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United States Department of Agriculture
Project Initiation

Project Data for Accession Number 7007286

Project Title

s1090: Animal Husbandry in the 21st Century: Enhancing the legacy of animal husbandry through integrated information systems utilizing precision livestock technology.

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** COMPLETE
Funding Source NIFA Formula	**Grant Year** 2024
Grant No.	**Cumulative Award Amt.** N/A
Proposal No.	**Multistate No.** S1090
Project Start Date May 29, 2024	**Project End Date** Sep 30, 2026
Program Code	

Project Director

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Recipient Organization

SAES - SOUTH DAKOTA STATE UNIVERSITY

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Performing Department

Animal Science

Non Technical Summary

The issue The northern Great Plains consists of the largest contiguous grassland steppe remaining in North America and is home to 50% of the United States cow herd. Managing animal nutrition in extensive landscapes is difficult and relies largely on nutrition and energetic models built from data collected using animals fed in a confined feeding or small pasture/paddock system. This results in multiple opportunities for lost efficiencies in the production system and mitigates the ability to identify management practices to improve production efficiencies. Modern biometric and ecosystem sensor technology coupled with dramatic improvements in battery performance allows for exponential improvements in data collection practices on extensive rangelands. However, a wealth of available data does not immediately translate into actionable management steps. This requires the creation and application of an information system capable of utilizing available data and providing pertinent information. Only then, can all available technology be applied to dynamic grazing ecosystems and leveraged to improve production inefficiencies. The overall project

objective is to build an integrated information system measuring metabolic energy expenditure, nutrient requirements, and forage utilization in grazing cattle based on data collected from precision livestock technology using fundamental animal and rangeland science knowledge. Goals and Objectives: Objective 1: Build an integrated information system to automate data storage and processing from biometric and remote sensing technology. Objective 2: Model near real-time energy balance and spatial contribution of individual land units to the growth of ruminants grazing extensive landscapes. Objective 3: Conduct a comparative nutrition study to measure the integrated energy modelsrsquo; performance in animals on functionally different planes of nutrition. Objective 4: Model the spatial contribution of extensive rangelands to ruminant growth and performance using the interaction between energy balance and the pasture to identify landscape metrics indicative of increased or decreased efficiency of growth and climate resilient variables. Target audience The target audience for this research is broad and varies by goal relative to their stakeholder interest in livestock production. Rangeland ecologists and range livestock nutritionists will be highly interested in research about ruminant space and forage utilization and energy requirements when grazing extensive landscapes. This will directly impact net energy equations used to calculate necessary supplement intake. Ultimately, the development of integrated information systems to support decision-making tools functioning in real-time will be highly applicable to nutritionists, range management agencies, and livestock producers. Activities Research activities will focus heavily on developing nutrition and energy balance research trials centered around precision livestock technology to collect data necessary to inform the next generation of net energy equations designed for grazing animals inhabiting extensive rangelands. These activities will rely heavily on 1) developing data pipelines, identifying and testing mechanistic systems dynamic models, and building a functional integrated data system. This will require 2) building systems dynamics models descriptive of animal and landscape energy balance, and 3) conducting scientific research using the biometric sensors to quantify animal and landscape energy balance and flow. This will facilitate the creation of new products which 4) inform the spatial-temporal relationships with ruminant animalsrsquo; energy expenditure and track the contribution of landscape strata to overall animal production and performance.

Research Effort Categories

Basic	10%
Applied	50%
Developmental	40%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
305	3399	1060	50%
121	0799	1070	25%
306	3399	1060	12%
307	3399	1060	13%

Knowledge Area

[305] Animal Physiological Processes

[121] Management of Range Resources

[306] Environmental Stress in Animals

[307] Animal Management Systems

United States Department of Agriculture
Project Initiation

Subject Of Investigation

[3399] Beef cattle, general/other

[0799] Rangelands and grasslands, general

Field Of Science

[1060] Biology (whole systems)

