USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Laboratory Support for a Study of Water Quality and Beef Production and Suitability of Water for Livestock Use

Focus Categories: Water Quality, Surface Water,

Keywords: Salinity, Water Quality, Health Effects (Livestock)

Duration: March 1, 2000 to February 29, 2001

FY 2000 Federal Funds: $6,252

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Names, university and city of principal investigator(s):

Patricia S. Johnson, South Dakota State University, Rapid City, South Dakota

David German, South Dakota State University, Brookings, South Dakota

Congressional District: First

Statement of critical regional or state water problem(s)

Water is a critical resource on semi-arid rangelands of western South Dakota. Livestock production on these rangelands is absolutely dependent on adequate quality water. We know that very poor quality water can kill livestock. It is not clear, however, the extent to which sub-lethal quality water affects production and health of grazing animals and the overall profitability of ranching enterprises. Water quality issues also have the potential to impact rangeland livestock operations through non-point source pollution regulations. The wording of recent regulations may allow scrutiny of livestock operations to expand beyond confinement operations to rangeland grazing. Information is needed to evaluate the effects of grazing livestock on the quality of water so that any decisions regarding regulations of grazing as it relates to pollution can be based on facts rather than assumptions and fears.

The objectives of this study are to: 1) determine the relationship between water quality and livestock production, 2) determine how livestock influence water quality in pastures they graze, and 3) evaluate the economic impacts of water quality on ranching enterprises. This 3-year project will be conducted principally at the SDSU Cottonwood and Antelope Research Stations, with some studies conducted on cooperator ranches. Water sources representing the full range of qualities available at the stations, from worst to best, will be identified. Cattle grazing pastures will have available only one source of water per pasture. A subset of pastures will be used to determine whether range condition interacts with water quality in livestock production. Cattle on all of these pastures will be weighed monthly and evaluated for health

problems. These data will be analyzed to determine the effects of water quality on animal production and health. The effects of livestock grazing on water quality will be studied on streams running through calving pastures and on pairs of summer pastures in which one pasture of each pair has the stock dam fenced and the other provides full access to the stock dam. Changes in nutrients, coliform counts and cryptosporidia loads will be evaluated.

Upgrading an aging AA spectrophotometer in the Water Quality Lab will support this study of water quality and beef production, other research projects, and provide service to livestock producers who need analysis of their water for livestock suitability.

An economic analysis of the production costs of poor water quality and the sale value of livestock and land will be used to evaluate the overall economic impacts of water quality on ranching enterprises. It is our intent to provide producers with information they can use to assess the impacts of water quality on their operations and evaluate the feasibility of developing alternate water sources.

It is clear that very poor water quality can kill livestock. It is not clear, however, the extent to which sub-lethal quality water affects production and health of grazing animals. It is logical to assume that poor quality water may reduce weight gains and make animals more susceptible to illness, however the level of water quality that causes a significant reduction in production or increase in susceptibility to illness is not known. Interest in this topic is high. Producers in western South Dakota have expressed great concern regarding the effects of water quality on livestock weight gains and health. A number of producers in southwestern South Dakota have recently suffered livestock losses (deaths, poor performance, health problems) that have been determined to be partly or wholly a result of poor water quality. Producers near the Antelope Research Station have also expressed an interest in seeing research done on the effects of water quality on livestock production.

Development of new, higher quality water supplies (e.g. drilling new wells, constructing new stock dams, assessing rural water) is costly. Livestock producers cannot economically justify developments to improve water quality without reliable information with which to evaluate the impacts of their current water supply on livestock production and health. Government officials are also unable to justify the expense of providing rural water systems without data showing the quality of existing water supplies and the losses to producers who have no access to good quality water. Unfortunately such information is not available. The water Resources Institute/Water Quality Lab receives numerous requests each year for livestock suitability analysis. Each year, several samples, usually received from producers located in western South Dakota, are found to be unsuitable for livestock use.

