

**ACCESSION NO:** 0184875 **SUBFILE:** CRIS  
**PROJ NO:** SD00050 **AGENCY:** CSREES SD.  
**PROJ TYPE:** HATCH **PROJ STATUS:** TERMINATED  
**START:** 01 JAN 2000 **TERM:** 30 SEP 2002 **FY:** 2002

**INVESTIGATOR:** Johnson, P. S.; Patterson, H. H.; Walker, J. A.; Beutler, M.; Oedekoven, D.; Epperson, W.

**PERFORMING INSTITUTION:**  
ANIMAL & RANGE SCIENCES  
SOUTH DAKOTA STATE UNIVERSITY  
BROOKINGS, SOUTH DAKOTA 57007

### ***WATER QUALITY AND BEEF PRODUCTION***

**NON-TECHNICAL SUMMARY:** Very poor quality water can kill livestock, but it is unclear how sublethal quality water affects animal production and health on rangelands or the extent to which livestock affect the quality of surface water. This project examines the relationship between water quality and range livestock production and health, the effects of animals on water quality, and the economic impacts of water quality.

**OBJECTIVES:** 1) Determine the relationship between water quality factors and livestock production, 2) determine the extent to which livestock influence water quality in pastures they graze, and 3) determine the economic impacts of water quality on production costs and sale value of livestock.

**APPROACH:** Experiment 1: A variety of water sources at the **Cottonwood** and Antelope Research **Stations** will be tested for water quality (alkalinity, electrical conductivity, total dissolved solids, and all cations and anions) in Year 1 and a range of water sources from very poor to very good will be selected. Each pasture will be supplied with water from a single source (of the selected sources) and will be grazed by cattle from May-August in Years 2 & 3 at moderate stocking rates (based on NRCS recommended rates). Eight pastures at the **Cottonwood Station** (4 in high and 4 in low condition) will be used to evaluate the interaction between pasture and water quality. Two replicates each of very low quality water and very high quality water will be randomly assigned to the 4 pastures of each condition class. An additional three pairs of pastures (from among those available at both stations) having stockdams with intermediate levels of water quality will be selected from those available at the stations. Pairs will be determined by similarity of water quality in Year 1. One of each pair will have the stockdam fenced to prevent cattle access and an alternate supply of water will be supplied. Cattle will have direct access to the stockdam in the other member of each pair. Change in water quality will be compared between members of each pair to determine the extent to which livestock access alters

quality. One or more additional pastures and water supplies will be used to ensure full representation of the range of water qualities in this study. Cattle grazing pastures in summer with the selected water supplies in Years 2 and 3 will be monitored for weight gains and health indicators (e.g. vaccine responses and trace mineral assessment). Water quality will be monitored periodically during the grazing season. Vegetation will be characterized for all pastures and photopoints will be established as additional documentation of any changes. Forage intake will be assessed through fecal analysis. Regression analysis will be used to evaluate the relationship between water quality factors and animal production and health. Analysis of variance/covariance will be used to evaluate the interaction between pasture quality and water quality. Economic analyses will be conducted to evaluate the effects of sublethal levels of water quality on ranching enterprises. Factors evaluated will include cost of production, production efficiency, sale value of cattle, and sale/rent value of land. Experiment 2. Streams running through winter/spring calving pastures will be monitored in all 3 years of the project for additions of fecal coliform and cryptosporia from the calving pastures. Water samples will be collected as the water enters and as it leaves a calving pasture. Water sampling will occur just prior to, biweekly during, and monthly until May following the calving season. Data will be analyzed using Analysis of Variance/covariance to determine whether bacterial contamination of water occurs, and if so, when. Vegetation will be characterized in all calving pastures. Stocking rates on calving pastures will be assessed, and used as a covariate in all analyses.

