Precision placement of manure

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

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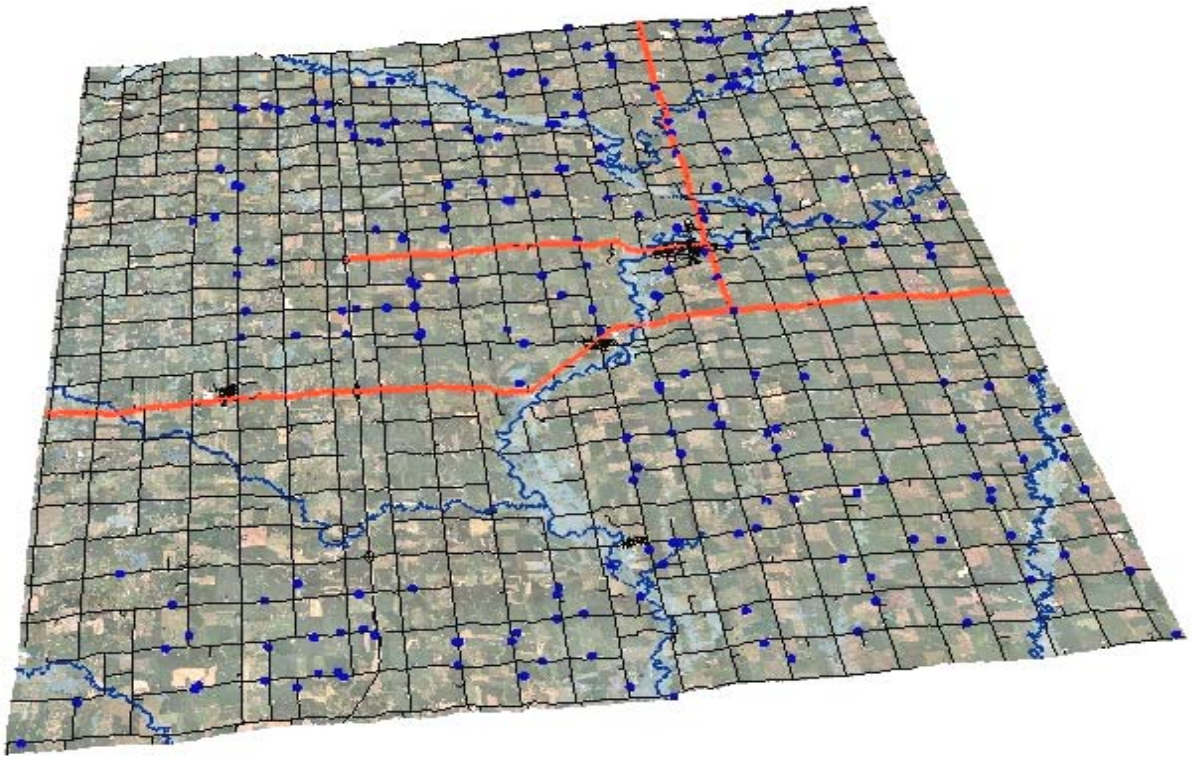
Manure Utilization
Better management practices

- 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.

Phosphorus Accumulation

- This application above nutrient requirements leads to P accumulation in the soil.
- P accumulation occurs at or near the soil surface.
- P can runoff into streams and lakes



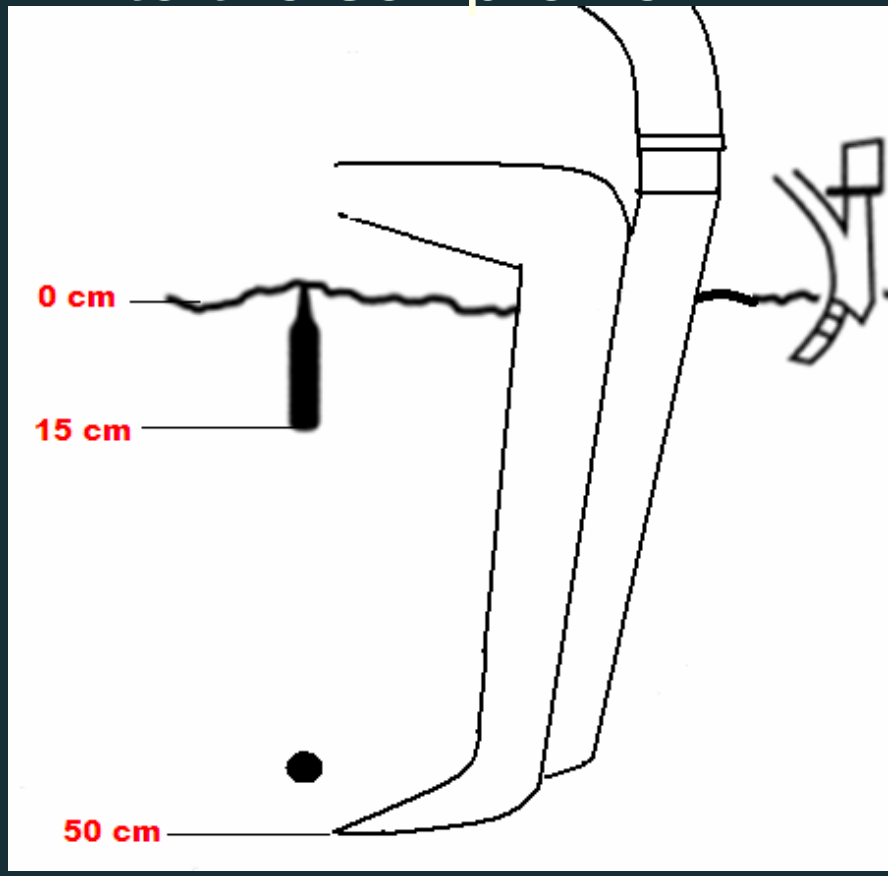
The location of feedlots (<1000 animal units), Big Sioux River (light blue) and Flandreau SD, and a Landsat image superimposed on a digital elevation map. Image collected when Big Sioux River was flooding.

Flandreau

- 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.

