SAES-422 Multistate Research Activity Accomplishments Report

Project No. and Title:	NC1179 Food, Feed, Fuel, and Fiber: Security Under a Changing Climate
Period Covered:	05-2011 to 05-2012
Date of Report:	31-Aug-2012
Annual Meeting Dates:	May 31, 2012 (01:00 PM) to June 1, 2012 (03:00 PM) at NWS Training Facility in Kansas City

Participants

Mickey Ransom, Bob Seem, F. Abel Ponce de Leon (Administrative Advisor), Clyde Fraisse (in person 5-31), Dennis Todey, Beth Hall, Mingchu Zhang, Steve Hu, Jim Angel, Linda Prokopy, Adnan Akyuz (via phone on 5-31), Qingwu Xue (via phone), Jeff Andresen (via phone on 5-31 and 6-1), Ken Hubbard (via phone on 5-31 and 6-1), Karen Garrett (via phone on 5-31; in person 6-1), Pat Guinan (in person 6-1), Ray Knighton (via phone on 6-1)

Brief Summary of Minutes of Annual Meeting

NC1179 Meeting
May 31 and June 1, 2012
National Weather Service Training Center, Kansas City, MO

1) Meeting started at 2 p.m.
2) Participants - Mickey Ransom, Bob Seem, F. Abel Ponce de Leon (Administrative Advisor), Clyde Fraisse (in person 5-31), Dennis Todey, Beth Hall, Mingchu Zhang, Steve Hu, Jim Angel, Linda Prokopy, Adnan Akyuz (via phone on 5-31), Qingwu Xue (via phone), Jeff Andresen (via phone on 5-31 and 6-1), Ken Hubbard (via phone on 5-31 and 6-1), Karen Garrett (via phone on 5-31; in person 6-1), Pat Guinan (in person 6-1), Ray Knighton (via phone on 6-1)
3) Introductions
4) Goals for the meeting
    a) Objectives
    b) Time lines
        i) Approved from October 2009 – October 2014
    c) State reports
    d) Officer selections
        i) Chair
        ii) Vice-Chair
        iii) Secretary
    e) Location and time of next meeting
5) Went over the objectives of the project (see project proposal)
    a) Enhance the understanding of crop-climate-soil interaction at a regional scale
    b) Application of risk assessment tools, including the existing NC-1018 database, for the crop-climate-soils interface on a regional scale.
    c) Enhance the understanding of potential bioenergy production systems.

   d) Disseminate the research outcomes on the potential effects of climate variability and climate change effects on crop production resource use and adaptation options to users and stakeholders
6) Timelines or milestones (see project proposal)

(2009): Develop a framework for testing or creating a new climatology based on climate change prediction scenario.

(2010): Create or adopt a climate change scenario for the North Central Region based on the A1B scenario or other scenario deemed appropriate by the committee.

Addition of three new variables (leaf wetness, soil moisture content, wind speed) to the existing database

(2011): Incorporate new variables into models that forecast disease, insect, weed and other stresses.

Update current database with measured data for the period of the end of the current database through 2010.

(2012): Update current database with measured data for the period of the end of the current database through 2010.

Evaluation and comparison of modeled crop responses to environmental stress and responses to predicted climate change.

Evaluation of the best locations in the North Central Region to establish new biofuel crops based on soil-crop-environmental systems, including water resources.

(2013): Evaluation and comparison of modeled crop responses to environmental stress and responses to predicted climate change.

Evaluation of bioenergy feedstocks and cropping systems that supply food, fiber and feedstocks while protecting soil and water quality.

Evaluation of the socioeconomic responses to crop production systems in the region and the change dynamics that impact where people live and work.

