Title. Determining soil moisture and temperature condition effects on potential run-off for cold season manure application.

Statement of critical regional or State water problem. Include an explanation of the need for the project, who wants it, and why.

Livestock production is a major component of the South Dakota agricultural economy and the overall economy. Because the economic importance of livestock production crosses watershed boundaries and affects both the rural and urban population, especially in heavily populated watersheds, the issue of manure management has been the subject of debate in recent years. At the center of this debate is the land application of manure and the possible impacts on the state’s water resources as nonpoint source (NPS) discharges of pollutants can be significant, especially where high concentrations of livestock are present if manure is not managed properly.

Spreading manure on frozen ground is a significant management issue for livestock producers since winter spreading of manure reduces the quantity of winter storage necessary, provides more time for application on cropland and reduces soil compaction problems which occur during spreading on wet non-frozen soils. While winter application of manure is often limited by recommendation, Srininvasan et al. (2006) reported that limitations on the application of manure during winter periods were determined largely from perceptions, not scientific data.

Previous studies have been conducted in other watersheds in other locations. But none have been conducted on predominant South Dakota soils and based on South Dakota conditions. There is great interest from producers, South Dakota Department of Environment and Natural Resources and Natural Resource Conservation Service to see data gathered on conditions in the state. Both groups are interested in the results of this study to use for policy recommendations.

Statement of results or benefits. Specify the type of information that is to be gained and how it will be used.

Year 1 of this project has produced a South Dakota soil temperature climatology. A winter rainfall climatology is under development. These two sets of data will be used to feed the next phase of the study, monitoring and gathering of run-off water for water quality testing with this study combined with potential parallel funding. Data gathered will be based around the testing the water gathered from run-off from the frozen soils. In-field rainfall simulations will provide the various rainfall effects necessary to create the run-off from manure applied to frozen soils. Water quality data will be gathered to measure the impact of manure applied to frozen soils on the run-off based on various management and soil temperature/moisture conditions. Summaries of these data will be used to create risk assessment products for manure application and help understand the potential impairments to water quality based on manure application. This data will be shared with producers and policy-makers in the state (through an advisory group already being established). Both ranchers and policy-makers (NRCS) are interested in the data to give guidance about the risk of
manure application to frozen soils in South Dakota. While we will not be able to be comprehensive and test all possible combinations of conditions (soils, slopes, rainfall rates, manure types, etc.), the testing of common management and climate conditions will provide established guidelines for potential run-off from manure-applied soils.

Nature, scope, and objectives of the project.

The current 104b proposal (ending in early 2009) will provide base-lines of the time period of frozen soil for South Dakota and give some guidance as to the common and distribution of rainfall rates during times of frozen soil as well as near-frozen times when manure may be applied. Soil sensors have been procured for the next phase of the project, to instrument six small watersheds in the Brookings area (three at a South Dakota State University Research Farm and three at a cooperator farm east of Madison, SD). These watersheds have already been instrumented.

Sensors in place have collected one winter’s data through the winter of 2007-08. We hope to have a graduate student to begin working with the data collection during this winter season or as soon afterward. Analysis of the first winter’s data can occur along with summarizing water quality data from the water samples can occur during the spring and summer. Initial results can be presented to interested parties during the summer. New simulations are set for the winter of 2008-09.

A parallel proposal has requested additional PI time to begin rainfall simulations and complete the climatic risk analysis for frozen soil period and winter rainfall rates on bare ground and soil.

Methods, procedures, and facilities. Provide enough information to permit evaluation of the technical adequacy of the approach to satisfy the objectives.

The plot studies completed in 2008 evaluated several treatments of winter manure applications followed by a simulated spring rainfall. Treatments included:

1. manure applied on frozen soil,
2. manure on frozen soil followed by snow,
3. manure applied to snow-covered soil receiving additional snow fall, and
4. a control (no manure on frozen soil).

A more commonly occurring condition is natural snowmelt without rainfall as temperatures rise in the spring. To evaluate the effect of winter manure applications on runoff during snowmelt events without rainfall, plots will be established using treatments two and three plus the control and monitored for runoff during spring 2009. Two treatments plus a control with four repetitions on tilled and untilled corn stubble will result in runoff from 24 plots each year.

An average of two snow melt events per year are anticipated. One set of plots will be established on untilled corn stubble and a second set will be established on fall-tilled corn stubble as recommended by the project steering committee. Additional treatments will be selected by the steering committee and evaluated during 2010
The plot studies will yield additional information on timing and placement of winter-applied manure with various surfaced conditions while the watershed scale runoff monitoring evaluates manure distribution strategies that can only be tested on a larger scale.

The graduate student requested in this proposal will assist with snow melt runoff collection from plots and collection of water quality data in the instrumented watersheds in the Brookings area. These watersheds will have two sets of soil temperature and soil moisture equipment (generally lower watershed and upper watershed) at two depths (10 cm and 50 cm). Flumes to collect run-off from the watersheds have been built and are installed. Manure will be applied to watersheds based on recommendations of local producers for commonly used management strategies. Rainfall simulations will be used to create run-off in the watersheds and water quality data collected based on climatological rainfall probabilities.

For the proposed project, watershed runoff from a projected six natural snowmelt and/or precipitation events will be collected by use of grab samples and automatic samplers at each of the six watersheds. Water samples will be collected from automatic samplers and flumes as soon as possible following runoff events. Samples will be collected each 30 minutes by an automatic sampler at each site during each runoff event. Samples will be selected for analysis to describe first flush, rising limb of the hydrograph, peak flow, and falling limb of the hydrograph. The automated system alerts investigators of both rain and runoff. Samples will be stored in polyethylene or polycarbonate bottles at 4°C and transported immediately to the lab for analysis. The plot runoff data indicates that timing of winter manure applications and surface condition during placement are important factors in determining concentrations of nutrient in runoff. This information will be useful in evaluation of risk of manure applications on frozen soils at different times of the year and different surface conditions and will be used to develop BMPs.

