Application of Animal Manure/Compost in an Irrigated Oat/Corn Rotation

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Cohorts and Collaborators

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The Problem

- **The recently enacted ruling regarding the application of animal waste on agricultural lands by CAFOs has caused many questions to rise**

- **The ruling calls for a balance between the amount of nutrients added by the manure and the amount used by the plants and held by the soil**

The Problem

- **In essence, a CAFO owner cannot apply animal waste in excess of the expected plant uptake and the soil's ability to hold the nutrients applied.**

- **The limiting nutrients that were chosen were nitrogen and phosphorus – each state could determine which nutrient would be the limiting nutrient.**

The Objective

- **In Arizona, nitrogen was considered to be the limiting nutrient since surface water is not prevalent.**

- **The objective was to use manure/compost in an oat/corn production system and assess whether there was nitrogen build-up in the soil.**

Methodology

- **In this study we looked at the soil, soil water and plant.**

- **We analyzed for bacteria (*E. Coli*, *Listeria*, coliphage), estrogenic activity, and nitrogen, phosphorus and EC.**

Methodology

- **The Soil**
  - **Biological – *Listeria*, *E. Coli*, coliphage**
  - **Nutrient loading – N and P**
  - **Salt accumulation - EC**

Soil Sampling

- **The soil was sampled prior to the initiation of the study to determine the levels of N, P, EC as well as any biological activity, namely *Listeria*, *E. Coli* and coliphage.**

- **In order to get a clean sample, a plastic insert was used with the Giddings soil sampler. The auger and other equipment were rinsed with bleach and soaked in sodium thiosulfate to assure no contamination.**

Soil Sampling

- **Once the sample was taken, the tubes were sealed and sent to the lab where they were cut into three pieces:**
  - **0-15 cm**
  - **15-30 cm**
  - **30-60 cm**
- **Each of these samples were analyzed for the presence of the three bacteria.**


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BIOHAZARD


SARSTEDT
SARSTEDT

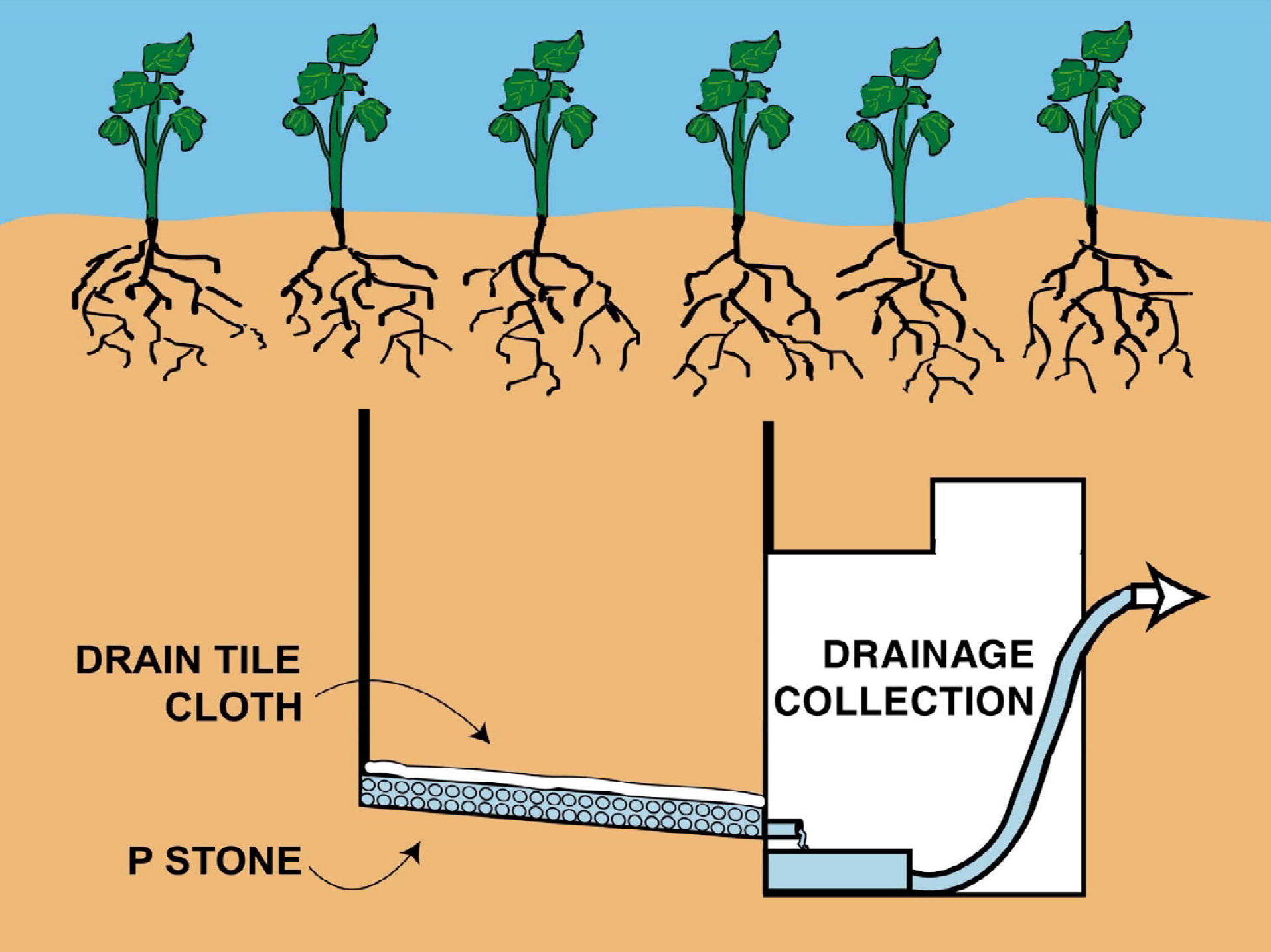
Soil Sampling

- **Samples were also taken to analyze for N, P and EC**
  - **Nitrogen**
    - **Nitrate - RFA**
    - **Ammonium - RFA**
    - **TKN - Digestion**
  - **Phosphorus – RFA**
  - **EC - Electrode**


