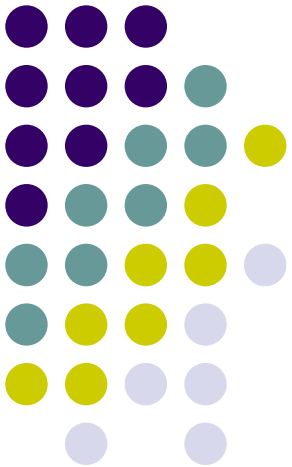
Precision placement of manure

DENR through EPA 319
SD Corn Utilization Council
SD Soybean Board
USDA-CSREES-406



D.E. Clay, C.G. Carlson, M. Reiman,
S.A. Clay, and D. Humberg

Survey

- Conducted in SD, ND, MT, WY, CO, UT
  - Asked people about water quality
  - Asked people about what type of educational programs they would most likely attend
  - Asked people about their understanding of agricultural systems.

  - Region wide: mailed 1925 returned 1087
  - South Dakota: mailed 250 returned 129

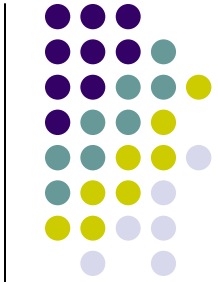
Responses (%Very or extremely important)

Topic	South Dakota	Region
Clean rivers	87	92
Clean ground water	90	93
Better Ag prac.	76	78
Pre riparian areas	53	61
Pre open areas	64	71

Awareness of problems
Perceived importance of factors

	South Dakota	Region
Animal waste management	70	65
High bacterial counts (water)	25	19
Nutrient pest man	66	58
nitrates	42	31
salinity	9	13

Bottom line



- People see water quality as important
- Many people believe we are doing reasonably good
- Many people do not understand watershed processes and are not willing to attend extensive training opportunities
  - 6% take a short course
  - 6% obtain certification
  - 9% conduct an assessment
  - 17% watch a video
  - 62% watch TV or read a newspaper

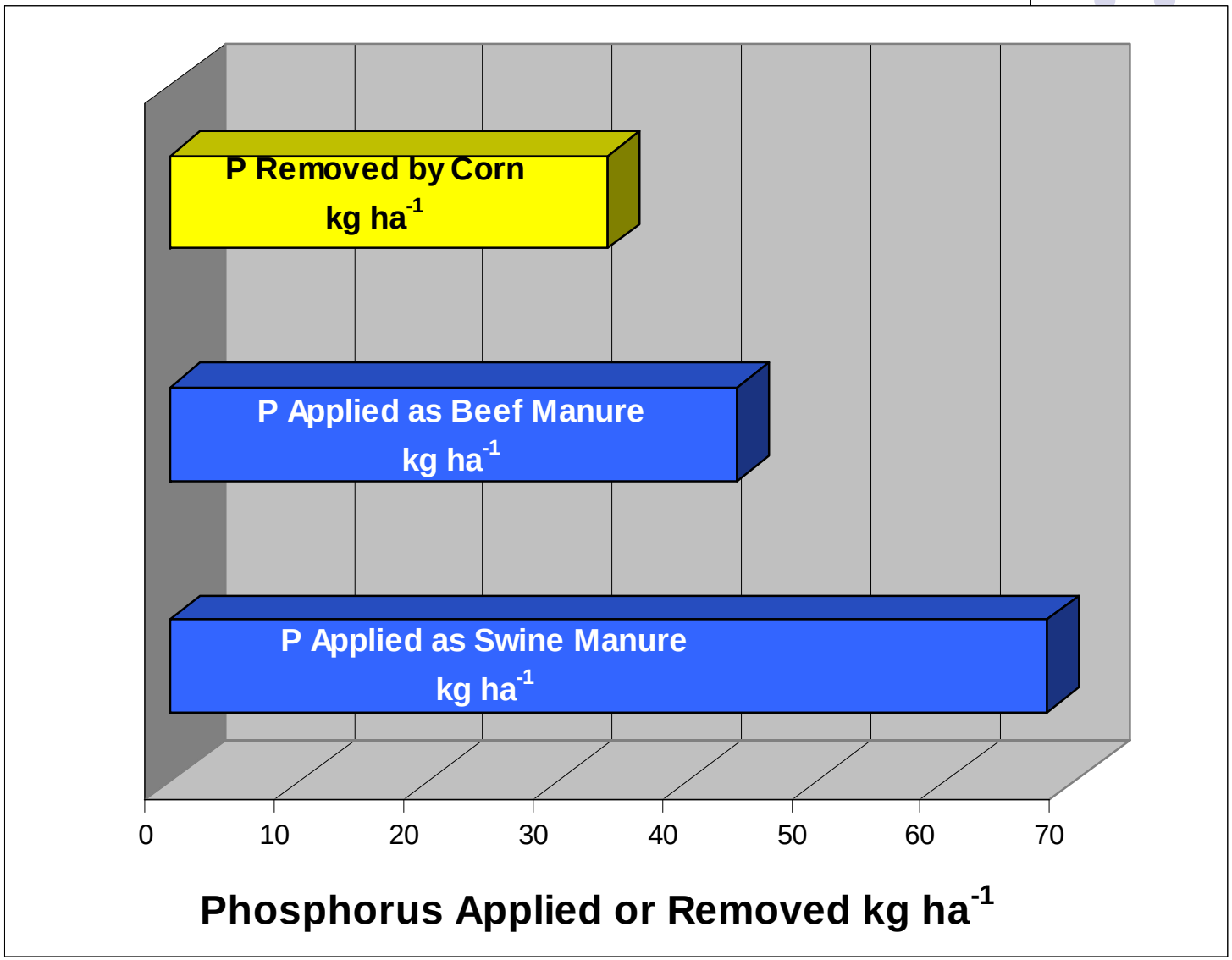
Manure Utilization
Better management practices

- Land application of livestock manure is an important tool for manure disposal as well as providing nutrients to crops.

- Problems can result when manure is applied to agricultural fields.

P Application and Removal

Problem: Manure application to supply the nitrogen needs of corn results in P over-application.



Phosphorus Accumulation

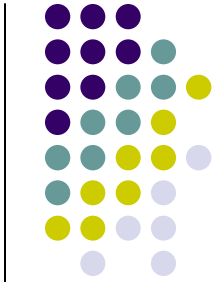
- This application above nutrient requirements leads to P accumulation in the soil.

- P accumulation occurs at or near the soil surface.

Phosphorus Loss

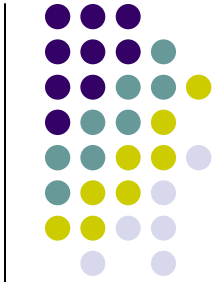
- Studies have shown that P in runoff increases with soil test-P.
  - Surface accumulation leaves the P vulnerable to loss with runoff.

