Developing a Water Quality Risk Map for Targeting Resources in South Dakota

Kurt Reitsma, Graig Reicks, Dave Clay, Gregg Carlson and *Jay Gilbertson

K.D. Reitsma, G.W. Reicks, D.E. and C.G. Carlson are with South Dakota State University, Plant Science Department

*J. Gilbertson is with the East Dakota Water Development District

Why Target?

- Funding is limited – Improve efficiency of use of funds.
- Indentify parcels where improved management will have the greatest impact.
- Focused education and technical assistance to improve rate of BMP adoption and efficacy.

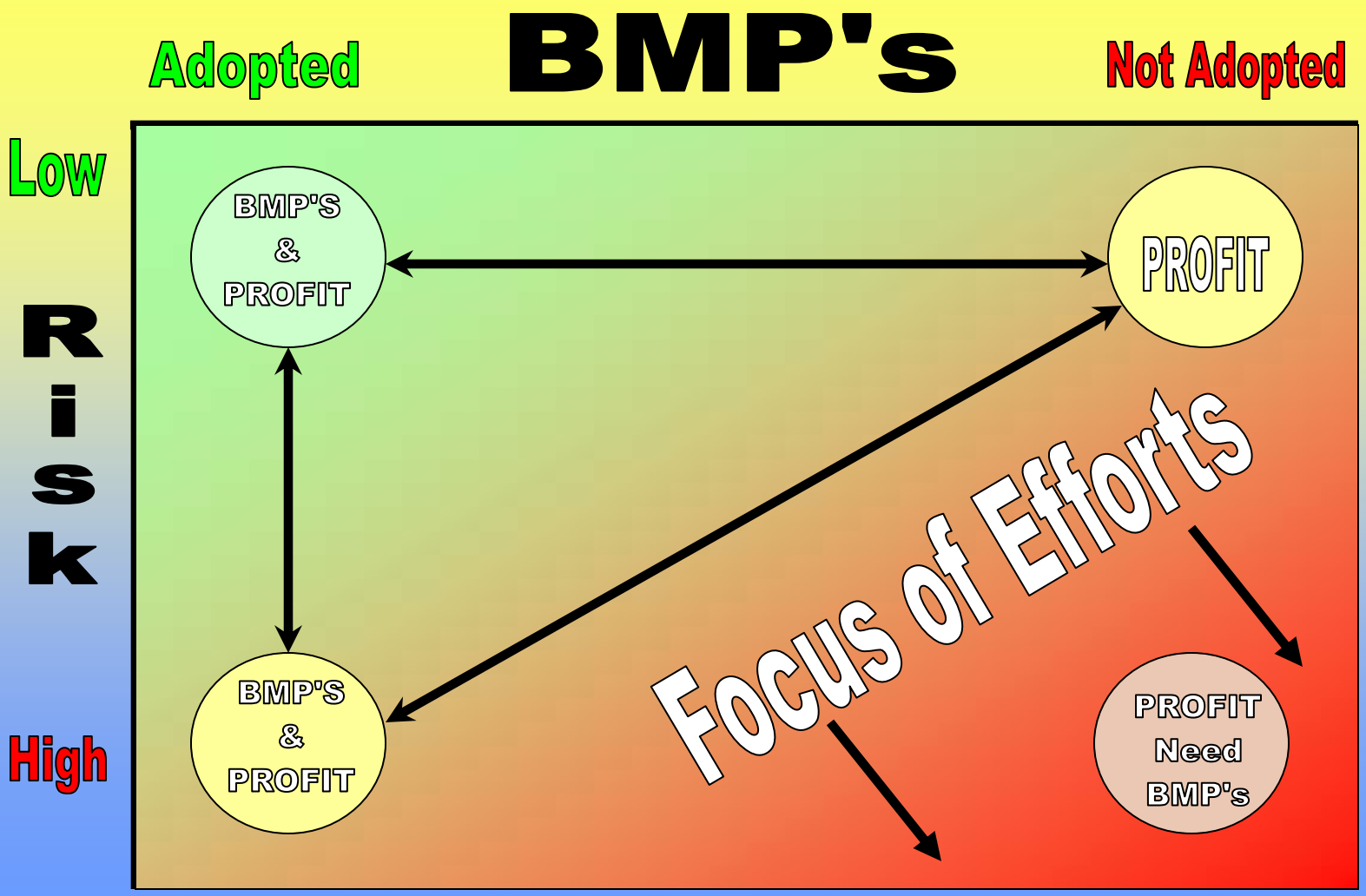
What Makes a BMP Effective?

- Well developed so it can be done and producers see it as an improvement
  - BMP’s need to;
    - Fit into existing operations
    - Be easy to understand and adopt
    - Maintain or improve profitability
    - Make sense to the producer
    - Present a benefit to the producer
- Apply where it will have the most impact
  - Identify areas likely to benefit most from BMP’S