VWR

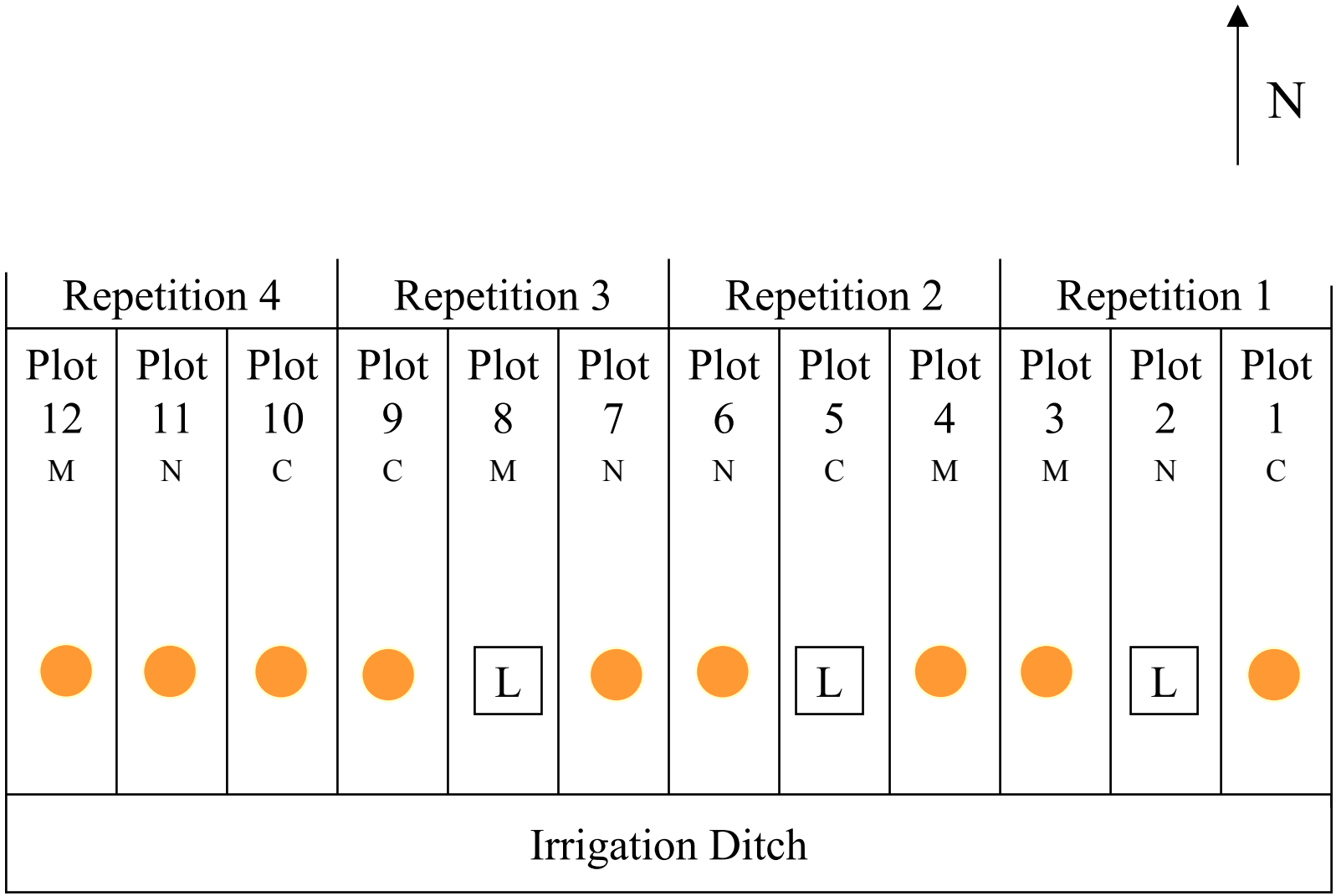
Methodology

- **Soil Water**
  - **Drainage Lysimeters**
    - **Biological – *Listeria*, *E. Coli*, coliphage and Estrogenic Activity (endocrine disruptors)**
    - **Nitrate**
  - **Suction Lysimeters**
    - **Nitrate**