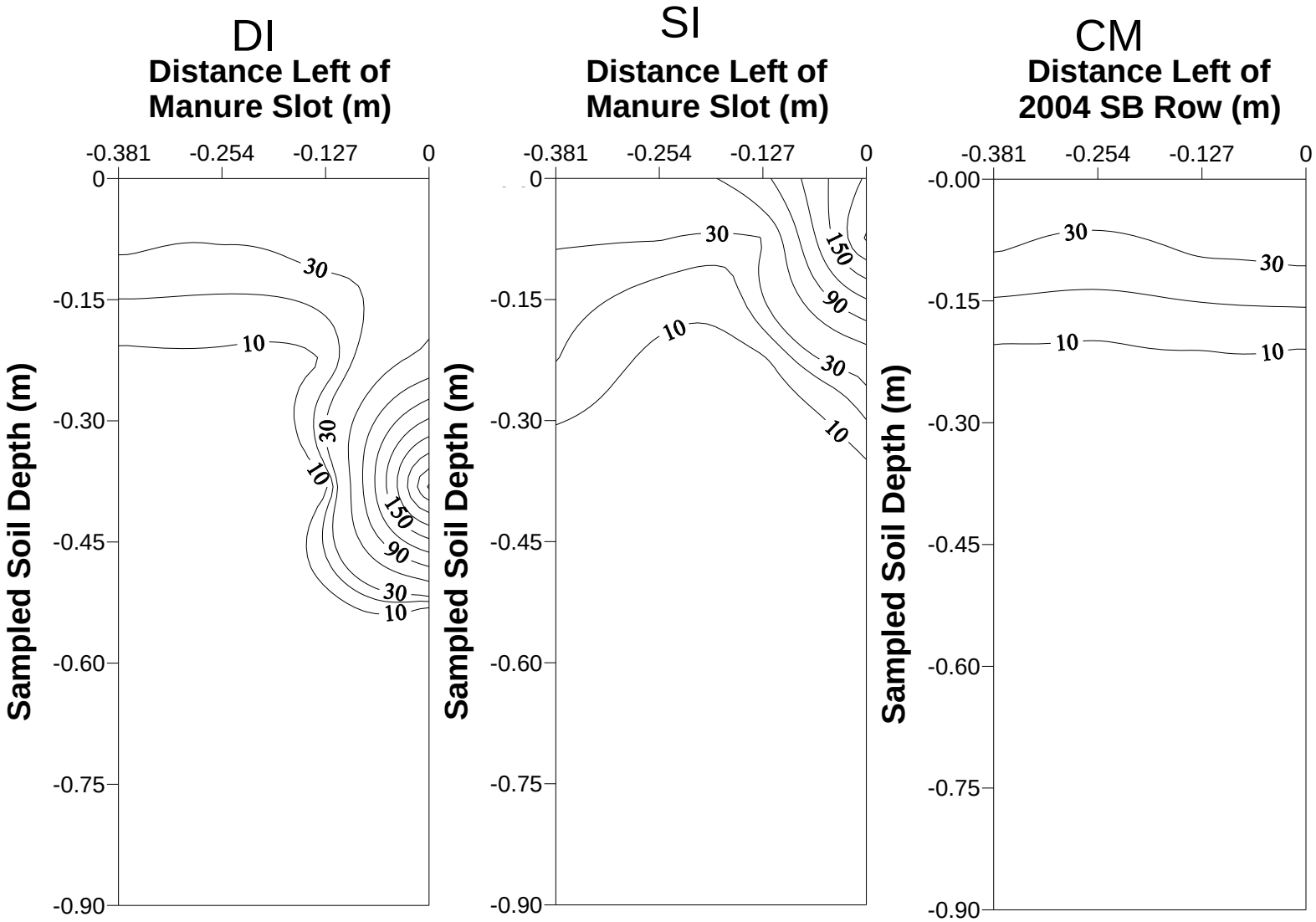
Manure Application Equipment

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



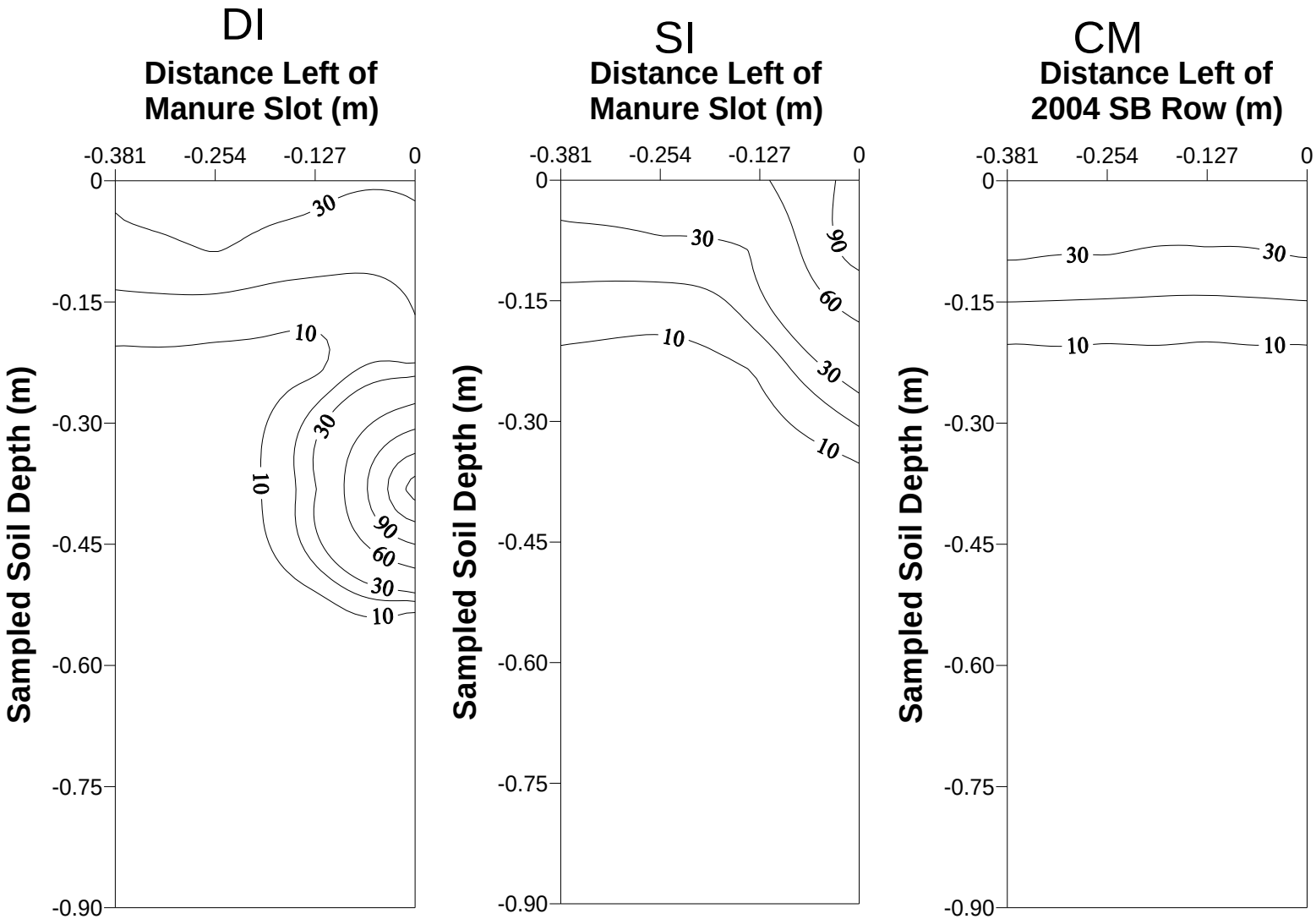
Phosphorus Distribution

Distribution 6 months after manure application



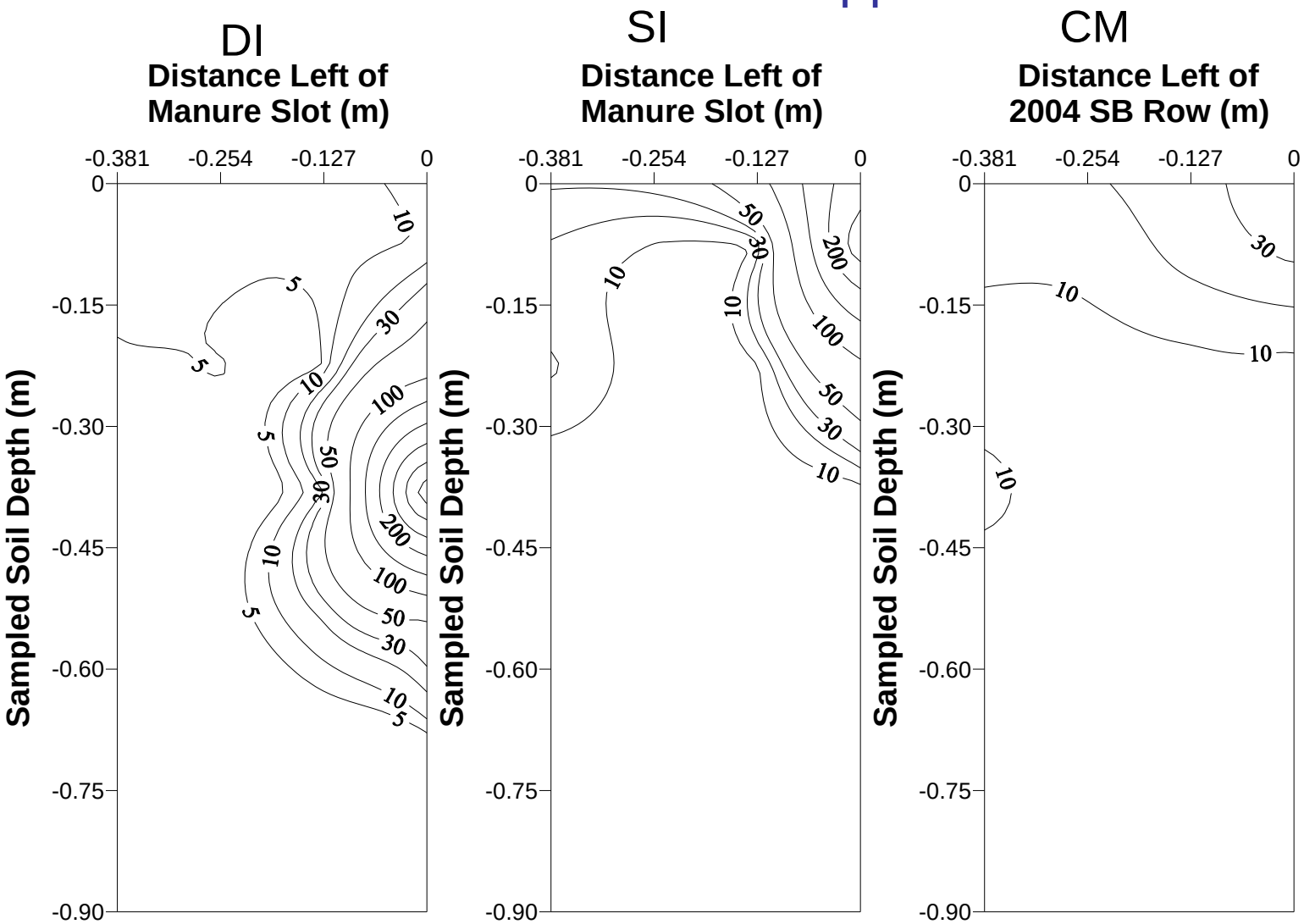
Phosphorus Distribution

Distribution 12 months after manure application



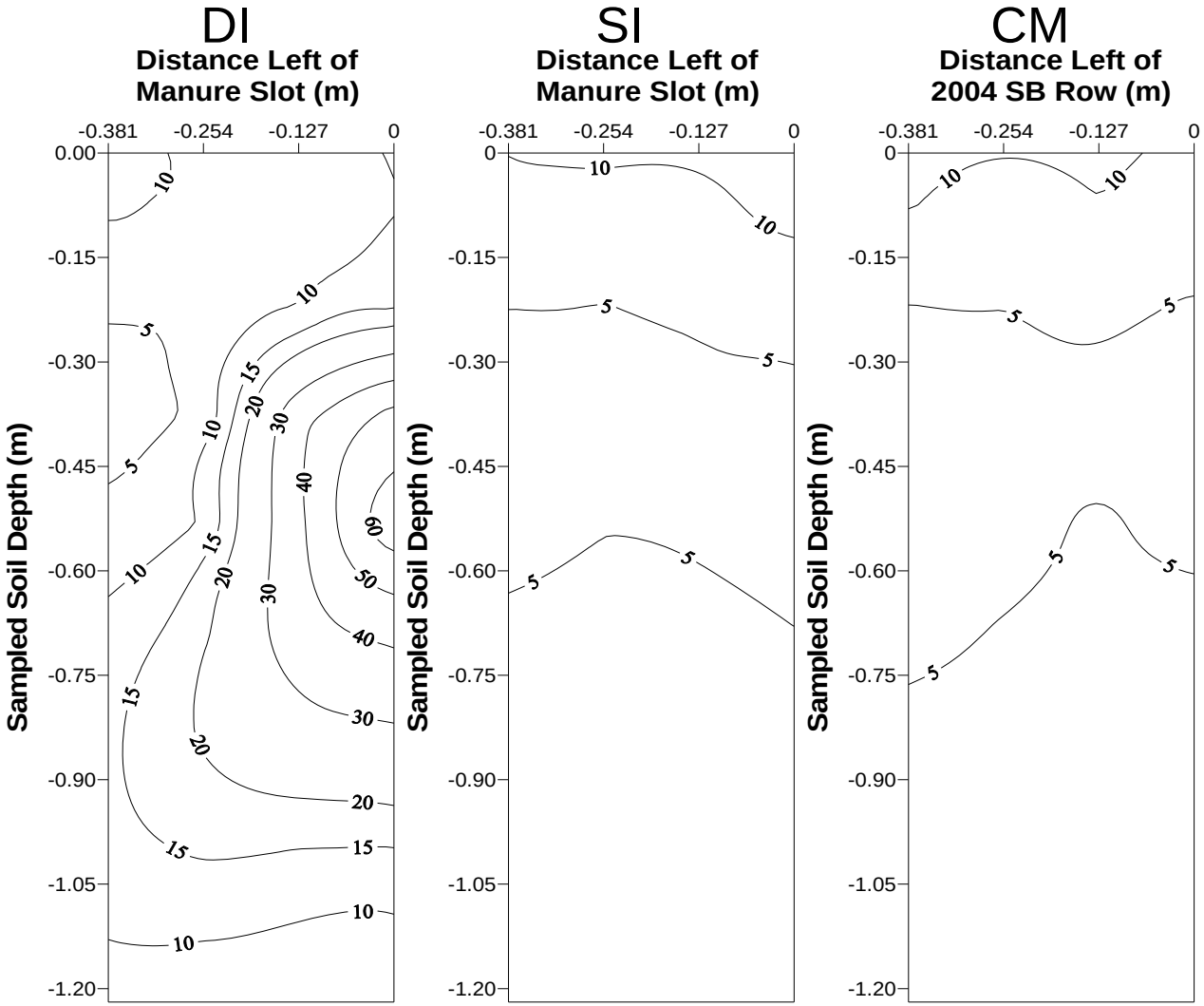
Ammonia distribution

Distribution 6 months after manure application



Nitrate Distribution

Distribution 12 months after manure application



Conclusions

- Deep injection did not increase surface P loading