A New Approach



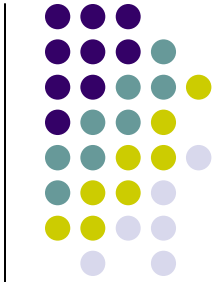
- Precision deep manure placement may help solve this problem by:
  - Not increasing the surface soil P concentration.
  - Reducing the amount of N lost through leaching, volatilization, and denitrification, thereby reducing the amount of N required to meet the N requirements.

Proposed Method



- Precision deep manure injection.

Objectives



1. Build an applicator
2. Demonstrate the technology on 5 farms
3. Develop educational materials

Applicator

- Dan Humberg, Joe Schumacher, and Gregg Carlson built an applicator.

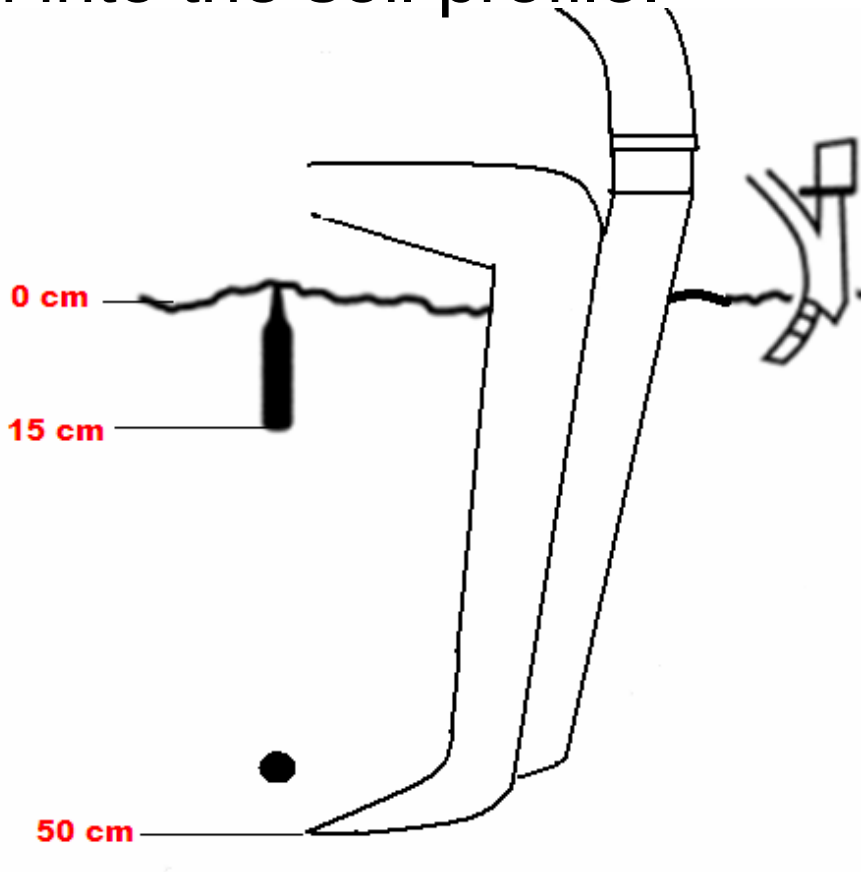
- A tank manufactured by Balzer was modified and soil rippers were installed on the tool bar.

Manure Application Equipment

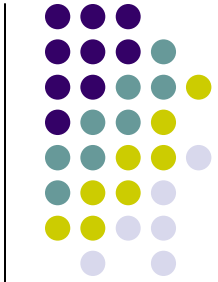
Complete application unit used to apply manure at the sites in the study.

Manure Application Equipment

Manure applicator was designed and built to place manure up to 45 cm into the soil profile.

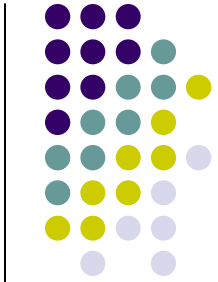


Demonstration studies



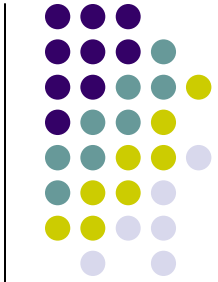
- 2004
  - Volga — Scott VanDerwal
  - Flandreau — Dale Tjark
- 2005
  - Brookings — SDSU
  - Corsica — Russell Metzger
  - Lake Preston — Justin Odengaard
- 2006
  - Bereford — Gordon Andersen

Activities



- Collect soil samples for assessing nutrient loading
- Assess water infiltration
- Determine yields
- Numerous presentations given at farmer meetings and field days
- Developed a water quality web-site
  - The site contains pertinent manure management materials
- In the process of analyzing field results
  - Based on this analysis fact sheets will be prepared

Unexpected results



- Soil and water samples collected from the demonstration sites had interesting results.

- Discuss findings from the Volga, Flandreau, and Brookings sites

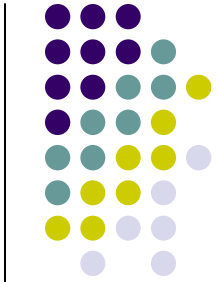
Manure Application

- Flandreau manure applied on October 25, 2005.
- Volga manure applied on October 21-22, 2005.
- Brookings: manure applied on May 4, 2005.

Manure Application

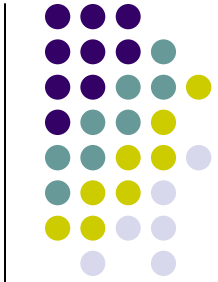
- Manure was sampled and analyzed at the Oscar E. Olson Biochemistry laboratory
- At Brookings manure was analyzed for density and dry matter content
- Nutrient application rates were calculated based on application rate and manure analysis

Manure Application



Site	Type	N	P	K	Dry matter
			Kg/ha		
Flan.	Swine	560	184	258	5780
Volga	Beef	270	52	123	4730

Fertilizer Application



- At Flandreau
  - 6.5 kg ha^{-1} N and 11.5 kg ha^{-1} P.
  - An additional 168 kg ha^{-1} N, 20 kg ha^{-1} P, and 46 kg ha^{-1} K was applied to the CM treatment.

- All plots at Volga were fertilized with an additional
  - 97 kg ha^{-1} N.

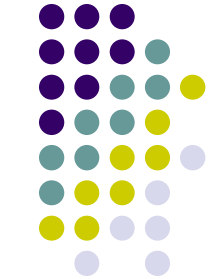
Plot Layout

- Flandreau
  - Treatments were 18 m x 150-300 m in three blocks.
  - Treatments:
    - DI
    - SI
    - Conventional management without manure (CM)

Plot Layout

- Volga
  - Treatments were 9 m x 687 m replicated in 3 blocks.
  - Treatments
    - DI
    - SI
    - Surface manure application (SA).
    - CM
  - The Volga site had a manure history.

