| Title: | Resilience and vulnerability of beef cattle production in the Southern Great Plains under changing climate, land use and markets |
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| **Sponsoring Agency** | NIFA | **Project Status** | ACTIVE |
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| **Submitted By** | Sheila Julian | **Date Submitted to NIFA** | 11/18/2013 |

**Program Code:** A3101

**Program Name:** Climate Change: Regional Approaches to


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**Non-Technical Summary**

Beef produced on pasture and rangeland forages and dual-purpose winter wheat in the Southern Great Plains (SGP: Texas, Oklahoma and Kansas) provides a significant portion of the nation's red meat; constitutes the largest land use and agricultural enterprise in the region; and is subject to a widely variable climate. Our uniquely qualified team will answer critically important research questions and deliver Extension programming about impacts of climate variability and climate change on system vulnerability and resilience. Our goals are to (1) better understand vulnerability and enhance resilience of SGP beef-grazing systems in a world of increased climate variability, dynamic land-use, and fluctuating markets and (2) safeguard regional production while mitigating the environmental footprint of agriculture. Our objectives are to (1) build capacity among regional institutions to move research and extension to a higher level of integration; (2) better understand beef-grazing system dynamics, quantify vulnerability and resilience, and balance sustainability of production and ecosystem services; (3) provide information and technology to enable producers to employ risk-based information in decision-making; and (4) train the next generation of producers and researchers to collectively address rising challenges. Interdisciplinary and community-based approaches will be used to organize research and extension activities. Research will be targeted toward filling key knowledge gaps and toward validation and application of environmental and economic models. Success will contribute to increased resilience to climate variability and climate change and sustained productivity of beef-grazing systems in the SGP and beyond.

**Accomplishments**

**Major goals of the project**

Our long-term goal is twofold: (1) to better understand vulnerability and enhance resilience of SGP beef-grazing systems in a world of increased climate variability, dynamic land-use, and fluctuating markets through introduction of diversified forages, improved management, multiple marketing options, strategic drought planning, and improved decision support systems for evaluation of alternative options; and (2) to safeguard and strengthen production and ecosystem services while mitigating greenhouse gas emissions in the SGP. The major institutional, scientific, educational, and extension objectives are: 1. To build capacity and strengthen collaboration among institutions at the regional scale to empower and enable research and extension at a higher level of integration; 2. To better understand, monitor and forecast dynamics of beef-grazing production systems; quantify vulnerability and resilience of the production systems; and balance and safeguard the sustainability of beef production and ecosystem services in the region; 3. To provide timely and accurate information, decision support tools, adaptation and mitigation management practices and technologies that will assist and empower producers to employ risk- and evidence- based information in their decision-making; 4. To better train and educate the next generation of ranchers, farmers and researchers to collectively address challenges due to climate variability, land use change and market dynamics. This integrated project consists of five research themes and two extension programming areas. Outputs for research will include documented results; recommendations resulting from scientific research regarding adaptation and mitigation practices; documented products (research reports and publications); and specific research outcomes (feedback from scientists/ participants regarding research impact). Outputs for extension will include documented products/results (e.g. workshops, demo sites, materials, decision-support-tools); and documented outcomes (feedback from stakeholders regarding impact of outreach and knowledge/behavior change).

**What was accomplished under these goals?**

Research Theme 1 - A protocol and plan is being created for the first intensive field campaign scheduled for June 2014. Soil and plant samples from long-term sites will be collected at dormancy (perennial) or at wheat planting in 2013. Soil samples and plant biomass by functional groups in was completed by USDA-ARS and OU co-PIs in September 2013. Collaborators launched the integrated grasslands observation sites (iGOS), each equipped with an advanced eddy covariance tower system for measuring energy and gasfluxes, a Phenocam to track plant phenology, and a COSMOS instrument to measure soil moisture. Remote sensing data are collected. Research Themes 2, 3, and 4 - Theme 2 collaborators outlined the steps involved in a Life Cycle Analysis (LCA) and identified the models and software the teams will use. Collaborators are developing an iPhone application to acquire geo-referenced field photos, as part of the citizen science effort. A modeling team meeting was held to discuss data inputs, outputs, reporting, and plans for verification. Research and Extension best management practices were discussed to allow for ranking and prioritizing adaptation and mitigation strategies. Protocols and research plans are developed for farm type preliminary cluster analysis. Collaborators purchased and are testing a Greenfeed system to measure methane and carbon dioxide production from cattle and the system. Collaborators also developed research protocols for footprint analysis and validation, a database from published literature to provide equations

