The following is a summary of the FY2006 progress report for the 2004-2009 research project entitled:

INTEGRATION OF CLIMATE VARIABILITY AND FORECASTS INTO RISK-BASED MANAGEMENT TOOLS FOR AGRICULTURE PRODUCTION AND RESOURCE CONSERVATION

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What major problem or issue is being resolved and how are you resolving it? How serious is the problem? Why does it matter?

Statement of problem: Agricultural production, conservation efforts and sustainable utilization of natural resources are sensitive to climatic variations. Particularly in the Southern Great Plains, year-to-year variations in precipitation are pronounced, and persistent dry or wet conditions often result in environmental impacts and agricultural losses on the order of several billion dollars. Losses affect farmers and ranchers, the economic well-being of rural communities, the consumer through volatile prices and irregular supplies, and the natural resource base through excessive erosion, nutrient movement and floods. The unpredictability of climate and weather limited our ability to optimize agricultural production under favorable climatic conditions, and to mitigate environmental impacts under adverse conditions. Farm planning and management decisions generally were reactive and conservative, and opportunities for diversification, greater profits, and enhanced environmental stewardship were missed.

Major objectives: The overall objective is to produce new tools, develop decision information, and demonstrate applications of climate variability and seasonal climate forecasts in agricultural production and resource conservation to benefit ranchers, farmers, and resource managers. Specific objectives are: 1) characterize and quantify multi-year regional climate variations and NOAA's seasonal climate forecasts at scales relevant for impact assessment and decision making in agricultural and conservation management; and 2) integrate multi-year climate variations and seasonal forecast information into planning and management of agricultural enterprises and natural resources.

Who benefits, how serious is the problem, and why the research matters:
The primary users of this research are resource managers, producers and service organizations of the agricultural infrastructure, such as crop insurance suppliers, emergency and risk management agencies, and fertilizer, seed and chemical companies, all of which could potentially benefit from forecasts of the next season's demands, production and yields. Models and methodologies developed by this research will also be valuable to scientists and engineers in federal, state and private institutions, consultants, and action agencies involved in various aspects of climate impacts on agricultural production and environments.

The problem is very serious because climatic variations drive and impact nearly every sector of the agricultural production system and result in significant annual losses that affect farmers and ranchers, the economic well-being of rural communities, and the natural resource base through soil erosion, nutrient movement, water shortages, and floods. This research matters because it can deliver critical, risk-based planning tools for farmers, ranchers, agri-businesses and natural resources managers that help mitigate the negative impact of climate variability and derive benefits from the positive aspects.

List the single most significant research accomplishment during FY 2006.

A new wheat-grazing model for assessing productivity impacts of climate forecasts.

A tool was developed to quantify the impact of weather forecasts and climate variations on the productivity of the winter wheat-grazing system in the Southern Great Plains. Climate variations can greatly affect the productivity of the wheat-grazing operation, and a climate impact assessment tool is necessary to evaluate planning and management alternatives in terms of forecasted climate conditions. A new grazing-cattle growth model was developed and incorporated into the commercial DSSAT wheat production model. Use of the wheat production and grazing model provides the means to plan and manage the wheat-grazing system under anticipated climate variations or forecasts.

This accomplishment is linked to the milestone "Modeling grazing effects on fall biomass availability." This work was conducted by the USDA, ARS, Grazinglands Research Laboratory, El Reno, Oklahoma. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability."

List other significant research accomplishment(s), if any.

More accurate monthly precipitation expectations based on persistent annual climate variations. Probabilities of monthly precipitation amounts in Central Oklahoma were quantified in terms of persistent multi-year wet and dry periods. Monthly precipitation is highly variable in Oklahoma, and this variability is a major impediment to the management of a sustainable agricultural production system. Historical monthly precipitation values were categorized according to multi-year wet and dry periods, and the range of anticipated precipitation amounts for certain months of the year was shown to be sizably different for wet and dry periods. Categorizing and conditioning monthly precipitation on wet and dry periods narrowed the range of expected precipitation and opened the door for more targeted management production strategies in terms of monthly precipitation expectations. This work was conducted by the USDA, ARS, Grazinglands Research Laboratory, El Reno, Oklahoma. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability."