Soil Sampling and Analysis



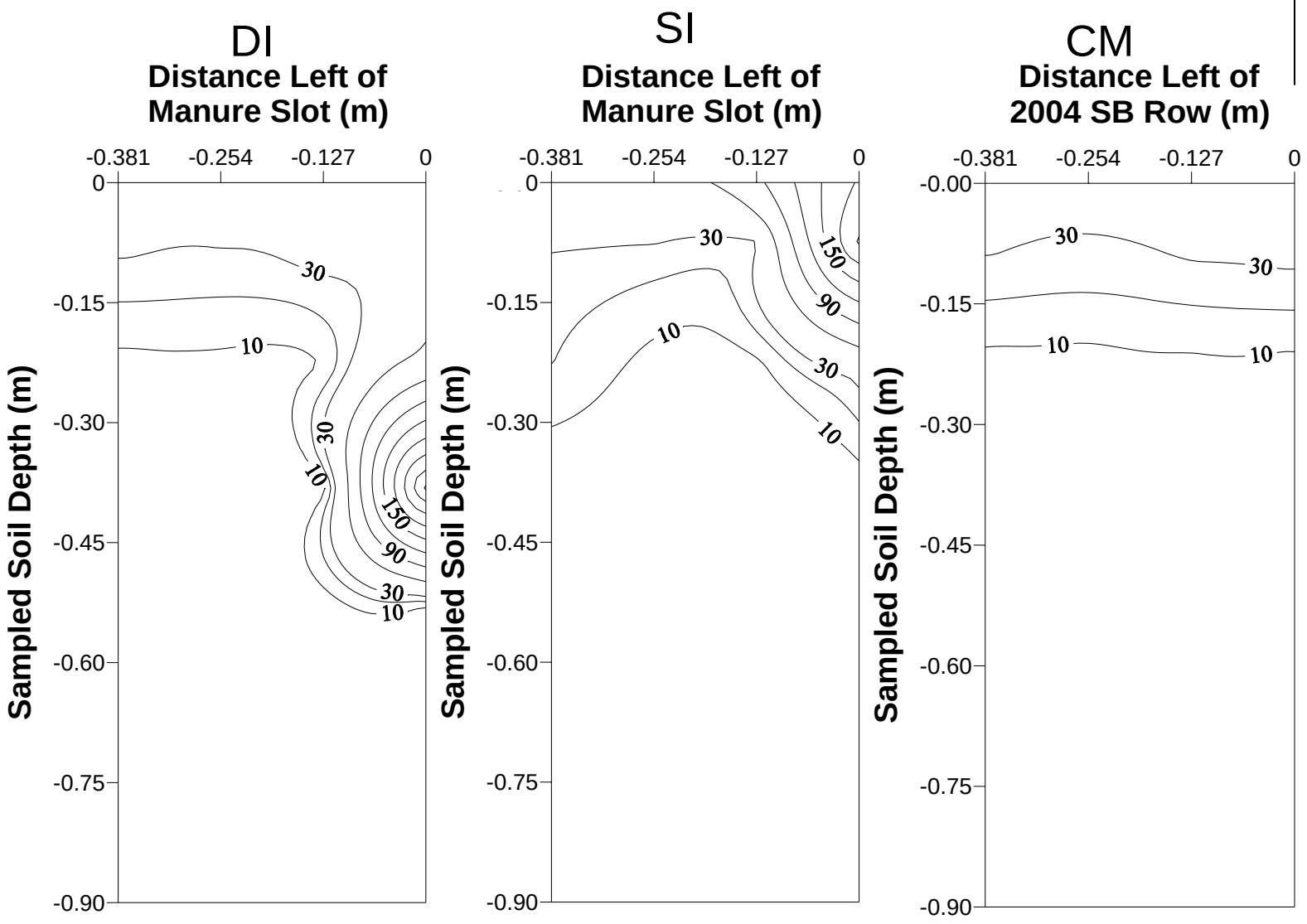
- Intensive grid sampling in both plots 0-15 cm
  - April 2005 (6 months)
  - October 2005 (1 year)

Intensive soil sampling Flandreau

	38	25	13	0
15				
30				
45				
60				
75				
105				
120				

Phosphorus Distribution

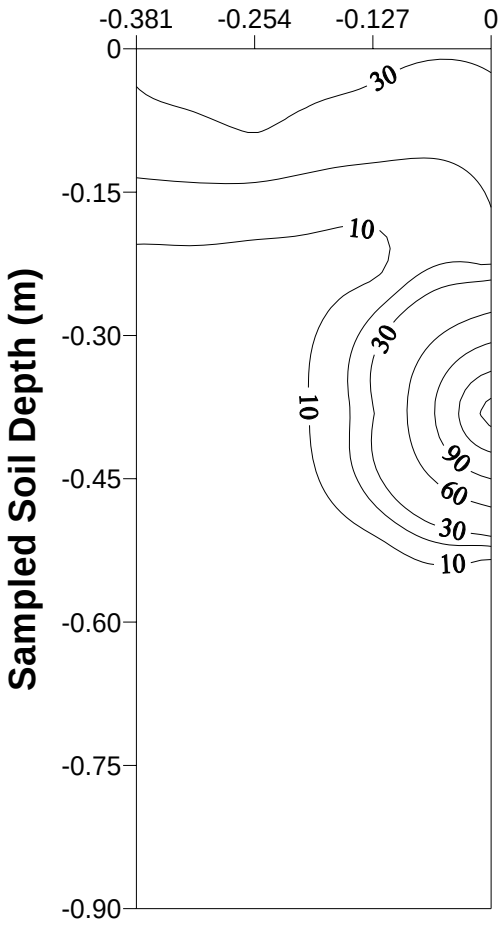
Distribution 6 months after manure application