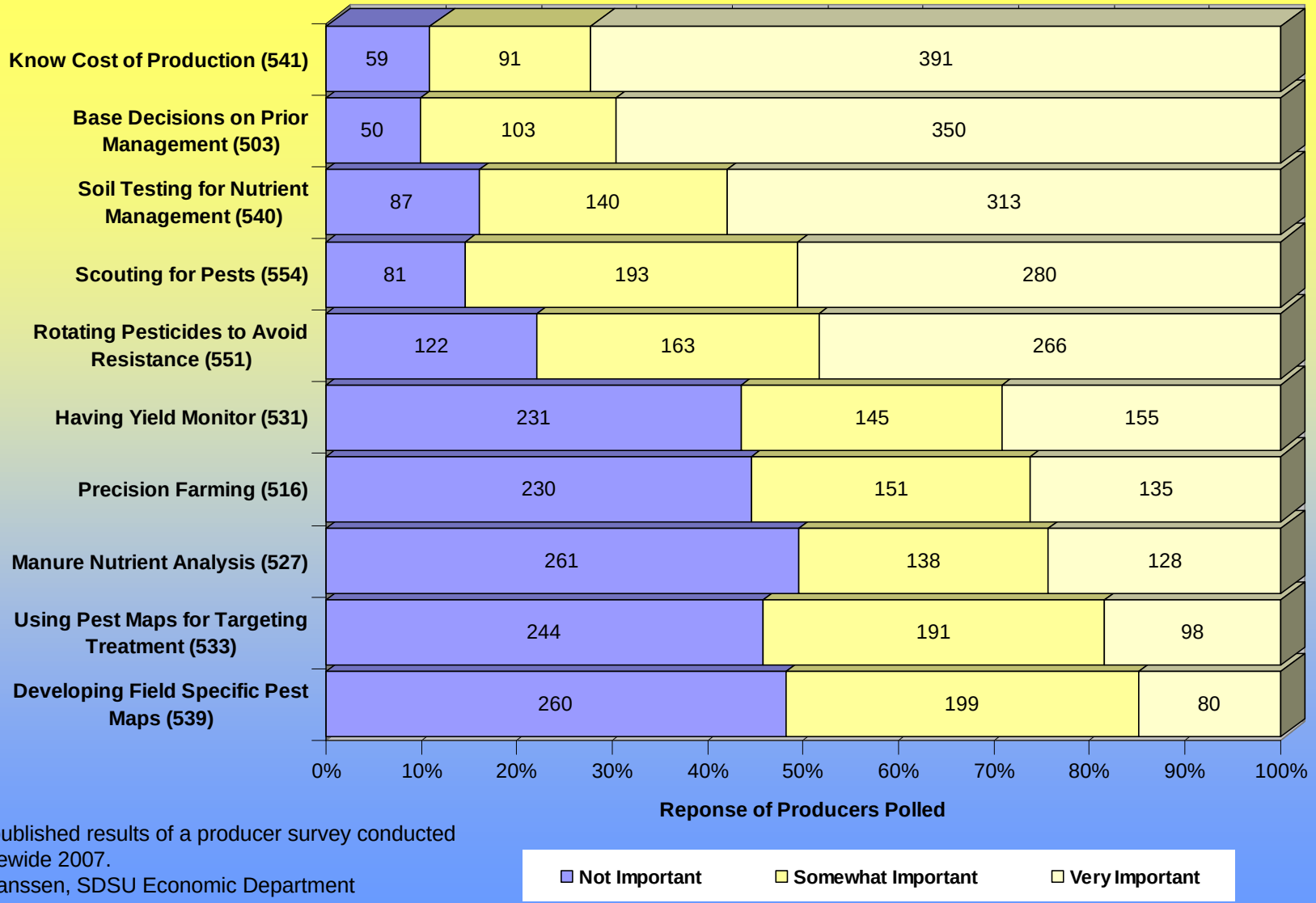
What Makes a BMP Effective?

- Testing and Validation of BMP's
  - Are they adoptable?
  - Are they profitable or beneficial?
  - Are they effective?
- One-on-One contact with Good Data
  - Data show's they work and are profitable
  - Here's how you can do it
  - Cost-share is available and here is where you can get it….We are able to help you.

Where To Focus Efforts?



What is Important to Producers?
May be different from what they are doing.



Unpublished results of a producer survey conducted statewide 2007.
L. Janssen, SDSU Economic Department

Project Area

- Big Sioux River
  - Designated Beneficial Uses
    - Stock Watering
    - Immersion Recreation
    - Warm-water Fishery
    - Public Water Supply
  - Water Quality Impairments
    - Coli-form bacteria
    - Sediment
    - Source thought to be from livestock
      - Direct deposition of livestock
      - Manure applied to cropland

Cropland in the Project Area

- Intensive crop production
- Primarily corn – soybean rotation.
- Manure applied to supplement fertilizer.
- Some areas are highly erodible.
  - Estimated annual soil loss > 6 tons * $acre^{-1}$
- May be a source of sediment, nutrients and fecal coliform bacteria.

Priority Cropland

Nitrogen Need/Phosphorus Crop Removal Manure Application Determination Table						
Soil Test Phosphorus (ppm)		Soil Loss – Erosion, Sheet and Rill Number (Tons * Acre^{-1})				
		Less than 4		4 to 6		Greater than 6
		100 Foot Vegetated Buffer		100 Foot Vegetated Buffer		
Olsen	Bray-P1	Yes	No	Yes	No	
0 – 25	0 – 35	Nitrogen Need	Nitrogen Need	Nitrogen Need	Nitrogen Need	No Application
26 – 50	36 – 75	Nitrogen Need	Nitrogen Need	Nitrogen Need	Phosphorus Crop Removal	No Application
51 – 75	76 – 110	Nitrogen Need	Phosphorus Crop Removal	Phosphorus Crop Removal	Phosphorus Crop Removal	No Application
76 – 100	111 – 150	Phosphorus Crop Removal	Phosphorus Crop Removal	Phosphorus Crop Removal	Phosphorus Crop Removal	No Application
> 100	> 150	No Application	No Application	No Application	No Application	No Application
Phosphorus Crop Removal is the amount of phosphorus a crop removes in one year of the crop rotation						
Source: USDA-NRCS. South Dakota Conservation Practice Standard, Nutrient Management (590). Base on research conducted by Guidry et. al, 2006.						