Seasonal climate forecast information is degraded when applied at farm and field scale. The degradation of the informational content of seasonal climate forecast as a result of downscaling from regional and seasonal scales to field and sub-seasonal time scales has been evaluated. The utility of seasonal climate forecasts for field applications needed to be established to promote adoption of forecasts by agricultural producer and water resources managers. The degradation of forecast information was quantified for 13 stations in the southern Great Plains and expressed as the change in utility of the seasonal forecasts between the regional scale of the original forecast

and the local application scale. This accomplishment improves our ability to translate current seasonal forecasts into statements of forecast risks for local applications in the southern Great Plains, and enhances the accuracy of the forecast information for field applications. This work was conducted by the USDA, ARS, Grazinglands Research Laboratory, El Reno, Oklahoma. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability."

Climate change impacts can be assessed at field and farm scales. Projected climate change estimates have been translated into local weather information to enable impact assessment on crop production and soil erosion. Existing climate change information could be used directly in crop production and resource conservation models. A simple and elegant downscaling method was developed to help assess climate change impacts on crop production and soil erosion at farm scales. The method enables the development of long-term management alternatives that minimize adverse impacts of climate change and maximize production expected future climate conditions. This work was conducted by the USDA, ARS, Grazinglands Research Laboratory, El Reno, Oklahoma. Aligned with National Program 204, Global Change; problem area "Scaling of climate change to field, farm, ranch and regional scales."

List significant activities that support special target populations.

The research leader and a scientist made a presentation of the unit's research to the Alabama Farmers Federation during their visit to the Grazinglands Research Laboratory.

The research leader supported the Southern Plains Agricultural Resource Coalition by providing information on soil quality, conservation tillage, and water quality to further their goals of identity-retained marketing agricultural products to enhance sustainability of small farmers and rural communities in western Oklahoma.

The research leader and scientists met with faculty and leadership at Redland Community College to discuss undergraduate research partnerships under their Center for Excellence grant for hydrology and soil and water.

Describe the major accomplishments to date and their predicted or actual impact.

Utility of NOAA's seasonal air temperature. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability." Utility measures of NOAA's seasonal air temperature forecasts are used to determine geographic regions for and seasons during which seasonal air temperature forecasts have greater potential for agricultural and water resource management applications. Application oriented utility measures for NOAA's seasonal air temperature forecasts were not available to agricultural producers and water resource managers and could not be used to determine forecast application potential. Utility measures were developed and evaluated by scientists at the Grazinglands Research Laboratory, El Reno, Oklahoma, and national maps that display the spatial variation of the utility measures were produced. The maps were presented to agronomists at the 2005 American Society of Agronomists meeting in Salt Lake City, Utah, and to other climate application scientists at the 2006 NOAA Climate Prediction Applications Workshop in Tucson, Arizona. The utility maps

will lead to greater interest and more effective applications of the seasonal air temperature forecasts in regions where the utility measures have been shown to have higher value.

Seasonal air temperature forecasts made more accessible for agricultural applications. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability." A methodology that extends the application potential of NOAA's seasonal air temperature forecasts to include a broader range of agricultural and water resource management applications was developed. The overlapping nature of NOAA's seasonal forecasts led to ambiguities in forecast interpretation, and the 3-month forecasts period was often too long for effective and practical applications in agriculture and water resource management. A methodology to disaggregate NOAA's 3-month overlapping seasonal temperature forecasts into non-overlapping 1-month forecasts was developed at the Grazinglands Research Laboratory, El Reno, Oklahoma. The disaggregated precipitation forecasts are in a form more suitable for applications in agriculture and water resource management, and will lead to a broader use of the forecasts.

World Meteorological Organization promotes use of seasonal climate forecasts. Aligned with National Program 204, Global Change; problem area "Climate and Weather Variability." A scientist of the Grazinglands Research Laboratory, El Reno, Oklahoma, was invited to be part of a team of experts that was convened by the World Meteorological Organization to confer on the application of seasonal climate forecast information in agricultural and water resource management applications. Seasonal climate forecast have been operationally issued for about 10 years, but the use of these forecasts in agricultural and water resource management applications has been limited. The team of experts identified gaps in the technology transfer process, discussed constraints to the adoption of seasonal climate forecasts in agriculture, and, at the request of the World Meteorological Organization, developed recommendations that will enhance agricultural applications of seasonal forecasts in developed and developing countries. The recommendations will be brought to the attention of institutions and organizations dealing with development and application of seasonal climate forecasts, and implementation of recommendations will accelerate use and application of seasonal forecasts in agriculture and water resource management. A special issue of the Australian Journal of Agricultural Research was dedicated to reporting of the findings at this meeting.