Effect of Livestock on Water Quality

There is great concern in the United States regarding the effects of livestock on surface water quality. Much of the focus has been on livestock confinement facilities because of their potential for large-scale pollution. Rangeland livestock grazing, however, can also affect the quality of surface water. This is done directly through fouling and stirring of sediments and indirectly through modification of the rangeland resource (e.g. changes in plant communities, overgrazing, etc.) or the movement of fecal contamination downslope during runoff events. The inherent quality of surface waters in western South Dakota is commonly low, leading to what many perceive to be chronic livestock production problems. The extent to which livestock exacerbate water quality problems, and thus reduce already low animal weight gains, is not well understood. This information is essential if problems with livestock production due to water quality are to be resolved. There is the additional concern of producers regarding potential government regulation of water quality on rangeland pastures, especially with respect to rules from the EPA/USDA Clean Water Action Plan that many fear may be applied in the future to calving pastures. Thus, information is also needed to determine the levels of pollution associated with calving pastures in western South Dakota.

Effect of Water Quality on Ranch Profitability

The overall consideration of the influence of water quality on cattle production for producers is in the economic consequences which affect the profit or loss of the ranching enterprise. There are two main areas of focus with respect to Objective 3 of this proposal: 1) the economic effects on production costs, and 2) the economic effects on sale value of livestock and land.

Statement of results and benefits, and/or information expected to be gained and how they will be used

Water is a critical resource on semi-arid rangelands of the western United States, including western South Dakota. Livestock production on these rangelands is absolutely dependent on adequate quantity and quality of water. It is well known that inadequate water supplies limit the extent to which available forage may be utilized on rangelands. There is little documentation, however, on the effects of poor water quality on rangeland livestock production. It is generally assumed that poor water quality may reduce livestock production by reducing animal weight gains and increasing animal health problems. This, then, increases costs and , ultimately, jeopardizes the economic success of rangeland livestock operations. Recently, several range livestock operations in western South Dakota have experienced livestock losses due to poor weight gains, health problems, and, in some cases, livestock deaths which have been blamed, to a large degree, on poor water quality. Given the current economic situation of livestock production, these losses reduce ranchers' ability to maintain sustainable range livestock operations. Clearly, the role that water quality plays in range livestock production is an issue of great importance to rancher in western South Dakota. Thus, it is extremely important that we evaluate the extent to which it affects the production and health of livestock and the economic viability of range livestock operations.

Nature, scope and objectives of the research

The intent of this proposal is to support objective one of a proposal to study water quality and beef production in western South Dakota. Purchase of the equipment will also allow the Water Resources Institute to continue to provide Livestock Suitability analysis and interpretations at a reasonable cost.

The objectives of the water quality and beef production study are to 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.

Justification and Potential Impact on Agriculture

Water is a critical resource on semi-arid rangelands of the western United States, including western South Dakota. Livestock production on these rangelands is absolutely dependent on adequate quantity and quality of water. It is well known that inadequate water supplies limit the extent to which available forage may be utilized on rangelands. There is little documentation, however, on the effects of poor water quality on rangeland livestock production. It is generally assumed that poor water quality may reduce livestock production by reducing animal weight gains and increasing animal health problems. This, then, increases costs and, ultimately, jeopardizes the economic success of rangeland livestock operations. Recently, several range livestock operations in western South Dakota have experienced livestock losses due to poor weight gains, health problems, and, in some cases livestock deaths which have been blamed, to a large degree, on poor water quality. Given the current economic situation of livestock production, these losses reduce ranchers' ability to maintain sustainable range livestock operations. Clearly, the role that water quality plays in range livestock production is an issue of great importance to ranchers in western South Dakota. Thus, it is extremely important that we evaluate the extent to which it affects the production and health of livestock and the economic viability of range livestock operations.

Another concern of the livestock industry in South Dakota regarding water quality is the fact that livestock production operations have come under scrutiny as possible non-point sources of pollution of the soil and of surface waters. While most of the scrutiny is currently directed towards confinement livestock operations, new regulations and directions taken by EPA and by USDA could signify that it is only a matter of time before range livestock production may be more closely evaluated. Recent regulations (e.g. the EPA/USDA Clean Water Action Plan) include verbiage that may be interpreted to include some management practices currently utilized by range cattle operations. In fact, data have already been reported in South Dakota by Taylor and Rickerl (1995), that suggest that 23% of all cow-calf operations may exceed the maximum recommended manure N (a benchmark developed by Taylor and Rickerl (1995) deposited directly on pastures and rangelands. Additional research is needed to evaluate the effect of grazing animals on water quality before benchmarks become established and regulations developed.