[1070] Ecology

Keywords

Goals / Objectives

(1) Introductory remark (2) Obj. 1. Develop AI-based approaches for agroecosystems production, processing, & monitoring (3) Obj. 2. Data curation, management, accessibility, security, and ethics (4) Obj. 3. AI adoption (technology transfer) and workforce development

Project Methods

Objective 1: Develop an integrated information system for biometric and remote sensing data automation to aid animal scientists in precision livestock technology (PLT) utilization. This involves creating a centralized database, data pipelines, and API integration for statistical modeling and hypothesis testing. Education efforts will focus on teaching data systems concepts to students. The project aims to produce scientific manuscripts and extension tools while tracking the system#39;s usage in research studies. Efforts Developing this system encompasses many areas of interest to both scientists and precision livestock technology developers. Education efforts will include formal classroom education and the development of innovative tools to teach concepts. Evaluation Qualitatively track the number of students taught these data systems concepts in formal classroom environments and informal graduate student education. This project should result in several scientific manuscripts targeted toward precision livestock technology. This will also be useful in developing extension articles and tools used for extension education. Also, this system will allow for assessing the number of studies conducted that choose to utilize the data system. Objective 2: Establish an integrated energy system for accurate nutrition, growth, and reproduction recommendations in livestock management. Utilizing precision livestock scales, gas respiration chambers, and biometric tags, the system will measure energy balance in real-time. Models will be developed to improve energy expenditure estimations and animal nutrition research. Success will be measured by model accuracy, presentations at scientific meetings, and publications in reputable journals. Efforts These will provide improved measurements of both energy expenditure for activity and energy used for maintenance, which are currently difficult to estimate in extensively managed animals. Efforts in this area will create a new area of research on grazing cattle nutrient requirements. Examples of successful products include iterative presentation of findings to scientific societies such as the American Society of Animal Science (ASAS) annual meetings and the Society for Range Management (SRM). Further, these efforts closely mirror the data collection and modeling efforts of the National Animal Nutrition Program (NANP), which serves as a forum to integrate a systems dynamic perspective into animal nutrition models. Evaluation Initial success will be indicated by the development of a model that tracks animal energy balance with greater accuracy and precision than currently deployed models. Further, success will be reached by the number of abstracts and manuscripts presented at scientific meetings such as ASAS and SRM, and the ability to publish meaningful papers in high-profile scientific journals. Objective 3: Conduct a comparative nutrition study to evaluate integrated energy models in animals on different nutrition plans. Animals will be monitored using biometric sensors and gas chambers to validate energy balance models. The study will provide data for creating informed energy models for grazing animals, benefiting scientific societies and industry stakeholders. Success will be determined by the inclusion of methodologies in updated nutrient compendiums. Efforts This will provide validation and data for the creation of an informed integrated energy model for

animals grazing extensive landscapes. Further, this will serve as a foundation for future nutrition research, be of particular interest to scientific societies and industry stakeholders and provide critical pilot data for pursuing NIFA grant opportunities. Evaluation Finally, the ultimate indicator of success will be the inclusion of these methodologies in updated nutrient compendiums. This is an area of need as identified by the NANP and NASEM committees, and an area where a great deal of interest has been shown by scientists around the globe. Objective 4: Analyze the spatial contribution of land units to ruminant growth on extensive landscapes. By integrating animal GPS data, biometric measurements, and landscape information, the project aims to understand animal behavior and forage utilization patterns. This will inform management strategies to optimize grazing practices and environmental sustainability. Results will support ongoing research projects and contribute to landscape and animal management tools development, leading to publications in scientific journals. Efforts Results from this effort directly inform ongoing research projects, including the Climate Smart Commodities project. These methods will connect grazing animal behavior with the landscape. Such knowledge lends to improving rangeland management practices by improving their economic productivity by making them more habitable for cattle or identifying alternative management goals, such as carbon sequestration or wildlife habitat development. Evaluation Outcomes are expected to inform ongoing Climate Smart projects and contribute to the development of animal and landscape management tools. These should result in multiple publications across a diversity of scientific journals including ecology and animal science.