for model modifications, and deployed two flux towers and initiated data collection for baseline greenhouse gas production from ungrazed grassland. Flight plans have been developed for sites at El Reno, Oklahoma and Noble Foundation properties for collection of very large scale aerial (VLSA) images. Data collection is complete and data processing is underway at the Noble Foundation. A cooperative agreement was developed between USDA-ARS and the Oak Ridge Institute for Science and Education (ORISE) to hire post docs for the research. Research Theme 5 - Collaborators drafted a manuscript, assembled soil data, tested soil data for model simulation, and defined procedures for defining the representative farms for the study region. This also constitutes a preliminary step towards addressing the above-described milestone for Year 2. A Research Theme 5 collaborator assisted Research Theme 2 collaborators in outlining the steps involved in a Life Cycle Analysis and in identifying the models and software the teams will use. Social Science - The social science team conducted a literature review on the social dimensions of climate change in agriculture, particularly research related to surveys of Extension and producers on perceptions of and attitudes toward climate change. This will aid in surveys of beef producers and Extension agents. The group also developed an instrument to survey Extension agents that will be administered early in Year 2. Extension - An Extension Group collaborator participated in 13 forage and livestock producer meetings and presented information on adapting forage management practice related to climate extremes to about 700 producers since February 2013. The Extension Group has also initiated the development of an educational materials inventory and K-12 lesson possibilities. Extension Group collaborators conducted a review of Extension materials and are completing a gap analysis by comparing existing materials to the current state of the science and to producer needs for information. Extension collaborators also implemented the science for the Wheat First Hollow Stem on the Oklahoma Mesonet. The Extension Group collaborators at Kansas State University hired an Extension project coordinator. The group is currently preparing a Kansas Climate and Weather external storage device resource for county Extension agents. A graduate student in Nutritional Sciences at Oklahoma State University has conducted focus groups to establish a baseline of how consumers factor in the environment when making beef purchasing or consumption choices. Cyber-Infrastructure - To address the milestone "Co-Principal Investigator's (Co-PI's) share data, metadata, model datasets within team," data sharing is facilitated through the use of online tools, including a website, listserv, and wiki.

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**What opportunities for training and professional development has the project provided?**

Various training and professional development opportunities were offered for graduate students, post-doctoral researchers, and lab technicians since February 2013. For instance, a graduate research assistant (GRA) in Human Sciences, Oklahoma State University, has received basic training on conducting focus groups. This training is expected to contribute to work for the Extension and Social Science Groups.

Another GRA received two weeks of intensive training in Matlab, a powerful computational environment that will be used to develop forage quantity and quality forecasts. The Matlab training is anticipated to contribute to the work of Research Themes 1 and 4, which focuses on network and data collections, as well as management practices, respectively.

A post-doctoral research fellow has received orientation and mentoring for the social science research aspects of the project. She is now contributing to the literature review and the development of the surveys and focus group instrumentation for the Social Science Group's future work.

Three technicians at the U.S. Department of Agriculture – Agricultural Research Service – Conservation and Production Research Laboratory (USDA-ARS-CPRL) were trained to operate the Greenfeed system to measure enteric methane and metabolic carbon dioxide production of cattle. Data using this system will be used for the mitigation and Life Cycle Analysis (LCA) activities. Also Drs. Sam Coleman, Jim Neel and Ken Turner from USDA-ARS-El Reno, OK visited the USDA-ARS-Bushland, TX laboratory to learn more about the respiration calorimetry and Greenfeed systems.

Twelve Grazing CAP collaborators and stakeholders were trained in a three-day event on the eddy flux system with methane sensor at the University of Oklahoma. The knowledge gained from this training event is anticipated to contribute to the project's LCA activities.