It has often been the case that agriculture has been forced to take a defensive position on issues such as water quality. The result has typically been unfavorable for agriculture. Thus it is the intent of this project to not only provide producers with useable information regarding

the impact of water quality on animal production, but to also begin developing a pro-active database regarding the issue of the impact of livestock on water quality. Such an effort would likely provide valuable information in the near future to ensure that efforts to regulate livestock production, with regard to water quality, is done in a manner substantiated by scientific data.

Methods, procedures and facilities:

Study Areas

This study will be conducted at the Cottonwood and Antelope Research Stations in western South Dakota. Both stations have a variety of water sources (stock dams, streams, wells, and, at Cottonwood, rural water) that should provide a wide range of water quality for this study. The two stations maintain native grass pastures typical of ranches in the region. Meteorological recording stations are located at the Cottonwood Research Station and at Buffalo, SD, 13 miles from the Antelope Station.

Research Approach and Rationale

The first objective of this project is to determine the effect that water quality has on livestock performance and health, and the second is to examine the effect that livestock grazing has on the quality of surface water in pastures. In this three-year project, we propose to address these objectives using summer-grazed pastures and calving pastures. The major thrust of the summer-grazed pastures is to evaluate the effects of water quality on livestock performance and health (Objective 1), however some of the summer-grazed pastures will be used simultaneously to evaluate the effect of livestock grazing on water quality (Objective 2). Calving pastures will be used only to evaluate the effect of livestock on water quality (Objective 2). Activities in Year 1 will include testing of water sources, selection of pastures and water sources, and establishment of fences needed to split pastures and fence out stock dams. Water quality in calving pastures will be assessed in Year 1 as well. Grazing on summer-grazed pastures will begin in Year 2 and continue in Year 3, as will all water, livestock, and vegetation measurements.

There will be some replication of water sources in this study, but replication is not needed for all water sources. Our goal is to include a range of water sources, which will be compared to livestock performance using regression analysis. We expect livestock performance to decline as water quality declines, though perhaps not linearly. Regression analysis, and subsequent economic analysis (Objective 3), will allow us to identify the level of water quality below which there are significant economic losses to producers. Producers can then use this information to evaluate the relative benefit of improving water supplies to their livestock. Government agencies can also use this information to evaluate the necessity of providing rural water systems within the region.

Analysis of data will be ongoing, with periodic reports provided as required and a final report, Extension circulars, and one or more journal articles produced at the end of the project. Dissemination of information will also occur through field days at both stations.

Water Quality Sources

During Year 1, water sources at both stations will be tested to determine quality of the water at each source and variation throughout the grazing season. Initial water samples from each potential source will be analyzed for alkalinity, electrical conductivity, total dissolved solids and all cations and anions. Subsequent analyses for each source will focus on changes in important components identified in the initial sample. Water sources will be ranked according to quality, and sources will be selected from both stations which represent the range from highest to lowest quality.

Treatments

Summer-Grazed Pastures

Each summer-grazed pasture will be supplied with water from a single source (e.g. stock dam, well, rural water), with water quality varying among the sources to represent as wide a range as possible of water quality. At least nine pastures and three water sources at the Cottonwood Station, and four pastures and three water sources at the Antelope Station will be used in the summers of Years 2 and 3. Eight of the pastures at Cottonwood will be used to both evaluate the effects of water quality on livestock production and health, and to determine if there is an interaction between water quality and pasture condition. We will use low condition pastures (pastures 1 and 4 will be divided to form 2 pastures each) and high condition pastures (pastures 2, 3, 5, and 6), and the highest and lowest quality water available on the station for this part of the study. Two replicates of high quality water and two replicates of low quality water will be randomly assigned within the high condition and low condition pastures, resulting in two replicates of each pasture condition/water quality combination. The ninth pasture at Cottonwood (pasture 7) will be supplied with water from a source with intermediate water quality. Four pastures at Antelope will be selected as two sets of pasture pairs, with variable water quality between pairs and similar water quality within each pair. One pasture of each pair will have the dam fenced to exclude cattle, and water from an alternate source will be made available in tanks. Stock dam water will be available to livestock in the other pasture of each pair. An additional pair of pastures with stock dams having similar water quality will be sought at the Cottonwood Station. If pastures and stock dams at Cottonwood do not meet the criteria for inclusion in this study, a pair of pastures on cooperator ranches will be located and used. Selection of pasture pairs and alternate water sources will be done to ensure full representation of the range of water qualities on the two stations.

