigm to assemble a data repository that conforms to the Open Archival Information System (OAIS) Reference Model primarily using a collection of free and open-source software. We detail the design and implementation of the repository, based upon common preservation practice and open standards that support interoperability with other institutions systems and with future versions of our own software components.

Drought effects on water resources in semiarid and crop production in semiarid regions

Authors	Title	Abstract
Arun K. Chhetri, Pramod K. Aggarwal, Seema Sehgal	Are seed banks a viable option for drought risk management in South Asia?	Drought is a primary constraint for cereal production systems in South Asia, where more than **A13** 60% of agricultural land is rain fed. Any prolonged drought event can severely impact agricultural production and food security. Seed banks can serve as emergency seed supply systems when farmers face a shortage of seeds due to failure of crops as a result of extreme climatic events such as floods and droughts. Maintenance of seed banks where extreme climatic events frequently occur could help farmers to establish crops quickly in the same season or the next season in case crops are destroyed. Research is needed in terms of (a) how much agricultural areas would have the requirement of seed banks, (b) what would be the return period for use of seed from such banks, (c) which crop's seed and varieties should be stored in a given location, and (d) will maintenance of seed bank be economically viable. Our study used a multi-disciplinary research methodology involving subjects of climatology, GIS, agronomy and economics for three distinct activities. This study indicates that the maximum frequency of seed bank requirement under any scenario is 15-20%, i.e., seed bank is required once in 5 to 7 years. About 90% of the study grids may require seed banks once in 15 years or more. The maximum number of grids which may require seed banks once in 5-7 years for climate risk preparedness lies in India. Afghanistan, Bhutan and Nepal may not require seed banks. The choice of main crops and/or alternate crops seeds for storage in the seed bank depends on agro-ecological conditions and timing and length of drought during the cropping season. In the areas with prolonged drought after few weeks of crop sowing, seed banks may require to established alternate crops on revival of rainfall.
Md Abiar Raham, Masakazu Tani	Drought impact on rice production in northwest region of Bangladesh	Bangladesh is one of the most vulnerable countries to climate change. Though most parts of **A14** Bangladesh are more or less prone to adverse impacts of climate change, the northwest region is particularly sensitive because of prolonged drought conditions. With climate change, more area would be exposed to severe droughts because of projected change in rainfall pattern and dry spell frequencies. Bangladesh is an agricultural country and rice is the main crop, which requires large amounts of water. The aim of this study was to assess the seasonal drought condition and its impact on rice production in the northwest region, which is considered a drought prone area. Long-term rainfall (1964-2011) data was collected from Bangladesh Meteorological Department. Data on the area and production were collected from the Department of Agricultural Extension. Standardized precipitation index (SPI) is widely used as a direct approach in comparison with other drought indices because of its simple and useful application. Long-term data showed a decreasing trend of rainfall, which were 1.64, 1.60 and 0.38 mm for aus, aman and boro rice seasons, respectively. The SPI values indicate frequent drought in recent years, particularly during boro season. It was observed that seasonal drought was responsible for yield loss by 18, 21 and 11% during aman, aus and boro seasons respectively. Drought during aus and aman seasons hamper rice production as those rice seasons are rain fed. On the contrary, drought during boro season increases the dependency on creating environmental problems, increasing production cost and decreasing food quality by contamination heavy metals. Suitable technologies and varieties should be introduced to sustain the rice production in northwest part of Bangladesh under changing climate.

Drought effects on water resources in semiarid and crop production in semiarid regions

Authors	Title	Abstract	
Kirti Rajagopalan, Kiran Chinnayakanahalli, Georgine Yorgey, Michael Brady, Claudio Stöckle, Jennifer Adam	Impacts of climate change on irrigated agriculture through water rights curtailment	Irrigated agriculture is impacted by climate change both directly and indirectly. Warmer temperatures and elevated CO_2 levels directly impact the plant growth cycle and potential crop yields. In addition to this, indirect effects include factors such as changes in water availability for irrigation, particularly in snowmelt dominated regions. This is especially relevant in regions that exercise irrigation water rights curtailment in times of shortages, e.g., to maintain environmental flows. The relative magnitudes and directions of both the direct and indirect effects will determine the net impact climate change has on agricultural production in such regions. We examine the indirect impacts of climate change in the 2030s on irrigated agricultural production in the Washington state part of the Columbia River Basin, using a coupled crop-hydrology model in conjunction with a water management model that includes an approximation of water rights curtailment in the region. The indirect effects are also considered relative to the direct impacts of climate change on agricultural production. Results indicate that although future curtailment rates are expected to be higher than historical conditions, the effects of curtailment on crop yields are not correspondingly larger in the future. Impacts are crop dependent and depend on the timing of curtailment in relation to crop growth stage. Earlier onset of crops and accelerated growing degree day accumulation under warmer future climate alter the crop growth cycle leading to interesting impacts of curtailment on agricultural production.	**A15**
Erin Brooks, Nicole Ward, Austin Wardall	Implications of wetter and warmer future climates on the soil water availability in the Palouse	With climate models suggesting that winter precipitation totals may increase by as much 75 mm (3 inches) by the latter half of the 21st century, there is the potential for major changes in the way cropping systems are managed in the dryland grain producing regions of the Pacific Northwest. Drier, warmer summers lead to earlier plant dates and rapid drying however wetter winters provide greater offseason soil water recharge potentially providing greater availability of soil water to dryland crops. In this project we examine the impacts of future climates at three climate zones within the Pacific Northwest and demonstrate the positive and negative effects of increased precipitation and temperature on future cropping systems. Crop modeling results suggest that the increase in precipitation in some areas will lead to a net increase in spring soil water, potentially increasing the portion of the region implementing annual cropping, despite overall warming temperatures which suggest increased fallow practices. This analysis implies that the impact of climate change on the cropping systems in the Palouse region will be more sensitive to changes in precipitation than to air temperature. Assumptions of this approach and future implications of these analysis will be discussed.	**B12**
Ashutosh K. Misra, Claudio O. Stöckle, Byju N. Govindan	Simulating optimal productivity for winter wheat under variable soil moisture regimes for Pacific Northwest USA	Irrigation water requirements are considered the most important limiting factor for efficient use of water resources and optimizing the crop yield under changing future climatic conditions. Scarce and uncertain information exists on soil water availability into the future for any region and hence crop simulation modeling can be an efficient and cost effective technique to estimate the crop irrigation water requirement. We identified four locations viz., George, Sunnyside, Othello and Imbler having at least 12 years of daily weather data from the Inland Pacific Northwest region of the USA during the winter wheat growing season. Amounts of average rainfall during the cropping season in these locations ranged from 197.53 mm to 378.85 mm. A calibrated and validated CropSyst model for these locations was run for winter wheat to develop response curves of leaf area index (LAI), biomass production and yield for different irrigation levels. The crop production function (CPF) allowed simulating irrigation events as a function of soil water level ranging from a completely rain fed to a fully irrigated scenario. Simulation outputs suggest optimal crop productivity at 60% soil water level in locations with high rainfall viz. Othello and Imbler. No significant increase in grain yield and biomass were observed at high rain fall locations with further enhancement in irrigation water levels. In contrast, in low rain fall sites viz. Sunnyside and George, crop productivity was optimized only when 80% or more soil water level was provisioned.	**B13**