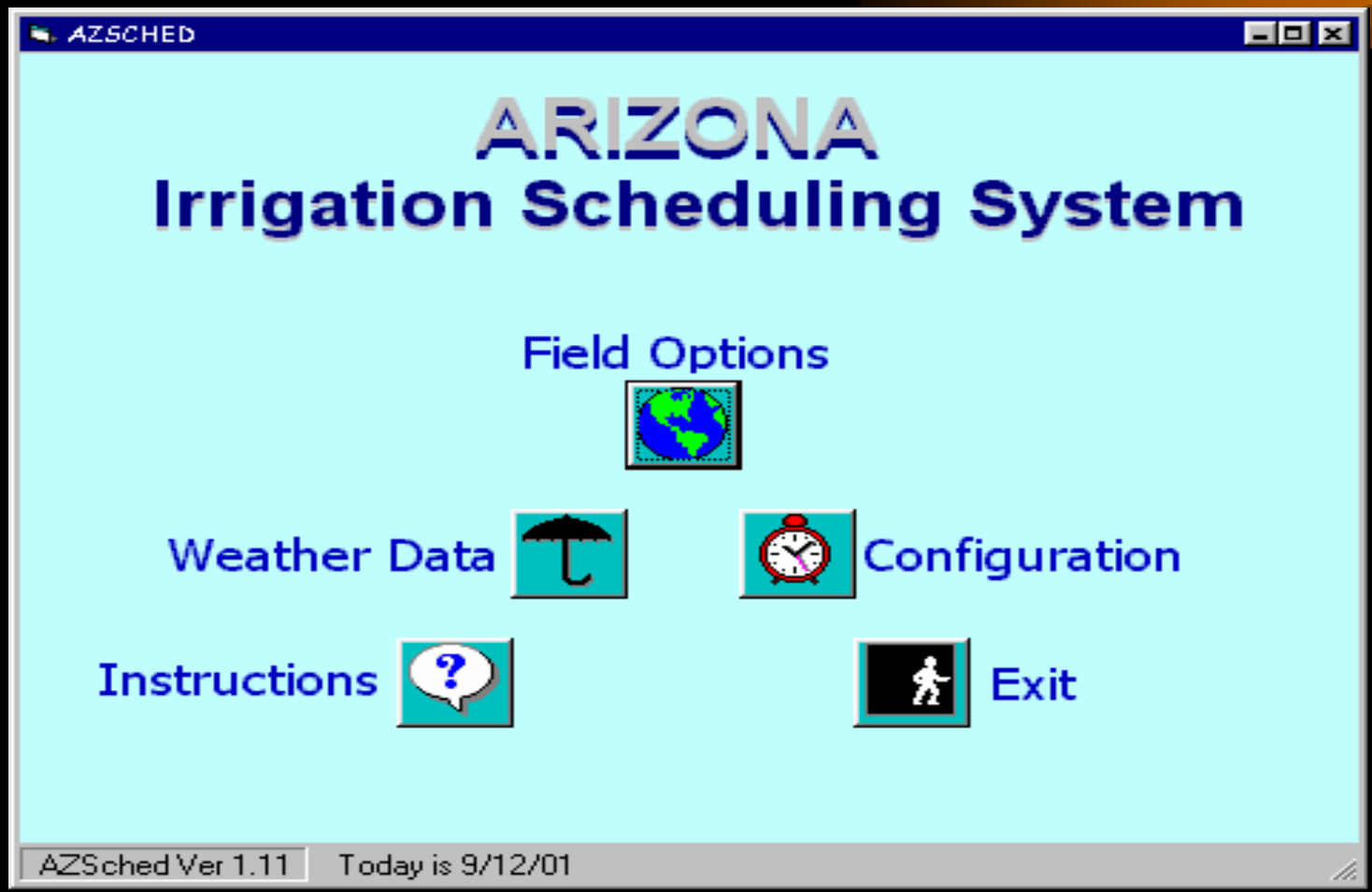

DRAIN TILE
CLOTH
P STONE
DRAINAGE
COLLECTION

Methodology

- **The Plant**
  - **Biological – *Listeria*, *E. Coli*, coliphage**
  - **Nitrogen (TKN)**
  - **Yield**


N
Repetition 4
Repetition 3
Repetition 2
Repetition 1
Plot 12 M
Plot 11 N
Plot 10 C
Plot 9 C
Plot 8 M
Plot 7 N
Plot 6 N
Plot 5 C
Plot 4 M
Plot 3 M
Plot 2 N
Plot 1 C
L
L
L
Irrigation Ditch

Irrigation - AZSCHED



Addition of Manure and Compost

- **Manure and compost were added, using a spreader, in the amount determined to be removed in the harvest.**

- **Nitrogen concentration was determined by Kjeldahl digestion and KCl extract.**

Nitrogen Analysis

- **Ammonium – KCl extract**
- **Nitrate – KCl extract**
- **Organic Nitrogen – TKN minus ammonium**
- **Total Nitrogen – TKN plus nitrate**