Calving Pastures

There currently exist one to two calving pastures with live streams at each of the stations. Four additional calving pastures with live streams will be identified on cooperator ranches near the two stations. No modifications of the pastures are planned. Pastures will be used for calving beginning in about February through the entire calving season (approximately 45 to 60 days). Assessment of water quality in the streams entering and leaving these pastures will occur throughout each of the 3 years of the study.

Livestock Grazing

During Years 2 and 3, all summer-grazed pastures at both stations will be grazed by yearling heifers and stocked at moderate stocking rates (based on Natural Resource Conservation Service recommended rates). The grazing period will be 4 months, beginning in early May and ending in early September of each year. Calving pastures will be stocked with heifers and/or cows just prior to the calving season (usually early February). Cow/calf pairs will be maintained on these pastures until the end of the calving season (approximately 45 to 60days). Stocking rates on calving pastures will not be standardized or modified from current levels, but will be monitored and recorded.

Water Quality Measurements

As stated above, in Year 1, water quality will be assessed from multiple samples of water from a variety of sources at both stations. After selection of sources for use in this study, sampling will be confined to only those sources. The first water sample collected from a source in each year (for Years 2 and 3) will be analyzed for alkalinity, electrical conductivity, total dissolved solids and all cations and anions. Subsequent analyses for each source will focus on changes in important components identified in the initial sample. Water samples collected in calving pastures will also be analyzed for coliform count and cryptosporidia assay. Stock dam water samples will be collected at monthly intervals from early spring until the end of the grazing season. Stream water samples will be collected just prior to entering calving pastures, every other week during the calving season, and monthly through May. Well water and rural water will be collected and evaluated at the beginning, middle, and end of the 4 month grazing season each year.

Livestock Production and Health

The heifers utilized in the summer-grazed pastures in Years 2 and 3 will be weighed at the beginning and end of the grazing period and at monthly intervals. Average daily gains (ADG) will be calculated by month and for the entire grazing season. Calves on calving pastures at the Cottonwood and Antelope Research Stations will be weighed shortly after birth. Weights of cows on station calving pastures will be assessed post-calving, and cow and calf weights on cooperator pastures will be estimated. These weights will be used to estimate stocking rates on calving pastures.

Health of heifers on summer pastures will be assessed in a variety of ways, including:

Vaccine Response: Blood will be collected from all heifers at vaccination time in August, at which time the heifers will be vaccinated for the common bovine respiratory viruses (IBR, PI_3, BVD, BRSV). A second blood sample will be collected 3-4 weeks later when heifers come off the summer-grazed pastures. Changes in antibody titers will be compared to treatments (water quality and, in some cases, pasture condition).

Trace Mineral Assessment: A blood sample from all heifers will be collected at the time of turnout onto summer-grazed pastures. The samples will be promptly processed and the serum

used for trace mineral analysis (Cu, Zn, Se). A second sample will be collected when the heifers are taken off the summer-grazed pastures. Liver biopsies will also be collected on a sub-sample of heifers. Animals to be sampled will be identified and an initial sample collected prior to turnout onto summer-grazed pastures. A second sample will be taken from the same animals when they are removed from the summer-grazed pastures. A full panel analysis of these matched liver samples will be run involving an assay for 22 trace minerals.