What science and/or technologies have been transferred and to whom? When is the science and/or technology likely to become available to the end-user (industry, farmer, other scientists)? What are the constraints, if known, to the adoption and durability of the technology products?

Presented research on water quality and climate forecasts to personnel from the Central NRCS Technical Center conducted by the research unit. These technologies are transferred to farmers and private land owners.

The Research Leader served as a member of NOAA's Interim Steering Group to develop a broad implementation plan for the National Integrated Drought Information System (NIDIS), providing input in particular on gaps in the science and research needs for improving the detection and monitoring of drought and application of drought information into mitigation planning programs. End users include every sector of the economy, including agriculture, energy, water

management, and communities. Constraints that NIDIS is addressing include inadequate coordination across local, state, and federal levels; communication across public and private sectors, and integration across meteorological, scientific, and social disciplines.

The Research Leader and scientists were asked by ARS Office of International Research Programs to transfer methodologies for long term climate analyses and seasonal climate forecast analyses to agricultural and meteorological organizations in Brazil. Constraints to technology transfer are primarily communications and coordination between scientists in the two countries, and are addressed by organizing workshops in both countries and hosting a visiting scientist.

The research unit hosted a two-day workshop by the Drought Mitigation Center of the University of Nebraska on risk assessment techniques for agricultural producers and advisors. The workshop was funded by the Risk Management Agency of the USDA and highlighted new products to help society prepare for future droughts. Constraints to technology transfer to users were the high technical nature of the computerized tools and the need for high speed internet connections.

List your most important publications in the popular press and presentations to organizations and articles written about your work.
Television interview (April 2006) on Climate Change and Oklahoma Drought by Oklahoma Educational Television Authority (OETA) for airing in Oklahoma and nationally by Rural America Television Network RFD-TV (June 2006).

Presentation on the ongoing drought in Oklahoma to the El Reno, Oklahoma Rotary Club given by J. Schneider (January 2006).

Invited presentation by J. Steiner on "Challenges of Water Policy in the Western U.S." at the 2005 Soil Science Society of America Annual conference, Salt Lake City, Utah, Symposium on Uses and Abuses of Soil and Water Resources: Historical and Contemporary Examples and the Lessons to be Learned from Them

Publication(s):
Garbrecht, J.D., Piechota, T.C. 2006. Climate Variations, Climate Change, and Water Resouces Engineering. Reston, VA:American Society of Civil Engineers. 192 p.

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Garbrecht, J.D., Schneider, J.M., Brown, G.O. 2005. Decade-long precipitation variations and water resources management. In: Garbrecht, J.D., Piechota, T.C., editors. Climate Variations, Climate Change, and Water Resources Engineering. Reston, VA:American Society of Civil Engineers. p. 37-50.

Piechota, T.C., Garbrecht, J.D., Schneider, J.M. 2006. Climate variability and climate change. In:

Garbrecht, J.D., Piechota, T.C., editors. Climate Variations, Climate Change, and Water Resources Engineering. Reston, VA:American Society of Civil Engineers. p. 3-18.

Schneider, J.M., Garbrecht, J.D. 2005. Recent utility of NOAA/CPC seasonal precipitation climate forecasts. In: Garbrecht, J.D., Piechota, T.C., editors. Climate Variations, Climate Change, and Water Resources Engineering. Reston, VA:American Society of Civil Engineers. p. 51-64.

Schneider, J.M., Garbrecht, J.D., Steiner, J.L. 2005. Seasonal climate forecasts: summary of current opportunities across the contiguous United States [abstract]. ASA-CSSA-SSSA International Annual Meeting, November 6-10, 2005, Salt Lake City, Utah. 2005 CDROM.

Schneider, J.M., Garbrecht, J.D. 2006. Does downscaling in space and time degrade the dependability of seasonal climate forecasts? In: Graham, R., editor. Proceedings of the World Water and Environmental Resources Congress, May 21-25, 2006, Omaha, Nebraska. 2006 CDROM.

Zhang, X.J., Liu, W. 2005. Simulating potential response of hydrology, soil erosion, and crop productivity to climate change in Changwu Tableland on southern Loess Plateau of China. Agricultural and Forest Meteorology. 131:127-142.

Zhang, X.J. 2005. Spatial downscaling of global climate model output for site-specific assessment of crop production and soil erosion. Agricultural and Forest Meteorology. 135:215-229.

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Kimoto, A., Nearing, M.A., Zhang, X.J., Powell, D.M. 2006. Applicability of rare earth element oxides as sediment tracers for coarse-textured soils. Catena 65:214.221.