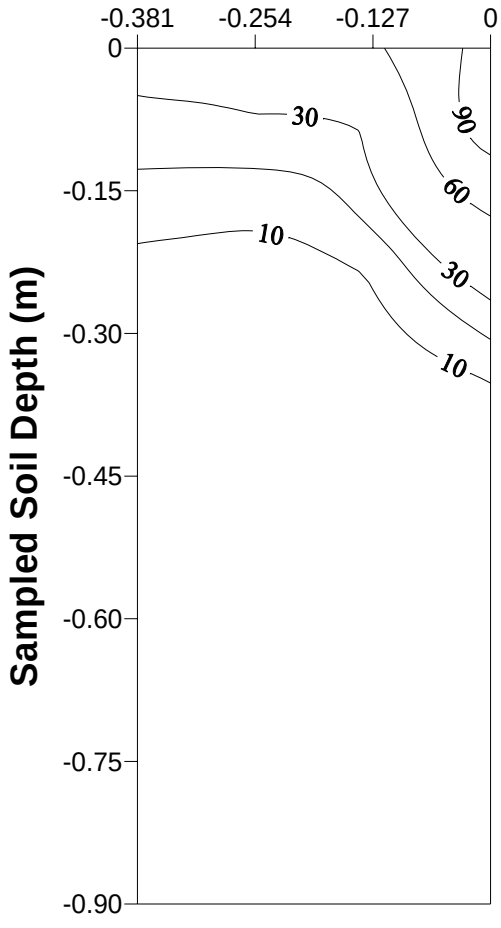
Phosphorus Distribution

Distribution 12 months after manure application

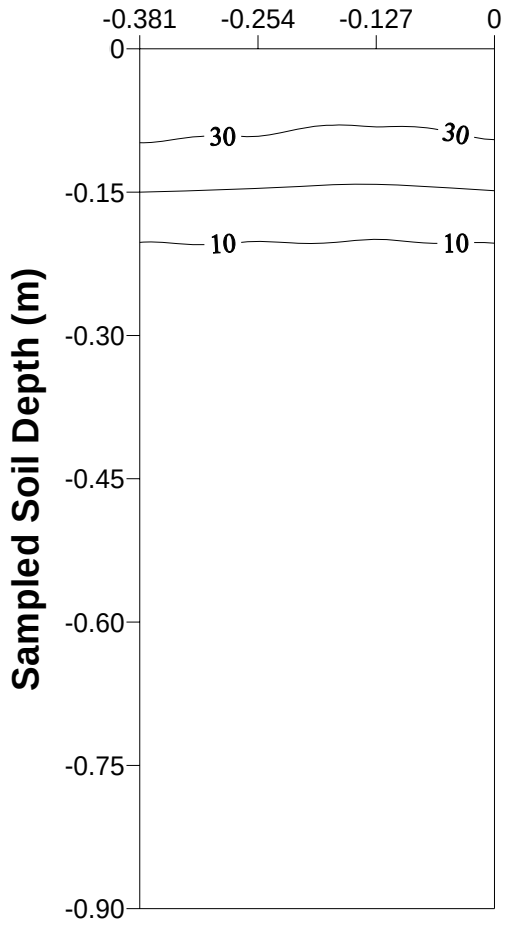
DI



SI

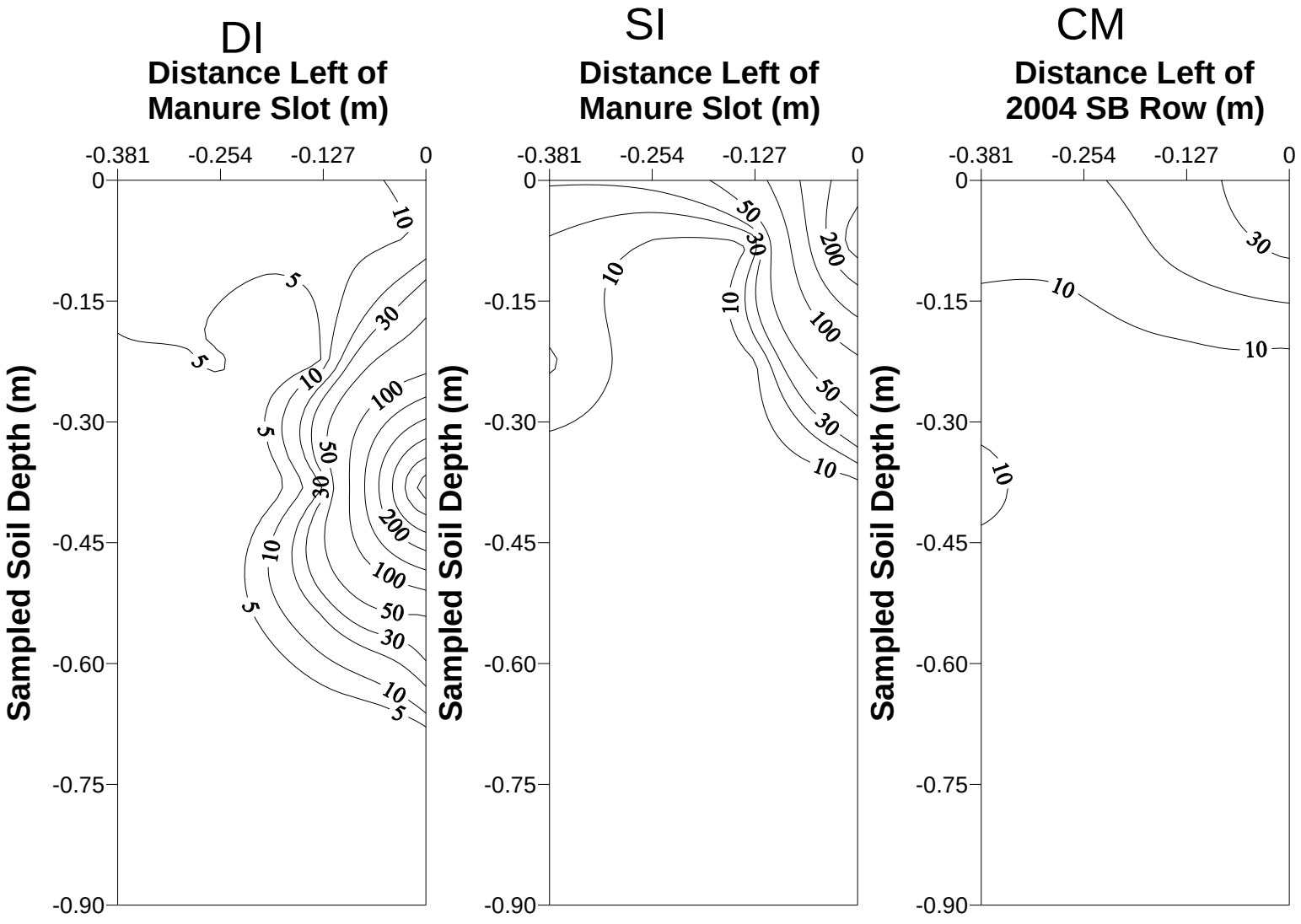


CM



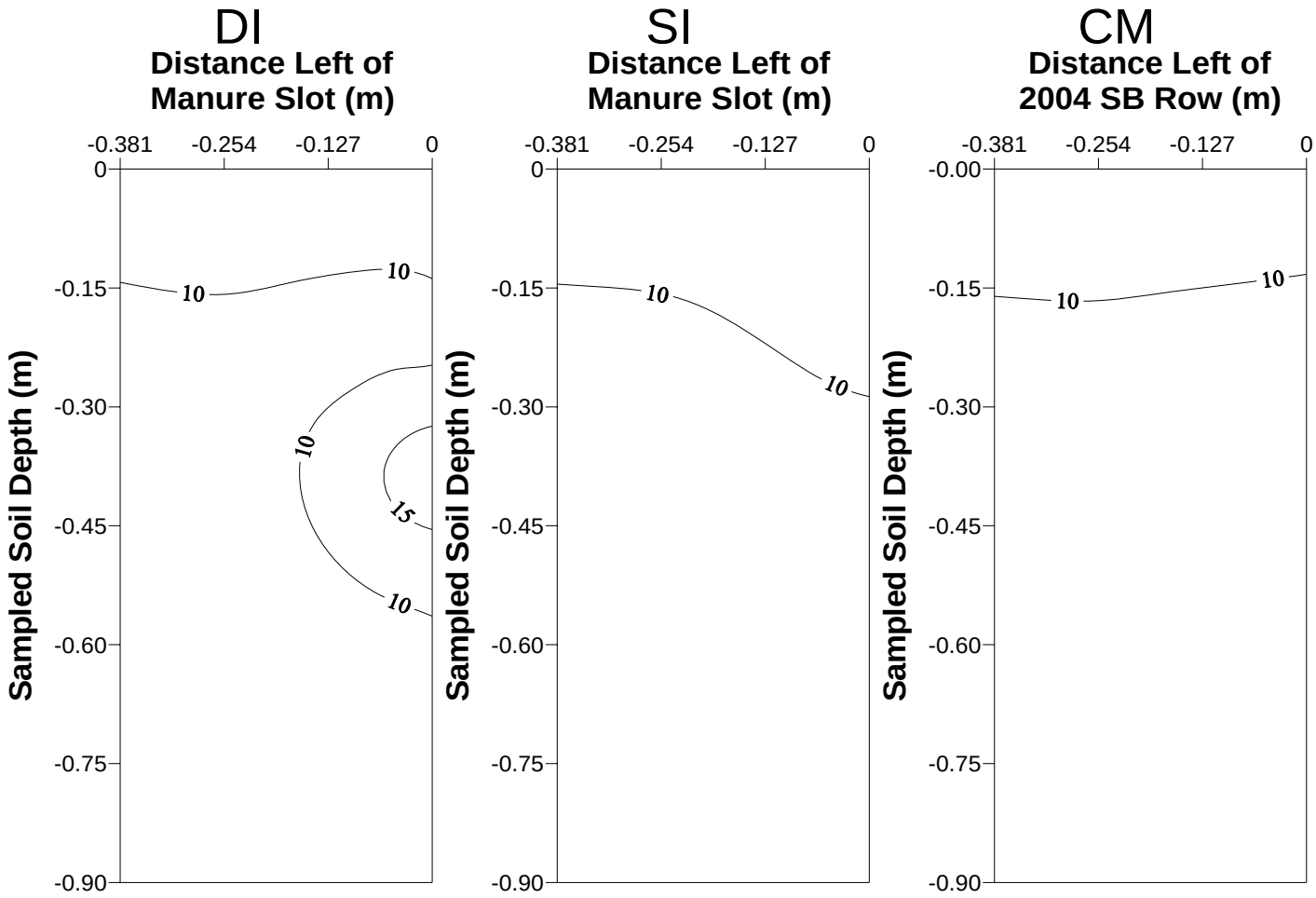
Ammonia Distribution

Distribution 6 months after manure application



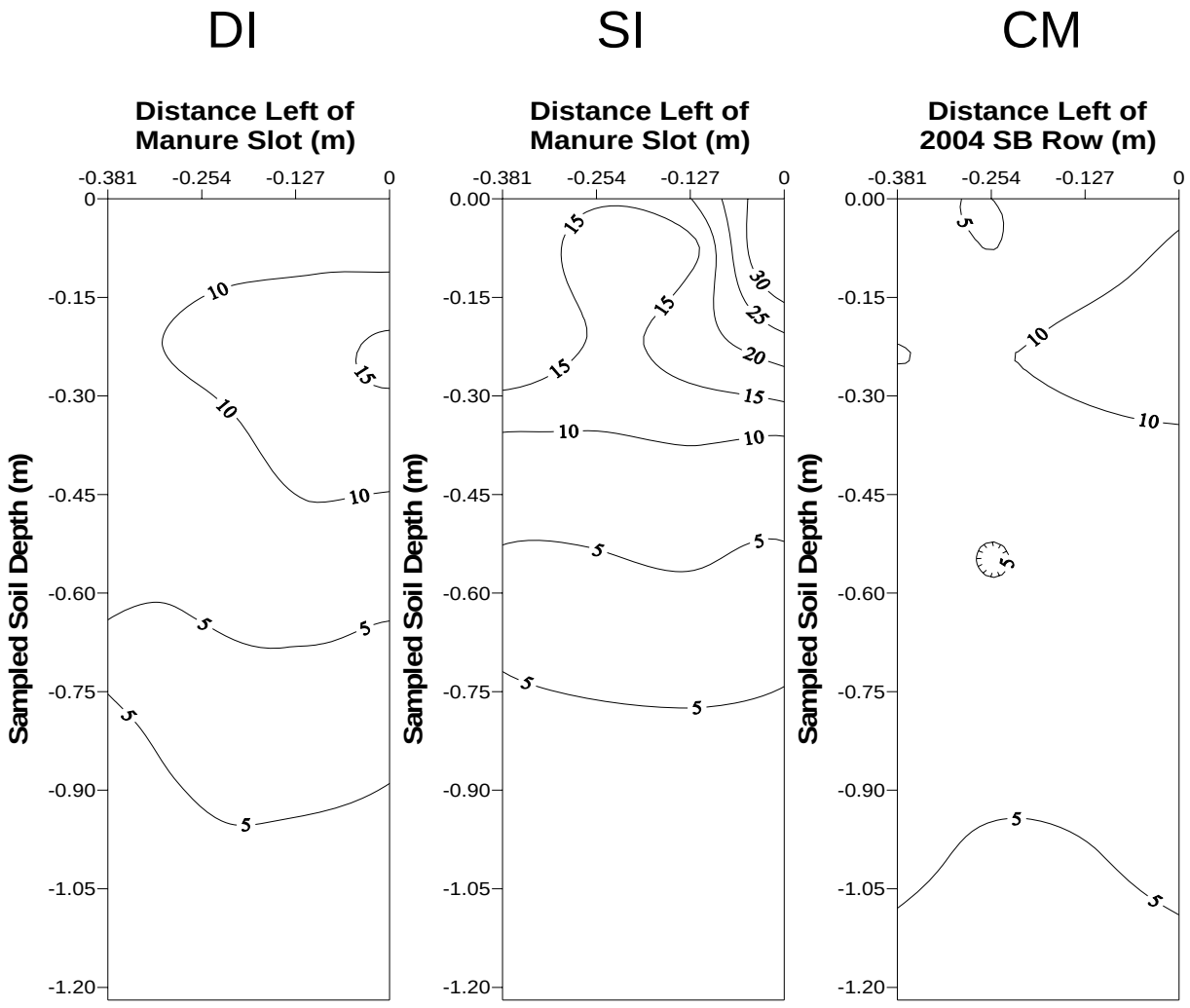
Ammonia Distribution

Distribution 12 months after manure application



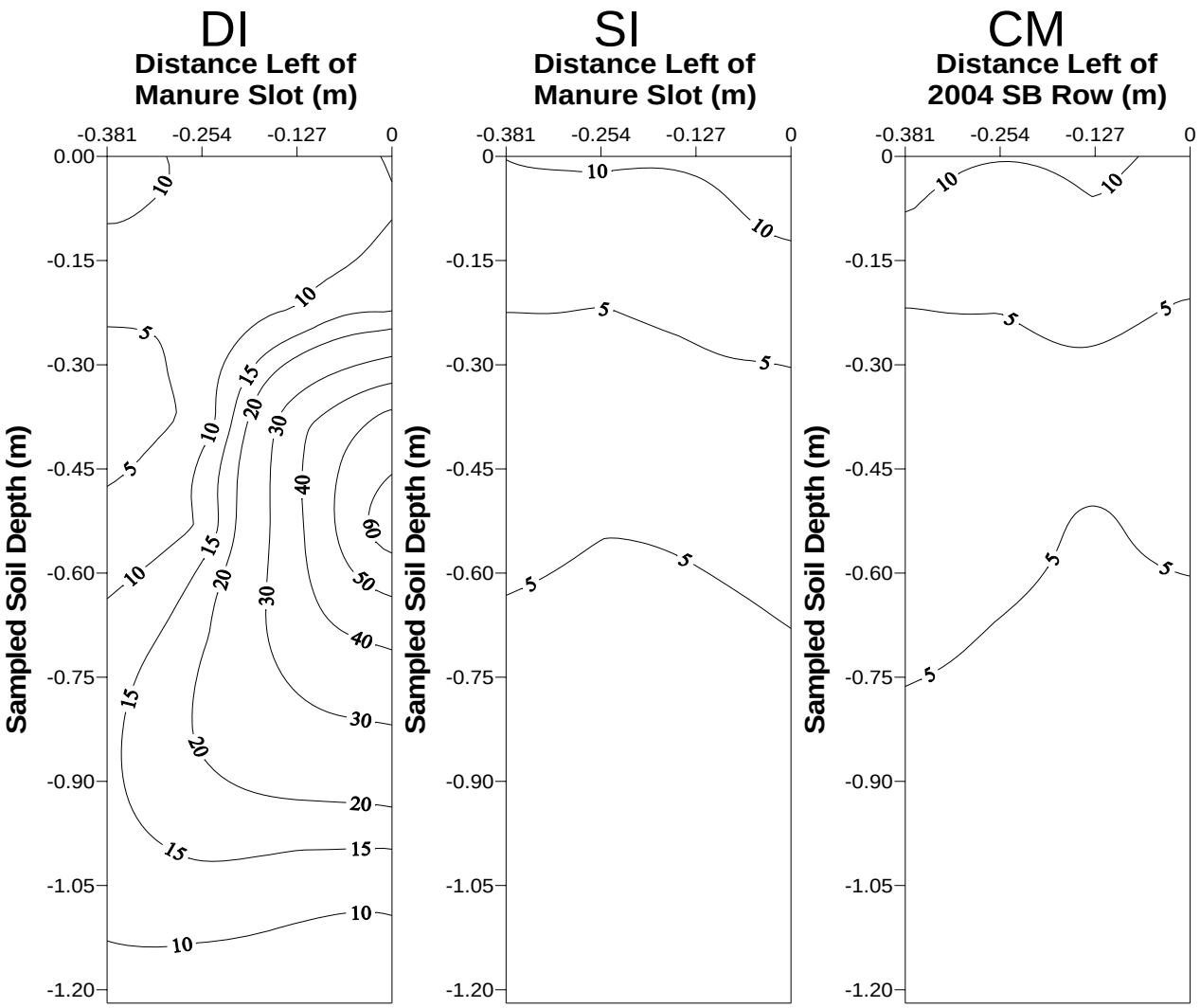
Nitrate Distribution

Distribution 6 months after manure application

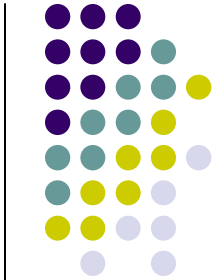


Nitrate Distribution

Distribution 12 months after manure application



Suggests

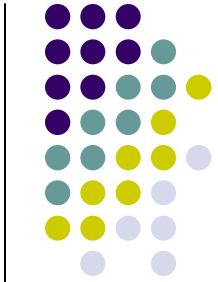