A newly hired Extension project coordinator attended the biannual America's Grasslands Conference in Manhattan, Kansas, in August 2013. The event focused on the status, threats, and opportunities facing America's declining grasslands. This conference served as a good opportunity to increase the project coordinator's knowledge and understanding of grasslands, which will serve as an important foundation for her role as Extension project coordinator.

**How have the results been disseminated to communities of interest?**

A total of eight presentations were given at various associations, meetings and conferences that targeted relevant external stakeholders. One manuscript detailing the Grazing CAP efforts is currently in preparation.

A key outcome for Year 1 of the project is the establishment of communications and collaborations within and across

Research Themes and Groups, and externally with various stakeholders. Communication and collaboration structures established during Year 1 provide a strong foundation to ensure the accomplishment of specified outcomes and impacts for the following years of the project. Specifically, team outputs in Year 1 consisted of conducting internal project events and participation in external events to facilitate the establishment of collaborations and partnerships through raising awareness of project activities and goals. Additionally, the Grazing CAP project is submitting its first newsletter in October to all project members to disseminate project related information.

**What do you plan to do during the next reporting period to accomplish the goals?**

{Nothing to report}

**Participants**

**Actual FTEs for this Reporting Period**

| Role | Faculty and Non-Students | Students within Staffing Roles | | | Computed Total by Role |
|---|---|---|---|---|---|
| | | Undergraduate | Graduate | Post-Doctorate | |
| Scientist | 3.2 | 1 | 13 | 3 | 20.2 |
| Professional | 2 | 0 | 0 | 0 | 2 |
| Technical | 2 | 0 | 0 | 0 | 2 |
| Administrative | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Computed Total | 7.2 | 1 | 13 | 3 | 24.2 |

**Target Audience**

The aim of the Resilience and Vulnerability of Beef Cattle Production in the Southern Great Plains Under Changing Climate, Land Use and Markets project (Grazing CAP) is to answer critically important research questions and deliver Extension programming about the impact of climate variability and climate change on system vulnerability and resilience. Thus, a number of target audiences were reached by programmatic efforts during this reporting period. The target audiences include: internal project collaborators, stakeholders in the agricultural industry, Extension and scientific communities that will be impacted by or are impacted by climate change and climate variability, regional educational institutions, K-12 teachers in the Southern Great Plains (SGP) region, consumers, and the next generation of ranchers, farmers, and researchers. To ensure goals of the project are addressed successfully, five Research Themes and Groups were established by the project team. A key outcome for Year 1 of the project is the establishment of communications and collaborations within and across Research Themes and Groups and externally with various stakeholders. A total of 34 collaborators are currently affiliated with the Grazing CAP project and work within the Research Themes and Groups. To ensure a comprehensive integration of the work conducted by each Research Theme and Group, the following project leadership structure has been established. In addition to the Principal Investigator (PI; Project Director) and the Co-Principal Investigator (Co-PI; Co-Project Director), an Executive Management Team (EMT) was formed. The EMT consists of the project PI, Co-PI, and key representatives from each partnering institution. The EMT developed a flow chart of interactions among Research Themes 1-5 and Groups to assist internal project collaborations in achieving team outcomes. The flow chart provides a visual representation of the Research Themes and Groups and how the collaborators will work together and communicate for project management purposes. As a result of establishing collaboration among Research Themes and Groups to measure greenhouse gases in wheat cropping systems, for example, they generated preliminary data that were used in the development and submission of an USDA Foundational proposal in February 2013. To establish collaborations with external stakeholders, potential partnerships were explored with alliances and associations including Global Research Alliance, National Cattlemen's Beef Association, Animal Agriculture and Climate Change, and other U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA)-funded Agriculture and Food Research Initiative (AFRI) Coordinated Agriculture Projects (CAPs). To illustrate, Grazing CAP collaborators met with the Natural Resources Conservation Service (NRCS) Oklahoma State Conservationist and key staff to discuss how the CAP research can contribute to the Soil Health initiatives of the USDA. In addition, four members of the Grazing CAP project modeling team are serving as researchers on an National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) funded proposal focusing on water-use sustainability and climate variability. This newly established partnership with the Oklahoma EPSCoR project provides an opportunity for future collaboration and the leveraging of resources and funds as both projects strive towards adapting to climate variability. Additionally, through the established Grazing CAP project connections with external stakeholders, a Grazing CAP collaborator was asked to actively contribute to the Southern Plains Regional Climate HUB proposal submitted by the USDA-