Selection of Priority Cropland

- Revised Universal Soil Loss Equation (RUSLE 2)
- Estimated Soil Loss = R*K*LS*C*P
  - Where:
    - R = Rainfall Intensity Factor
    - K = Soil Erodibility (Soil Mapping Unit)
    - LS = Slope Length Factor (Soil Mapping Unit, NRCS – Used for CRP eligibility)
    - C = Residue (Assume Corn – Soybean rotation
    - P = Contributing Practice (Ignored)

Using RUSLE 2

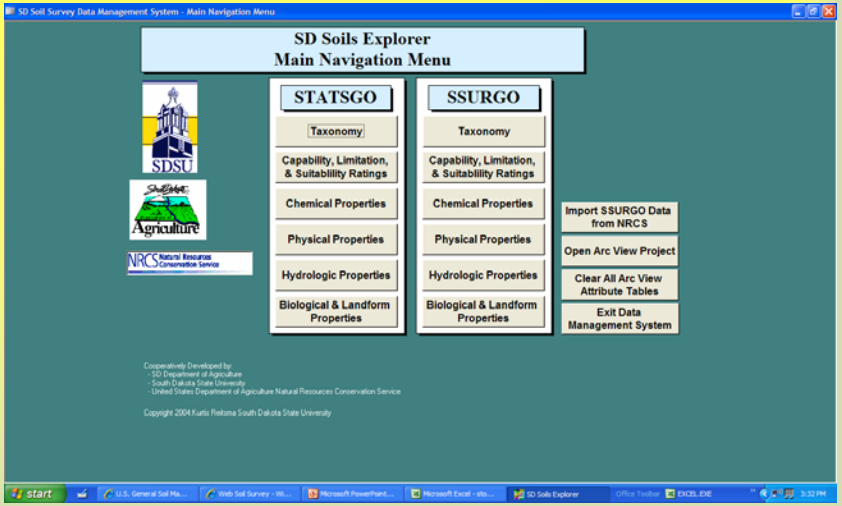
- R – Rainfall intensity factors are assigned to each county by USDA-NRCS.
- K – Soil Erodibility factors are assigned to “components” of soil mapping units.
- LS – Slope Length values are usually measured in the field, NRCS-USDA has developed a set of LS values used for CRP eligibility.
- C – Cover Management are highly variable depending on crop – Assumed corn – soybean rotation > 30% residue (0.145).
- P – Supporting Practice. This was ignored, reduced soil loss can result from implementing BMP considered a supporting practice

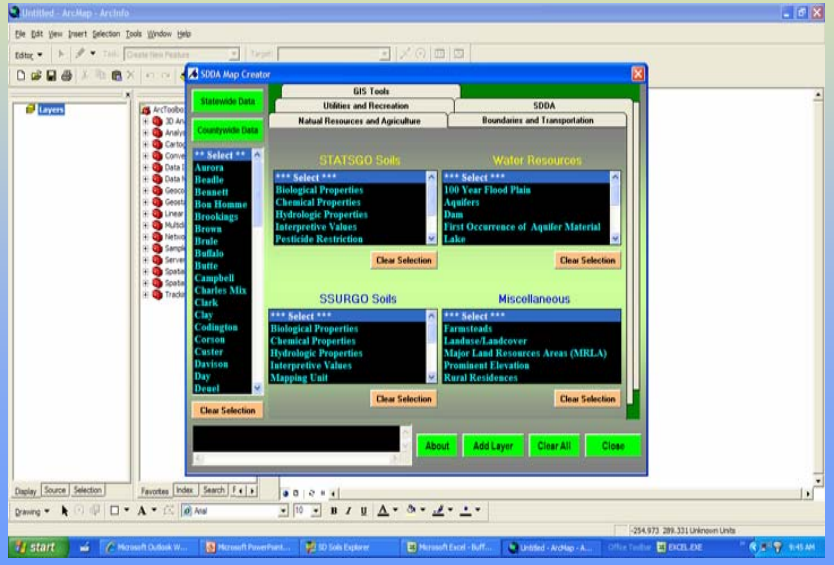
Estimating Soil Loss on a Broad Scale

- Integrating data from USDA-NRCS
  - Soil Survey Geographic Database (SSURGO)
  - National Soil Information System (NASIS)
- With data provided by USDA-NRCS the SD Soils Explorer can estimate soil loss for a mapping unit by using:
  - County R values.
  - Mapping unit K values (Weighted Average).
  - Mapping unit LS values (USDA-NRCS).
  - Assumed C value estimates (0.145)

SD Soils Explorer & MapCreator

- MS Access® User Interface
- USDA-NRCS State Soil Geographic Database (STATSGO)
- USDA-NRCS State Soil Survey Geographic Database (SSURGO).
- Builds datasets based on user criteria
- Custom datasets can be directly joined to spatial data in ArcMap
- MapCreator creates custom soils layers based on selected attributes on-the-fly.
- Similar to USDA-NRCS Web Soil Survey but more robust and faster