- Deep manure injection influences P distribution in the soil.
  - Injected: P concentrations are very high in the soil above the slot.
- Nitrogen distribution changed
  - Nitrification and mineralization slowed by deep placement
    - Organic-N → ammonia
    - Ammonia → nitrate
      - Nitrate can leach or be denitrified

Field Inorganic N

- Soil sampling (depth of 90 cm)
  - Prior to manure applications
  - Spring 2005 (6 months after)
  - Fall 2005 (1 year after)
  - Spring 2006 (1.5 years after)
- All samples were analyzed for P, NH_4^+-N, and NO_3^--N.

Inorganic N (kg/ha)

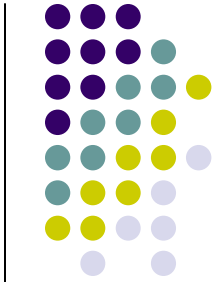


	Flan			Volga		
Treat	**Prior**	**1 y.**	**1.5 y**	**Prior**	**1 y**	**1.5 y**
CM	188	129	187	120	172	192
SA				117	187	205
SI	147	157	201	115	192	206
DI	139	261	267	119	230	248
p	0.2	0.003	0.01	0.92	0.003	0.04

Soil test P (0-15 cm, ppm)

	Flan			Volga		
Treat	**Prior**	**1 y.**	**1.5 y**	**Prior**	**1 y**	**1.5 y**
CM	31	33		155	159	116
SA				101	126	119
SI	26	46		106	122	146
DI	25	32		123	115	103
p	0.53	0.13		0.12	0.11	0.39

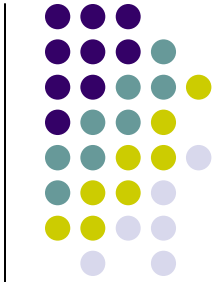
Water infiltration



- Apparent saturated hydraulic conductivity

- Unsaturated water infiltration

Water Infiltration



- Ponded (Double-Ring) water infiltration was measured at all three sites
  - Apparent saturated hydraulic conductivity

- Sprinkle infiltration was measured at the Brookings and Flandreau sites.