7) Jim Andresen presented an update on the progress of the U2U funded project
   a) Some of the objectives of this group overlap with some of our objectives
   b) The U2U project does run crop models
   c) The models do incorporate some soil parameters but the resolution is very coarse
   d) Bob Seems suggested that this group might be able to use our existing dataset
8) Discussion of the existing database
   a) It still resides online at the University of Illinois
   b) The data base can be updated
   c) Should we work on getting additional variables in the database
   d) Ken Hubbard mentioned the need to get soil moisture sensors
      i) 10, 25, 50, and 100 cm depths using TDR probes
      ii) University of Washington is also doing measurements of soil moisture

iii) Clyde Fraisse mentioned that the University of Florida is also making some measurements
iv) Dennis Todey mentioned that the Corps of Engineers may be funding soil moistures sensors for several of the states within the Missouri River basin
v) U2U has also discussed measuring soil moisture
vi) Funding is potentially available for measuring soil moisture
vii) Jeff Andersen mentioned the high variability of soil moisture measurements
viii) Bob Seem mentioned the need to add leaf wetness or surface wetness
(1) Clyde Fraisse supported this need
(2) Used mostly for horticultural crops
(3) Also useful for predicting disease outbreaks in wheat
ix) Consensus was to update the database

9) Administrative Advisor's Report – F. Abel Ponce de Leon
a) Work needs to be done this year if we plan to renew
i) Establish a group to draft the proposal
ii) What we need to do
(1) Membership
(2) Integration of research
(3) Leveraging the financial support
(a) Conducive to proposal development
(b) Show that the committee is effective in related proposal development
(4) Develop new set of objective
iii) $36 more million if FY12 from NIFA
iv) APLU has proposed a single line item for funding instead of the current approximately 50 line items
(1) Did not pass this year
(2) Will probably be revisited next year.
v) FY13 will have significant cuts (potentially 10% cut across the board)
(1) For USDA, a significant part of the budget is not touchable, so the cuts will be considerably more than 10%
vi) After this meeting, we have 60 days to submit a project report
(1) Should contain impacts
(2) AD-422
vii) Recommended structure for administration
(1) Chair
(2) Chair-elect
(3) Secretary
(4) Secretary-elect
(5) In general, these are one year terms

10) Discussion of impacts for the report this year

11) Discussion of the purpose of the database used and developed by the committee
a) Historical
b) Members of this committee have used the database
c) Has been used by crops modelers
d) Discussion about the need to make sure that the database is available
e) The program used to put the database together used punch cards

12) Discussed the history of the committee and how that might be documented
    a) Dennis Todey and Jim Angel agreed to head up an effort to document the history
13) State reports on 5-31
    a) Adnan Akyuz – North Dakota State University
14) State reports on 6-1
    a) Bob Seem – Cornell University
    b) Mickey Ransom – Kansas State University (also reported for Scott Staggenborg and John Holman)
    c) Karen Garrett – Kansas State University
    d) Pat Guinan – University of Missouri
    e) Linda Prokopy – Purdue University
        i) Gave an update on the U2U project
    f) Dennis Todey – South Dakota State University
    g) Steve Hu – University of Nebraska
    h) Mingchu Zhang – University of Alaska, Fairbanks
15) NIFA report from Ray Knighton
    a) Ask for questions about Federal funding
    b) RFA's are coming out if August for FY13
        i) Can't give out specific information
        ii) There is no hard date yet
        iii) Challenge areas will be the same as those sponsored in the past
        iv) Could be some change to the challenge areas in FY14
        v) Foundational programs will be of interest to soil scientists
        vi) Also a program on climate change
        vii) Programs funded the first year are using a sizeable portion of the budget
        viii) More funds are expected to be available for FY14
        ix) Sonny Ramaswami will be the new Director of NIFA
16) Officers effective now (one year terms)
    a) Adnan Akyuz– Past Chair
    b) Clyde Fraisse – Chair
    c) Karen Garrett – Chair Elect
    d) Pat Guinan - Secretary
17) Discussion of Meeting Location
    a) Tag along with U2U one week earlier – week before Memorial Day
18) Discussion of preparation of SAES – 422 Annual Report
    a) Emphasized the need to have collaboration activities that fit into the project objectives
    b) Everyone needs to submit their CRIS report to Karen Garrett if they have a report specific to this committee
19) Will have to decide at the meeting next year if we will seek renewal of the committee
20) Meeting adjourned at 12:15 pm