Vegetation Analysis

The vegetation in each pasture of the study will be characterized for production, species composition, cover, and utilization in Years 2 and 3 of the study. Summer-grazed pastures will be assessed during the growing season, whereas calving pastures will be assessed prior to and following the calving season. Vegetation surrounding stock dams in paired pastures, which have the stock dam in one pasture fenced and the other unfenced, will be assessed for production and cover at the end of the growing season in all 3 years. Photo points will be established in each pasture of this study, and photographs will be taken in all three years.

Summer-Grazed Pastures: Ten grazing exclusion cages will be randomly placed in each summer-grazed pasture prior to the grazing season in Years 2 and 3. Two plots (0.25 m^2) will be established under each cage, and, for each caged plot, a plot outside the cage will be selected which matches the caged plot for species composition, production and cover. Non-destructive techniques will be used to estimate biomass, by species, of vegetation in both caged and uncaged plots at the beginning of the grazing season and at the end. Additional clip plots will be established to calibrate biomass estimates. Ocular estimates of cover, by species, will be made on all caged and uncaged plots at both sampling dates in both years. Similarity of paired plots will be assessed using data from the initial sampling period. Production during the grazing season will be estimated from the caged plots. Utilization will be determined as the difference between the biomass inside and outside the cages.

Calving Pastures: Ten randomly placed permanent plots (0.25m^2) will be established in each of the calving pastures in Years 2 and 3 of the study. Prior to the calving season (late fall or early winter), biomass estimates will be made on each plot using the techniques described above. Plots will be re-estimated at the end of the calving season (when cow/calf pairs are moved to new pasture). The initial biomass sampling provides an estimate of forage available during the calving season, and the difference between initial biomass and ending biomass provides an estimate of utilization.

Paired Stock Dams: Four permanent transects will be established on each stock dam. The transects will run parallel to the slope of the land and will begin at a point 10m above the average high water mark (based on waterline evidence and/or station superintendent experience). At the end of the growing season in Years 1, 2, and 3, a plot (0.25m^2) will be placed at the beginning of each transect and at 2m intervals downslope until reaching the water's edge. On each plot, ocular estimates of cover and non-destructive biomass estimates, by species, will be obtained using the methods described above. Biomass and cover in Year 1 (at about the time fencing is constructed for fenced dams) will provide an initial comparison of the vegetation surrounding paired stock dams. Changes in biomass associated with fencing

will be evaluated in Years 2 and 3 and related to the potential sediment filtering capacity of vegetation surrounding each dam. It is expected that vegetation composition may differ (perhaps dramatically) from water's edge to the upland areas around dams. Thus, plots will be stratified according to distance from the high water mark, and pairs of dams will be compared within strata. Existence and/or development of vegetation strata for stock dams will also be evaluated and the effect of fencing on stratum development will be determined.

Forage Intake

During Years 2 and 3, forage intake of livestock on summer-grazed pastures will be assessed monthly during the grazing season. A composite fresh fecal sample will be collected from each pasture and subjected to diet quality analysis (Stuth and Lyons 1995). The NutBal program (Stuth and Lyons 1995) provides information on forage intake in addition to diet quality factors, such as the N and P content of the forage. Forage intake values from NutBal are not exact, but can provide an index to forage intake and can be used for comparison among treatments. Forage intake estimates from fecal samples are expected to be less than the utilization estimates gained from vegetation sampling (see above) because the vegetation-based estimates also include non-consumptive destruction. These data will be evaluated to determine the extent to which forage consumption changes in relation to the quality of water in each pasture.

Economic Analyses

Production Costs

Given the hypothesis that poor water quality will decrease animal health, the expectation is that animals which receive lower quality water would have higher production costs. This would be a direct result of increased veterinary services (labor and vaccines) required to treat sick animals. It is also our hypothesis that animals on lower quality water will have reduced daily gains and feed efficiency, thus increasing cost of gain and overall production costs. These animals might also be expected to require additional management time and nutrient supplements (minerals) which would increase production costs. In order to address these concerns, data on production costs will be collected on livestock in each treatment to determine any significant differences in production costs.