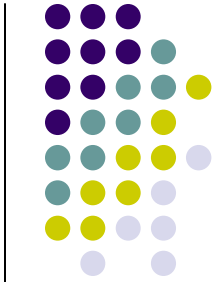
Apparent saturated hydraulic conductivity (mm/hr)

	Flan			Volga	
Treat	**6 month**	**1.5 year**		**6 month**	**1.5 year**
CM	226	246		295	129
SA				283	158
SI	281	260		329	154
DI	263	229		387	196
p	0.28	0.85		0.01	0.38

Apparent saturated hydraulic conductivity (mm/hr) Brookings

Treatment	2 months	6 months	1 year
CH	196	147	45
SI	336	262	92
Rip	225	348	115
DI	240	349	149
P	0.03	0.003	0.42

Planting and Harvesting

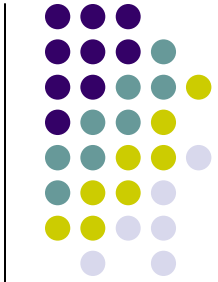


- Corn was planted at all sites in 76 cm row spacing at all sites.
- Corn was harvested for grain at maturity with combines that had yield monitors.
- Weigh wagons were used to determine grain weight. Yields were calculated using grain weight, moisture content and the area harvested.

Yields (Bu/A)

	Flan		Volga	
	Corn		Corn	Soybean
	2005	2006	2005	2006
DI	216	192	147	61
SA			142	59
SI	209	184	145	59
CM	203	181	144	57
P	0.08	0.02	0.09	0.12

Conclusions



- Stratification of P with depth occurred.
- Deep manure injection increase water infiltration for up to one year. With time differences decreased.
- Deep manure injection increased corn yields 8 bu/acre at Flandreau.
  - At Volga yield differences were smaller because, the producer applied N on top of the experiment.

Conclusions

- Deep manure injection reduced the loss of N through dentrification, leaching, or volatilization.
  - At Flandreau, N was increased 90 and 40 kg N ha in the first and 2nd growing seasons
  - At Volga, N was increased 60 and 40 kg N ha in the first and 2nd growing season.
  - If N costs $0.40/lb, this represents a savings of $35/a in year 1 and a savings of $14/acre in year 2.

Conclusions

Manure injection to a depth of 45 cm provided superior performance and should be a tool available to producers.

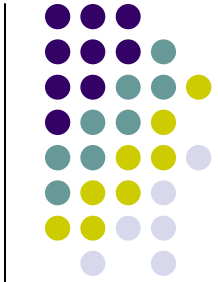
It will reduce P pollution from manured land by storing P deeper in the profile,

Deep placement of manure increased yields and reduced N losses through denitrification, leaching, or volatilization.

Reduced N losses could result in a decrease in the amount of N needed to meet the N requirements of plants.

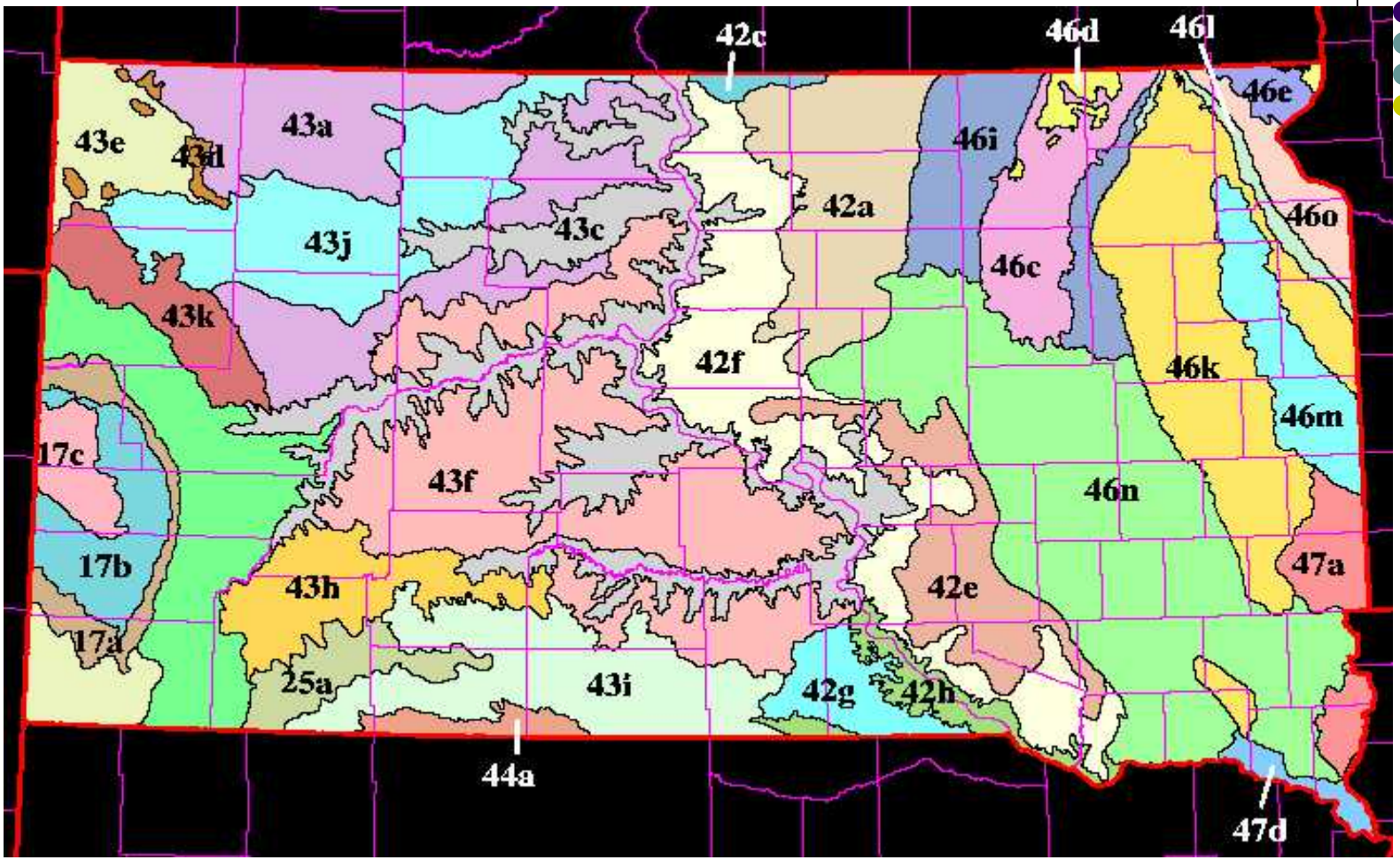
QUESTIONS?