ARS Grazing Lands Research Unit in August 2013. In summary, the above-described established external collaborations have resulted in contributions towards securing external funding to sustain project outcomes and impacts. In addition to establishing internal and external communication and collaboration structures, stakeholders for the Grazing CAP project were identified, consisting of researchers, legislators and county commissioners, regulatory entities, producers, consumers, industry, consumer outlets, and retail sectors. Communications with the various stakeholders also occurred during Year 1 of the project. For example, a collaborator presented at the 2013 Beef Improvement Federation Convention meeting in Oklahoma City, Oklahoma. After the presentation, evaluation feedback was collected from beef producers who attended the meeting. Feedback highlighted the usefulness of the presentation for stakeholder's work, demonstrated increases in knowledge, and described the benefits derived from interactions with colleagues. Moreover, networking and professional interactions with conference attendees and speakers were seen as extremely beneficial to producers. Thus, during Year 1, external stakeholders were informed of the work of the Grazing CAP project and understood the importance of Grazing CAP outcomes in relation to their own efforts. Stakeholders were also recruited to collaborate with the Grazing CAP team by serving as members of the advisory board. The Extension Group also targeted producers by participating in county level meetings hosted by the county Cattlemen's Association or by providing in-service training to County Extension educators. For example, a daylong in-service training "Current Issues in Forage and Pasture Management" was held for approximately 15 County Extension educators. This training event provided information regarding water use and forage and pasture systems.

Efforts of the Extension/Outreach Group also included targeting K-12 teachers. Specifically, the aim is to connect climate change research to lessons for K-12 teachers that will be posted for all educators in the SGP region and across the country to use to better understand climate issues. The Extension/Outreach Group initiated the development of educational materials inventory and K-12 lesson possibilities. The Extension Group is also currently preparing a Kansas Climate and Weather external storage device resource for County Extension agents.

**Products**

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Cole, N. A. (July, 2013). Nutrient Management and Environmental and Societal Issues Affecting Sustainability of Feedlot Finishing Systems. Invited presentation at the American Society of Animal Science, Indianapolis, IN.

Lalman, D. (August, 2013). Restocking for an Efficient Operation. Presentation at the Beef Improvement Federation Convention meeting in Oklahoma City, OK.

Middendorf, G. (October, 2013). Invited panelist/discussant for World Food Day Panel. Meeting World Food Needs: Challenges and Opportunities, Kansas State University.

Moffet, C., Reuter, R., Steiner, J., & Engle, D. (September, 2013). USDA grant focuses on beef cattle production. The Samuel Roberts Noble Foundation Ag News and Views Newsletter published at http://www.noble.org/ag/news-views/

Warren, J. (May, 2013). Greenhouse Gas Emissions from Crop Production and EQUIP. Presentation at the Nutrient Management and Equip Meeting in Gould, OK.

Warren, J. (June, 2013). Managing for Soil Quality and its Assessment. Presentation at the National Resources Conservation Society No-till Meeting in Purcell, OK.

Warren, J., & Mullock, R. (February, 2013). Managing Compaction under Grazed No-Till Systems. Presentation at the No-Till Oklahoma Conference in Norman, OK.

Warren, J., Sharma, S., Mullock, A., & and Wilson, T. (July, 2013). Feasibility of Soil Carbon Monitoring for Carbon Offset. Presentation at the International Soil and Water Conservation Society conference in Reno, NV.

Warren, J., Sharma, S., & Wilson, T. (May, 2013). Variability in Soil Carbon Stock Measurements. Presentation at the Southern Soil Physics Working Group meeting in Lexington, KY.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Lalman, D. (August, 2013). Restocking for an Efficient Operation. Presentation at the Beef Improvement Federation Convention meeting in Oklahoma City, OK.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Middendorf, G. (October, 2013). Invited panelist/discussant for World Food Day Panel. Meeting World Food Needs: Challenges and Opportunities, Kansas State University.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Other | Published | 2013 | YES |

**Citation**

Moffet, C., Reuter, R., Steiner, J., & Engle, D. (September, 2013). USDA grant focuses on beef cattle production. The Samuel Roberts Noble Foundation Ag News and Views Newsletter published at http://www.noble.org/ag/news-views/