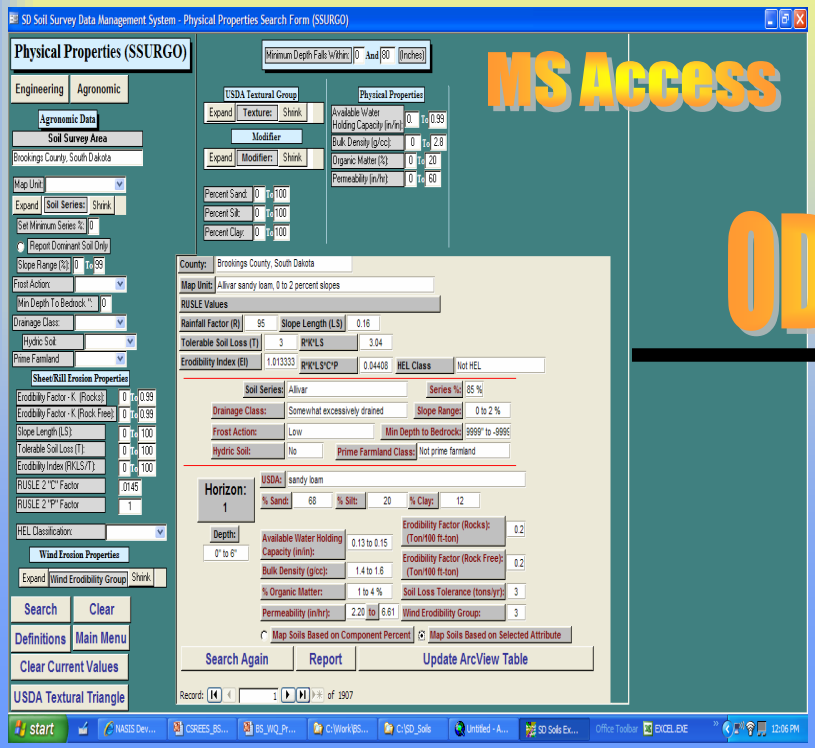


SD Soils Explorer Data Categories

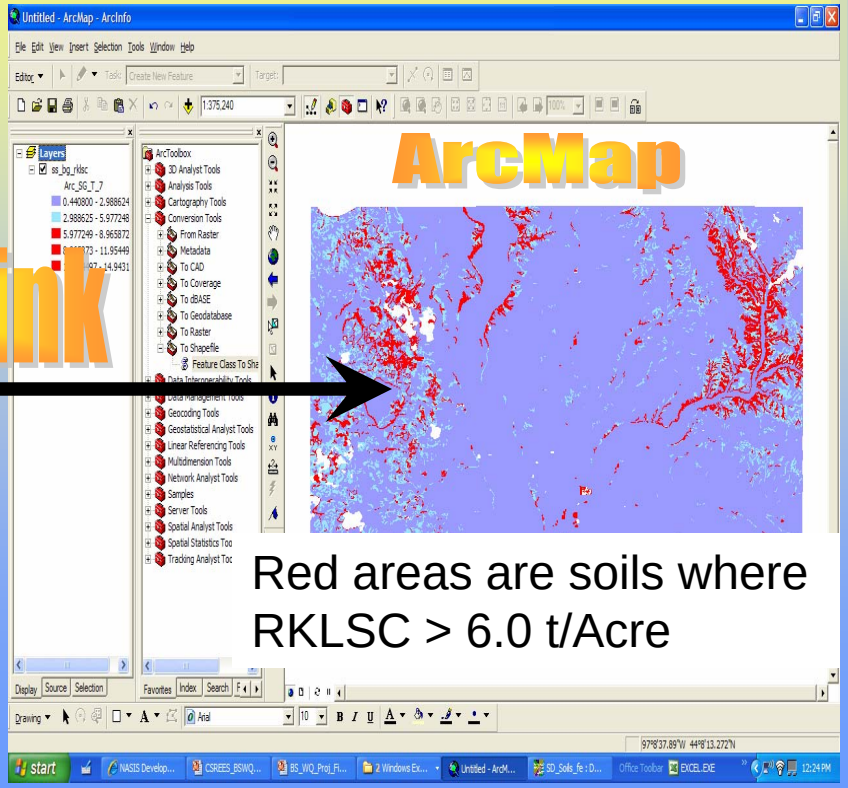
- Taxonomy
  - Orders and Families
- Interpretive Values
  - Agronomic and Engineering
- Chemical Properties
  - SAR, CEC, OM, etc.
- Physical Properties
  - Texture, Erosion (RUSTLE 2) etc.
- Hydrologic Properties
  - Hydrologic Group, Flooding, Drainage, etc.
- Biological and Landform Properties
  - Plant Community, Pesticide Restriction, Productivity, etc.

Creating the Soils Layer

- Joining soil loss estimates from SD Soils Explorer with spatial data provides estimate of soil loss.