Sale Value

Given the hypothesis that poor water quality will decrease average daily gains and feed efficiency, the expectation is that cattle which receive lower quality water will gain less and do so less efficiently than cattle on higher quality water. If true, fewer total pounds of beef would be available for sale and hence less revenue would be earned.

In a breeding herd, if the cows/heifers are adversely affected by water quality (especially during the critical breeding season) there would also be the possible expectation of reduced fertility and abortions, resulting in fewer calves available for sale, again reducing the total gross revenue of the livestock operation.

A comparison will be made between cattle in the different treatments to determine the total dollar value of beef produced in each treatment, the value of cattle available for sale, and the estimated gross and net returns earned by each treatment group. The data will be used to develop representative production budgets for each group of cattle.

The other important hypothesis that will be tested from this research, from an economics standpoint, is verification that grazing land with a supply of higher water quality is indeed worth more in terms of dollars per acre or dollars per animal unit month (AUM) than similar grazing land with a lower quality water supply. This result would confirm the ongoing practice, by many ranchers, of paying more in rents for land with higher water quality supplies, and of justifying the expense of rangeland improvement practices (e.g. of putting in fences, wells and/or pipelines) on their own land to provide higher quality water to their livestock.

Facilities and Major Equipment Available

Pastures are available for use at both the Antelope and Cottonwood Research Stations. A variety of water sources are also available at both stations which should provide a substantial range of water quality for this study. Livestock will come from herds maintained on the stations plus additional animals purchased using the Livestock Revolving Fund. Necessary livestock handling facilities (scales, corrals, chutes, etc.) are available at the Cottonwood Station. They are also available at the Antelope Station with the exception of a portable scale, which will be necessary for weighing animals monthly in the summer-grazed pastures. Some fencing materials are available for building cross-fences at the Cottonwood Station, but fencing materials are needed at both stations to build fences around stock dams.

Related Research

The Northern Great Plains encompass approximately 40 million hectares of native rangelands in the United States, representing over 50% of the total land area of the states in the region, principally North Dakota, South Dakota, Montana and Wyoming (adapted from Lauenroth et al. 1993). Much of the region is generally unsuited to crop production, thus the agricultural systems of the Northern Great Plains are dominated by livestock production on rangelands. It is critical to the long-term viability of agriculture in this region that livestock production on Northern Great Plains rangelands be environmentally and economically sustainable. Rural communities of the region are inexorably tied to the stability of ranching enterprises surrounding them, and the fate of those ranches often determines the fate of the rural communities.

Water is an important resource on the rangelands of the Northern Great Plains. Adequate water is required for animals to make optimal use of forage available on rangelands (Vallentine 1989). Water quality is also of great importance. Objectionable water may decrease consumption by cattle (Vallentine 1989). Toxins and heavy salt concentrations may result in reduced gains and even death losses (Vallentine 1989). Embry et al. (1959) determined that levels of soluble salts up to 7000 ppm caused no apparent harm to livestock, but the animals drank less of the water. They also indicated that concentrations of 10,000 ppm

or greater would produce toxic effects, regardless of the type of salts. For grazing livestock, water quality has been linked to forage intake and performance (Holechek et al., 1989). Willms et al. (1994, 1996) demonstrated weight gain differences in cattle consuming water with small differences in quality. These differences in water quality were small and do not approach the differences in water quality seen in South Dakota (Tennyson 1999). Most studies evaluating water quality have not determined the effects on animal performance and hence there exists a lack of knowledge in that area. Recent events (poor performance, poor health and death) in South Dakota suggest a need for more definitive data to be collected regarding the impact of water quality on livestock performance.

There are many types of water sources used on rangelands in South Dakota. Dams, dugouts, and streams serve as the major surface water sources in many range operations. Dams and dugouts are typically recharged by surface run-off which can add significant quantities of salts to the waters, depending on the surrounding soils. Because of the way dams and dugouts are filled, and because they typically are not drained, they serve as a sink for nutrients yielding water qualities altered from the original sources. Lauritzen (1960) also identified poor quality of water as a principal problem associated with these types of water sources. Wells are also common sources of water for range livestock operations in South Dakota. Quality of water in wells is extremely variable, ranging from very good to extremely poor, and is dependent on a variety of factors, including the geologic formations of the aquifer being tapped. Livestock do not normally drink harmful amounts of poor quality water if good water is available (Vallentine 1989). Unfortunately, many pastures in western South Dakota have only a single supply of water available. If that water is of poor quality, animals are then forced to consume that water to survive.

