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IMPROVING ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY OF SOUTH DAKOTA PASTURES THROUGH MULTIPLE-SEASON USE AND CORRECT STOCKING RATE

NON-TECHNICAL SUMMARY: Grazing stratagies and stocking rate decisions and are critical in determining long-range health and productivity of range ecosystems and ultimately the financial success of ranches. This project examines the effects of multiple season use and stocking rate of pastures in western South Dakota

OBJECTIVES: The first objective is to evaluate multiple-season use. The overall objective is to determine summer by winter defoliation effects on the sustainable use of South Dakota mixed-grass rangeland. Specific short-term objectives are to: 1. Determine the effects of summer defoliation date and intensity on annual herbage production for pursuant winter grazing of western wheatgrass on western South Dakota rangeland. 2. Determine the effects of summer defoliation date and intensity on forage nutritive value for pursuant winter grazing of western wheatgrass on western South Dakota rangeland. 3. Determine the effects of summer defoliation date and intensity by winter defoliation intensity on vigor of western wheatgrass on western South Dakota rangeland. 4. Determine the cumulative effects of summer defoliation date and intensity by winter defoliation intensity on species composition and annual herbage production of mixed-grass vegetation on western South Dakota rangeland. Specific long-term objective is to: 1. Develop a decision support system needed to ensure the integrity of this vast and fragile ecosystem and to enhance the sustainability of commercial enterprises under current and potential future environmental conditions. The proposed project will significantly contribute to the quantification and understanding of the physiological and growth response of western wheatgrass to summer defoliation time and intensity by winter defoliation intensity. The second objective is to evaluate correct stocking rate. The overall objective is to evaluate stocking rate effects on the sustainable use of South Dakota mixed-grass rangeland. Specific short-term objectives are to: 1. Review and analyze stocking rate data from the Cottonwood Range and Livestock **Station** collected

by James K."Tex" Lewis. 2. Determine relationships between weather data (investigate past droughts) and response variables measured from long-term stocking rate study. 3. Summarize effects of stocking rate on forage and animal productivity. 4. Develop an economic model on stocking rate and animal production. 5. Publish manuscripts on the stocking rate data from Cottonwood related to vegetation change, production, drought, and economics. Specific long-term objectives are to: 1. Identify ecoregions in South Dakota and study environmental and production variables effected by stocking rate. 2. Identify steady-state plant communities in these different ecoregions. 3. Identify and study transitions between different steady-state plant communities. 4. Publish manuscripts on information learned in previous objectives.

APPROACH: To evaluate multiple-season use, the proposed study will be carried out at the SDSU Range and Livestock **Research Station** near **Cottonwood**, SD in Jackson County and at Antelope Research **Station** near Buffalo, SD in Harding County. The experiment will be a clipping study with three replications arranged in a randomized complete block design. Treatment design will consist of a split-split-plot. Whole-plot treatments will consist of 4 by 8 m plots that are defoliated in the summer at 4 dates (15 May, 15 June, 15 July, and 15 August) and a non-defoliated control. Each whole-plot will be split into two subplots (2 by 8 m) and clipped at a height to achieve either 25% or 50% biomass defoliation of western wheatgrass. In December, during the dormant season, each subplot will be further divided into 4 sub-subplots (2 by 2 m), three will defoliated at a height to achieve a total utilization of 55%, 60%, or 65%. One sub-subplot will not be defoliated in the dormant season to measure the effect of summer defoliation alone. Number of tillers, average plant height, and biomass of western wheatgrass will be measured from each plot. Forage samples will be collected, stored, and measured for nutritive value. In the following spring, plant vigor will be measured by etiolated tiller growth from each sub-subplot. The proposed experiment will start in May 2002 and end September 2007. Plots will be set up in May 2002 and treatments will be applied in summer 2002 and in December 2002. Standing biomass measured in the dormant season from summer and winter treatments will give valuable information for establishing appropriate winter stocking rates on pastures that are also grazed in summer. To evaluate correct stocking rate, the proposed investigation will proceed in fall 2002 by reviewing the data collected by Tex Lewis. Reviewing the data will be a tedious process and some assistance from Tex Lewis himself will probably be required to help with identification of experimental procedures used to collect the data. To achieve the long-term objectives, survey techniques will be used to investigate stocking rate impacts on animal production variables in selected ecoregions of South Dakota. Environmental variables such as, species composition, forage production, utilization, residual height, water infiltration, sediment production, soil fertility, and water quality will be measured on farms and ranches. These data will be used to determine relationships between stocking rate and the environmental variables. This baseline information will then be used to identify steady-state plant communities. Then further investigation will