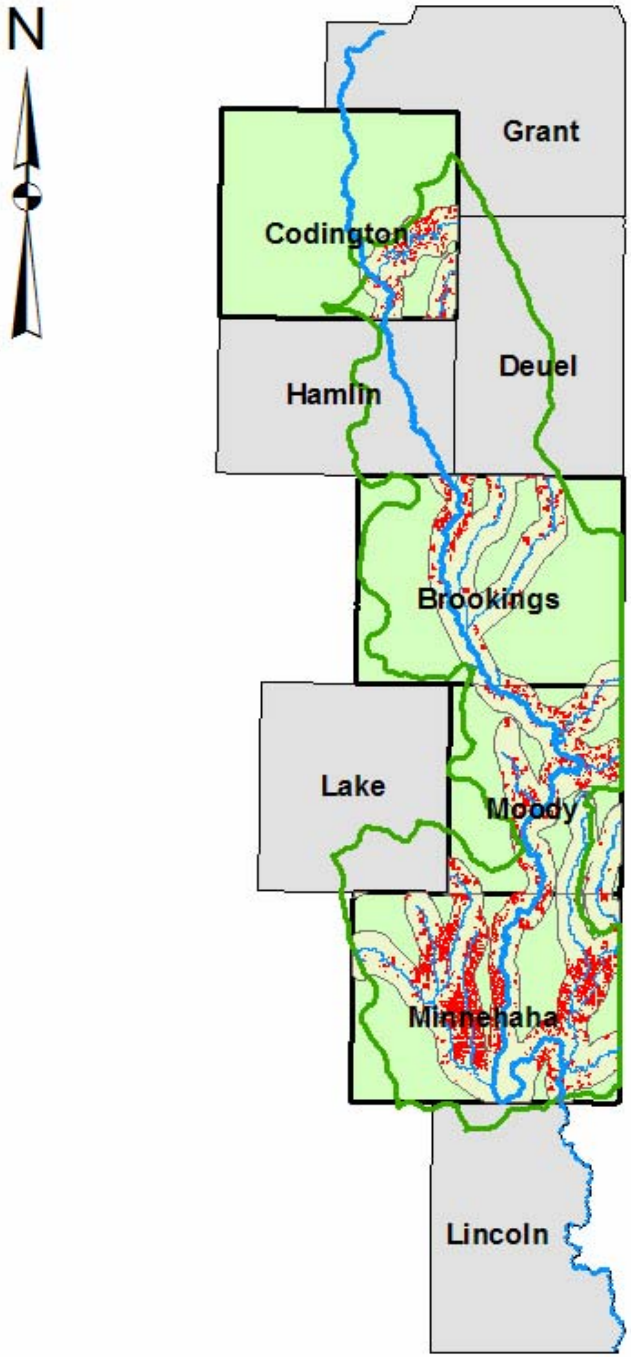


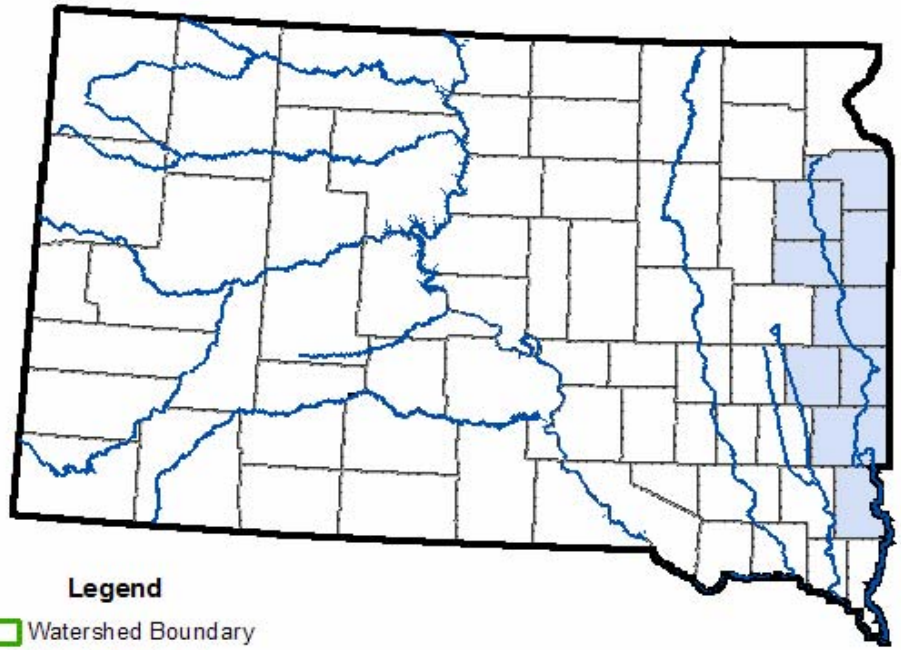
ODBC Link



Identifying Cropland

- Common Land Unit (CLU)
  - Available from Farm Services Agency (Cleansed Dataset)
  - Includes land use – Cropland
- Spatial Join between Soils & CLU
- Query for Cropland
- Cropland with HEL
- Within 2 miles of Big Sioux River or Tributaries = Priority Cropland





Legend

- Watershed Boundary
- Priority Cropland
- 2 Mile Buffer
- Counties in Project

Agricultural Cropland Summary		
County	Total Cropland (Acres)	Priority Cropland (Acres)
Codington	289,897	11,040
Brookings	329,099	6,718
Moody	237,146	18,058
Minnehaha	364,807	80,641
Total	1,220,949	116,457