Environmental concerns regarding non-point pollution of surface waters by livestock production have increased in recent years. Taylor and Rickerl (1995) indicated that, in South Dakota, livestock operations may be exceeding the manure nutrient loading levels on cropland and rangelands. They reported that as many as 23% of cow-calf operations may exceed those levels, with manure being deposited directly on pastures by animals. Recently, new regulations put forth by EPA and USDA have raised the concern of many livestock producers regarding their potential impacts on livestock production. While the focus of these new regulations is on confined production, wording of these regulations would allow for application in some instances to rangeland production practices. Pollution of surface water sources by animal feces can occur by deposition on land with run-off and over-land transport of fecal material into surface water. Grassland vegetation can, however, serve as a filtration system and limit the opportunity for pollutants to enter water sources. Pollution can also occur through direct deposition of feces in water sources by animals (Larsen et al., 1988). They reported that, during the late summer, cattle deposited 3.4% of feces directly into the water, while in late fall only 1.7% was deposited directly. A number of studies have evaluated the level of pollution entering surface waters from feces deposited on land and have found little evidence for concern. Buckhouse and Gifford (1976) indicated that cattle grazing in a southeastern Utah watershed did not significantly change the level of fecal coliform contamination. This watershed had not been grazed for seven years prior to the study. Similarly, Larsen et al. (1994) reported that, in a series of runoff and infiltration studies with bovine feces placed at various distances from the collection point, no significant differences

were noted in bacteria transport in response to rainfall intensities. While these studies demonstrate no impact on water quality as a result of grazing cattle or the use of bovine fecal material, the concentration of livestock or amount of feces utilized was less than what is typical in South Dakota, especially during certain production cycle times (calving).

While there are scattered studies relating to the impact of water quality on livestock performance and on the impact of grazing livestock on water quality in surface water sources, many holes in the literature still remain. Specifically, definitive impact on performance and health of animals has not been addressed utilizing a large difference in water source qualities similar to those that exist in South Dakota. Also, more definitive information is needed on the impact of grazing animals on water quality when concentrated in a given area for a period of time (e.g. in calving pastures).

Information Transfer Plan

The research team plans to disseminate the information from this project using a variety of formats, including:

Field Days: This project will be highlighted yearly at the Antelope and Cottonwood Field Days where updates on the project progress will be given and the results discussed. Work of this type has been of particular interest at the Antelope Station with the establishment of the new water system there, so we expect considerable interest in this study during the annual field days.

Publications: We will develop Extension publications for dissemination at the end of the project and expect to also develop one or more scientific journal articles. At least one article will also be written for the Animal and Range Sciences Beef Report. We expect to involve an MS level graduate student in this project, resulting in a thesis at the end of the study.

Meetings and Programs: Julie Walker, Doug Zalesky, Bill Epperson, and Jim Johnson are frequently asked to speak at programs on topics related to animal production, health, waste management and water quality. Dan Odekoven and Martin Beutler often are asked to speak on profitability issues associated with these topics. This project will provide them with considerable information which they will incorporate into their programs. We expect demand for information from this study to be extensive, as livestock water quality issues are often the Achilles heel of range livestock operations.

Extension Educator Training: Information from this study will be incorporated into study modules and courses developed by the Animal and Range Sciences Department, Economics Department, and Veterinary Sciences for Extension Educator Training. Examples include developing a module on water quality in the Animal and Range Sciences Self-Study Nutrition Program and inclusion of water quality testing in the hands-on Educator Training programs being developed for Livestock and Agronomy Educators.