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Warren, J. (May, 2013). Greenhouse Gas Emissions from Crop Production and EQUIP. Presentation at the Nutrient Management and Equip Meeting in Gould, OK.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Warren, J. (June, 2013). Managing for Soil Quality and its Assessment. Presentation at the National Resources Conservation Society No-till Meeting in Purcell, OK.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Warren, J., & Mullock, R. (February, 2013). Managing Compaction under Grazed No-Till Systems. Presentation at the No-Till Oklahoma Conference in Norman, OK.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Warren, J., Sharma, S., Mullock, A., & and Wilson, T. (July, 2013). Feasibility of Soil Carbon Monitoring for Carbon Offset. Presentation at the International Soil and Water Conservation Society conference in Reno, NV.

| Type | Status | Year Published | NIFA Support Acknowledged |
|---|---|---|---|
| Conference Papers and | Other | 2013 | YES |

**Citation**

Warren, J., Sharma, S., & Wilson, T. (May, 2013). Variability in Soil Carbon Stock Measurements. Presentation at the Southern Soil Physics Working Group meeting in Lexington, KY.

**Other Products**

**Product Type**

Evaluation Instruments

**Description**

A comprehensive program evaluation plan was developed and will be implemented by the Office of Educational Innovation and Evaluation (OEIE) throughout the life of the Grazing CAP. In Year 1 of the project, evaluation activities consisted of survey and questionnaire administration and follow-up telephone discussions with Research Themes and Groups leads and co-leads. Specifically, an online post-participation feedback survey was administered by the external evaluator, OEIE, to all participants at Executive Management Team (EMT) Planning Meeting, May 31-June 1, 2013. Participants' expectations for the planning meeting were met, outcomes were rated favorably, and the survey was used to inform the structure of the First Annual Team Meeting. An online post-participation feedback survey administered by OEIE demonstrated the value of the meeting, provides the foundation for future Annual Team Meetings, and provides guidance to the team leadership.

**Product Type**

Other

**Description**

Grazing CAP collaborators met with organizations to align research objectives with industry need and served as co-Principal Investigators (co-PIs) on other grant funded projects. To illustrate, Grazing CAP collaborators met with the Oklahoma State Conservationist of the Natural Resources Conservation Service (NRCS) and key staff members to discuss how the CAP research can contribute to the Soil Health initiatives of the USDA. Team outputs consisted of conducting internal project events and participation in external events to facilitate the establishment of collaborations and partnerships through raising awareness of project activities and goals. An Executive Management Team (EMT) Planning Meeting conducted May 31-June 1, 2013 and facilitated by the OEIE focused on project needs. Roles and responsibilities for each Research Theme and Group were discussed, project activities and a timeline were clearly defined, and the expected outcomes of the First Annual Team Meeting were identified. EMT members worked collaboratively to develop the agenda for the Annual Team Meeting.

**Product Type**

Other

**Description**

At the First Annual Team Meeting, July 15-16, 2013, the geographic extent of the study region was defined more clearly, collaborators identified their project roles, and work plans were formulated. Project management structures and internal and external communication tools were discussed. Attendees discussed the importance of showcasing USDA NIFA as the funding source on future publications, ways to discuss the topic of climate change with various audiences, and potential partnerships with alliances and associations.

**Product Type**

Other

**Description**

Dr. Shoup participated in five forage utilization meetings in southeast Kansas with over 250 producers, ranchers, and agricultural professionals in attendance. The meetings covered topics such as utilization of cover crops, managing forage resources during drought, and alternative forages. Dr. Edwards presented to approximately 250 stakeholders at eight county-level meetings. Dr. Redfearn participated in 13 forage and livestock producer meetings and presented information on adapting management practices related to climate extremes to about 700 producers since February 2013. A daylong in-service training was held for about 15 County Extension educators to provide information about managing forage resources in a highly variable climate. Dr. Lalman attended the Oklahoma Cattlemen's Association Cattlemen's College, the Five State Beef Conference, and the Beef Improvement Federation Research Symposium.