Genetic improvements and integration

Authors	Title	Abstract	
Kulvinder Gill, **Amita Mohan**	Developing heat tolerant and climate resilient wheat	Climate change, particularly the heat stress, poses a serious challenge to the wheat production, which needs to double by 2050 in order to meet the food demand of the growing population. Every 1°C rise in temperature above the optimal results in wheat yield losses of up to 3-4%. By the end of the 21st century, global annual mean temperature, including South Asia, is projected to go up by 4°C, thus adversely affecting the wheat production in most of fertile Indo-Gangetic plains. Therefore, improving wheat heat tolerance is crucial in today's context. As a public-private partnership, 'Feed the Future Innovation Lab' has been setup with the funding from USAID, DBT, ICAR, and BIRAC with a goal to develop climate resilient wheat cultivars by combining all available information, tools, and technologies. Evaluation of heat tolerant material from around the globe both under controlled as well as field conditions showed extensive natural variation for the trait, although, only few lines maintained 'normal' productivity at 30°C. A short period of heat stress during germination had serious and long-term effect on plant development and yield. A ten-day heat stress at germination reduced germination percentage, coleoptile length, and yield. Sugars availability maybe a reason for the effect on germination as external application of sucrose showed significant recovery in germination percentage and coleoptile length. Heat stress during vegetative phase significantly affected tiller number, flowering time, pollen fertility, plant height and yield. During the reproductive stage, heat stress adversely affected photosynthesis and increased membrane disintegration due to decreased chlorophyll index, increased ROS and lipid peroxidase activity. The identified heat tolerant lines will be used to transfer the trait into wheat cultivars by marker assisted background selection combined with simultaneous detection and utilization of QTLs. Various molecular and physiological studies for the trait are underway and an update will be presented.	A16

GHG: Monitoring and approaches to mitigation

Neville Millar, Kevin Khamark, Abisai Urrea, G. Philip Robertson, Ivan Ortiz-Monasterio	Nitrous oxide response to nitrogen fertilizer in irrigated spring wheat in the Yaqui Valley, Mexico	The Yaqui Valley, one of Mexico's major breadbaskets, encompasses 225,000 hectares of cultivated, irrigated cropland, up to 75% of which is planted to spring wheat annually. Nitrogen (N) fertilizer applications to this crop have nearly doubled since the 1980s, and currently average around 300 kg N ha-1. A substantial component of total production costs, these rates also result in significant N losses to the environment via leaching and gaseous emissions. Nitrous oxide (N_2O), a potent greenhouse gas (GHG) is produced naturally by microbial denitrification and nitrification. Emissions increase following soil management activities, especially fertilizer N application, and particularly when this input exceeds crop requirement. Our major objectives are to 1) investigate tradeoffs between fertilizer N input, spring wheat yield, and N_2Oemissions, to inform management strategies that can mitigate N_2O emissions without compromising productivity and economic return, and 2) explore opportunities for farmers to take advantage of global carbon markets, and generate income from improved N management practices they adopt. Manual chambers were used to observe N_2O fluxes from spring wheat at five N inputs (0, 80, 160, 240, and 280 kg N ha^{-1}) during two growing seasons at CIMMYT in Ciudad Obregon, Sonora, Mexico. Average daily N_2O fluxes were 2.1 to 14.4 g N_2O-N ha^{-1} day^{-1}, with lower emissions at N rates below or close to those that optimized yield, and substantially higher emissions at N rates beyond where yield optimization occurred. The exponential response, consistent with other crops, suggests large decreases in N_2O flux are possible with lower N inputs and without negative yield impacts. With fertilizer use patterns in Yaqui Valley a likely gauge for high-productivity irrigated cereal systems elsewhere, our results provide evidence for a win-win-win scenario; large reductions in agricultural GHG emissions, increased farmer income, and maintained or even improved productivity.	A17
Brian Lamb, Sarah Waldo, Jinshu Chi, Shelley Pressley, Patrick O'Keeffe	REACCH Monitoring objective: Assessing dynamics of carbon dioxide, water vapor, and nitrous oxide at multiple agricultural ecosystems in the Inland Pacific Northwest	Local meteorology, crop management practices and site characteristics have important impacts on carbon, water, and nitrogen cycling in agricultural ecosystems. Future climate projections for some regions (e.g. Inland Pacific Northwest (IPNW) of the U.S.) show a likely increase in temperature and significant reductions in precipitation that will affect agricultural carbon, water, and nitrogen cycling. Agriculture is highly dependent on climate, yet it is also a primary contributor of the greenhouse gases nitrous oxide (N_2O) and methane (CH_4). Agricultural fields can be net carbon dioxide (CO_2) sinks or sources depending on management practices and climatic conditions. Therefore, there is a critical need to quantify greenhouse gases (GHGs) in different agricultural ecosystems to better understand their distribution, cycles, and how they are impacted by ongoing climate change. The REACCH project is investigating the feedbacks between agricultural ecosystems and climate change in the IPNW region by assessing carbon, water, and N_2O dynamics in multiple cropping systems using micrometeorological methods. Our team has installed five flux towers at sites representing different agroecological classes across the region that continuously monitor fluxes of CO_2, H_2O, and energy, totalling eleven site-years of results as of October 2014. Two of the flux towers are also outfitted to monitor N_2O emissions, using both micrometeorological methods and an array of automated chambers. We found that all five sites were net CO_2 sinks over the measurement period, with cumulative sink strengths ranging from 63 to 326 g C m^{-2} yr^{-1}. However, the N_2O results indicate that emissions are higher than the IPCC Tier 1 estimate, at 3-6 kg N_2O-N ha^{-1} yr^{-1}.	B14