lead to identifying the transition paths, which management tools will be used to shift plant species composition toward or away from identified steady-states. Successful grant funding will be imperative for the achievement of the long-term objectives. The proposed timetable to investigate the long-term objectives would begin fall 2003.

PROGRESS: 2004/01 TO 2004/12
Progress has been made toward meeting objective 1) Evaluate multiple-season use on western wheatgrass dominated rangeland. Specifically, we made progress toward meeting objective 1.1 Determine the effects of summer defoliation date and intensity on annual herbage production for pursuant winter grazing of western wheatgrass on western South Dakota rangeland. Late-fall standing herbage biomass was collected from the Cottonwood and Antelope sites. Plots from the May clipping at 25% or 50% and June plots clipped at 25% relative utilization had similar standing herbage biomass as the winter clipped control plots at Cottonwood. However, summer clipping plots at every clipping date and intensity averaged 460 kg/ha less winter standing herbage than the winter clipped control plots at Antelope. Summer clipping at 50% relative utilization averaged 200 kg/ha lower ($P<0.001$) in standing herbage biomass than plots clipped at 25% relative utilization. Differences in biomass production between sites could be related to the larger amount of previous year fall precipitation. At both sites, spring precipitation was 75% of normal; however, the Cottonwood site received approximately 100 mm more of previous fall precipitation than at the Antelope site. Objectives 1.2, 1.3, and 1.4 have not been evaluated at this time. We expect this study to assist ranchers to utilize pastures more effectively by incorporating multiple-season use. Winter pasture could be grazed lightly in May followed by non-use during the remainder of the growing season and still produce adequate forage for winter grazing if soil moisture levels during May and June are adequate for regrowth. Summer pasture grazed in July or August does not produce adequate regrowth for winter grazing. Progress has been made toward meeting objective 2)Evaluate stocking rate effects on the sustainable use of South Dakota mixed-grass rangeland. Specifically we have achieved objectives 2.1, 2.2, and part of 2.3. We have compiled a data set from 1942 through 2002 of stocking rate, forage production, average daily gain, and gain per hectare from six pastures at three stocking rates (light, moderate, and heavy) and two replications. We have determined that spring precipitation (cumulative precipitation of the months of April, May, and June), previous year spring precipitation, and the last spring day when the temperature reached below -1oC (DOY30) were the best predictors of forage production. Forage production in heavily stocked pastures were best predicted by spring precipitation (R-square 0.52). Forage production in moderately stocked pastures were best predicted by spring precipitation and DOY30 (R-square 0.69). Forage production in lightly grazed pastures were best predicted by spring precipition, previous year spring precipitation, and DOY30 (R-square 0.81). Work is currently underway to summarize the gain per head and gain per hectare relating to stocking rate from 1960 to present.

IMPACT: 2004/01 TO 2004/12
We expect this study to assist ranchers to utilize pastures more effectively by incorporating multiple-season use. We expect that ranchers could estimate annual forage production from spring precipitation of April, May and June along with the last spring day when nighttime temperature reaches below -1 degree C. The effect of weather was different on pastures that were stocked differently, so ranchers will need to take into account their pasture condition to estimate forage production for the current year.

PUBLICATIONS: 2004/01 TO 2004/12
Smart, A.J., B.H. Dunn, L. Xu. 2004. Long-term stocking rate effects on mixed-grass prairie vegetation. p. 185. In Abstracts: Rangelands in transition. Society for Range Management 57th Annual Meeting. Jan 24-30, Salt Lake City, UT.

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