- Deep manure injection reduced the loss of N through denitrification, 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.

Detecting Shifts in Soil Microbial Community Structure & Herbicide Degrading Function Post Landspread of Manure Containing Antimicrobial Chemicals

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Funded through Region 8 EPA Grant

South Dakota Agricultural Experiment Station

Antibiotics

- Human Health
  - Tetracycline (TET)
  - TET residue found in processed biosolids

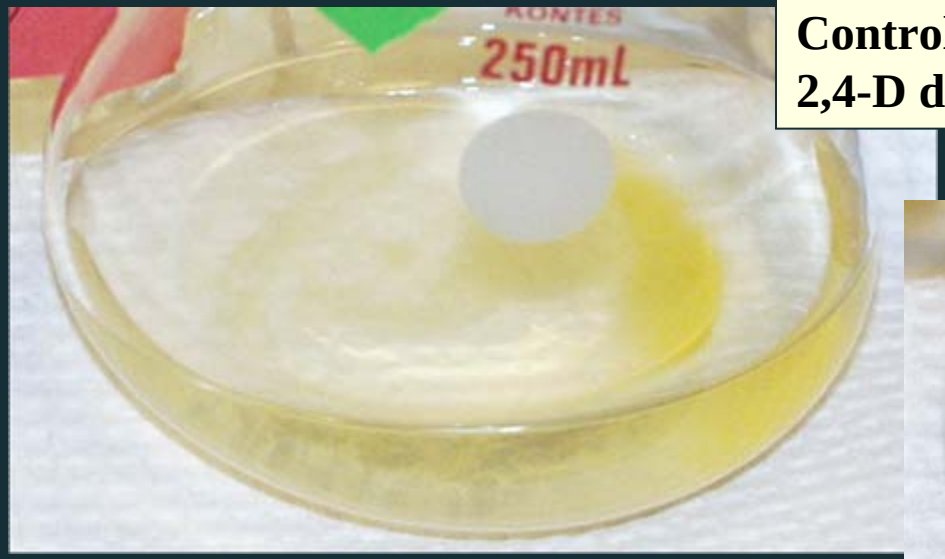
- Swine feed additives
  - Chlortetracycline (CTC)
  - 90% or more CTC recovered in swine manure/urine chemically unchanged (Halling-Sorenson et al. 1998)

Hypothesis

CTC antibiotic feed additive residue in swine manure will influence soil microbial community biodiversity and function.

Laboratory Studies

- 2,4-D and atrazine degradation were monitored in laboratory studies
  - 2,4-D used pure cultures of the 2,4-D degrading bacteria *Sphingobium herbicidovorans*, technical grade antibiotic, and ^{14}C-ring labeled 2,4-D
  - ^{14}C-ring labeled atrazine was applied to soil, soil amended with manure, or soil amended with manure containing CTC
- $^{14}CO_2$ was monitored in NaOH traps and radioactivity quantified by liquid scintillation counting