Authors	Title	Abstract	
Tai M. Maaz, Lauren E. Port, William L. Pan, Isaac J. Madsen, Frank L. Young, Aaron Esser	Rotational nitrogen and water use efficiencies in intensified and diversified cropping systems across the precipitation gradient of Eastern Washington	Rotational estimates of nitrogen (N) and water use are needed to assess the impacts of rotational designs as long-term strategies to improve efficiencies. Typically, nitrogen use efficiency (NUE) and water use efficiency (WUE) are calculated for a single season rather than across multiple years, which ignore potential carry-over from one season to the next. We constructed N and water balances across the precipitation gradient of Eastern WA (including the irrigation, low, intermediate, and high rainfall zones) to (1) quantify unaccounted for N and rotational NUE and (2) determine differences in water use with crop intensification and diversification across the region. In an integrated regional study, we found higher N recoveries than reported in literature in the low rainfall zones, even with continuous cropping in grain-fallow region. Because of higher inputs in the intensified rotations, improvements can be still made to reduce unaccounted for N. Nitrogen carry-over from fertilizer and cover crops to subsequent crops was observed across the region, which demonstrates the importance of crop rotation and fertilization. Subsoil storage and extraction are essential for overall efficiencies of water and N, thus illustrating the need for routine testing and accounting of subsoil N and water content.	B15

Identifying and assessing adaption strategies

Authors	Title	Abstract	
Clark Seavert, **Laurie Houston**, Jenna Way, Susan Capalbo	AgBiz Logic™: An economic, financial and environmental decision tool for farmers, ranchers and land managers	The Earth's climate is warming and will continue to warm throughout the next century. This has the potential to affect agriculture worldwide both positively (e.g., longer growing seasons) and negatively (e.g., increased heat stress) depending on the commodity (e.g., crop, livestock) and location. This poster presents a decision support tool called AgBiz Logic™ which allows producers to step into the world of 20-30 years from the present and consider how their current enterprises and operations will continue to serve them in the future. Then they can consider if there are any long-range planning decisions they may want to consider in order to maintain profitable operations. AgBiz Logic™ (ABL) is a cutting-edge web application for agribusinesses designed to help agricultural producers make short-, medium- and long-term investment decisions. This unique application is designed to collect, manage and optimize data from a variety of sources, from balance sheets and weather stations to site-specific zones in the field. The robust data lays the foundation for economic, financial, and environmental decision-support tools, which enable agribusiness professionals to make optimal choices that impact their bottom-line and environmental impacts. A unique component of AgBiz Logic™ is AgBizClimate™, an application that provides near-term climate change projections for average weather conditions relevant to agricultural commodities in a specific region. This tool allows producers to adjust their investments, commodities, and yields based on how they think such changes will affect their particular production process.	A18
Funmilayo Grace Oni, Theophillus O. Odekunle	Assessment of climate change on trend of maize (*Zea mays*) yield in southwestern Nigeria	Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food. Africa produces 6.5% of maize worldwide and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa, however, most maize production in Africa is rain fed. Thus, formulating practical, affordable and acceptable response strategies for maize production in Nigeria requires a study that evaluates the impacts of climate change on maize under varying climatic conditions over a period of twenty years in the southwestern Nigeria. Yield data of maize for twenty years (1983-2003) was sourced from the International Agricultural, Research and Teaching (IAR&T) Institute, Ibadan, Oyo state, Nigeria. Corresponding climatic data (minimum and maximum temperature, solar radiation and rainfall) for the period was obtained from the Nigeria Meteorological Agency (NIMET), Oshodi, Nigeria. The data set was smoothened and adjusted for appropriate statistical analysis to generate a model that could be adopted for seasonal planning and future yield optimization of *Zea mays* in the region. Keywords: *Zea mays*, climate change, yield optimization, southwestern Nigeria.	A19
John Antle, Elina Mu, Hongliang Zhang, Claudio O. Stöckle	Climate change impacts and adaption of Pacific Northwest wheat systems	This study examines how wheat production systems in the Inland Pacific Northwest respond, and maybe adapt, to climate change, under plausible future biophysical and socio-economic conditions. The analysis combines future climate and socio-economic scenarios with results of crop model simulations in an economic assessment model called TOA-MD. This model is used to average the impacts of climate change on the economic vulnerability of wheat producing farms, and how this vulnerability can be reduced through cropping system and management adaptations. Results show that the average impact of climate change is likely to be positive in this region but due to the heterogeneity of the wheat production system across farms under future climate conditions, a substantial proportion of farms could still be vulnerable to losses from climate change due to variations in weather, biophysical and socio-economic conditions. Secondly; while there is a high degree of uncertainty associated with climate change and with future scenarios, it is clear that the overall impact as well as the degree of vulnerability will depend substantially on future socio-economic conditions as well as climate change and farmers adaptation strategies.	A20