Accomplishments

1. Enhance the understanding of crop-climate-soil interaction at a regional scale

Addressed by Lupo and Guinan using the National Center for Environmental Prediction (NCEP) re-analyses. These are available via the Mass Store Facility at the National Center for Atmospheric Research in Boulder, CO, and a complete description of the data set can be found at: http://www.cdc.noaa.gov/cdc/reanalysis/. The dynamic diagnostics used in the examination of blocking have been described in Burkhardt and Lupo (2005). These methods would be used for objectives 1), 2), and 4). The blocking criterion of Lupo and Smith (1995a) were used in this study, and this can be summarized as a combination of the Rex (1950) subjective criterion and the Lejenas and Okland (1983) objective criterion, with the exception that a "block" is defined as persisting for five days or more. The method for finding interannual and interdecadal variations in a dataset are taken from Mokhov et al. (2004) and can be described here briefly. The data set needed for this set of calculations would be a time series of, for example monthly mean temperatures and precipitation values, and these can be acquired from the Missouri Climate Center and the Midwestern Regional Climate Center (e.g, Berger et al., 2003). These methods would be useful in obtaining objective 3). This methodology is called here the "method of cycles" following (e.g., Mokhov and Eliseev, 1998; Mokhov et al., 2000; Mokhov et al. 2004). The studies cited above have used these methodologies to examine the variations of ENSO amplitudes and periods as determined from Pacific Region SSTs, the variations of temperatures in the lower tropical stratosphere, and the variations in globally averaged temperatures. Chaos Theory is a new way in which people can interact with and describe nature (e.g., Lorenz, 1993). Chaos can be defined as order without periodicity (e.g., Lorenz, 1993). In atmospheric analysis, this type of research began with an examination of the classic Rayleigh - Barnard convection problem (e.g., Lorenz, 1963), and there are basically three ways one can determine whether or not chaos exists within a given system, or a system is chaotic. These are: a low autocorrelation function: this would indicate that a system has poor internal "memory", or strong internal dynamics, calculate spectral density: if after you calculate spectral density from a set of data, and no frequencies rise above the background noise, then a system is could be chaotic, otherwise such a system would be quasi-periodic, one or more positive Lyapunov exponents. The characteristic of chaotic systems are: the system is a dissipative, the system is sensitively dependent on initial conditions, and the system can be characterized by fractal geometry. A Lyapunov exponent is a value that defines the average rate of divergence/convergence of nearby trajectories. They arise mathematically from the solutions to (eigenvalues of) equations that describe motion within a system.

Wheat experiments by Xue and colleagues: Field experiments have been conducted at 2 locations under 2 soil water regimes (irrigated and dryland) among 10 genotypes with a wide range of genetic background and yield potential. Quantified seasonal water use by monitoring soil water content, precipitation and the amount of irrigation; measured canopy temperature depression to differentiate drought and high temperature tolerance among wheat genotypes, using wireless infrared thermometers (IRTs), hand-held IRTs and thermal camera; measured CO_2 assimilation rate, stomatal conductance, transpiration and water use efficiency at leaf level in dryland plots; analyzed biomass accumulation, yield components, harvest index, and carbon remobilization among wheat genotypes. **Corn experiments by Xue and colleagues:** Field experiment was conducted in 3 high yielding hybrids at 4 planting densities. We limited the amount of irrigation less than 300 mm. Quantified seasonal evapotranspiration (ET); measured plant height, and aboveground biomass at silking and maturity; measured CO_2 assimilation rate, stomatal conductance, transpiration and water use efficiency at leaf level during grain filling; quantified yield components, harvest index, and water use efficiency. **Sorghum experiments by Xue and colleagues:** Field experiment has been conducted in 3 irrigation regimes (dryland, limited irrigation and full irrigation) and 6 fertilization treatments. Data collections included soil N and P levels before planting and after harvest, CO_2 assimilation rate, stomatal conductance, transpiration and water use efficiency at leaf level, biomass, yield, and yield components. Climate change and variability along with decreasing profit margins require that decision tools be developed to more efficiently manage agricultural systems. Xue and colleagues examine soil climate crop interactions with a view towards developing better cropping systems in a semi-arid environment. The overall goal of this research has been to devise and to implement intensified, income-oriented cropping systems for the Texas High Plains that address major production constraints including drought, soil degradation, falling water tables, and rising energy costs. This will be accomplished through the introduction of drought-tolerant species and cultivars, and increased reliance upon forage crops. Our goal is to provide producers with a range of cropping system alternatives that fit their resources and production objectives.