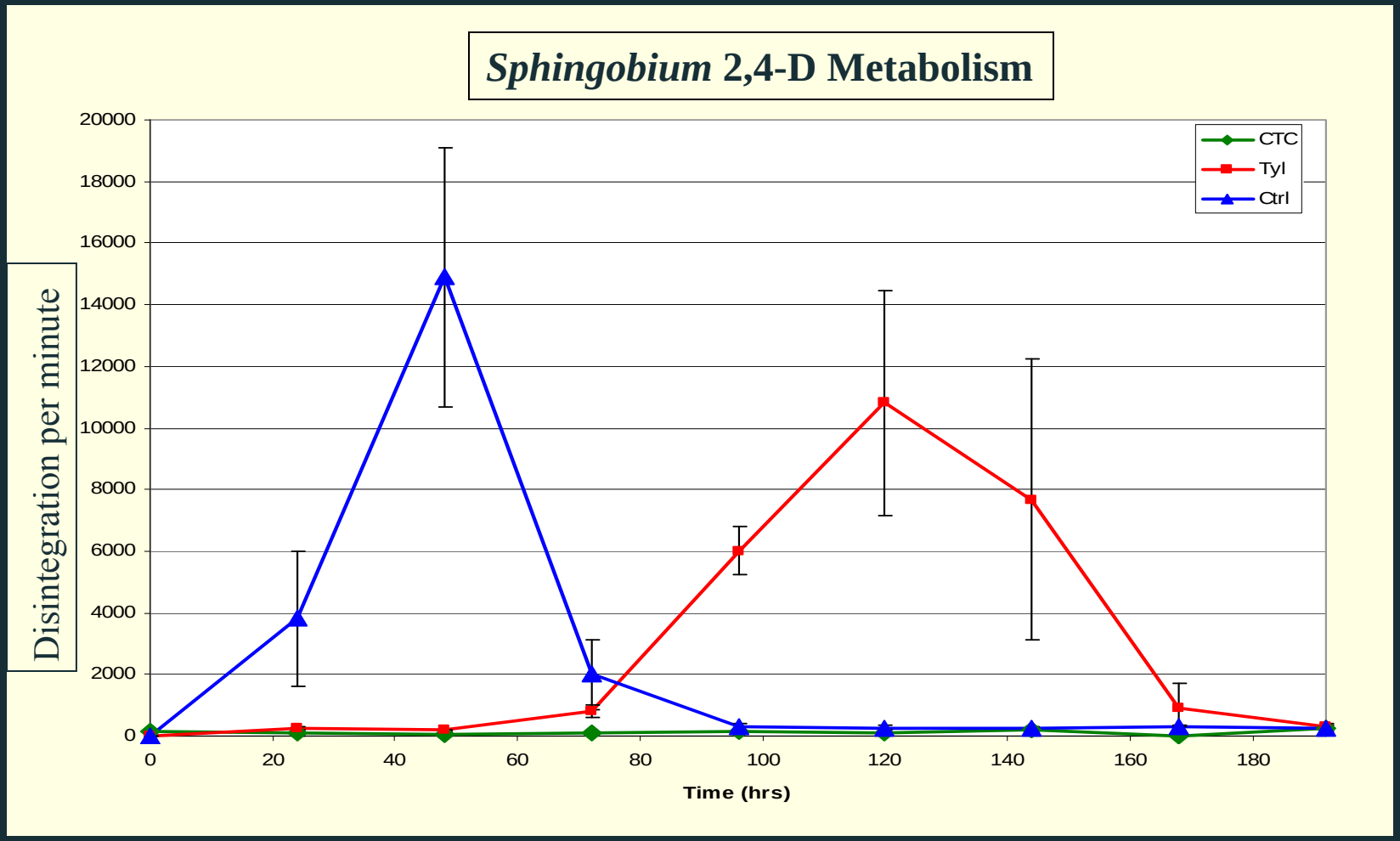


Control with *Sphingobium* after 2,4-D degradation

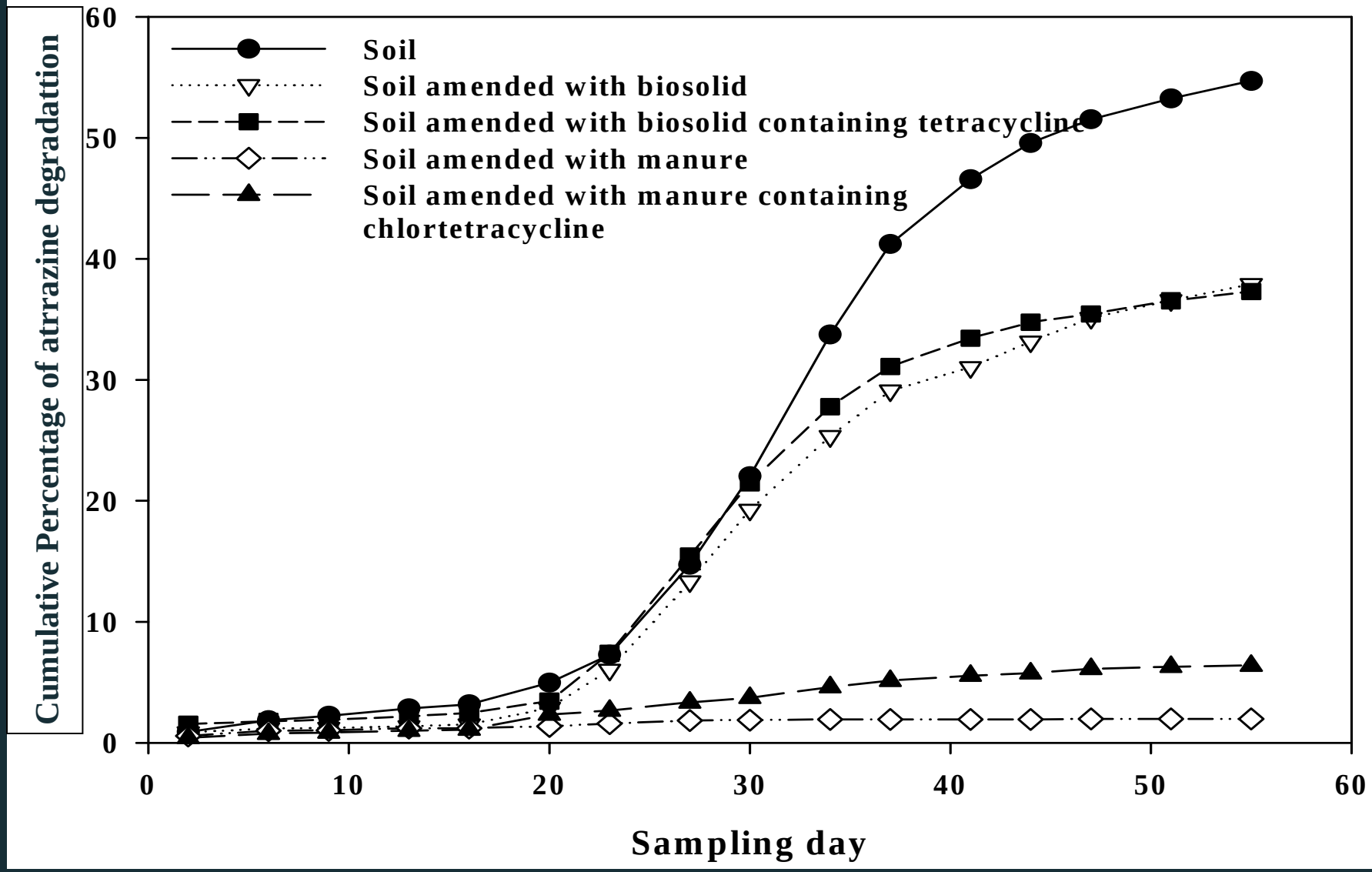
Tylosin Treatment= 2,4-D degrading bacteria growth is minimal

CTC Treatment=2,4-D degrading bacteria growth is absent

In preliminary studies, CTC was deleterious to herbicide degrading bacteria in pure culture



In soil studies, atrazine degradation and soil microflora was influenced by manure and manure+CTC addition


Cumulative Percentage of atrrazine degradattion
Sampling day
Soil
Soil amended with biosolid
Soil amended with biosolid containing tetracycline
Soil amended with manure
Soil amended with manure containing chlortetracycline
0
10
20
30
40
50
60

Field Study

- Two groups of juvenile swine (3 per group) were fed two different diets (both corn/soybean based):
  - No antibiotic additives (control group)
  - CTC additive (100 mg/kg of feed)
- Manure collection occurred for 5 days after the start of feeding these diets

Soil Treatments

- Manure samples applied to soil near Aurora, SD
- Experimental design was a randomized complete block design with 4 reps.