Authors	Title	Abstract
Mitchell Hunter, David Mortensen	Cover crops and drought: Implications for climate resilience	Cover crops are a potential climate adaptation tool, helping buffer soils against degradation during extreme precipitation events. However, it is less clear how cover crops will interact with drought, another projected effect of climate change. Therefore, it is important to consider potential cover crop impacts on cash crop drought physiology. I report results from two years of a field study investigating maize (*Zea mays*) responses to drought imposed following a functionally diverse set of cover crop treatments. Maize was grown in rotation with soybean (G*lycine max*) and wheat (*Triticum aestivum*) in a full-till organically managed system in central Pennsylvania. I am testing the following hypothesis: Cover crops affect the following cash crop's physiological responses to drought by a) transpiring soil water in the spring and b) altering nitrogen cycling and availability during the cash crop window. Preliminary results indicate that cover crop transpiration did not affect maize available water due to sufficient spring precipitation. However, cover crop effects on nitrogen (N) availability exerted strong control over maize drought responses. An ANCOVA with early-season chlorophyll meter readings and drought treatment explains 74% of the variation in kernel yield for year 1 ($p < 0.001$). Cover crops with higher C:N ratio biomass exacerbated corn drought stress due to N immobilization, while cover crops with lower C:N ratios mitigated drought stress due to N mineralization. These results have implications for cover cropping and N management strategies under climate change. A21
Michelle Miller, Dan Vimont, Alfonso Morales, Janey Camp	Creating a framework to assess climate change impacts on agriculture and transportation in the Upper Mississippi River Valley	A reoccurring challenge with increasing fuel prices is optimization of multi- and inter-modal freight transport to move products most efficiently. The experience of supply chain actors, projections for the future of agriculture in the U.S. and regional climate models indicate a shift in warm temperatures northward and potential shift in agricultural growing seasons and conditions for optimized crop yield. We expect to see changes in global markets for commodity crops, as well as national markets for animal feed and biofuels. Conservation challenges, especially due to extreme spring rainfall events and volatile temperature change, may also impact production decisions. This leads to a potential change in how much, where and with what fuel freight will be needed to move these crops in the future. Given recent history, we are already experiencing changes in regional weather trends and growing seasons likely due to climate change and these can be used as indicators of future changes. It would be beneficial for freight carriers to have an awareness of likely farmer and supply chain response to changes, and where and to what extent fleets will be needed to continue export of grains from the upper Midwest to the rest of the U.S. and the world. This project seeks to use recent historical climate, crop information and the input of supply chain actors, combined with regional climate modeling and other tools to project forward the demands on freight transportation for the upper Midwest grain distribution in the future. A22
Muhammad Aqeel Aslam, Mukhtar Ahmed, Fayyaz-ul-Hassan, Riffat Hayat, Claudio O. Stöckle	Is rain fed wheat productivity vulnerable to climate change?	Climate change impacts on crop productivity have threatened global food security. Global climate change continues to be a major concern in this century, and temperature is the main signal of the change on both global and regional scales. Wheat yield might be adversely effected by increase in seasonal temperature. The changing climate is adversely effecting wheat yield in rain fed areas of Pakistan. In the current study three crop simulation models (CropSyst, APSIM and DSSAT) were calibrated to ensure food security. The objective of the model comparison was to examine how different simulation models act at varying climatic locations across Pakistan when given minimal information for model validation and calibration. To calibrate crop models, the field experiment was carried out at three varying climatic conditions (high, medium and low rainfall) of Pothwar, Pakistan. The field experiment was laid out using RCBD four way factorial design. The treatments were four sowing times (21 Oct, 11 Nov, 1st Dec and 21 Dec), three varying climatic locations (Islamabad, Koont and Talagang), five wheat genotypes (NARC-2009,AUR-809,Pak-13,Chakwal-50 and Dhurabi) and the experiment was repeated for two years (2013-14 and 2014-15). The results showed that models performed very well for all study parameters. Highest grain yield (4.050 t/ha) recorded at Islamabad (High rainfall and low temperature) under optimum sowing time during second growing season while lowest grain yield recorded at Talagang (low rainfall and high temperature) under late sowing (1.28 t/ha). Less wheat yield production was a clear evidence of vulnerability of wheat crop to climate change. Meanwhile, models simulated results will be compared with observed data to utilized crop models as decision support tools for rain fed wheat production in Pakistan. Furthermore scenario analysis will also be conducted to design adaptation strategies for wheat crop in the context of climate variability. A23