2. Application of risk assessment tools, including the existing NC-1018 database, for the crop-climate-soils interface on a regional scale.

Also addressed by Lupo and Guinan using the National Center for Environmental Prediction (NCEP) re-analyses. These are available via the Mass Store Facility at the National Center for Atmospheric Research in Boulder, CO, and a complete description of the data set can be found at: http://www.cdc.noaa.gov/cdc/reanalysis/.

Seem and colleagues have been studying the interactions between winter chilling, asynchronous crop phenology, ontogenic resistance, and the risk of disease in grapevine and other perennial fruit crops. Minimum chilling requirements of perennial fruit crops have been extensively studied, but little is known of how the degree and depth of winter chilling affects synchronization of host regrowth upon emergence from dormancy. The European grapevine species *Vitis vinifera* is a useful model system for studying the interactions between chilling, asynchronous phenology, development of ontogenic resistance, and the consequent risk of disease. The mean winter temperature ranged from -4.1 to 11.8C among 15 vineyard sites on 3 continents, and was associated with duration of bloom at each site: 2 d at the coldest sites, and > 2 wks at the warmest sites. This 7-fold increase in the duration of bloom directly translated to protracted susceptibility of grape berries due to their delayed acquisition of ontogenic resistance to major fungal pathogens, including *Erysiphe necator* and *Plasmopara viticola*. Downstream effects of asynchronous bloom such as asynchronous ripening and sugar accumulation also were recorded. Asynchronous regrowth following unusually warm winters has been noted in grapevine, apple, and stone fruits. This asynchrony could prolong the risk of disease in many pathosystems typified by phenology-defined windows of susceptibility to infection. The impact of climate change on the foregoing can be projected by examining these interactions across extant climatic gradients.
Impacts: Disease management strategies must be adjusted to better coincide with the periods of susceptibility of crops to major pathogens. In the case of our model system, grapes, protection of fruit from major pathogens, such as grape powdery and downy mildews, will need to be

extended over a longer period of time during the growing season in regions with warmer climates. The same adjustment will need to be made as regions of cooler climates experience warmer winters and springs.

Outputs from Hu and colleagues

1) The observed daily soil temperatures at 295 stations in the contiguous United States were updated from 2001 to 2010. The data during 2001-2010 are quality controlled following the procedures described in Hu and Feng (2003).
2) Drought is one of major natural disasters that damage the crop growth and yield. To evaluate the possible impact of the drought on agriculture, the Palmer Drought Severity Index (PDSI) and the Standardized Precipitation-Evapotranspiration Index (SPEI) were both modified so that they can be used to evaluate the drought variability based on the common calibration period (e.g., 1971-2000). The modified indices are termed as relative PDSI (rPDSI) and relative SPEI (rSPEI), respectively. The rPDSI, and the 1-month, 6-month and the 12-month rSPEI for North America were computed using the observed and projected future temperature and precipitation from 1900-2099. The observed and projected future drought occurrences in the Great Plains as well as the global land areas were also analyzed.
3) The projected monthly temperature and precipitation during 2040-59 under three greenhouse gases emission scenarios (A2, A1b and B1) for 4 watersheds in Nebraska were developed. Based on the projected rates of change in monthly temperature and precipitation, daily averaged temperature and precipitation in the middle of the twenty-first century were calculated using a stochastic weather generator (LARS-WG 5.0, Semenov and Stratonovitch, 2010). These generated daily temperature and precipitation changes were further used to drive the SWAT model to simulate the possible impact of climate changes on water quantities and qualities in the 4 watersheds in Nebraska.

1) Soil temperature changes

The changes in soil temperature in the contiguous United States were analyzed. The results show consistent warming during the past 40 years.