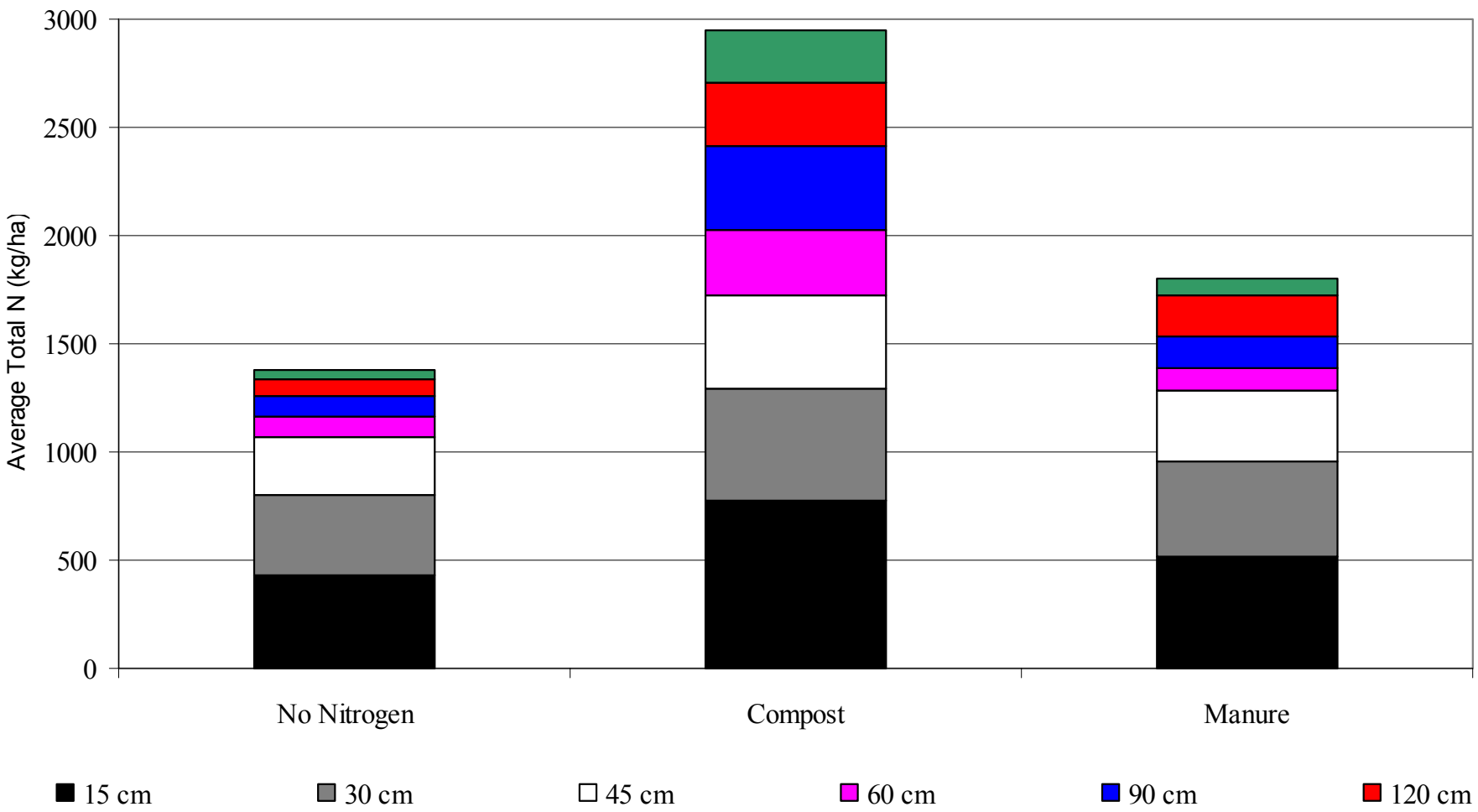

CASE

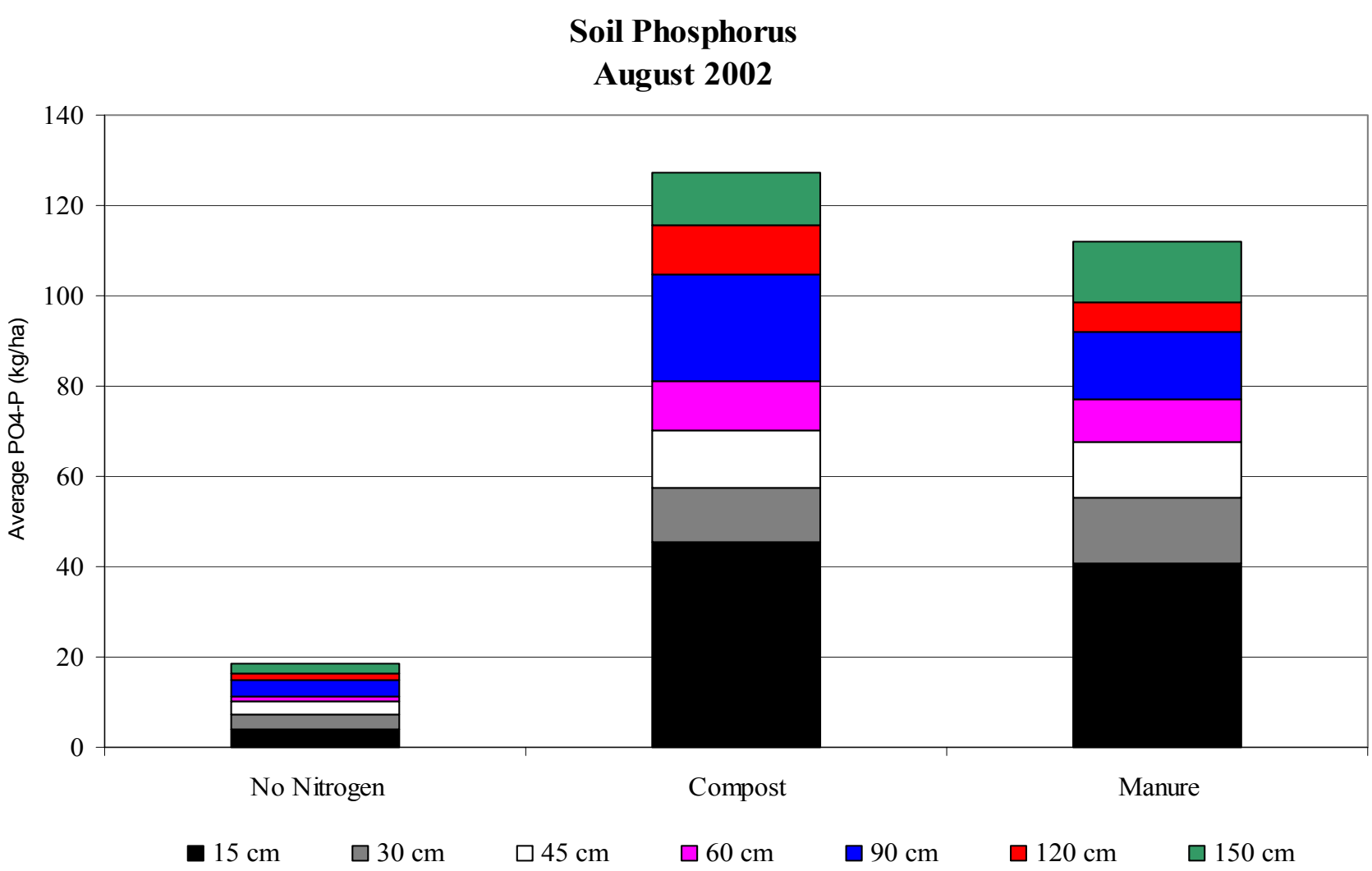
RESULTS

Initial Soil Sampling

- **The initial soil sampling showed that the all plots contained *E. Coli* and some coliphage. However, *Listeria* was not present in the any of the soil samples**

- **Elemental analysis showed that the manure and compost plots had elevated levels of nitrogen and phosphorus. This was probably due to the previous study which also included applications of manure and compost on the same plots.**