6 Soil Treatments (with controls)

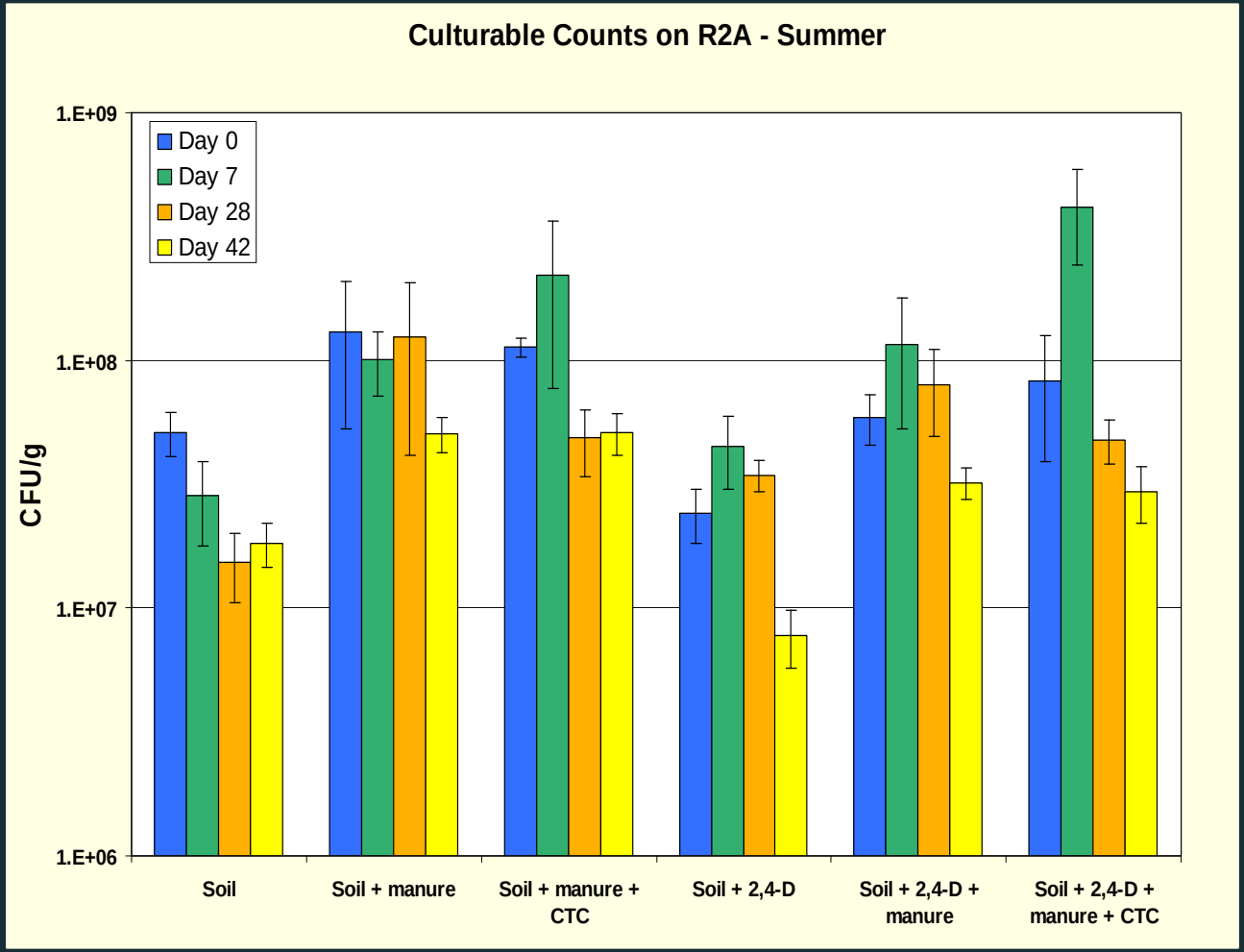
No 2,4-D Enrichment:	2,4-D Enrichment (2,2 kg/ha):
1. Unamended soil (control)	4. 2,4-D
2. Manure	5. 2,4-D and manure
3. Manure with CTC	6. 2,4-D and manure with CTC

- Soil samples were taken from the 0-2cm depth on the day applied and 7, 28 and 42 days after treatment (DAT).