2) Observed and projected future drought variability

a) The annual temperature is projected to increase by 2-4ºC in the Great Plains. Nebraska is expected to warm by 3.0-3.5ºC by the end of the twenty-first century.

b) The annual precipitation is projected to decrease by 5-15% in the southern Great Plains, and to increase by 5-10% in the northern Great Plains.

c) Persistent drying is projected over most of the contiguous U.S. The projected drought is most severe in the Southwest US (SWUS) and the southern Great Plains. The northeast U.S. will be in neutral or slightly wetter conditions by the end of this century.

d) The exceptional drought during the instrumental period (1948-present) will become the norm by the end of this century, especially over the SWUS and the southern Great Plains.

e) Moderate to severe droughts will become the norm in Nebraska by the end of this century.

3) Impact of the climate change on water quantities and qualities in Nebraska

a) Notable differences in water quality response from the four watersheds in Nebraska were apparent from simulations that were performed using a baseline and the three future climatic conditions. These differences in responses were attributed to soil and climatic factors that govern water balance and the fate and transport of sediment, nitrogen, and phosphorus.

b) Under the future climate change scenarios examined in this study, modest to moderate increases in streamflow, sediment, and nutrients are projected to occur on Shell Creek while substantial increases are expected for Logan Creek. Findings from this study also suggest that future projected increases in both precipitation and CO_2 concentration account for net increases in streamflow, but in very different ways on each watershed

Garrett and colleagues have evaluated the effects of variance and color in weather time series on potential yield losses to disease (Garrett et al., in press-a), in addition to general analyses of how information about the effects of weather on plant disease risk can be used to improve IPM adaptation to climate change (Garrett et al., in press-b; Garrett 2012; Cox et al., in revision; Borer et al. 2011; Skelsey et al., in review; Sutrave et al. 2012). We have also evaluated the role of microbial resources in adaptation to climate change (Beed et al 2011). In related teaching publications we have demonstrated the use of models for students (Garrett et al. in press-c).

Outputs from Hu and colleagues

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c) Notable differences in water quality response from the four watersheds in Nebraska were apparent from simulations that were performed using a baseline and the three future climatic conditions. These differences in responses were attributed to soil and climatic factors that govern water balance and the fate and transport of sediment, nitrogen, and phosphorus.

d) Under the future climate change scenarios examined in this study, modest to moderate increases in streamflow, sediment, and nutrients are projected to occur on Shell Creek while substantial increases are expected for Logan Creek. Findings from this study also suggest that future projected increases in both precipitation and CO_2 concentration account for net increases in streamflow, but in very different ways on each watershed

3. Enhance the understanding of potential bioenergy production systems.

Ransom and colleagues used crop simulation models to examine the impacts of cropping systems within the 10 states of the North Central Region. The project accomplished activities related to modeling and weather data collection and dissemination. Biotic system models have been used to investigate soil carbon dynamics, the performance of cellulosic biofuel crops, and the impact of biomass removal on soil quality and soil erosion. Crop models were used to evaluate the potential impact of climate change on crops in Western Kansas. In regards to weather data collection and dissemination, the mesonet was expanded in Kansas, which included the deployment of soil moisture sensors. The results were distributed to peers, crop producers, and policy makers through peer-reviewed research articles, presentations at scientific society meetings, extension publications, and web-based publications.

The work of Ransom and colleagues shows that crop models are useful tools in studying cropping system performance within a region. The results from the simulations will allow producers and policy makers to develop programs aimed at maintaining rural economic viability under a changing climate coupled with a decline in the availability of ground water.. The coupling of a crop model, a soil drainage model, and an economic model resulted in initial evaluations of crop selection and irrigation practices on recharge in the Ogallala Aquifer. The addition of soil moisture sensors to the mesonet has expanded soil moisture monitoring efforts.

Data will be obtained for work by Lupo and Guinan via the Missouri Climate Center and the Midwest Climate Center.

4. Disseminate the research outcomes on the potential effects of climate variability and climate change effects on crop production resource use and adaptation options to users and stakeholders.

Team members have presented results through extension programs and through teaching, in addition to publications as listed below.