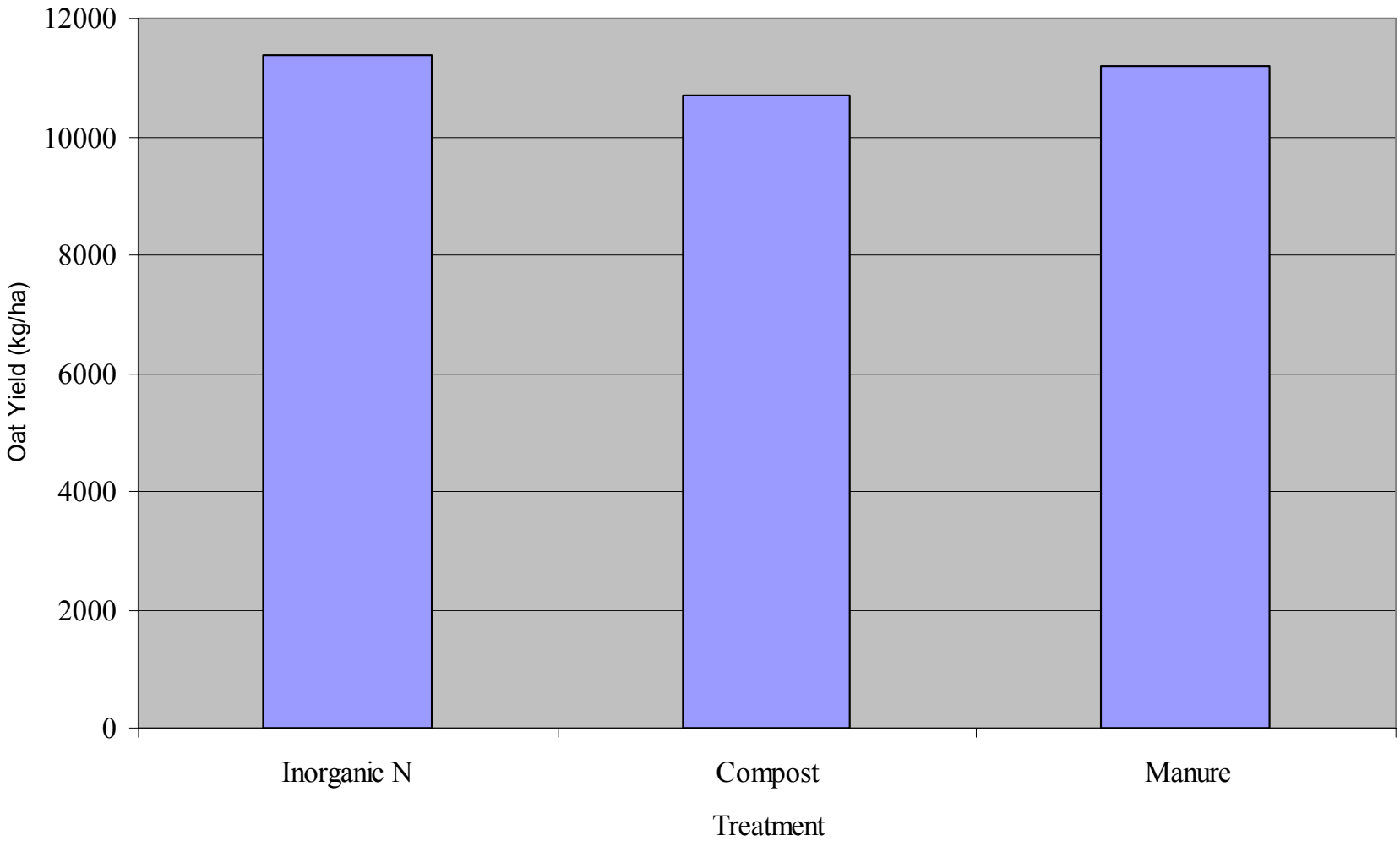

Total Soil Nitrogen
August 2002
Average Total N (kg/ha)
3000
2500
2000
1500
1000
500
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm

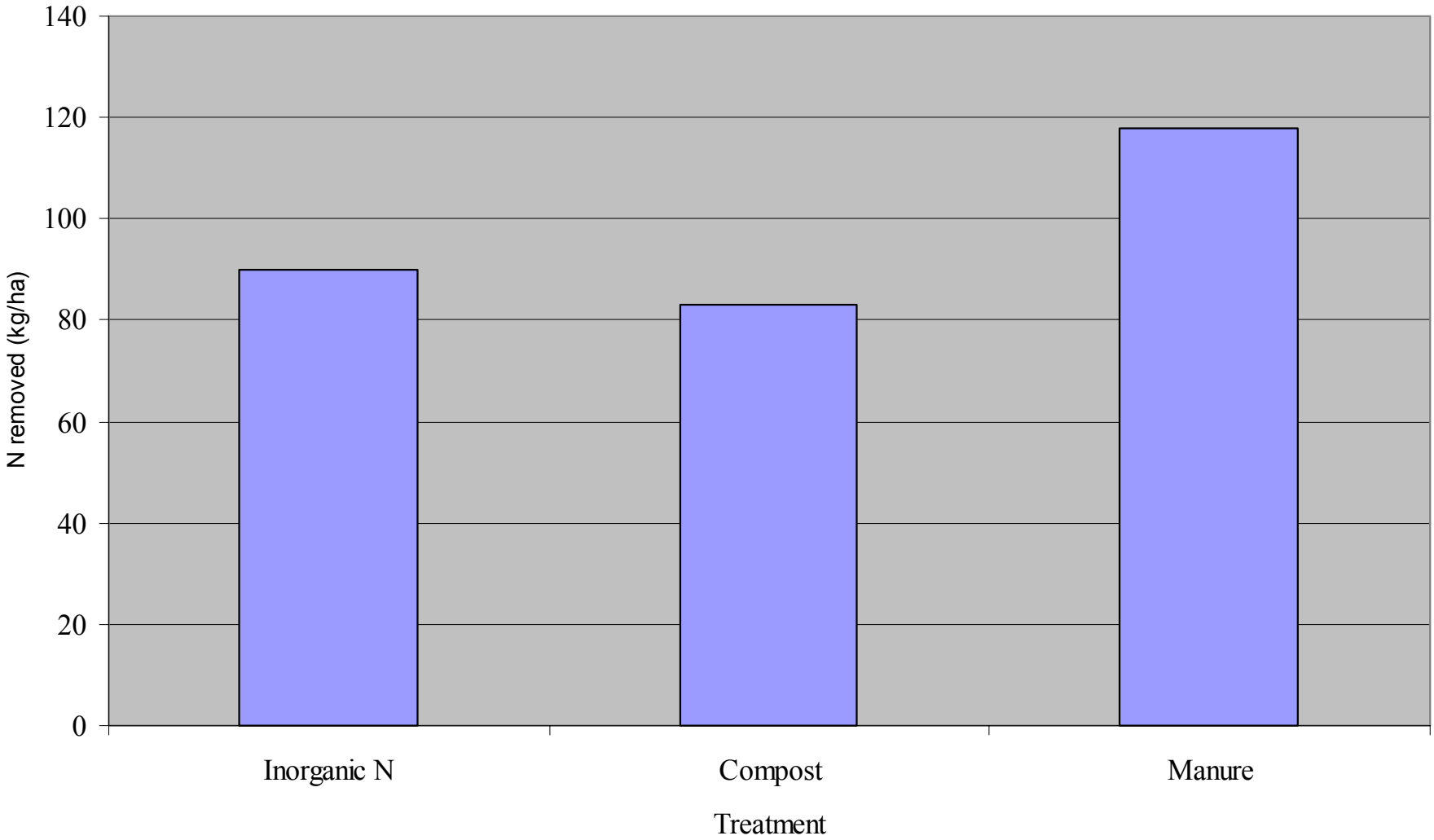

Soil Phosphorus
August 2002
Average PO4-P (kg/ha)
140
120
100
80
60
40
20
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm

Oat Yield

- **The yield was the same for the three treatments. Although the manure and inorganic treatments averaged higher, there was no statistical significance between treatments.**

- **Nitrogen removed ranged from 83-118 kg/ha but the treatments differences were not significant.**


Oat Yield
12000
10000
8000
6000
4000
2000
0
Oat Yield (kg/ha)
Inorganic N
Compost
Manure
Treatment


Nitrogen Removed in Oat Harvest
140
120
100
80
60
40
20
0
N removed (kg/ha)
Inorganic N
Compost
Manure
Treatment

Bacterial Analysis

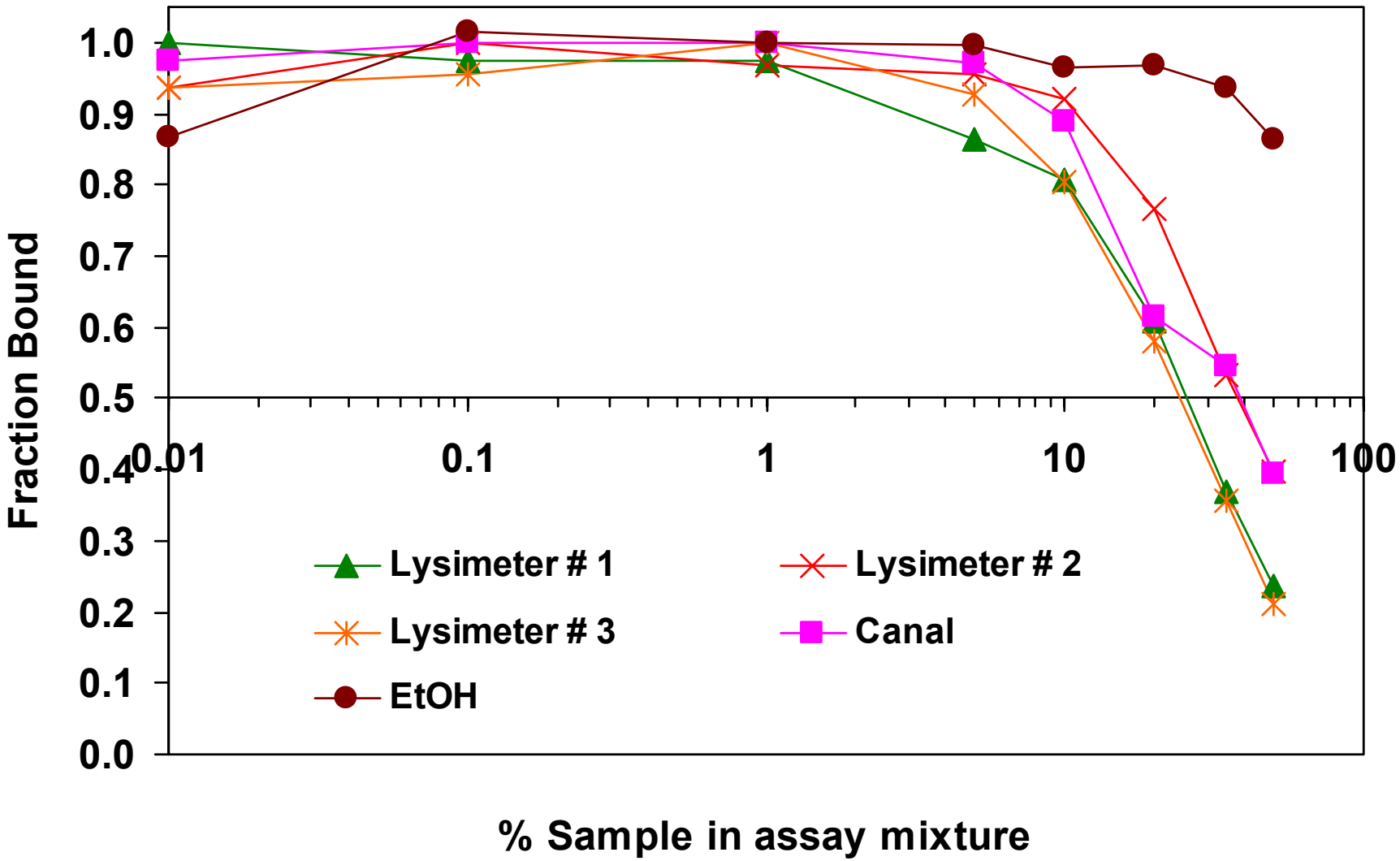
- **Soil water (from the drainage lysimeters) and the irrigation water showed no *Listeria* present in any samples.**
- ***E. Coli* was found in 2 of 8 irrigation water samples and 1 of 7 drainage samples.**
- **Two drainage samples tested positive for coliphage.**
- **Only one plant sample (compost plot) tested positive for *E. Coli*. All others tests were negative.**

Estrogenic Analysis

- **Results indicate that estrogenic activity is consistently detected in the lysimeter samples.**

- **The irrigation canal water is less estrogenic, indicating addition of compounds exhibiting estrogenic activity during percolation of the water to the lysimeters.**