TIMETABLE[1]

	Year		
	1999-2000	2000-01	2001-02
Identify cooperator calving pastures	11-12		
Water quality samples/analyses	2-9	2-9	2-9
Selection of summer water sources and pastures	7-8		
Fencing of stock dams	7-9		
Vegetation sampling – calving pastures	11-12, 3	11-12,3	11-2,3
Vegetation sampling – summer pastures	4-5,9	4-5,9	4-5,9
Cattle grazing – calving pastures	2-4	2-4	2-4
Cattle grazing – summer pastures	5-9	5-9	5-9
Fecal samples – summer pastures	5-9	5-9	
Transport of water to pastures	5-9	5-9	5-9
Station cows and calves weighed	2-4	2-4	2-4
Summer cattle weighed	5-9	5-9	5-9
Cattle health assessments	5-9	5-9	5-9
Data analyses	11-12,1-9	10-12,1-9	10-12,1-9
Written reports (CRIS)	11-12	11-12	11-12
Field Day reports	9	9	9
Publications (Ext. circulars, journal articles, etc.)			9-10

[1]Months for each year of the project in which activities are expected to occur.

INFORMATION TRANSFER PROGRAM

Information transfer is an important area of emphasis of the South Dakota Water Resources Institute (SD WRI). It emanates from the philosophy that the Institute is ultimately responsible for providing assistance to the public that funds it. Consequently, information

dissemination is emphasized and encouraged, as an integral part of all program efforts. Information transfer at the SD WRI includes activities in public outreach, interaction with State and Federal agencies, youth education, and Institute publications.

Public Outreach

Public outreach takes many forms. One of the most recent at SD WRI is providing information over the Internet. A Web site for the SD WRI and Water Quality Lab (**www.abs.sdstate.edu/wrri**) has been established which allows the public to be in touch with the activities of the Institute, including prioritizing water problems, presenting research results, linking users with other water resource related information available on the Web, a water expertise directory, and an extensive library of information are all available on-line. Information regarding analytical services available at the SD WRI's Water Quality Laboratory and information that may be used to address drinking water problems have also been developed on-line.

The Water Resources Institute's Water Quality Laboratory provides important testing services to water users across the state. Water Resources Institute staff continue to provide interpretation of analysis and recommendations for use of water samples submitted for analysis. Information transfer to individuals to solve water quality problems is an important component of the Institute's Information Transfer activities. Interpretation of analysis and recommendations for suitability of use is produced for water samples submitted for livestock suitability, irrigation, lawn and garden, household, farmstead, heat pump, rural runoff, and land application of waste.

SD WRI staff routinely respond to questions unrelated to laboratory analysis from the general public, other state agencies, livestock producers and County Extension Agents concerning water quality issues related to stream monitoring, surface water/ground water interactions, livestock poisoning by algae, lake protection and management, fish kills, soil-water compatibility, and irrigation drainage. A WRI staff member continues to provide soil and water compatibility recommendations for irrigation permits to the SD Division of Water Rights. These outreach activities will continue in FY2000.

Agency Interaction

The SD WRI Information Transfer program includes interaction with local, state and federal agencies/entities in the discussion of water-related problems in South Dakota, and the development of the processes necessary to solve these problems. A Non-Point Source (NPS) Task Force exists in South Dakota to coordinate and fund research and information projects in this high priority area. Many of the information transfer efforts of the Institute are cooperative efforts with the other state-wide and regional entities that serve on the Task Force.

Several local and state agencies conduct cooperative research with SD WRI or contribute funding for research. Feedback to these agencies is often given in the form of presentations at state meetings, local zoning boards, and informational meetings for non point source projects.

Youth Education

Water Festivals were included in the NPS Task Force's Information and Education plan in 1992 with one Water Festival held in Spearfish, South Dakota. Water Festivals have since been held in seven sites including Spearfish, Rapid City, Pierre, Huron, Vermillion, Brookings and Sioux Falls. Since their inception, Water Festivals in South Dakota have impacted approximately 32,500 fourth grade students state wide, 8,400 of which have attended our own local festival, the Big Sioux Water Festival (BSWF). SD WRI staff members will continue to support and participate in Water Festivals throughout the state in FY2000. SD WRI will continue other activities to support water quality education in local schools including classroom presentations and assisting local educators with field trips.