The main outputs of work by Hoogenboom and colleagues are the environmental data that are being collected by AgWeatherNet. AgWeatherNet is a network of 138 automated weather stations that are located across the state of Washington. It produces a detailed database that can be used for scientific modeling applications as well as for decision making by stakeholders through the AgWeatherNet web site www.weather.wsu.edu. Staff of AgWeatherNet participated in the Washington State Wine Grape Growers Annual Meeting to introduce AgWeatherNet and its associated weather data and models to local growers and other stakeholders. A presentation was also made during the Annual Meeting of the Washington Potato Growers.

The investigator is also involved in the development of the Decision Support System for Agrotechnology Transfer (DSSAT), a crop modeling system for over 25 crops, and that is being used by several modelers associated with the regional project. The software can be obtained from the DSSAT Foundation web site (www.DSSAT.net) that is currently under development. The investigator participated in a international workshop on DSSAT at the International Fertilizer Development Center in which more than 60 international scientists were trained on the use and application of crop simulation models and decision support systems.

IMPACT: Most climate change studies that address potential impacts and potential adaptation strategies are largely based on modeling technologies. While models are useful for visualizing potential future outcomes and pathways and evaluating options for potential adaptation, they do not adequately represent and integrate adaptive human agency. Richards' concept of 'agriculture as performance' is useful in counterbalancing the modeling approach to adaptation because it highlights how adaptive processes and technologies, whether short term or long term, are more than simple technical responses to biophysical conditions. Instead, adaptive processes are social phenomena whose significance and effects expand well beyond changing climate conditions. It is unlikely that either is adequate to meet the challenges posed by the uncertainties associated with climate change. However, building a synergistic relationship between the two promises to be as difficult as it is necessary. We evaluated the performance of the Agricultural Land Management Alternative with Numerical Assessment Criteria (ALMANAC) model for simulating switchgrass performance based on experimental data that were collected in Alabama. We found that this modeling approach can help plan bioenergy systems that are based on switchgrass. A study was conducted to to estimate the changes in Soil Organic Carbon (SOC) for different cropping systems encompassing eight crop rotations in West Africa using the Cropping System Model (CSM) of the Decision Support System for Agrotechnology Transfer (DSSAT) a simulation model. The CSM was able to simulate the yield trends of various crops, with inconsistencies for a few years. The simulated SOC increased slightly across the years for the sorghum–fallow rotation with manure application. However, SOC decreased for all other rotations except for the continuous fallow (native grassland), in which the SOC remained stable. Following careful evaluation of the CSM with observed soil organic matter (SOM) data similar to the study presented here, there are many opportunities for the application of the CSM for carbon sequestration and resource management. The predictions from the Weather Research and Forecasting (WRF) model were used for developing high resolution spatial and temporal forecast maps of favorable conditions for thrips' development, including locations where weather stations are not available. Tobacco thrips and western flower thrips were evaluated based on degree-day models. An accurate prediction of pest development based on forecasts of favorable conditions may assist growers in pest management decisions and in timely application of insecticides.

Action Items

The NC1179 team has a wide range of important achievements. In the coming year we will emphasize integration of these projects to produce projects that are greater than the sum of the parts.

Publications

Van Liew, M.W., S. Feng and T.B. Pathak (2011). Climate change impacts on streamflow, water quality and best management practices for the Shell and Logan Creek Watersheds in Nebraska. International Agricultural Engineering Journal (in review)

Van Liew, M.W., S. Feng and T. B. Pathak (2011). Assessing climate change impact on runoff and water quality at the field scale for four locations in the Heartland. Transaction of ASAE (in review).

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Gadoury, D.M., Cadle-Davidson, L., Wilcox, W.F., Dry, I.B., Seem, R.C., and Milgroom, M.G. 2012. Grapevine Powdery Mildew (*Erysiphe necator*): a Fascinating System for the Study of the Biology, Ecology, and Epidemiology of an Obligate Biotroph. Mol. Plant Pathol. 13:1-16.

Gadoury, D.M., Wakefield, L.M., Cadle-Davidson, L., Dry, I.B., and Seem, R.C. 2012. Effects prior vegetative growth, inoculum density, light, and mating on conidiation of *Erisyphe necator*. Phytopathology 102:65-72.

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