**Product Type**

Other

**Description**

The modeling group met to discuss: (i) models and variables needed for simulating the mitigation strategies using the proposed models, (ii) develop a strategy to simulate the proposed mitigation strategies using the proposed models individually or integrated with other models, and (iii) discussed best practices to accomplish the Life Cycle Analysis process.

**Product Type**

Other

**Description**

Drs. Jean Steiner, Sam Coleman, and Xiangming Xiao presented information about the Grazing CAP at the ARS Grazinglands Research Laboratory Field Day 2013. About 250 producers and stakeholders attended the Field Day event. Dr. Xiao expects to host over 100 high school students and several hundred college students at the GIS Day at the University of Oklahoma in November 2013.

**Product Type**

Other

**Description**

Grazing CAP collaborators were invited to participate in two webinars which have been conducted by external stakeholders. Representing the Grazing CAP, Dr. Jean Steiner will present a paper on “Impact of Protein Production on the Environment” at the New York Academy of Sciences/Sackler Institute for Nutrition Science symposium entitled: “Frontiers in Agricultural Sustainability: Studying the Protein Supply Chain to Improve Dietary Quality” in December 2013.

**Product Type**

Other

**Description**

The Executive Management Team (EMT) developed a flow chart of interactions that provides a visual representation of the Research Themes and Groups and how the collaborators will work together and communicate for project management purposes. Collaboration among Research Themes and Groups to measure greenhouse gases in wheat cropping systems followed. This collaboration resulted in the generation of preliminary data that were used in the development and submission of an USDA Foundational proposal in February 2013.

**Product Type**

Other

**Description**

A Grazing CAP collaborator was asked to be a part of the Southern Plains Regional Climate HUB proposal submitted by the USDA-ARS Grazing Lands Research Unit in August 2013.

**Product Type**

Educational Aids or Curricula

**Description**

For the ARS Grazinglands Research Laboratory (GRL) Field Day 2013, Drs Jean Steiner, Sam Coleman, and Xiangming Xiao prepared a Grazing CAP fact sheet for the field day book, prepared a poster exhibit, and made oral presentations at a field site.

**Product Type**

Data and Research Material

**Description**

Research Theme 1 team members established experiment sites and some forecasting tools. Collaborators assisted in the development and launching of the integrated grasslands observation sites (iGOS), and carbon dioxide, water, and methane flux towers. As part of a collaborative effort between OU Department of Microbiology and Plant Biology, OU School of Meteorology, the Oklahoma Climatological Survey, and the GRL, two iGOS have recently been established at the GRL in EL Reno, Oklahoma. One iGOS is located on native grassland, which has never been cultivated, and the other iGOS sits on pastureland, a mixed stand of warm-season introduced forage grasses dominated by Old World bluestem. Each site is equipped with an advanced eddy covariance tower system for measuring energy, carbon, water and methane fluxes between the land surface and the atmosphere, a Phenocam to track plant phenology, and a COSMOS instrument to measure soil moisture at the landscape scale.

**Product Type**

Data and Research Material

**Description**

Team members of Research Themes 2 and 3 developed research protocols for footprint analysis and validation, a database from published literature to provide equations for model modifications, and deployed two flux towers and initiated data collection for baseline greenhouse gas production from un-grazed grassland.

**Product Type**

Data and Research Material

**Description**

Team members of Research Theme 5 assembled and tested soil data for model simulation for the study region. They identified the role and expectation of economic modeling, which spans across multiple Research Themes. Specifically, the collaborators established the required procedures for defining the representative farms for the study area.

**Product Type**

Software or NetWare

**Description**

The Cyber-Infrastructure Group developed a project wiki to facilitate data sharing through the use of online tools. Members of the modeling team from ARS-El Reno, ARS-Bushland, University of Oklahoma, and Tarleton State University submitted a proposal to the National Science Foundation – National Institute of Food and Agriculture (NSF-NIFA) Water Sustainability and Climate Program: Water and Agro-Ecosystem Dynamics in Watersheds under Changing Climate and Land Use.

**Product Type**

Data and Research Material

**Description**

The Social Science Group conducted a literature review for future data collection from beef producers and Extension agents. They also developed instrumentation for surveys and focus groups with Extension agents.

**Changes/Problems**

{Nothing to report}