Estrogenic activity for MAC samples, March 2003



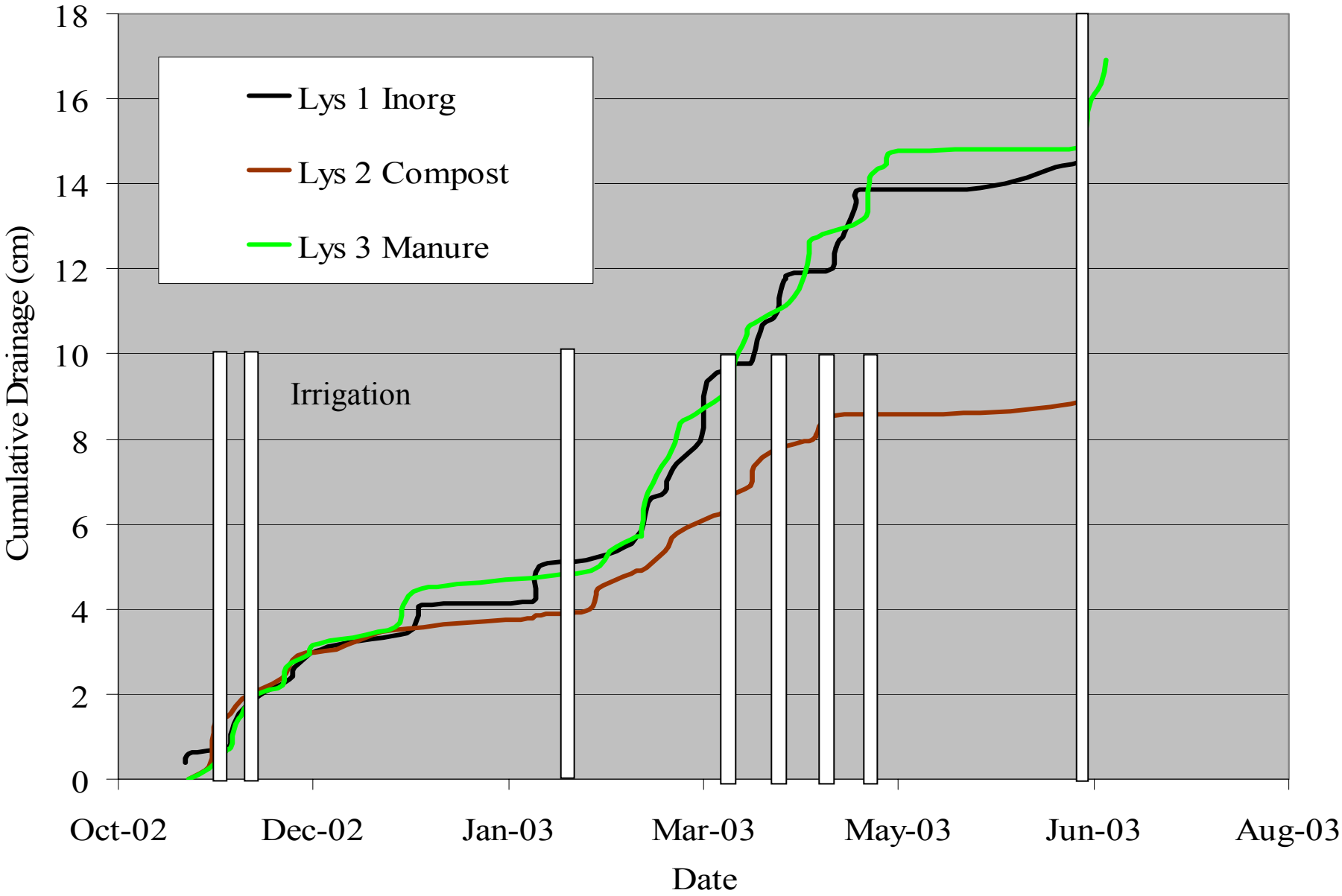
Leachate

- **Drainage and leachate samples were collected from all of the drainage lysimeters and the suction lysimeters. Only the drainage data has been analyzed at this time.**

Drainage

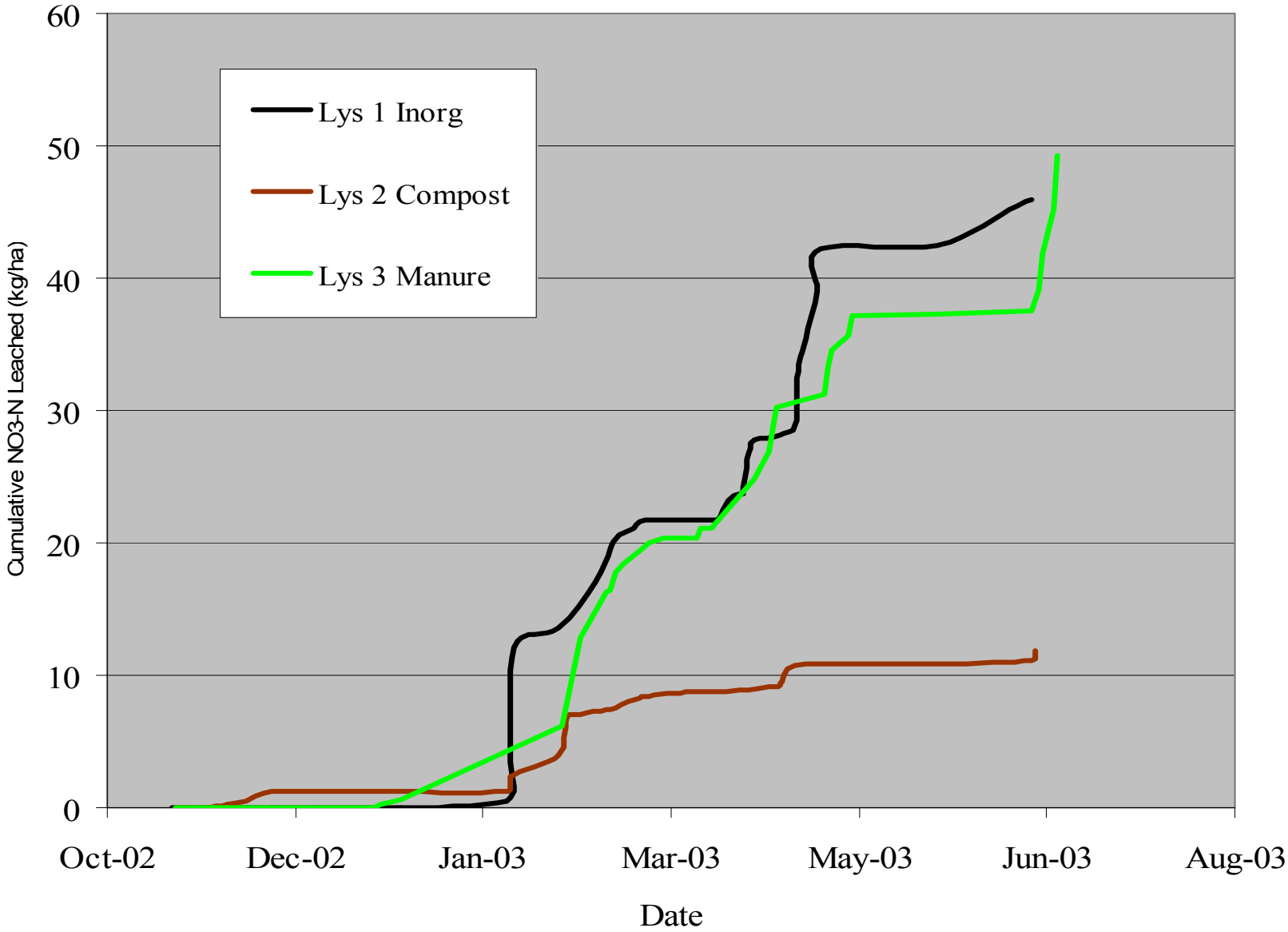
- **Lysimeters 1 and 3 (inorganic N and manure) have drained at approximately the same rate.**