0 12.5 25 50 Miles

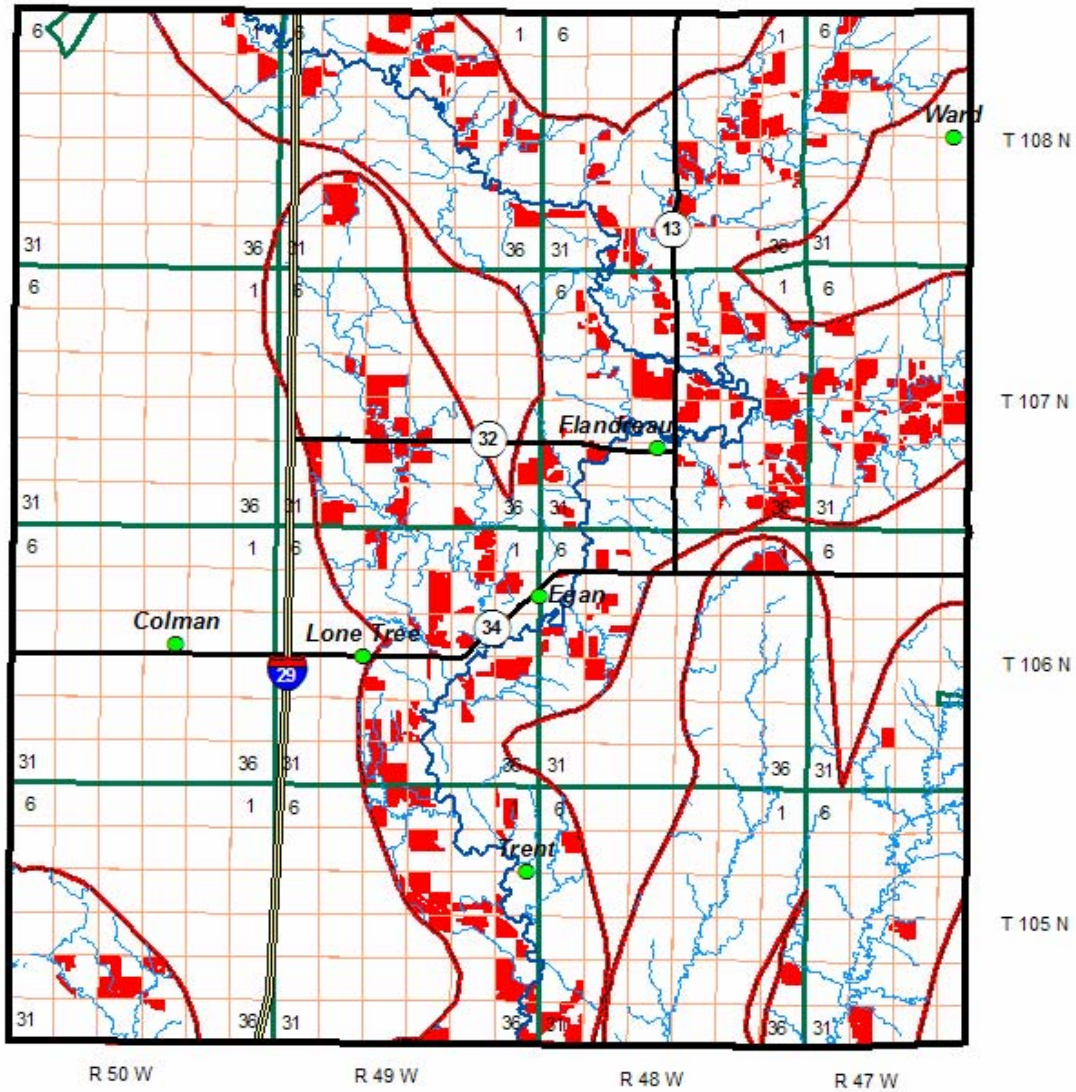
Map Created: January 4, 2008

Kurtis Reitsma
South Dakota State University
Plant Science Department
Brookings SD 57007
(605) 688-4594

This Map is for Planning Purposes Only

Although every effort has been made to ensure the accuracy of information; errors and conditions originating from the physical sources used to develop the database may be reflected in the data supplied. The end user must be aware of the data conditions and ultimately bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data and other conditions specific to certain data.

Big Sioux Water Quality Project
Moody County South Dakota - Priority Cropland



N

Legend

- Interstate Highway
- State Highway
- Two (2) Mile Buffer
- Priority Cropland

Agricultural Cropland Summary		
County	Total Cropland (Acres)	Priority Cropland (Acres)
Codington	289,897	11,040
Brookings	329,099	6,718
Moody	**237,146**	**18,058**
Minnehaha	364,807	80,641
Total	1,220,949	116,457

Map Created: January 7, 2008

Kurtis Reitsma
South Dakota State University
Plant Science Department
Brookings SD 57007
(605) 688-4594