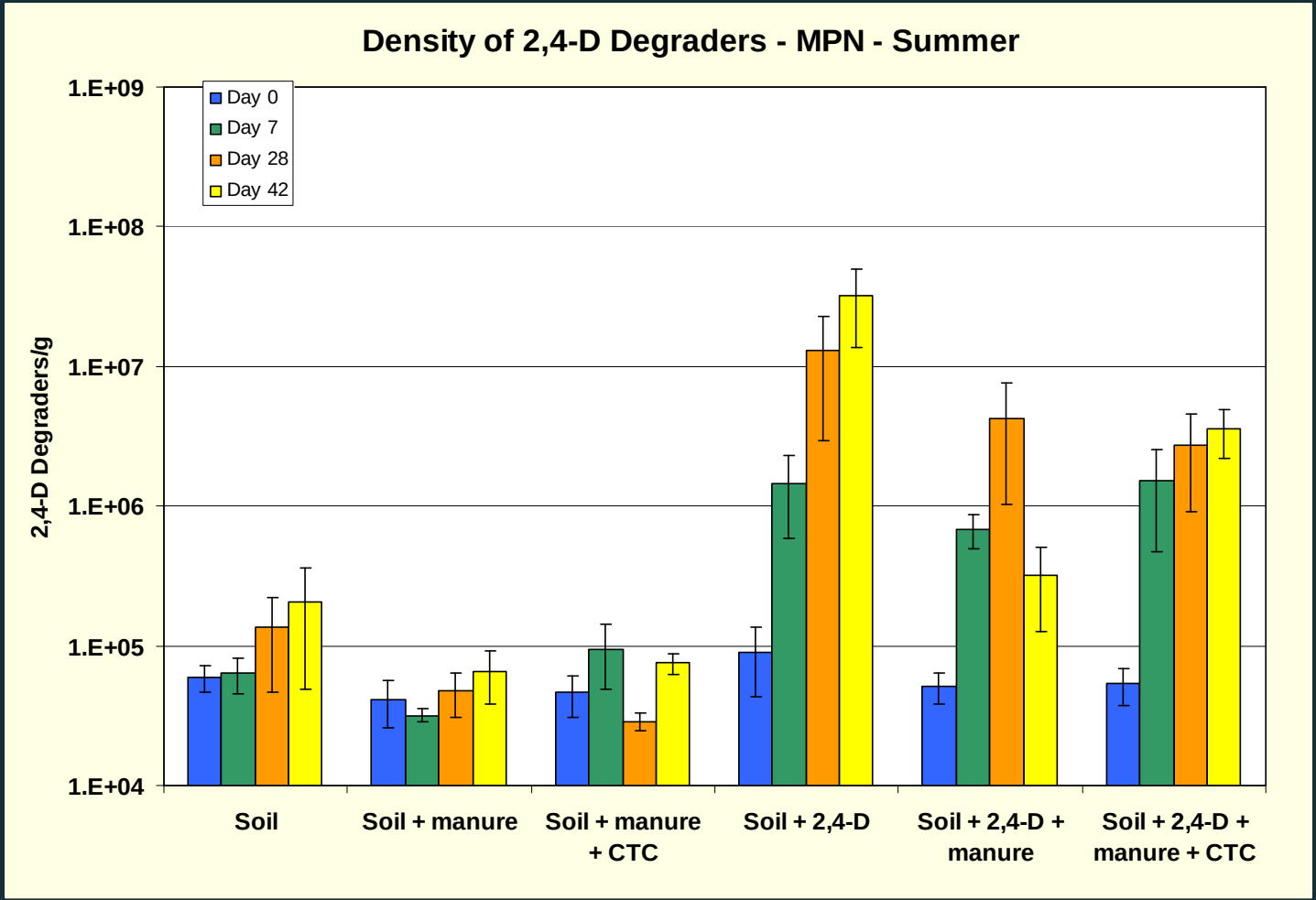
Immediate Culturing Techniques

- R2A spread plates
  - Duplicate plates from serial dilution
  - CFU (colony forming units) enumerated
- MPN (Most Probable Number)
  - Three-tube procedure
  - 0.56mM 2,4-D minimal broth
  - Incubation: 6 weeks at 23°C/darkness
  - Spectrophotometer (turbidity ~ growth)
  - HPLC to determine 2,4-D residual

Results-CFU for Summer



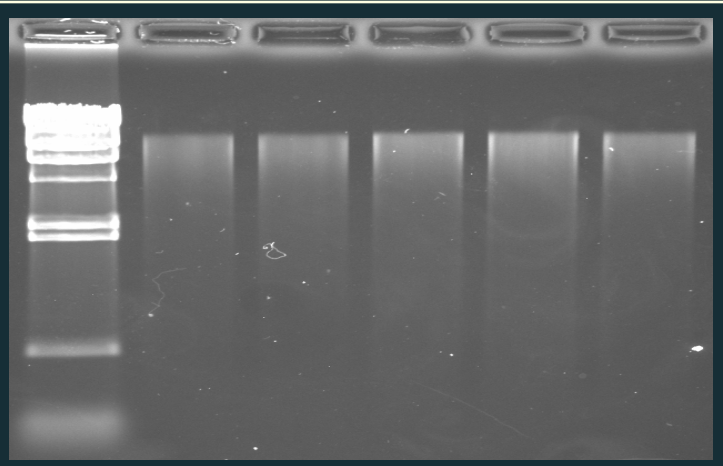
Results-MPN for Summer



Molecular Techniques

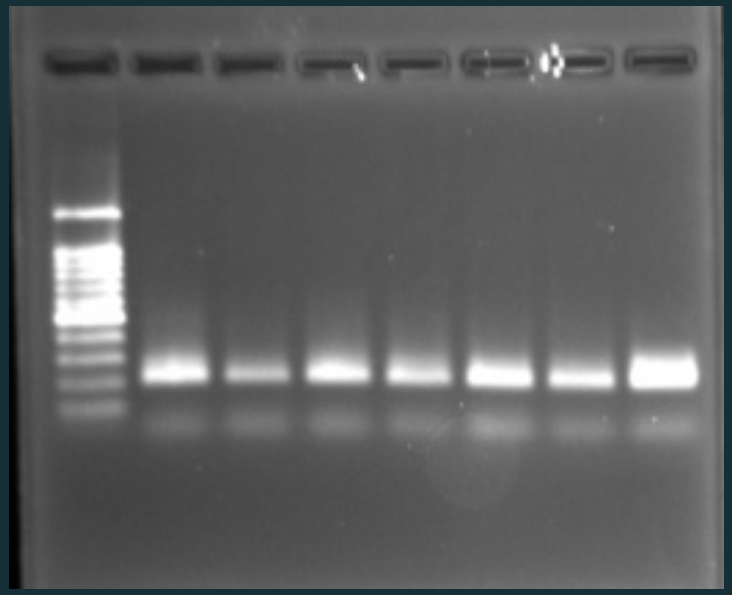
DNA extractions from soil samples

- Using Powersoil DNA Extraction Kit-MoBio
- Modified protocol by utilizing bead beater