Identifying and assessing adaption strategies

Authors	Title	Abstract	
Kamal Dutt Sharma, Rajesh Gera, Jagdev Singh	Physiological characteristics and yield improvement by *Arbuscular mycorrhizal* fungus in wheat under terminal warm environment	*Arbuscular mycorrhizal* (AM) fungi are ubiquitous root symbionts of more than 90% of vascular plants and are thought to contribute to plant nutrition, particularly phosphorus. The field experiment was conducted at CCS Haryana Agricultural University, Hisar. The experiment was designed in a split plot, with wheat genotypes, WH 1021, WH 1105, WH 1123, WH 1124, WH 1158 in main plots and seed treatment practices i.e., dry seeding, primed seed (seed soaking overnight in water), primed seed + AM fungi (*Glomus mosseae*), primed seed + *Azotobacter* in the sub plots with three replications under late sown situation. *Glomus mosseae* was introduced in the soil, and the crop seeds were also inoculated with the fungi before seeding. The crop was planted after a pre-sowing irrigation, and four post sowing irrigations were applied. Physiological characters, canopy temperature depression, membrane thermo stability and rates of photosynthesis of flag leaves were measured after anthesis. Yield-attributes and yields were recorded at harvest. The sowing of wheat genotypes with water primed and primed seed inoculated with AM fungi and *Azotobacter* increased grain yields by 2.4, 8.1 and 3.8 % respectively over conventional practice (3998 kg/ha) under late sown condition. The yield gains were mainly due to early seedling emergence and vigour, more numbers of spikes per plant and higher biomass and improved physiological traits like higher membrane stability and photosynthetic efficiency of flag leaf during anthesis. Among the genotypes, WH 1105 followed by WH 1158 showed significantly higher yield (4315 and 4278 kg/ha) respectively over the other tested genotypes/varieties due to higher membrane stability, more tillering and test weight. The increase in seed yield by seed priming and AM fungi was positively associated with days to emergence and heading, membrane stability and photosynthetic rate.	**B16**
Elnayer H. Suliman, Khalafalla A. Ali, Hanan A. Salman, Najda I. Elhag	The impacts of climate changes on agriculture and patterns of human migration in Gedarif State, Eastern Sudan	The experiments were conducted in Gedarif State, Eastern Sudan to study the impact of climate change on human migration in Eastern Sudan during the period 2008-2014. The results showed that the productivity of sorghum has decreased in the southern parts of the state from 1500 kg/ha in the 1970s to less than 410.4 kg/ha at the present time (2014). Additionally, sesame crop productivity has decreased from 1750 kg/ha to 278.4 kg/ha in 2014. In the northern parts of the State, sorghum production has decreased from 1050 kg/ha in the 1970s to 425 kg/ha in 2013. Increasing rates of out-migration from the region to the city of Gedarif and other cities in Sudan has increased rapidly. Immigration to the region has declined and the rate of annual population growth in the region has also declined, from 5.3% from 1983-1993 to 1.2% from 1993-2013. Populations may be migrating because the upper portions of the soil were removed by wind and water runoff (reducing soil productivity and food production sustainability) and deposited in the low lands. Additionally, increasing proportions of sand, especially in the northern parts, and increasing loss of surface water (excavations - rivers - coves - Maat) by evaporation were observed. Other factors recorded that could account for this change include imbalance in values and social systems and high crime rates. The conflicts between residents, farmers, pastoralists and invading nomads from Ethiopia and Eritrea were also recorded.	**B17**
Gopal Algarswamy, Jennifer Olson, Jeff Andersen, Nathan Moore, Joseph Maitima, Brian Mulenga, William Otim-Nape, Phillip Thornton, Pius Yanda	The impact of climate change on water and nitrogen deficits for maize production in East and Southern Africa	Warming temperatures and altered precipitation patterns are expected to affect productivity of maize, particularly in sub-Saharan Africa where water and nitrogen deficits already severely restrict harvests. This study examines impact of climate change on water and nitrogen deficits for maize productivity across East and Southern Africa, and tests the potential of management practices. The study region ranges from near-deserts in northern Kenya to savannas in Tanzania and Uganda, and extremely humid areas in Zambia. Coupled climate and the CERES Maize model embedded in DSSAT v. 4.0 were calibrated for the region, and point and spatial modeling were conducted using locally grown maize varieties. Historical climate data sets (observed, CHIRPS and WorldClim) and four GCMs downscaled to 6 km were used. Results include maps of where water and nitrogen deficits are expected to change, and potential benefits of management practices. Climate change will generally reduce yields due to warmer temperatures and higher water demand. However the study identified dry locations that will still have moderate temperatures and where lowering water deficits would have large yield benefits. Similarly, yield benefits to nitrogen fertilizer are expected to decline across large areas since fertilizer's ability to raise yields diminishes with higher water deficits. In wet zones, however, negative effects of climate change are related to more severe precipitation events leading to worsening nitrogen leaching. Multiple rather than single doses of nitrogen reduce yield variability and increase yield under these situations.	**B18**

| Authors	Title	Abstract
Ram A. Jat, Rahul P. Solanki, Naveen K. Jain	Tillage and residue retention influences on wheat grain yield and soil moisture content in groundnut-wheat cropping systems in semiarid western India	Climate change and variability has emerged as one of the major challenges to agriculture in the semiarid tropics (SAT) of India. A field experiment was initiated during *kharif*, 2012 to evaluate the effects of three tillage practices viz. conventional tillage (CT), minimum tillage (MT), and zero tillage (ZT); and three residue management practices viz. no residue application (NR), wheat residue application (WR), and wheat residue application+*Cassia tora* mulch (WCR) on moisture availability and yield of wheat in wheat-groundnut cropping system at ICAR-Directorate of Groundnut Research, Junagadh, India. The experiment was laid out in split plot design with three replications. The soil moisture content was measured in 0-15 cm depth at different growth stages of wheat following the gravimetric method during 2013-14 and 2014-15. The wheat grain yield was measured from three strips of 3x5 m each for each treatment plot, and was converted into kg/ha. During 2013-14 CT-NR gave highest grain yield of wheat whereas in 2014-15 ZT-WR gave highest wheat grain yield which was 35.9 % higher compared to CT-NR. The mean data of 2013-14 and 2014-15 revealed that MT-WCR and ZT-WCR had higher soil moisture percentage as compared to CT-WCR and other treatments during wheat growing period, however, difference was significant with CT-NR, MT-NR and ZT-NR only ($P<0.05$). It indicates that minimum and zero tillage are effective in improving soil moisture content when combined with surface retention of crop residues and other biomass. By outstretching moisture availability over a greater period, minimum and zero tillage along with residue retention, may help to reduce water stress related impacts of climate change and variability on wheat crop, and stabilize/improve yield in semiarid tropical regions of western India. **B19**
Gerard W. Wall, Laura M. Olivieri, Matthew M. Conely, Katherine West, Joseph Turner, Bruce A. Kimball	Thermal regime agronomic experiment	Global warming will alter thermal regimes of the Earth's major cereal grain production regions. Therefore, a need exists to elucidate thermal tolerant mechanisms in cereal grain crops and to what extent genetic controls are available for adaptation. Globally, semiarid desert regions experience some of the widest ranges in high temperatures over the course of a year. So, intra- and inter-annual variations in natural temperature provide a cost effective means to obtain robust data set for multiple cereal grain crops simultaneously. We intend to stagger planting dates from the normal cropping season in December to be at closer intervals in the April-May time frame to refine crop model thermal response curves at higher temperatures. Experimental artifacts such as photoperiod, soil properties, vapor pressure deficit, precipitation, and solar radiation are unavoidable, and may complicate interpretation of thermal response. Nevertheless, use of day-neutral cultivars without a vernalization requirement will minimize photoperiod effects and ensure floral induction regardless of planting date. Our objectives are: (1) determine cereal grain crop responses to a wide range of air temperature via planting date; (2) quantify crop growth; (3) evaluate and refine thermal response on crop growth and development; (4) validate crop growth models with regard to thermal dependent processes believed to be mediated through canopy energy balance. Study materials include: Wheat (*Tritium aestivum* L.); Durum Wheat (*T. durum* L.); Barley (*Hordeum vulgare* L.); *Triticalea* (x*TriticumSecale*) WheatxRye. Overall, 4 replicates of 4 cereal grain crops, over 8 planting dates (4 replicates within a year to determine intra-annual variability), over 2 years (inter-annual variability) will provide 384 differently treated crop responses over an air temperature range from -2 to 42°C. These data will be assembled and formatted in accordance with ICASA Version 2.0 standards, and be distributed to the AgMIP-wheat team for model improvement/validation as deemed appropriate. **B20**