Developing educational materials for extension educator led one-on-one discussions



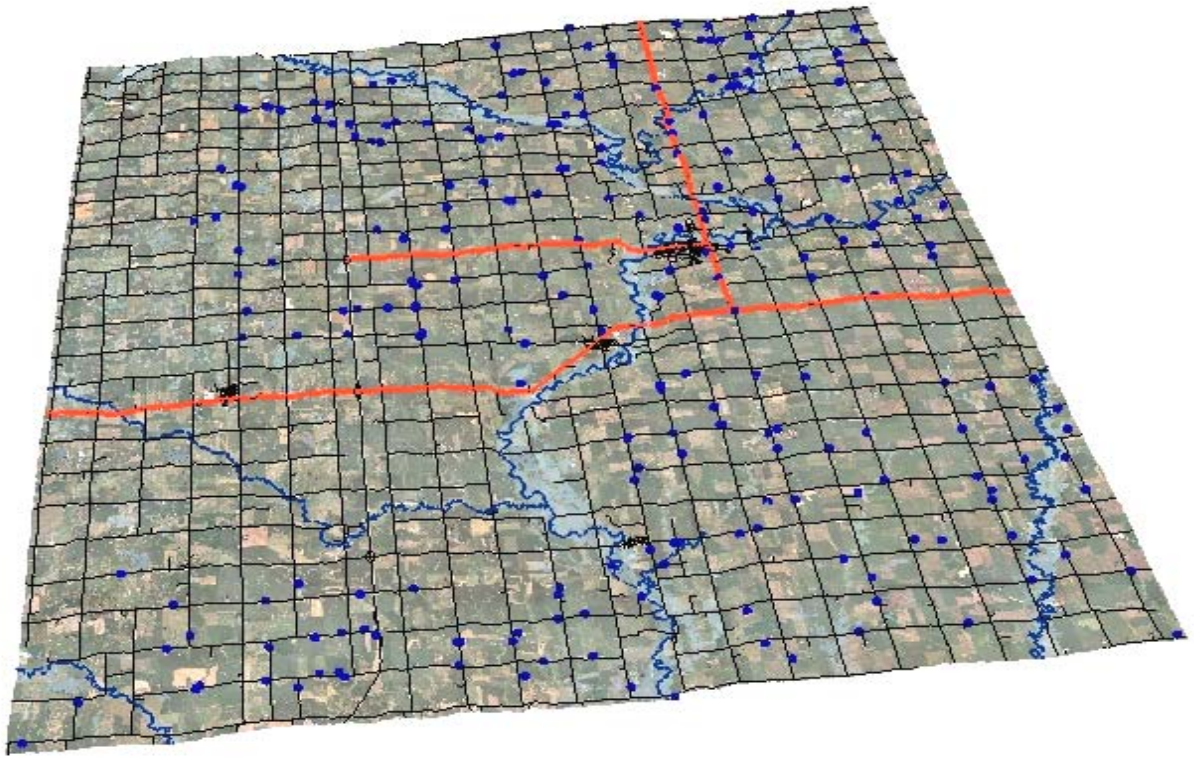
- Wanted to create maps that show individuals that they can make a difference.

Ecoregions of South Dakota



Maps such as these may not engage producers

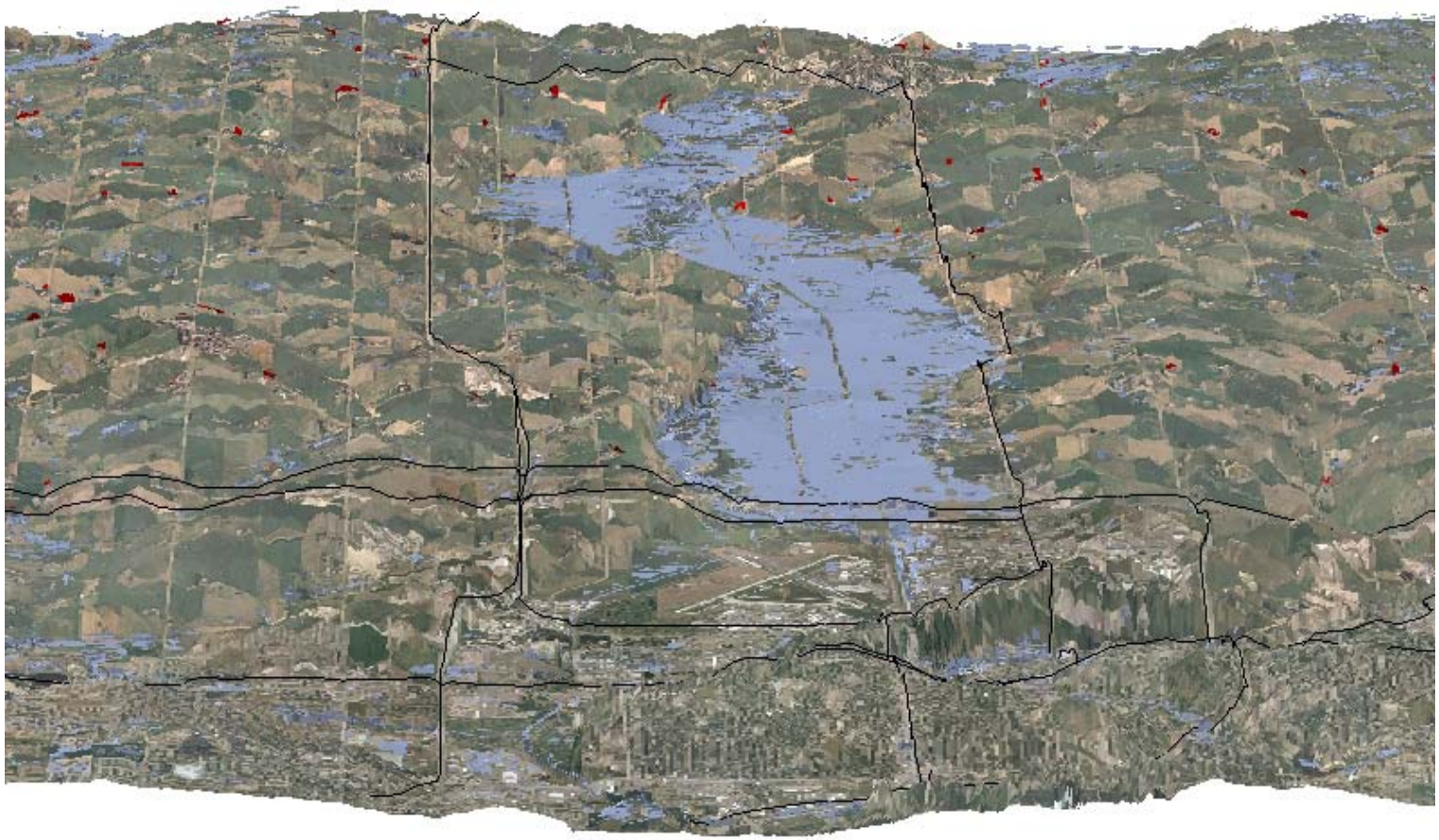
http://sdakotabirds.com/habitat/ecoregions.htm#43a



The location of feedlots (<1000 animal units), Big Sioux River (light blue) and Flandreau SD, and a Landsat image superimposed on a digital elevation map. Image collected when Big Siouix River was flooding.

Flandreau

Minnehaha



- Images such as these will be integrated into an educational guideline manual that provides a very simple discussion about the advantages and disadvantages of different BMP.

- We will also use these materials to develop a short (<5 minute) presentation about water quality in the Big Sioux River.

- We believe that to change behavior, individuals must be personally connected to the solution.
- Education must start at the local level by people they trust.
- One-on-one works best