0 2.5 5 10 Miles

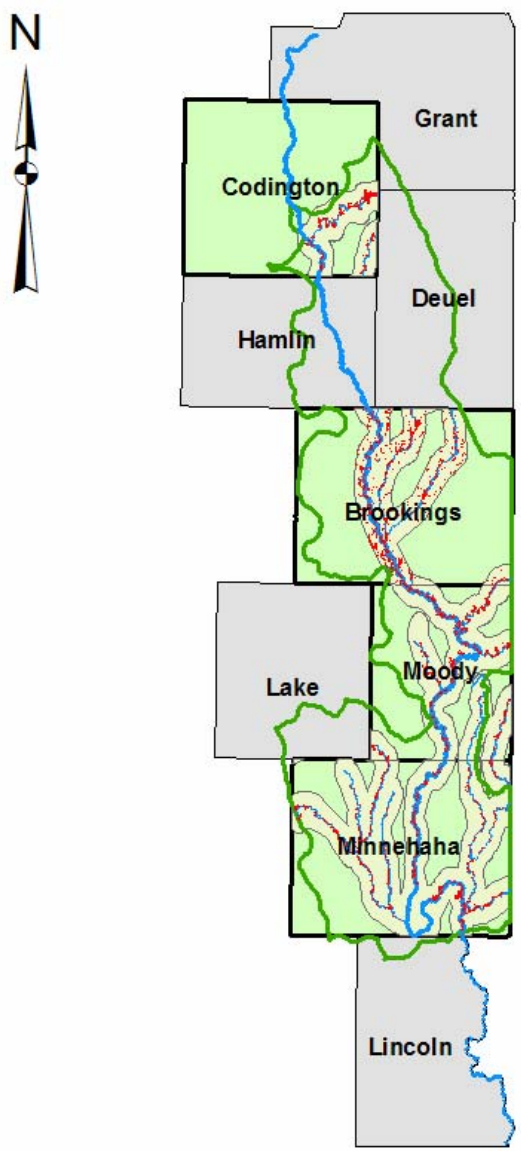
This Map is for Planning Purposes Only

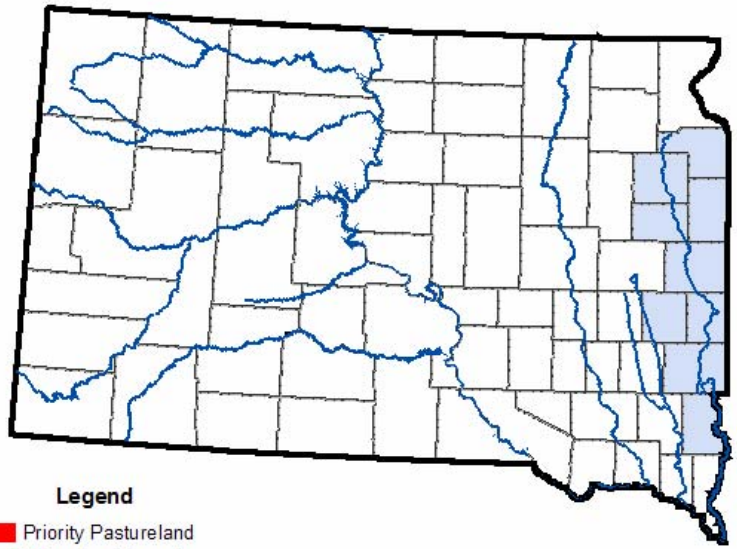
Although every effort has been made to ensure the accuracy of Information; errors and conditions originating from the physical sources used to develop the database may be reflected in the data supplied. The end user must be aware of the data conditions and ultimately bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data and other conditions specific to certain data.

Priority Pastureland

- Within 100 feet of the Big Sioux River or Major Tributary.
- Identification Process
  - Create 100 foot buffer of selected streams
  - Spatial join; Buffer – CLU (Pastureland)

Big Sioux Water Quality Project
Distribution of Priority Pastureland





Legend

- Priority Pastureland
- Watershed Boundary
- 2 Mile Buffer
- Counties in Project

Agricultural Pastureland Summary		
County	Total Pastureland (Acres)	Priority Pastureland (Acres)
Codington	23,746	5,777
Brookings	65,682	9,273
Moody	47,434	12,396
Minnehaha	66,498	18,166
Total	203,360	45,612