Welcome to REACCH:
Project overview

Sanford Eigenbrode, Project Director (sanforde@uidaho.edu) UI

Some of the most productive wheat land in the world can be found in the Inland Pacific Northwest (IPNW) region, which includes northern Idaho, north central Oregon, and eastern Washington. The tremendous importance of cereal-based agriculture greatly impacts local economies, and influences regional culture and communities. The REACCH project is designed to enhance the sustainability of cereal production systems in the IPNW under ongoing and projected climate change, while contributing to climate change mitigation by reducing emissions of greenhouse gases. REACCH is a comprehensive response to the implications of climate change for the already challenging task of managing cereal production systems for long-term profitability. Scientists from many disciplines including engineering, climate science, agronomy, sociology and economics, are working together to ensure greater relevance of the information to regional cereal farmers and their associates. Our aim is to conduct the best agricultural science relevant to regional climate projections and the needs for adaptation and mitigation, and extend this science to stakeholders. In addition to our focus on the IPNW, REACCH sees itself as part of global efforts to help production systems adapt to climate change and mitigate the impacts of agriculture on the climate system.To address these challenges, integrated approaches like those underway within REACCH will be needed. We hope to contribute approaches useful in other regions and learn from successful efforts around the world.
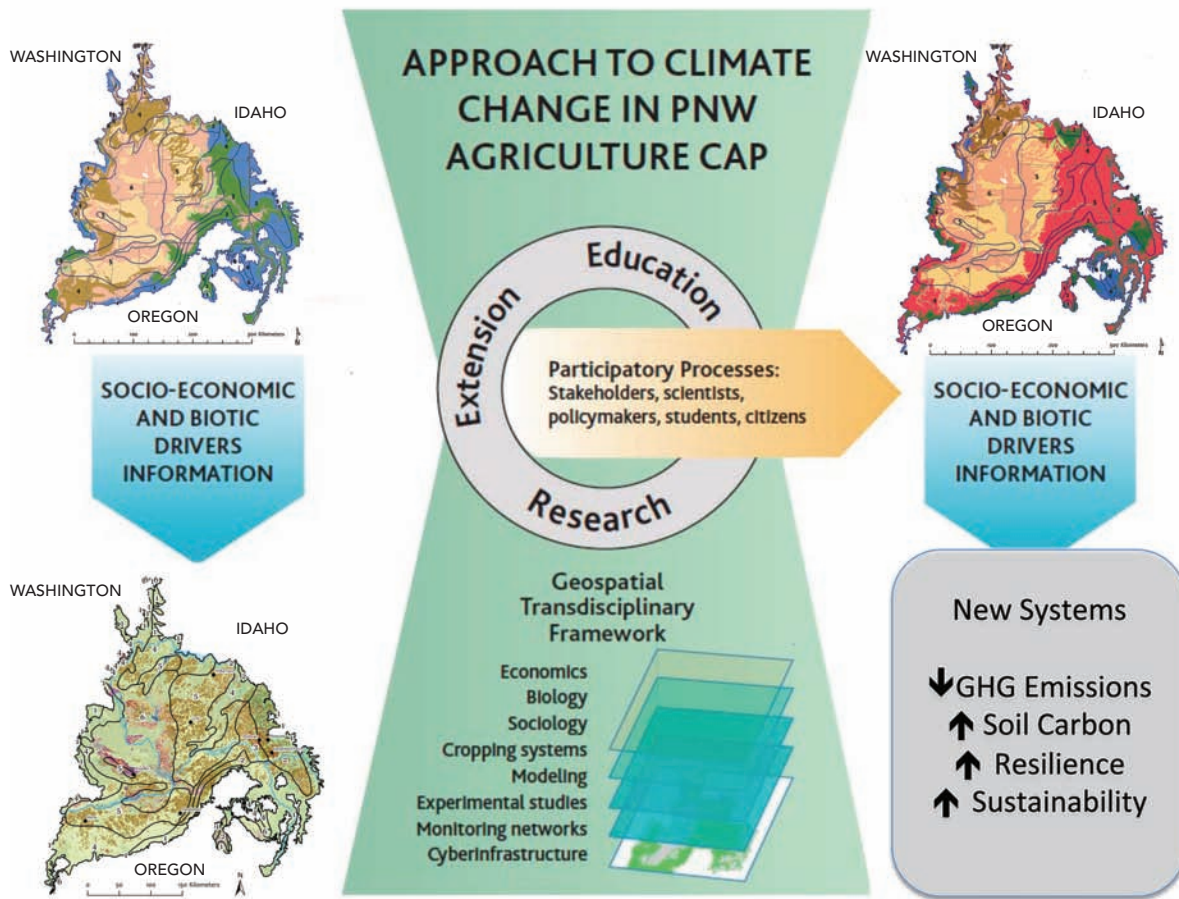
The REACCH project in overview. If the REACCH project could be represented in a single figure, it might look like this. The maps at the top show the climatically determined production zones of the REACCH region in their approximate distribution in 1990 (on the left) and in 2050 (on the right). Warmer summers and wetter winters cause these zones to shift, and create a new zone (in red) that has not existed in our region before. How will wheat production systems need to change to adapt to this shift? The project is using a transdisciplinary approach (involving social and biological sciences, stakeholder involvement, Extension and education) to help this happen in a way that remains profitable, conserves the soil resource, increases resilience, and reduces emissions that can exacerbate climate change.