**PROGRESS: 2000/01 TO 2002/09**

This project was conducted at the Cottonwood and Antelope Research Stations and on several western South Dakota cooperator ranches. The project examined the effects of water quality on cattle performance and health, and the effects of livestock on bacterial loading of water sources. Water Quality Study: This study used yearling steers grazing rangeland and in drylot. In 2001, water quality treatments were: 1000 (1,019 ppm TDS; 404 ppm sulfates), 5000 (4,835 ppm TDS; 3,087 ppm sulfates), and 6000 (6,191 ppm TDS; 3,947 ppm sulfates). Sources were: 1000:rural water, 5000:well water (Cottonwood Station); 6000:water from a local stock dam. In 2002, water treatments were: 1000 (1150 ppm TDS; 385 ppm sulfates), 3000 (2800 ppm TDS; 1812 ppm sulfates), 5000 (4800 ppm TDS; 3000 ppm sulfates), and 7000 (7500 ppm TDS; 4800 ppm sulfates). Sources were: 1000:rural water, 3000:blend of rural water and well water, 5000:well water, 7000:blend of well water and dam water (all water sources the same in both years). Drylot steers: Steers were allotted to the water treatments for each year, with 3 pens/treatment and 6-7 (in 2001) and 8 (in 2002) steers/pen. Cattle were fed a diet (ad lib) to mimic expected gains of steers on pasture. ADG in 2001 for the 1000 treatment was greater (P Cottonwood Station) were grazed by yearling steers, May - Sept. (2001) and May - July (2002). Two water treatments, 1000 and 6000 in 2001 and 1000 and 7000 in 2002, were used. Cattle in two high condition and two low condition pastures were assigned the 1000 water treatment; the remaining four pastures were assigned the 7000

water treatment. ADG on the 1000 treatment (0.84 kg/hd/d in 2001; 1.1 kg/hd/d in 2002) was greater ( $p=0.01$ ) than on the 6000 treatment in 2001 (0.75 kg/hd/d) and the 7000 treatment in 2002 (0.81 kg/hd/d). The data for both the pasture and drylot studies indicate that significant losses in ADG can occur with moderately poor quality water (TDS > 5000 and <10,000). More importantly, moderately poor quality water can result in significant illness and death. Bacterial Loading: Eight calving pastures with live streams through or adjacent were used. Water was sampled in 2001 and 2002 (March - June) just upstream and immediately downstream of each calving pasture and analyzed for coliform bacteria. Differences between upstream and downstream bacterial populations ranged from -247.5 to +2050 coliform/100 ml in 2001 and -1230 to + 4800 coliform/100 ml in 2002. The greatest additions occurred in 2002 following a major runoff event. None of our samples exceeded 5000 coliform/100 ml, which is currently recommended as the maximum coliform addition to waterways.

**IMPACT: 2000/01 TO 2002/09**

This research documented a substantial impact of water quality on animal performance and health. The data clearly indicate that moderately poor quality water (based on concentrations of salts) reduces animal weight gains and can lead to serious health problems and even death. This study also documented substantial economic losses due to moderately poor water. Per steer losses for 120 days (at a price of \$0.80/lb) would be \$34.56 in 2001 (for 43.2 lb) and \$112.32 in 2002 (for 140.4 lb) for steers in confinement, and \$19.20 for 2001 (for 24 lb) and \$62.40 for 2002 (for 78 lb) for steers on pasture. These data represent only the losses in gross revenue, and do not include costs of treating sick steers or the cost of reduced feed efficiency. Dissemination of results of our research has 1) resulted in our research team modifying previously published guidelines for safe salt levels in livestock water, 2) made CES personnel and producers aware of the impacts of water quality on animal health and performance, and 3) led producers to conduct suitability tests on livestock water (estimated 1800 samples). Our bacterial study indicates that there is considerable variability in bacterial loading of streams from calving pastures. Depending on the pasture, bacterial loads may decrease, remain unchanged, or increase as streams pass through. Our data indicate that, while calving pastures differ with regard to potential bacterial loading, serious bacterial loading is not occurring.

**PUBLICATIONS: 2000/01 TO 2002/09**

1. Patterson, H.H., P.S. Johnson, T.R. Patterson, D.B. Young, and R. Haigh. 2002. Effects of water quality on performance and health of growing steers. *Proc. West. Sec. Amer. Soc. Anim. Sci.* 53:217-220.
2. Patterson, H.H., P.S. Johnson, T.R. Patterson, D.B. Young, and R. Haigh. 2002. Effects of water quality on performance and health of growing steers. *West. Sec. Amer. Soc. Anim. Sci.* (Abstract).
3. Nixon, L. 2002. Cattle are what they drink. *SDAES Farm & Home Research* 53(1): 5-7.
4. Walker, J. and C.Ullery. 2002. How to measure total dissolved solids (TDS)

using the HANNA Portable Conductivity Meter. SD CES Extension Extra ExEx 2030.

5. Gordon, K. 2003. Keep water quality in mind. Angus Beef Bulletin. 18(1):65.

**PROJECT CONTACT:**

Name: Johnson, P. S.

Phone: 605-394-2236

Fax: 605-394-6607

Email: [patj@ces.sdstate.edu](mailto:patj@ces.sdstate.edu)

---