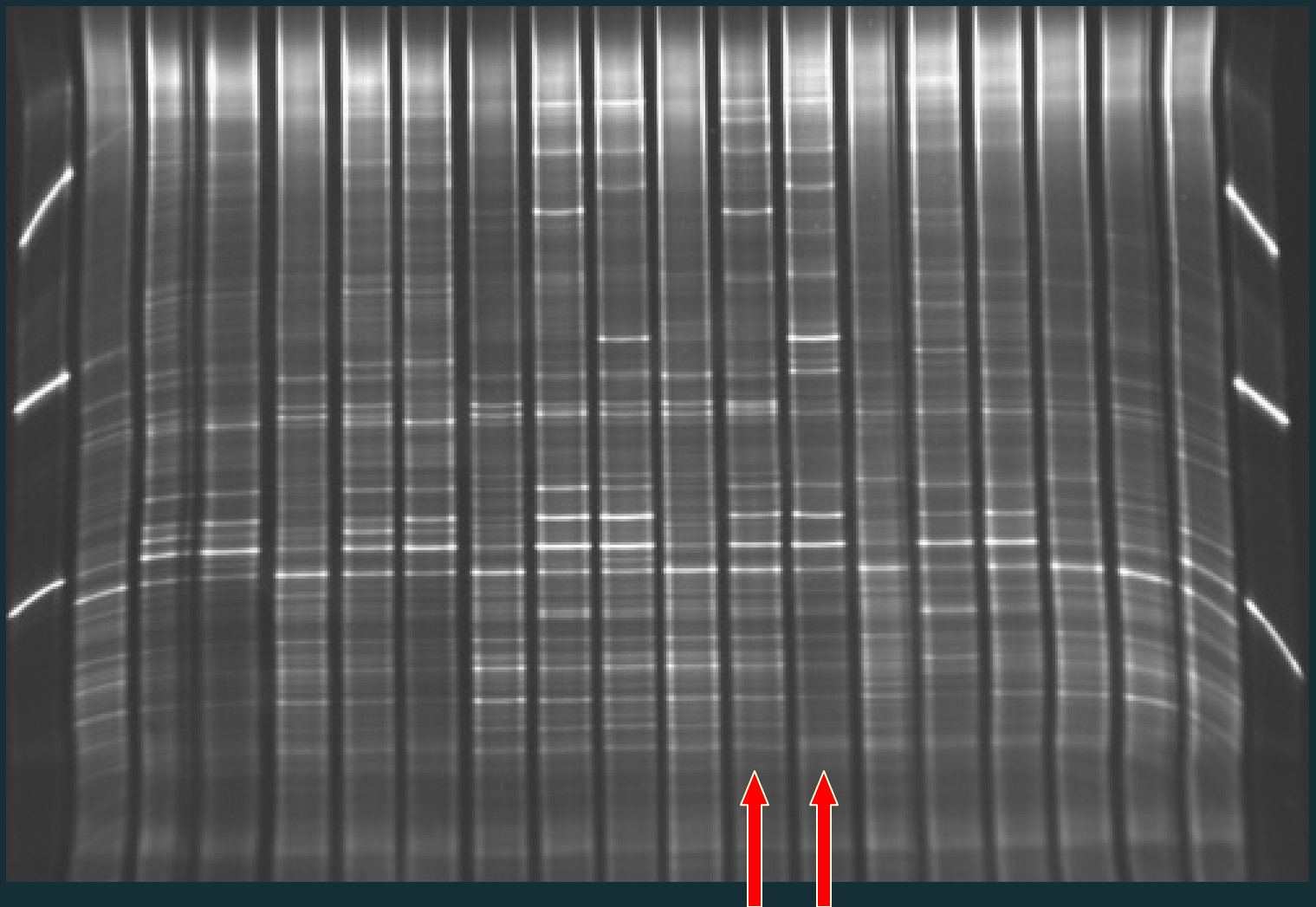


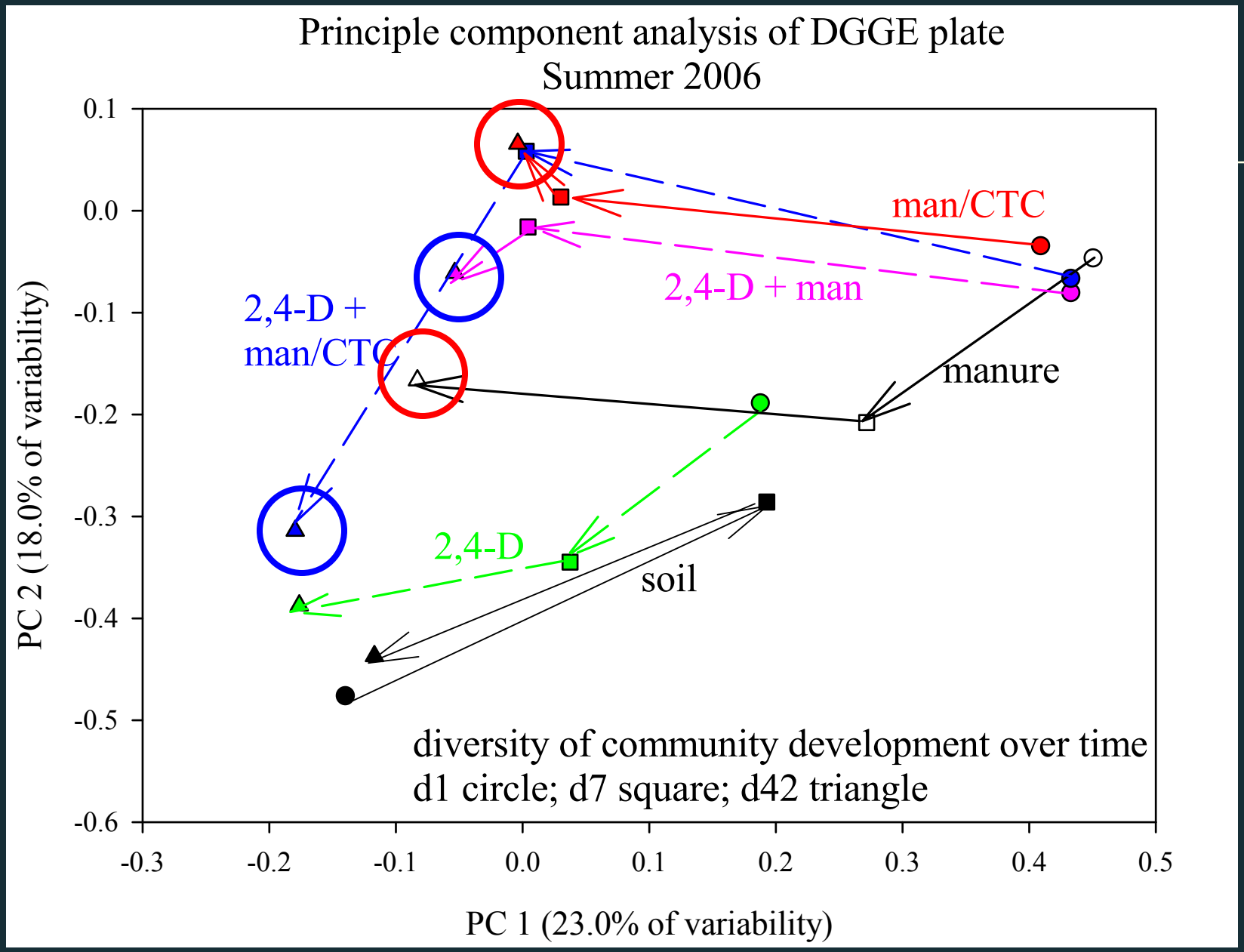
PCR (polymerase chain reaction)

- Amplification of variable V3 region of the conserved 16S rRNA gene with GC clamp addition
- PCR product used for DGGE analysis



Denaturing Gradient Gel Electrophoresis




Principle component analysis of DGGE plate
Summer 2006
man/CTC
2,4-D + man
2,4-D +
man/CTC
manure
2,4-D
soil
diversity of community development over time
d1 circle; d7 square; d42 triangle
PC 2 (18.0% of variability)
PC 1 (23.0% of variability)
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5

Conclusions

MPN results show 2,4-D degrading bacteria present at day 0 in soil at $\approx 5 \times 10^4$/g.

The density of 2,4-D degrading bacteria increased in the presence of 2,4-D treatment.

In the presence of manure, the density increase of 2,4-D degrading bacteria was impeded.

Initial culturing data show little effect of antibiotics on aerobic culturable counts and density of 2,4-D degrading organisms.

Conclusions

Microbial community shifts were observed over time

The effect of 2,4-D was most prominent after 7 d after, however, after 42 d few differences were observed

7 d after treatment

- Manure decreased the intensity of 2 bands that were prominent in the 2,4-D treatment alone
- The addition of manure containing CTC intensified this response to a greater extent

42 d after treatment

- Both manure and manure + CTC continued to influence the microflora with more suppression observed in the CTC treatment than the manure alone treatment