Proposal for a Special Issue of a Prominent International Journal

Title of the Issue:
Transitioning Cereal Systems to Adapt to Climate Change

Description of Scope:
The following proposal for a special issue based around the themes of our conference has been welcomed for review by two prominent international journals. Publication is anticipated within one year of completion of this conference. The articles in this special issue concern the integrated approaches needed to address the challenges of changing climates for cereal production systems around the world. Many of these systems are rain fed and already water limited. Projected increasing temperatures and changing precipitation patterns will demand rapid adaptation to ensure productivity is maintained or increased in response to increasing demands for food production. Achieving this requires not only technological innovation, but coupling this with efforts that incorporate the economic and social aspects of these systems, cropping system management and alternative designs, crop protection, and others. Most of the contributions to the issue are developed from presentations at our Transitioning Cereal Systems to Adapt to Climate Change conference/workshop. With support from the National Institute of Food and Agriculture, the University of Idaho, Washington State University, Oregon State University, CHS Primeland and other donors, our conference assembled scientists from around the globe to discuss the interdisciplinary and disciplinary aspects of climate change and cereal production. Papers range from disciplinary to broadly interdisciplinary, but all seek to identify needs and best practices to achieve transdisciplinary integration.

Names and Affiliations of Guest Editors:
Sanford D. Eigenbrode, University of Idaho
David R. Huggins, USDA-ARS, Pullman, Washington

Structure and Contributions:
The proposed volume will be divided into thematic sections.

Preface

1. Overview of the special issue: Transitioning cereal systems to adapt to climate change
   S. D. Eigenbrode[1] and D. R. Huggins[2,] [1]University of Idaho, [2]USDA-ARS

Synthesis

2. Position paper: An agenda for cooperation and collaborative, transdisciplinary research to address climate change and cereal systems
   J. Antle[1], E. Brooks[2], P. Binns[3], S. D. Eigenbrode[4], P. Gessler[5], K. Gill[6], J. Hatfield[7], H. Herren[8], D. R. Huggins[9], J. Kirkegaard[10], C. E. Kruger1[1], B. K. Lamb[12], B. McCarl[13], W. Pan[6], G. P. Robertson[14], C. O. Stöckle[15], C. Valdivia[16], et al. (other contributors)

Section – Challenges Across the Globe

3. Challenges and responses to ongoing and projected climate change for dryland cereal production systems throughout the world
   P. Aggarwal[1], D. Calderini[2], P. Craufurd[3], Xue Han[4], J. Hatfield[5] : [1]CCAFS, [2]Plant Production and Health, Austral University, [3]ICRISAT, India, [4]Chinese Academy of Agricultural Sciences, [5]USDA-ARS, Ames Iowa

Section – Conserving Services and Resources – Water, Nutrients, Soil Health (coordinators, Kruger and Huggins)

4. Understanding the importance of managing climate risk in the restoration and conservation of natural capital in the dryland cereal systems
   A. Whitbread, ICRISAT, Pancheru

5. Transitioning cereal systems to adapt to climate change – the growing importance of irrigation
   S. Siebert, G. Zhao, H. Webber, F. Ewert, Institute for Crop Science and Resource Conservation, University of Bonn, Katzenburgweg 5, 53115 Bonn, Germany

Section – Cropping System Designs (coordinators, Pan and Kirkegaard)

6. Translation of nutrient use analytics into climate-adaptable nutrient management strategies for global semiarid cereal cropping systems
W. Pan[1], P. Fixen[2], B. Govaerts[3], D. Huggins[4], J. Kirkegaard[5], T. Maaz[1] : [1]Washington State University, [2]IPNI, [3]CIMMYT, [4]USDA-ARS, [5]CSIRO

7. Environmental, ecological, economic, extension and policy drivers for cereal rotation diversification
T. Maaz[1], P. Fixen[2], B. Govaerts[3], J. Kirkegaard[4], V. McCracken[1], W. Pan[1] : [1]Washington State University, [2]IPNI, [3]CIMMYT, [4]CSIRO

8. Crop-animal integration for improving farming systems resilience to climate change.
J. Kirkegaard[1], B. Govaerts[2], D. Lyons[3], D. Huggins[4], K. Johnson[1], S. Niebergs[1], W. Pan[3] : [1]CSIRO, [2]CIMMYT, [3]Washington State University, [4]USDA-ARS

9. Soil nutrient management for mitigation of and adaption to climate change
Peter P. Motavalli, Soil, Environmental and Atmospheric Sciences, University of Missouri

Section – Data and Data Management (coordinator, Gessler)

10. Strategies for the management, curation, and sharing of agricultural research data amongst global research groups focused on cereal grain production and food security
P.E. Gessler[1], M. Devare[2], P. Fitch[3], E.D. Yeumo[4], C. Porter[5], E. Seamon[1], E. Flathers[1] : [1]University of Idaho, [2]CGIAR, [3]CSIRO, [4]Research Data Alliance & INRA, [5]University of Florida

Section – Pests, Weeds and Diseases (coordinator, Eigenbrode)

11. The 'Push-Pull' farming system: Climate-smart, sustainable agriculture for cereal-livestock production in Africa
Zeyaur Khan, ICIPE, Nairobi

12. From impact assessment to climate change adaptation: what do we need to know for invertebrate pest management in grains?
S. Macfadyen[1], G. McDonald[2], M. Hill[3] : [1]CSIRO, Canberra, Australia, [2]The University of Melbourne, [3]Centre for Invasion Biology, Department of Conservation Ecology & Entomology, Stellenbosch University, South Africa

13. Climate change, CO_2 and weed biology: Yield threats and management consequences
Lewis H. Ziska, Ph.D., Crop Systems and Global Change Laboratory, USDA-ARS.

Section – Working with Producers, Communities and Other Stakeholders

14. Useful knowledge for local level adaptation: Opportunities and barriers
Gilles, Jere L., Rural Sociology, University of Missouri

15. Farmer risk perception and adaptation to cereals production in the Pacific Northwest
J.D. Wulfhorst, University of Idaho

16. The human dimensions of agro-ecosystem resilience in an uncertain world: Livelihood decisions, uncertainty, and translational approaches in rain fed semiarid ecosystems of the tropics
C. Valdivia, University of Missouri

Section – Coordinating Breeding and Agronomy (G x E x M) (coordinator, TBD)

17. Addressing climate challenges in cereal systems by attending to genetic x environment x management interactions: breeders' perspective

Section – Identifying and assessing adaptation strategies (coordinator, Antle)

18. Using agronomic and economic models to assess adaptation and resilience of agricultural systems to weather variability, extremes and climate change
John M. Antle[1], James W. Jones[2] and Bruce McCarl[3] : [1]Dept of Applied Economics, Oregon State University, [2]Dept of Agricultural and Biological Engineering, University of Florida, [3]Dept of Agricultural Economics, Texas A&M University.