0 12.5 25 50 Miles

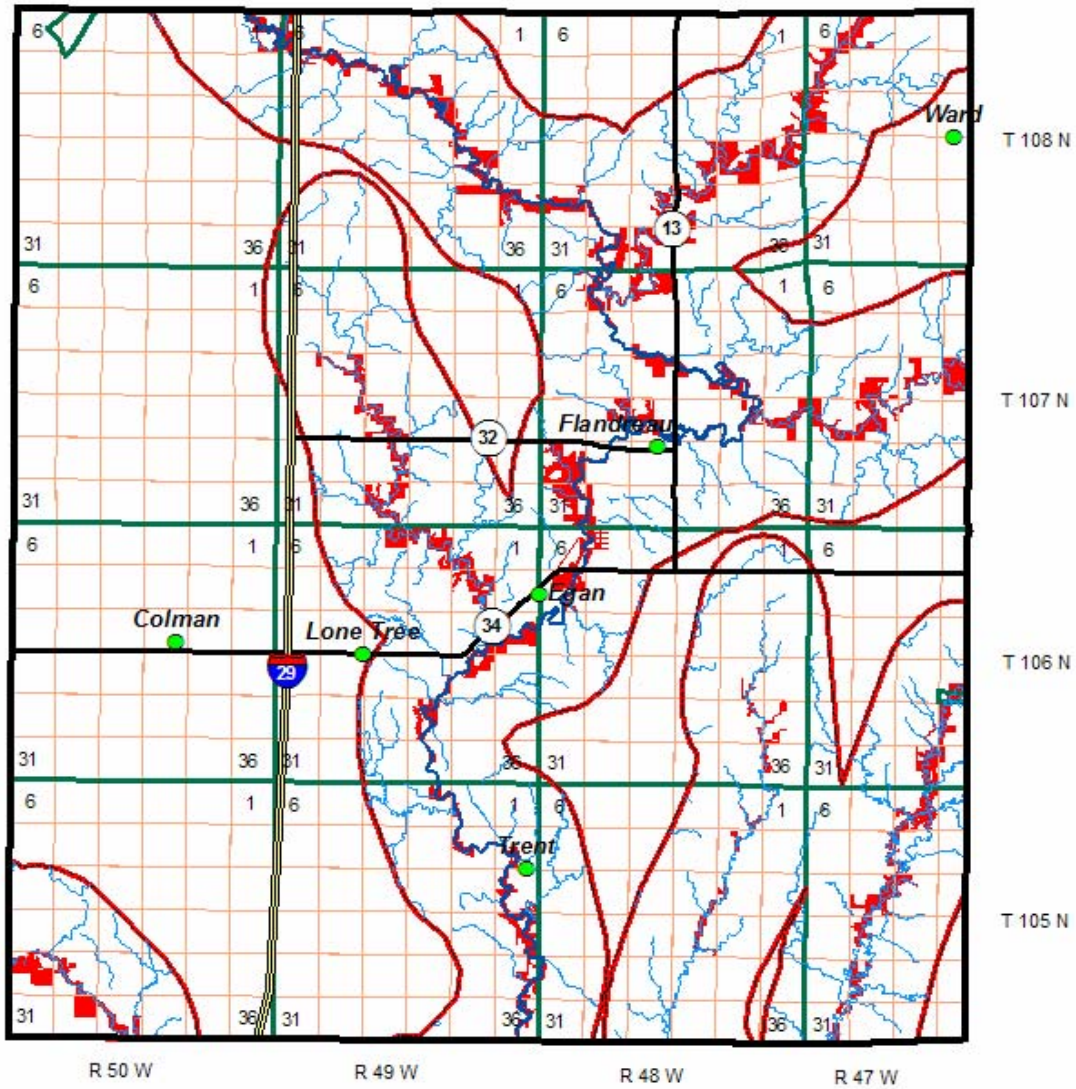
Map Created: January 7, 2008

Kurtis Reitsma
South Dakota State University
Plant Science Department
Brookings SD 57007
(605) 688-4594

This Map is for Planning Purposes Only

Although every effort has been made to ensure the accuracy of information; errors and conditions originating from the physical sources used to develop the database may be reflected in the data supplied. The end user must be aware of the data conditions and ultimately bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data and other conditions specific to certain data.

Big Sioux Water Quality Project
Moody County South Dakota - Priority Pastureland



N

Legend

- Interstate Highway
- State Highway
- Two (2) Mile Buffer
- Priority Pastureland

Agricultural Pastureland Summary		
County	Total Pastureland (Acres)	Priority Pastureland (Acres)
Codington	23,746	5,777
Brookings	65,682	9,273
Moody	**47,434**	**12,396**
Minnehaha	66,498	18,166
Total	203,360	45,612

Map Created: January 7, 2008

Kurtis Reitsma
South Dakota State University
Plant Science Department
Brookings SD 57007
(605) 688-4594

0 2.5 5 10 Miles

This Map is for Planning Purposes Only

Although every effort has been made to ensure the accuracy of information; errors and conditions originating from the physical sources used to develop the database may be reflected in the data supplied. The end user must be aware ofthe data conditions and ultimately bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data and other conditions specific to certain data.

Approach for Improved Management

- Develop a set of tools for CES Educators
  - Maps to find priority landowners
  - BMP’s that fit the situation
  - How BMP’s can improve productivity
  - Reference materials
  - Multi-media presentations
  - List of cost-share programs and contacts
- Personally contact producers
  - Propose BMP’s specific to the situation
  - Provide technical assistance or referrals

Can We Contact Everyone?

- Average farm size in South Dakota
  - 1,400 Acres (2002 Census of Agriculture)
- Farms in watershed
  - 974,000 Acres Cropland
  - 203,000 Acres Pastureland
  - 1,117,000 Acres Total = 840 Farms
- Farms identified having priority land.
  - 116,000 Acres Cropland
  - 46,000 Acres Pastureland
  - 162,000 Acres Total = 116 Farms
- With limited resources this is manageable

Targeting BMP's

- Estimating contact with 116 farms
- Survey data indicates % of producers where practices are Not or Somewhat Important.
  - Soil testing - 42% = 49 farms
  - Scouting for pests – 49% = 57 farms
  - Rotating pesticides – 52% = 60 farms
  - Manure nutrient analysis – 76% = 88 farms
  - Using maps to control pests – 82% = 95 farms

Does it Make a Difference?

- Targeting priority areas and BMP’s increase manageability. 840 farms to 116 farms
- The likelihood of BMP adoption is greater if personal contact is made.
- Focusing educational efforts and providing technical assistance on priority areas increase the probability that improved management will improve water quality.

Funding

- East Dakota Water Development District and the South Dakota Department of Environment and Natural Resources with a grant received through Section 319 of the Clean Water Act.

- USDA-CSREES-406 program

Acknowledgements

- Guidry, A.R., F.V. Schindler, D.R. German, R.H. Gelderman, and J.R. Gerwing. 2006. Using Simulated Rainfall to Evaluate Field and Indoor Surface Runoff Phosphorus Relationships. J. Environ. Qual. 35:2236-2243.
- USDA-NRCS. 2007. Nutrient Management (Ac.) Code 590, SD Field Office Technical Guide, 264.
- USDA-NRCS. Soil Survey Geographic Database (SSURGO), South Dakota. Available at: http://soildatamart.nrcs.usda.gov/
- Janssen, L. 2008. Unpublished results of producer survey conducted in South Dakota.
South Dakota State University, Economics Department.