- **Lysimeter 2 (compost) has drained less – This may be due to lag time for drainage?**


Lys 1 Inorg
Lys 2 Compost
Lys 3 Manure
Irrigation
Cumulative Drainage (cm)
0
2
4
6
8
10
12
14
16
18
Oct-02
Dec-02
Jan-03
Mar-03
May-03
Jun-03
Aug-03
Date

Leachate

- **Similarly, the amount of nitrogen lost in leaching was relatively equal for lysimeter 1 and 3 while lysimeter 2 leached less N.**


Lys 1 Inorg
Lys 2 Compost
Lys 3 Manure
Cumulative NO3-N Leached (kg/ha)
60
50
40
30
20
10
0
Oct-02
Dec-02
Jan-03
Mar-03
May-03
Jun-03
Aug-03
Date

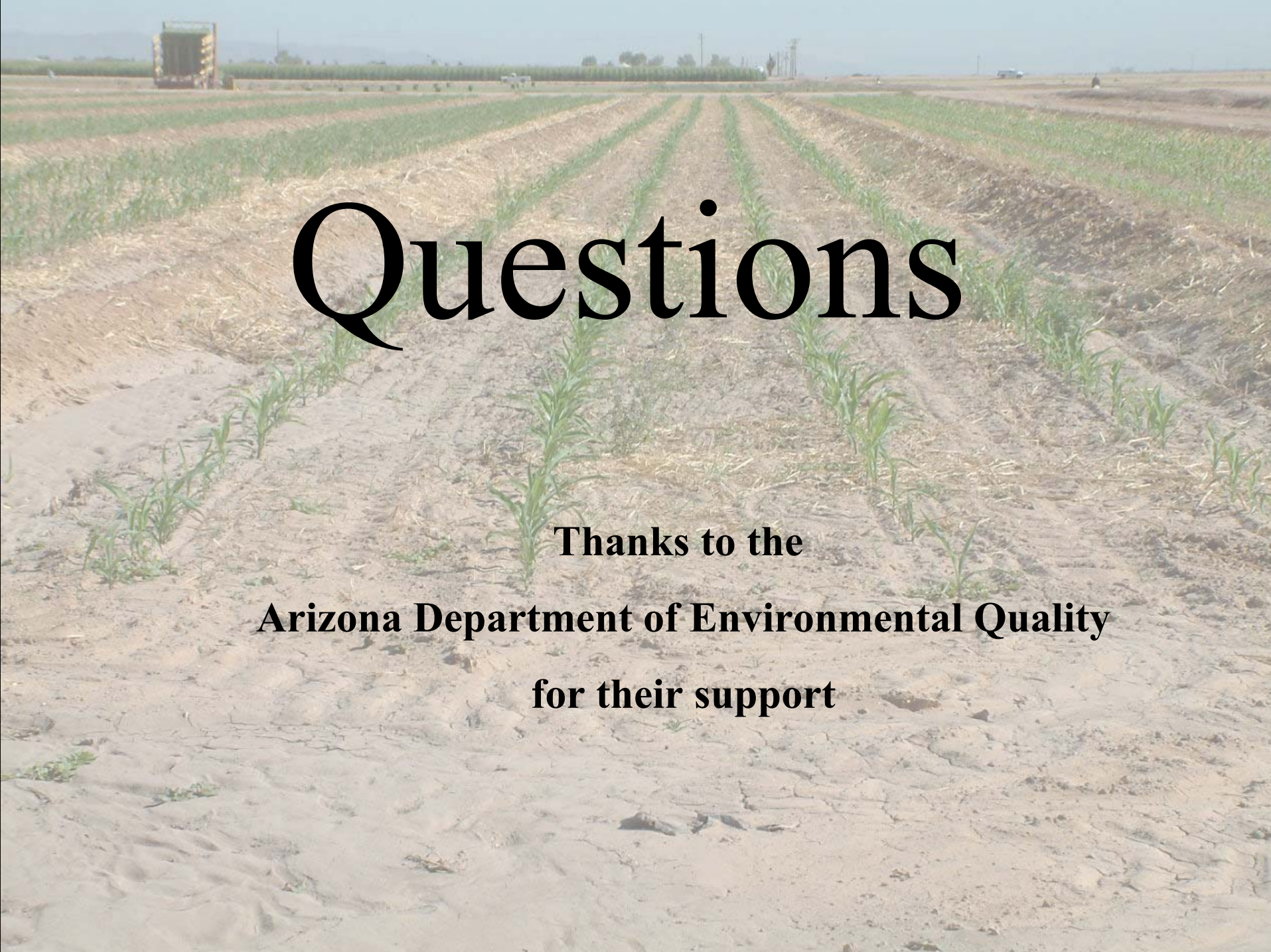
Summary

- **This is the first cropping season – there's 3 more to go.**

- **Indications are that the bacteria are present in the soil, soil water and irrigation water, but the levels change over time. However, bacteria in the soil does not automatically translate to bacteria in the soil water.**

Summary

- **Estrogenic activity is high in both the irrigation and the drainage samples.**
- **Nitrogen is being leached, but at the present the amounts are low.**



Questions

Thanks to the

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