Section – Greenhouse gas monitoring and mitigation (coordinators, Lamb and Roberston)

19. Nitrous oxide response to nitrogen fertilizer in irrigated spring wheat in the Yaqui Valley, Mexico
Neville Millar[1,2], Abisai Urrea[3], Kevin Kahmark[1], Ivan Ortiz-Monasterio[3], and G. Philip Robertson[1,2] : [1]W.K. Kellogg Biological Station, Michigan State University, [2]Dept. of Plant, Soil and Microbial Sciences, Michigan State University, [3]CIMMYT, Mexico,

## Section – Integration themes (coordinators, Eigenbrode and Huggins)

20. International Wheat Initiative: A network promoting genetic improvement and utilization of wheat
H. Braun, H. Lucas, others (tentative)

21. Transdisciplinary integration to address climate change in a cereal producing region: Case study–the REACCH project
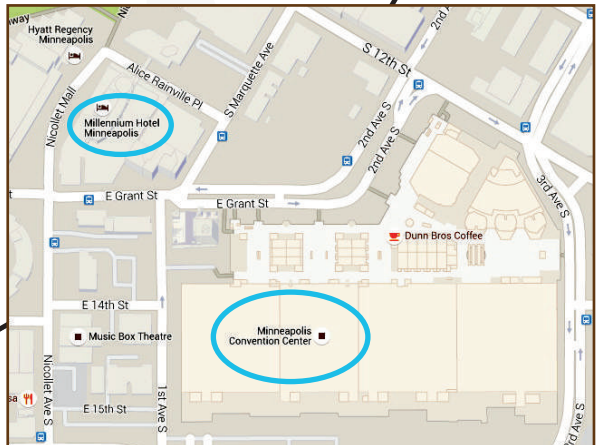S. D. Eigenbrode, et al., University of Idaho

Plenary Meeting Room

Breakout Rooms

Gathering Tables

Registration

Lunch/Poster Reception

Coffee Break

Speaker Ready Room
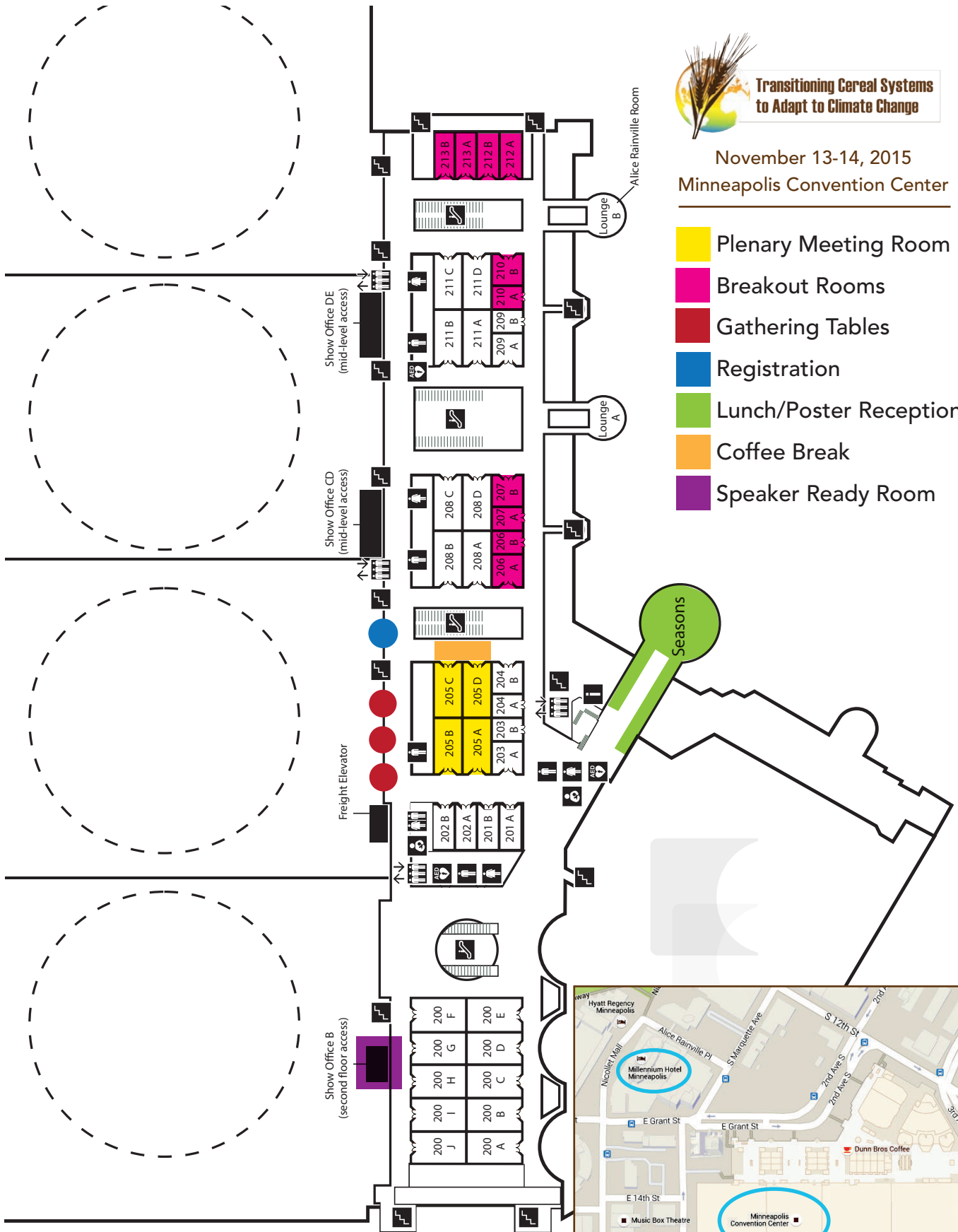
Vicinity map for Millenium Hotel in
downtown Minneapolis

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Developing a global network to integrate approaches to address changes in cereal production due to climate change in semiarid regions.

www.aridcereals.org

REACCH
Regional Approaches
to Climate Change –
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