A total of 468 water samples will be collected over a one year period. An additional 10 percent of the total samples will be collected for QA/QC. Samples will be stored in polycarbonate bottles at 4°C and transported immediately to the lab for analysis. Each sample will be analyzed for nitrate nitrite-nitrogen (NO$_3$-N), ammonia-nitrogen (NH$_3$-N), total Kjeldahl nitrogen (TKN), total phosphorus (TP), total dissolved phosphorus (TDP), total suspended solids (TSS), and fecal coliform/100 ml. Fecal coliform bacteria samples will be collected by grab sample using sterilized sample bottles during spring snowmelt and following rain induced runoff. Sample analysis will be by established procedures (standard methods) (AWWA, 1998) (EPA, 1983). The cost of sampling analysis will be covered by local matching funds.

**Related research.** Show by literature and communication citations the similarities and dissimilarities of the proposed project to completed or on-going work on the same topic.

Training potential. Estimate the number of graduate and undergraduate students, by degree level, who are expected to receive training in the project.

We propose to use dollars from this project with local funding to support one graduate student at the MS level for two years. This person would be a graduate student in the Agricultural and Biosystems Engineering department in soil and water or climate. Undergraduate students are involved in the research and encouraged to use the data for undergrad research projects.

Investigator’s qualifications.
- Please see attached.
**Dennis P. Todey**  
Assistant Professor Agricultural and Biosystems Engineering  
South Dakota State University  

**Professional Preparation**  

<table>
<thead>
<tr>
<th>Institution</th>
<th>Program</th>
<th>Degree</th>
<th>Year</th>
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<tr>
<td>Iowa State University</td>
<td>Meteorology</td>
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<td>1988</td>
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<tr>
<td>South Dakota School of Mines and Technology</td>
<td>Meteorology</td>
<td>MS</td>
<td>1990</td>
</tr>
<tr>
<td>Iowa State University</td>
<td>Agricultural Meteorology</td>
<td>Ph.D</td>
<td>1995</td>
</tr>
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**Appointments**  

- Acting Director High Plains Regional Climate Center  
  University Nebraska-Lincoln  
  8/08-present  
- Assistant Professor of Agricultural and Biosystems Engineering  
  South Dakota State University  
  2003-Present  
- Adjunct Assistant Professor of Agricultural Meteorology  
  Iowa State University  
  1998-2003  
- Adjunct Assistant Professor of Geography  
  Central College (Iowa)  
  1996-1999  
- Postdoctoral Research Associate in Agricultural Meteorology  
  Iowa State University  
  1996-1998  
- Graduate Teaching Assistant in Meteorology  
  Iowa State University  
  1990-1995  
- Graduate Research Associate in Meteorology  
  South Dakota School of Mines and Technology  
  1988-1990  

**Refereed Papers**  


**Relevant publications**  


**Other publications**


**Synergistic Activities**

State/extension climatologist for South Dakota developing an integrated environmental monitoring system using various existing observation platforms and expanding observations with new weather station network

Comparing yield trends of various crops to long term climate data to develop yield expectations and potential climate change impacts of various climate variables

Member of USDA Regional Climate Committee examining the impact of climate on regional crop management and production

State water quality coordinator as part of a USDA-funded regional water quality group developing regional and in-state water quality initiatives

**Awards**

Certificate of Merit South Dakota Extension Specialist’s Association 2004

Larry R. Johnson Special Award National Weather Association 2002

Teaching Excellence Award Iowa State University 1993

**Collaborators**

Adnan Akyuz (North Dakota State), Jeff Andresen (Michigan State), Rhoda Burrows (SDSU), Bill Capehart (SDSMT), Rick Cruse (Iowa State), Stuart Gage (Michigan State), Daryl Herzmann (Iowa State), Carter Johnson (SDSU), Boris Shmagin (SDSU), Todd Trooien (SDSU)

**Graduate Advisors**

Carlson, Richard E. Iowa State University (Ph.D.)

Orville, Harold South Dakota School of Mines and Technology (M.S.)
Name: David R. German - Limnologist

Address: Water Resources Institute
Box 2120 - South Dakota State University
Brookings, SD  57007

Education:
M.S. Biology (Aquatic Ecology), 1978
B.S. Biology (minor Chemistry), 1975
South Dakota State University, Brookings, SD


Academic Teaching:
- Biology 290E Undergraduate Seminar in F 2003 and Sp 2004
- Biology 490E Senior Seminar in Sp and F 2004
- AST 463 Ag Waste Management, guest lecturer 2005-2006
- Environmental Management 225 F 2004 and Sp 2005
- Biology 498 Undergraduate Research in F 2006

Research:
- 2000-present: Lake water-quality monitoring and watershed assessments of Northeast South Dakota lakes.
- 2005-2006: German D.R. “A Study of Water Treatment for Phosphorus Removal from Lake Kampseska.” Funded by the Lake Kampseska Water Project District.
- 2006: German, D. R. “Development of a Lake Bioassessment Index Based on Evaluation of Prairie Lakes in Northeastern South Dakota.” Funded by the USGS 104b Grant Program.
1982-1983: Diagnostic feasibility study for Big Stone Lake restoration project.

Relevant Publications and Presentations:

