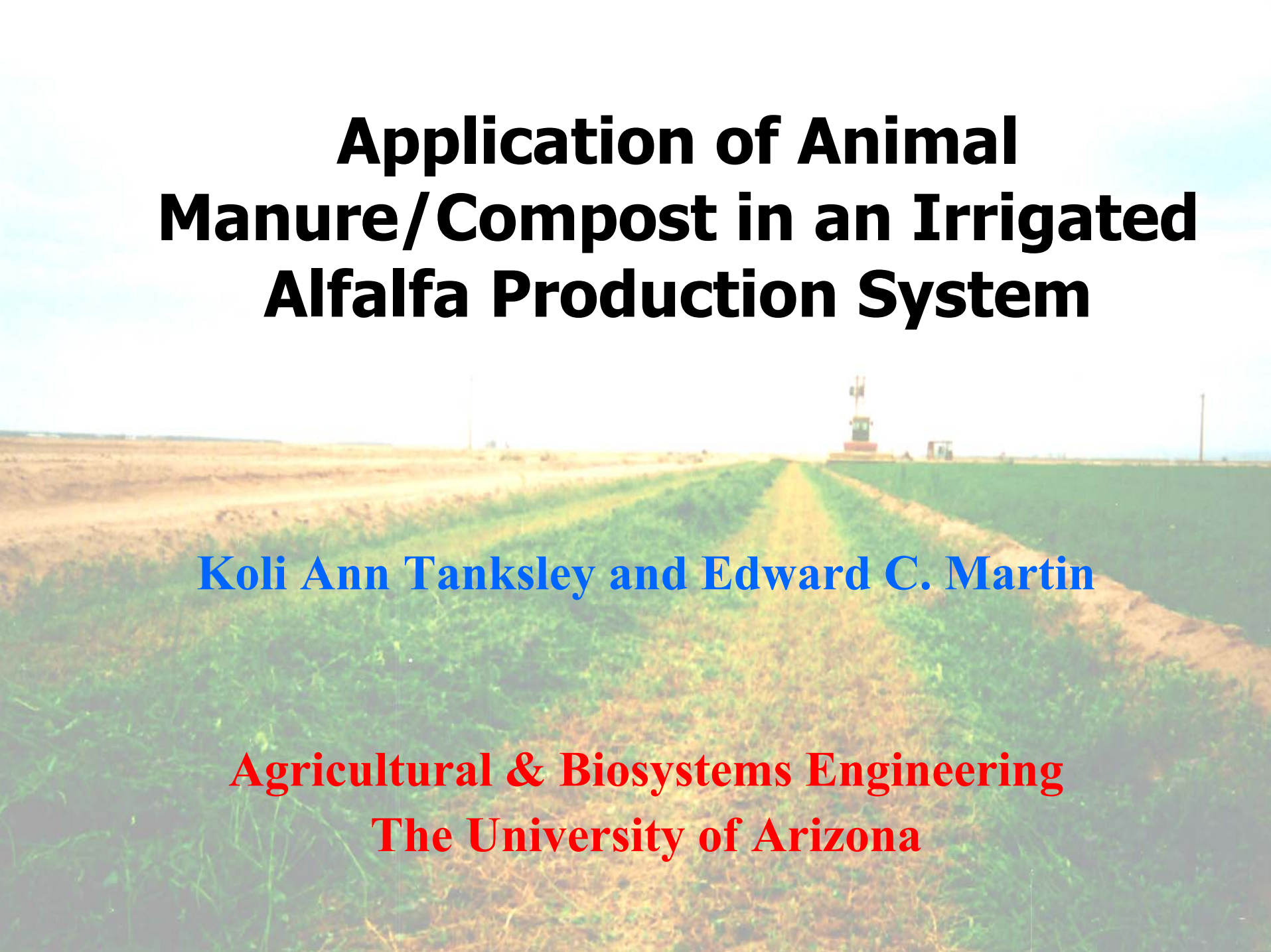
Application of Animal Manure/Compost in an Irrigated Alfalfa Production System



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The Problem

- The recently enacted ruling (Unified National Animal Feeding Operation Strategy) set restrictions on the application of animal waste on agricultural lands by CAFOs.

- 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.

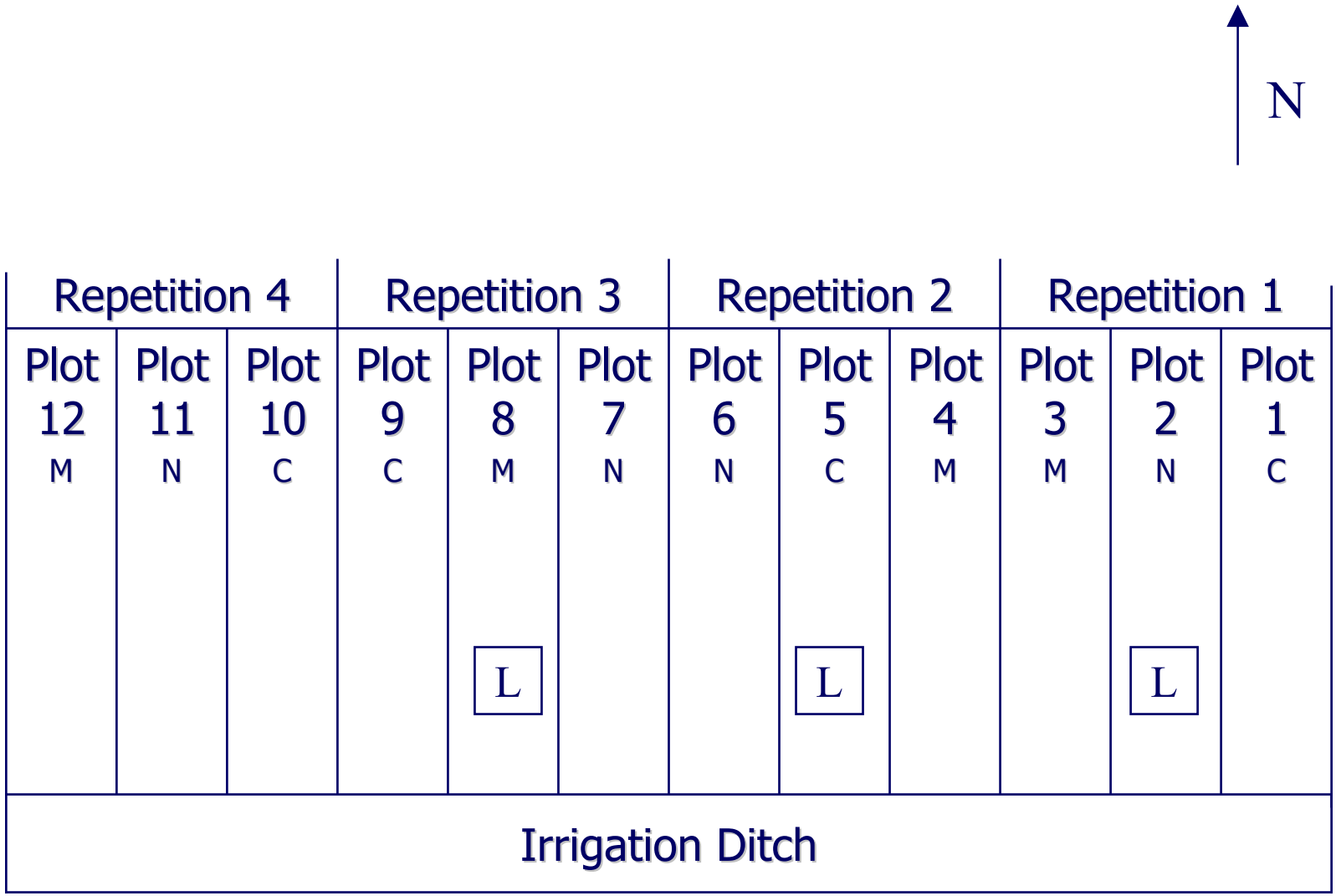
The Problem

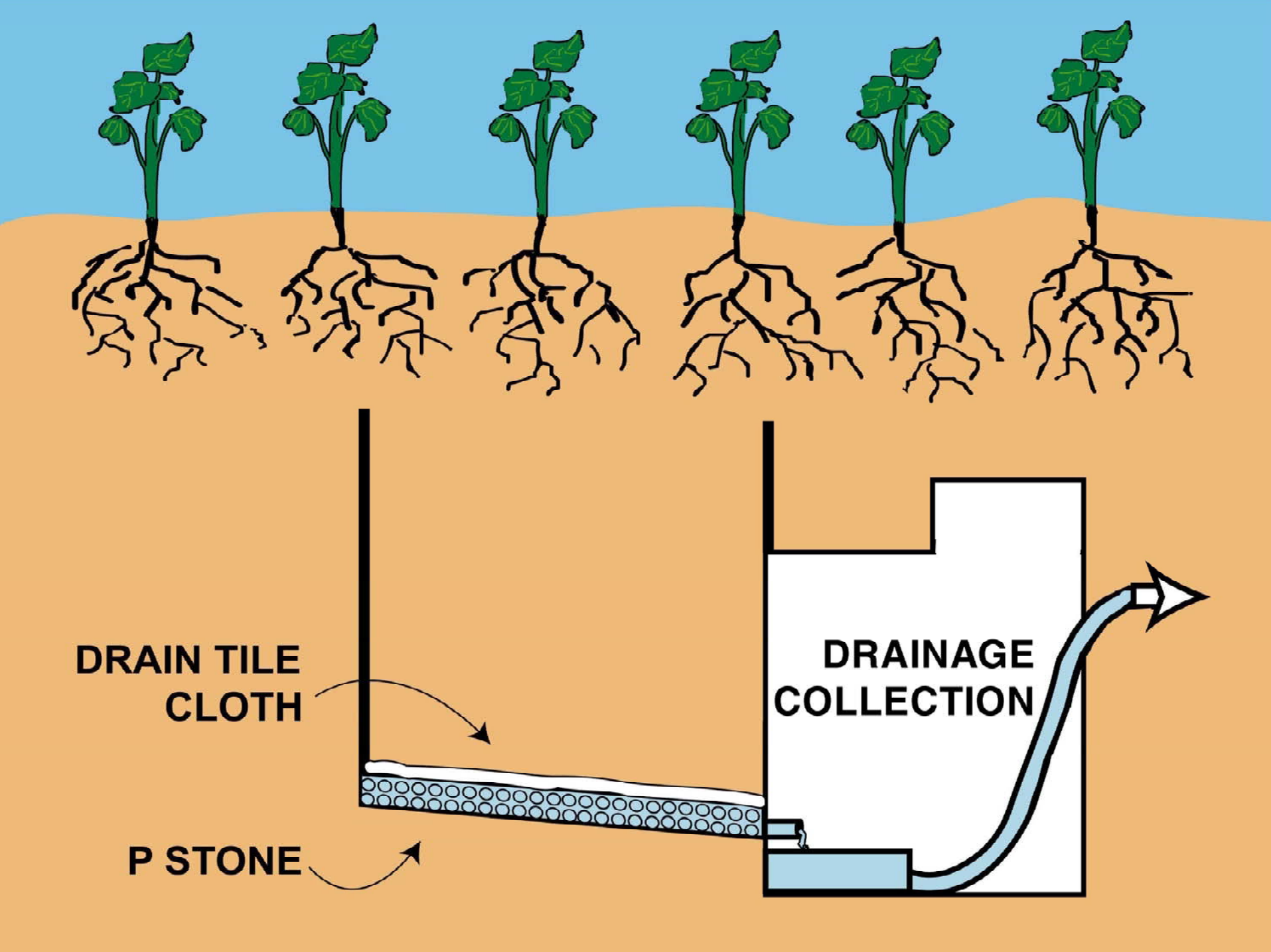
- In essence, a CAFO owner cannot apply animal waste in excess of the expected plant uptake and the soil's ability to hold the nutrients in the animal waste applied.

- The nutrients chosen for limiting animal waste applications were nitrogen and phosphorus – each state could determine which nutrient would be the limiting nutrient.

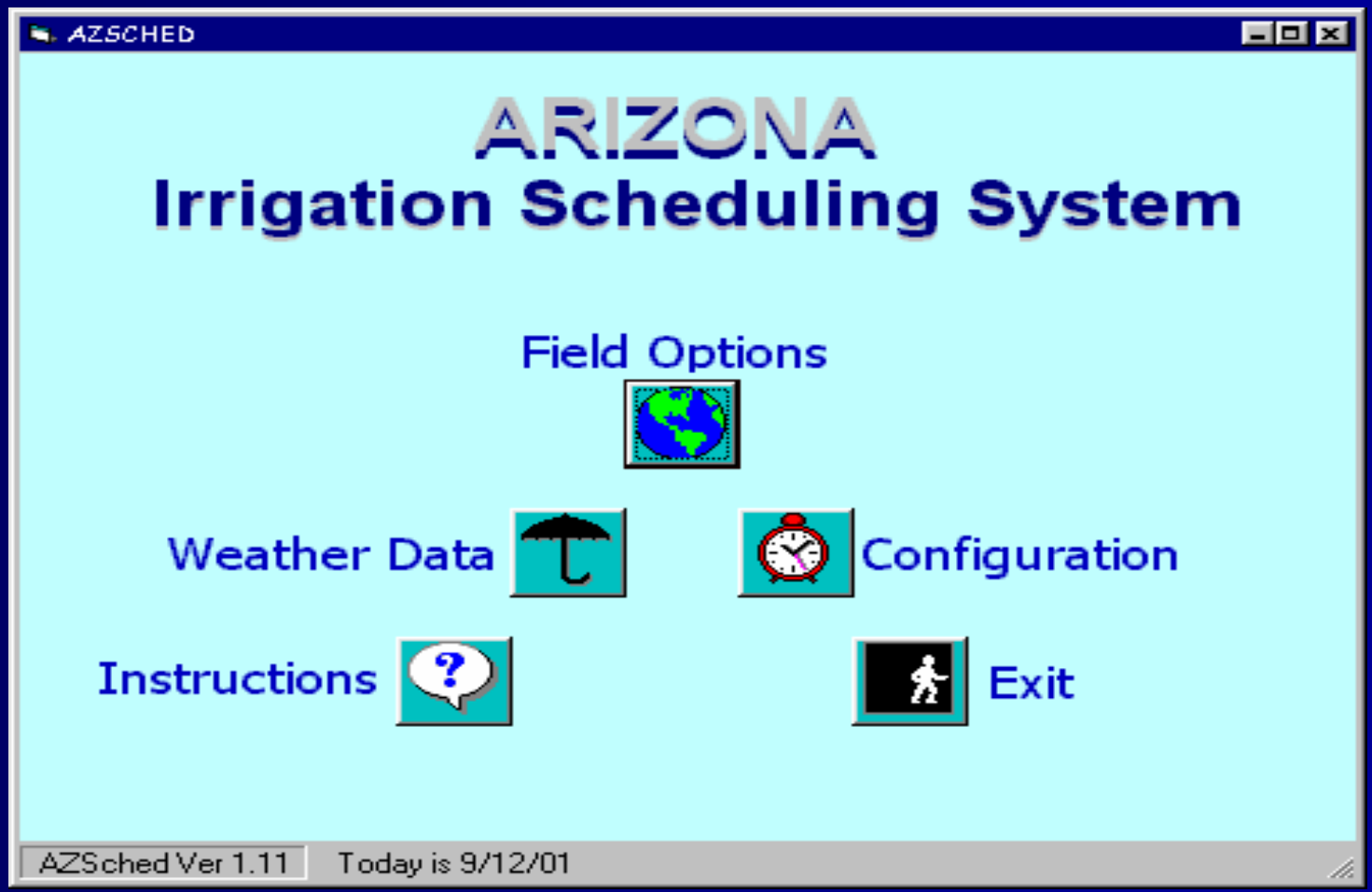
The Objective

- 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 alfalfa production system and assess whether there was nitrogen build-up in the soil.

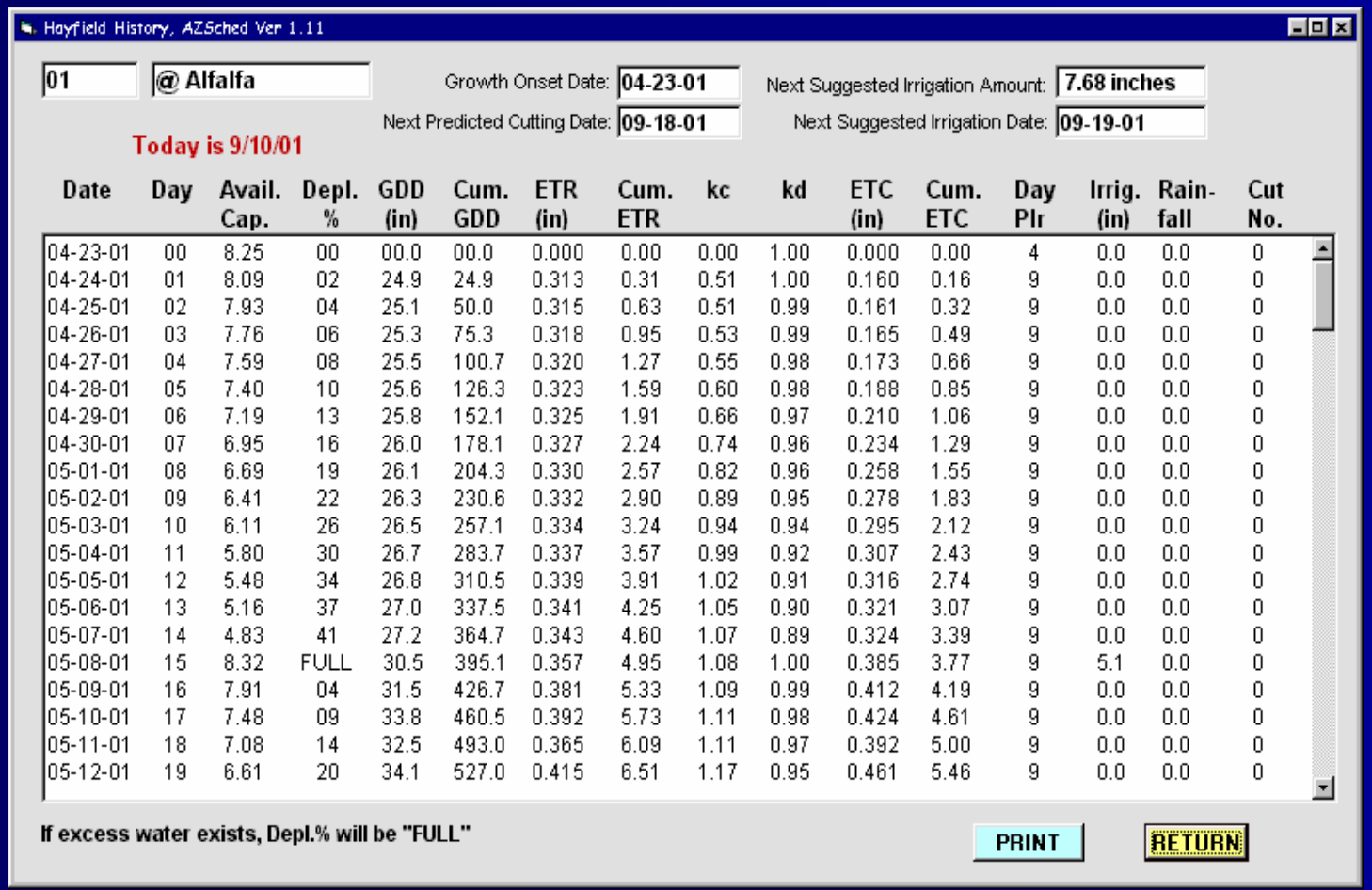

N
Repetition 4
Repetition 3
Repetition 2
Repetition 1
Plot 12 M
Plot 11 N
Plot 10 C
Plot 9 C
Plot 8 M
Plot 7 N
Plot 6 N
Plot 5 C
Plot 4 M
Plot 3 M
Plot 2 N
Plot 1 C
L
L
L
Irrigation Ditch


DRAIN TILE
CLOTH
P STONE
DRAINAGE
COLLECTION

Irrigation - AZSCHED



AZSCHED



Hayfield History, AZSched Ver 1.11

01 @ Alfalfa

Growth Onset Date: 04-23-01

Next Predicted Cutting Date: 09-18-01

Next Suggested Irrigation Amount: 7.68 inches

Next Suggested Irrigation Date: 09-19-01

Today is 9/10/01

Date	Day	Avail. Cap.	Depl. %	GDD (in)	Cum. GDD	ETR (in)	Cum. ETR	kc	kd	ETC (in)	Cum. ETC	Day Plr	Irrig. (in)	Rain-fall	Cut No.
04-23-01	00	8.25	00	00.0	00.0	0.000	0.00	0.00	1.00	0.000	0.00	4	0.0	0.0	0
04-24-01	01	8.09	02	24.9	24.9	0.313	0.31	0.51	1.00	0.160	0.16	9	0.0	0.0	0
04-25-01	02	7.93	04	25.1	50.0	0.315	0.63	0.51	0.99	0.161	0.32	9	0.0	0.0	0
04-26-01	03	7.76	06	25.3	75.3	0.318	0.95	0.53	0.99	0.165	0.49	9	0.0	0.0	0
04-27-01	04	7.59	08	25.5	100.7	0.320	1.27	0.55	0.98	0.173	0.66	9	0.0	0.0	0
04-28-01	05	7.40	10	25.6	126.3	0.323	1.59	0.60	0.98	0.188	0.85	9	0.0	0.0	0
04-29-01	06	7.19	13	25.8	152.1	0.325	1.91	0.66	0.97	0.210	1.06	9	0.0	0.0	0
04-30-01	07	6.95	16	26.0	178.1	0.327	2.24	0.74	0.96	0.234	1.29	9	0.0	0.0	0
05-01-01	08	6.69	19	26.1	204.3	0.330	2.57	0.82	0.96	0.258	1.55	9	0.0	0.0	0
05-02-01	09	6.41	22	26.3	230.6	0.332	2.90	0.89	0.95	0.278	1.83	9	0.0	0.0	0
05-03-01	10	6.11	26	26.5	257.1	0.334	3.24	0.94	0.94	0.295	2.12	9	0.0	0.0	0
05-04-01	11	5.80	30	26.7	283.7	0.337	3.57	0.99	0.92	0.307	2.43	9	0.0	0.0	0
05-05-01	12	5.48	34	26.8	310.5	0.339	3.91	1.02	0.91	0.316	2.74	9	0.0	0.0	0
05-06-01	13	5.16	37	27.0	337.5	0.341	4.25	1.05	0.90	0.321	3.07	9	0.0	0.0	0
05-07-01	14	4.83	41	27.2	364.7	0.343	4.60	1.07	0.89	0.324	3.39	9	0.0	0.0	0
05-08-01	15	8.32	FULL	30.5	395.1	0.357	4.95	1.08	1.00	0.385	3.77	9	5.1	0.0	0
05-09-01	16	7.91	04	31.5	426.7	0.381	5.33	1.09	0.99	0.412	4.19	9	0.0	0.0	0
05-10-01	17	7.48	09	33.8	460.5	0.392	5.73	1.11	0.98	0.424	4.61	9	0.0	0.0	0
05-11-01	18	7.08	14	32.5	493.0	0.365	6.09	1.11	0.97	0.392	5.00	9	0.0	0.0	0
05-12-01	19	6.61	20	34.1	527.0	0.415	6.51	1.17	0.95	0.461	5.46	9	0.0	0.0	0

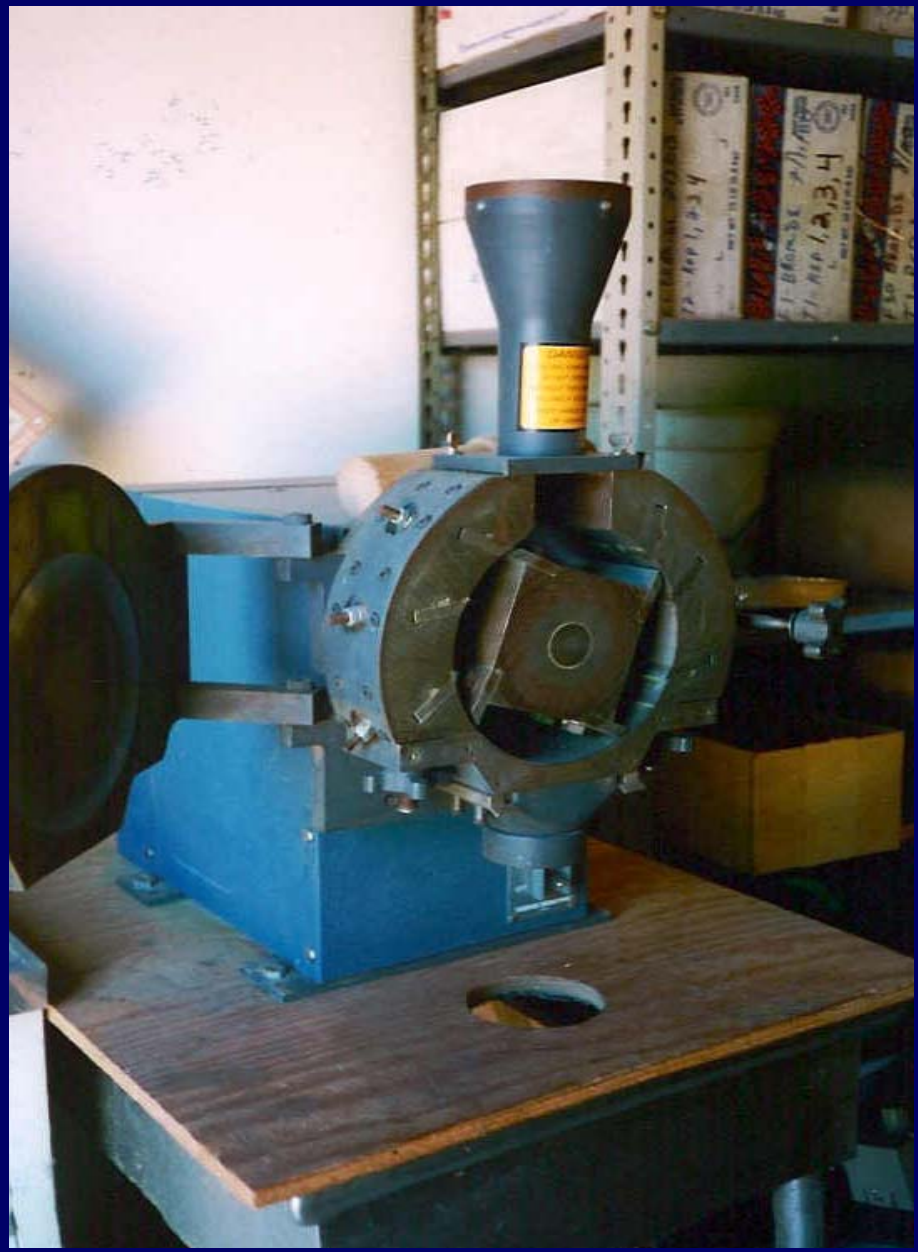
If excess water exists, Depl.% will be "FULL"

PRINT RETURN

Procedures

- Alfalfa was harvested
- Yield was determined
- Harvest was analyzed for nitrogen removed
- Manure and compost were analyzed for nitrogen
- Manure and compost were added in an amount equal to the nitrogen removed by the cutting


NEW HOLLAND



Digestion

Total nitrogen in the alfalfa was determined from a Kjeldahl digestion that converted the organic nitrogen to ammonium.


HOT
DANGER
Techne
DG-1 Block Digestor


VWR

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

Procedures

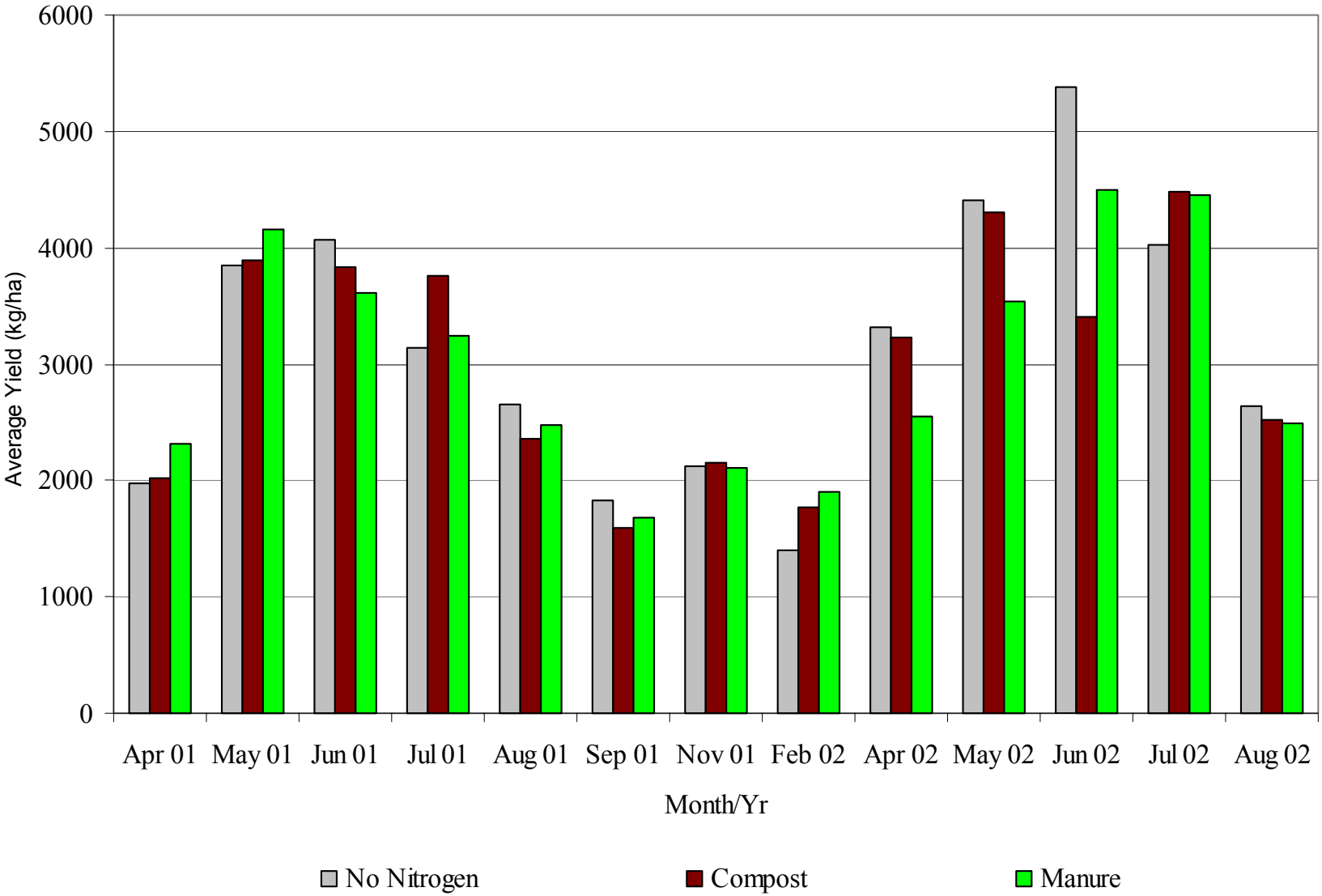
- Drainage was analyzed for nitrogen and phosphorous.
- Soil samples were analyzed for nitrogen, phosphorous, and electrical conductivity.

RESULTS

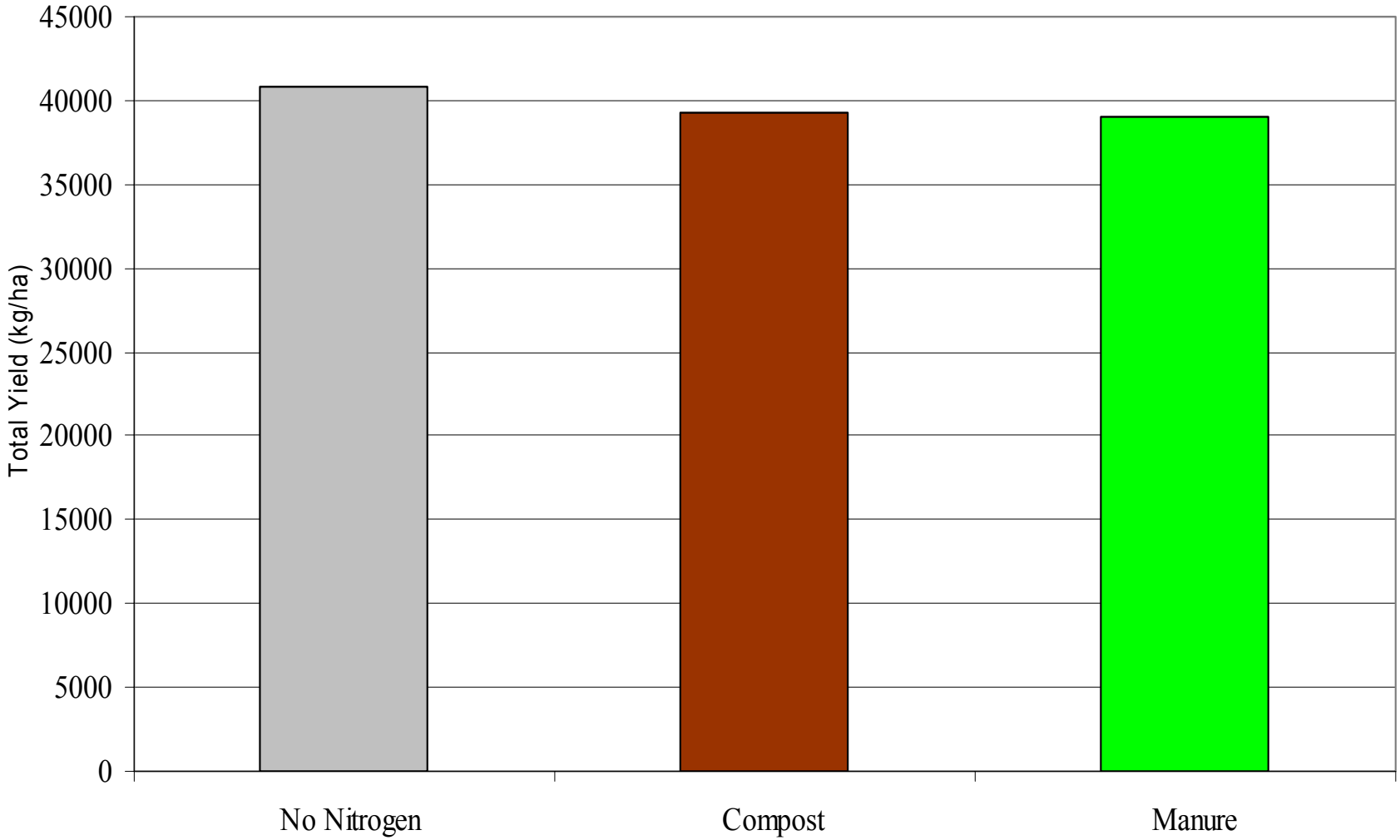
Alfalfa Yield and Nitrogen Composition

- Total yield did not vary between treatments.
- Nitrogen removed in alfalfa harvest did not vary between treatments.

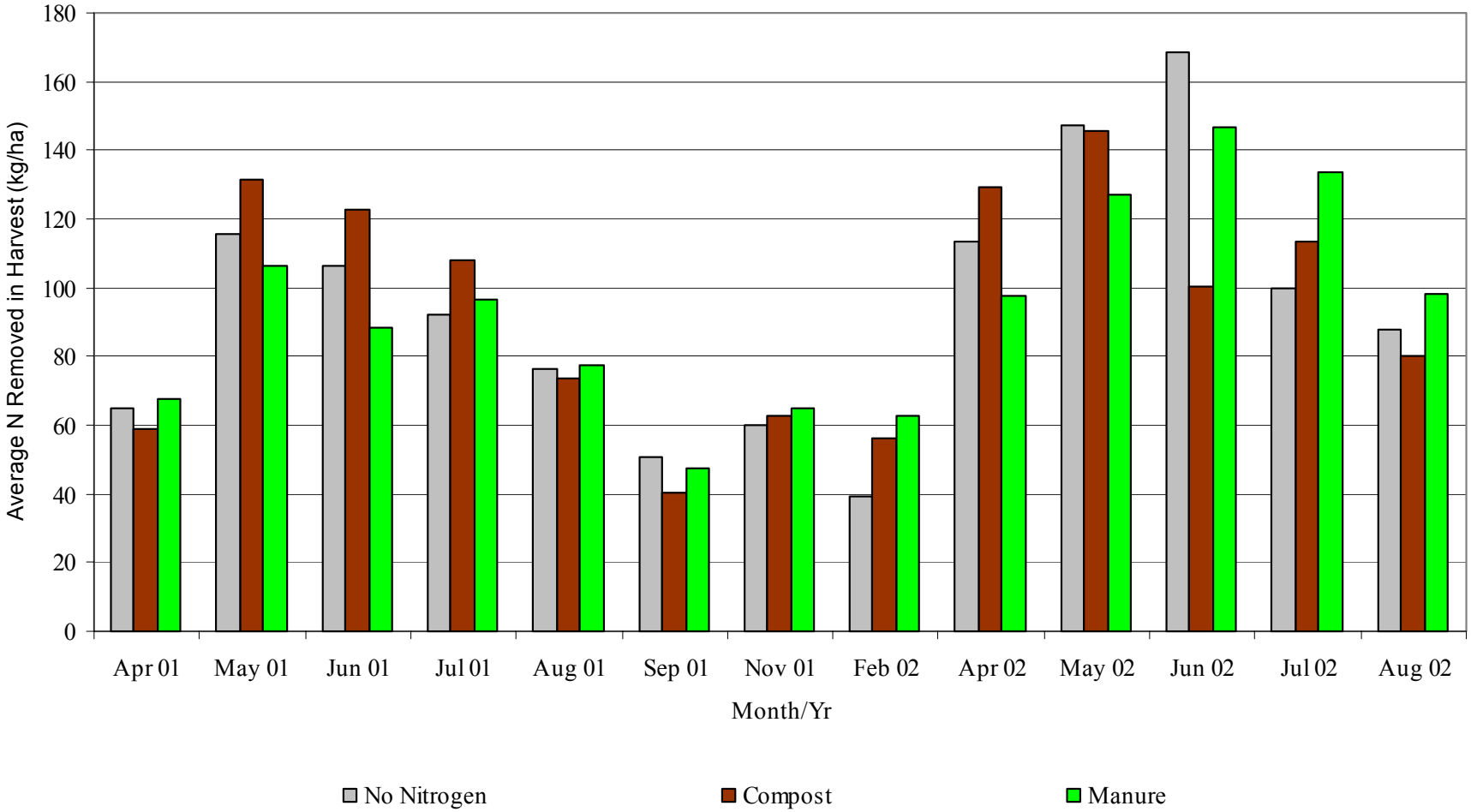
Average Yield



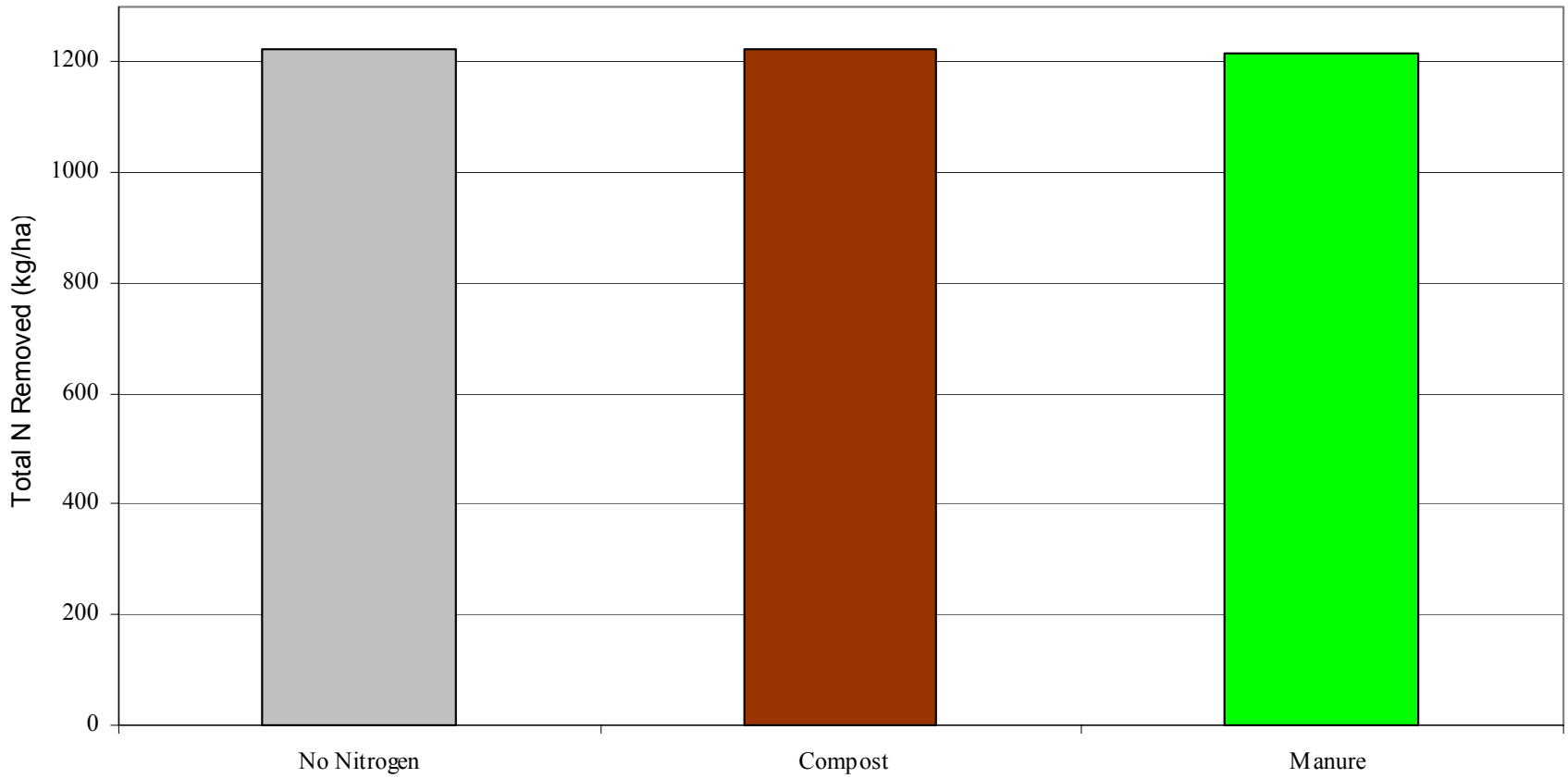
Alfalfa Yield



Nitrogen Removed



Total N Removed for the Entire Study Period

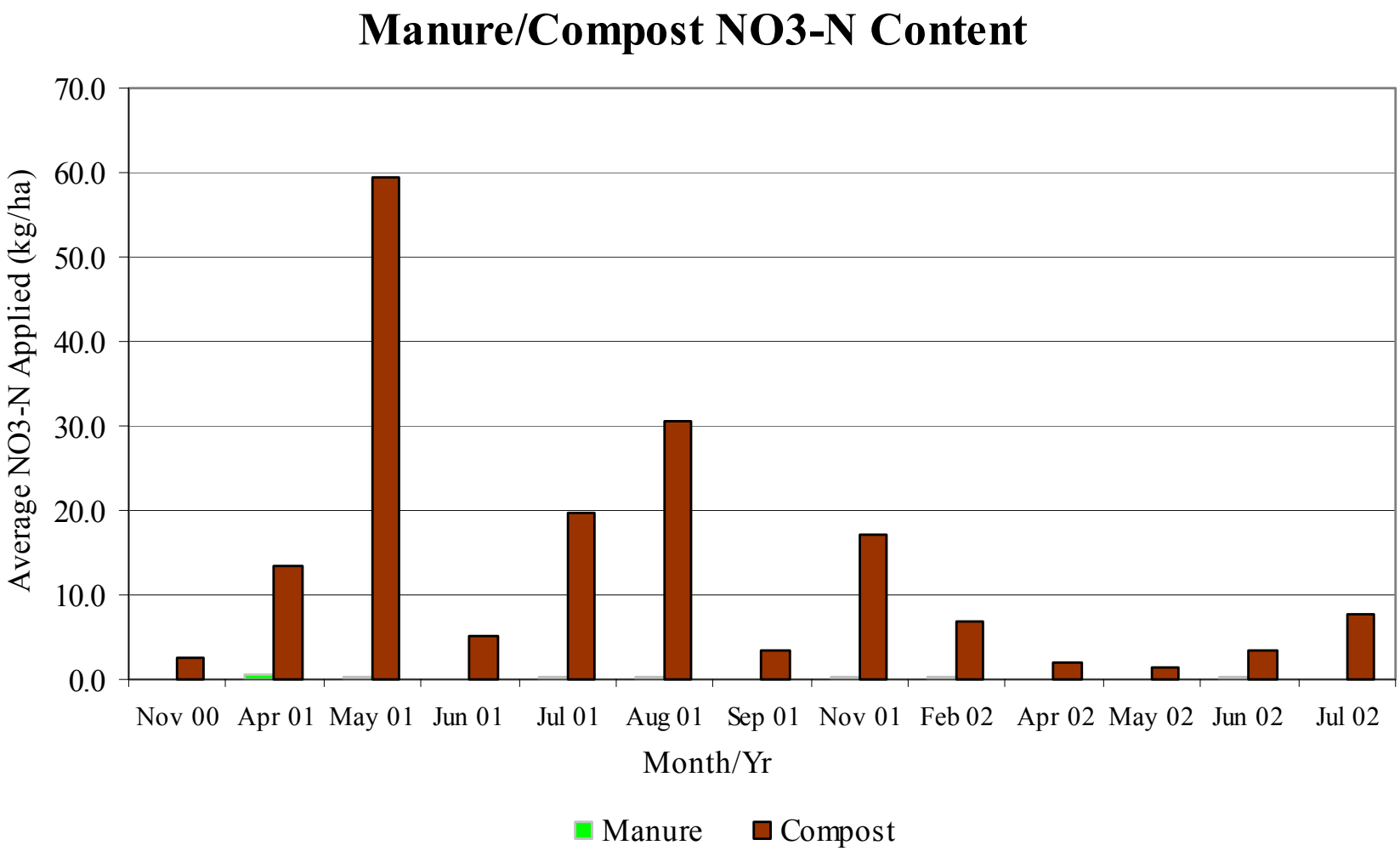


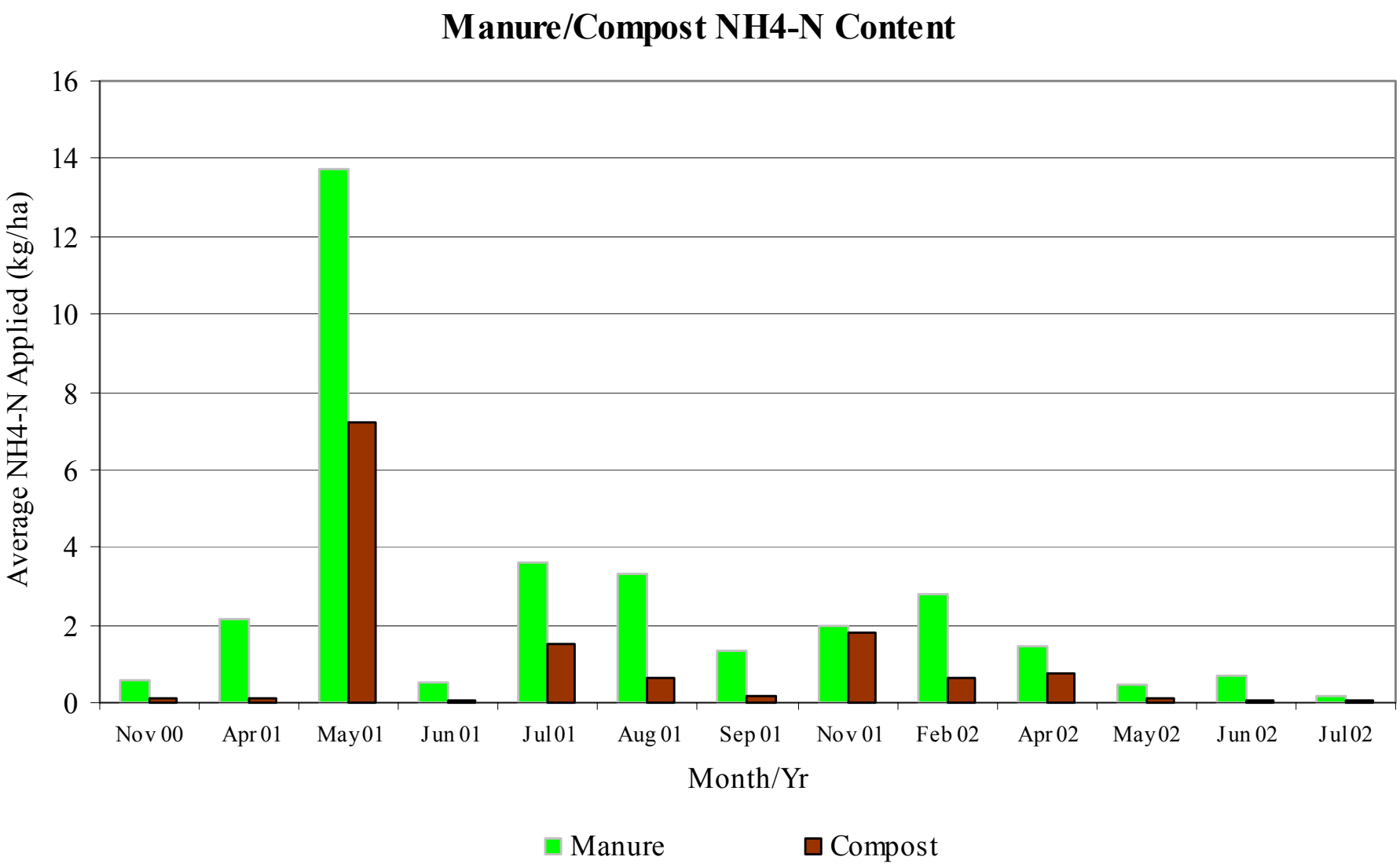
Manure and Compost Composition

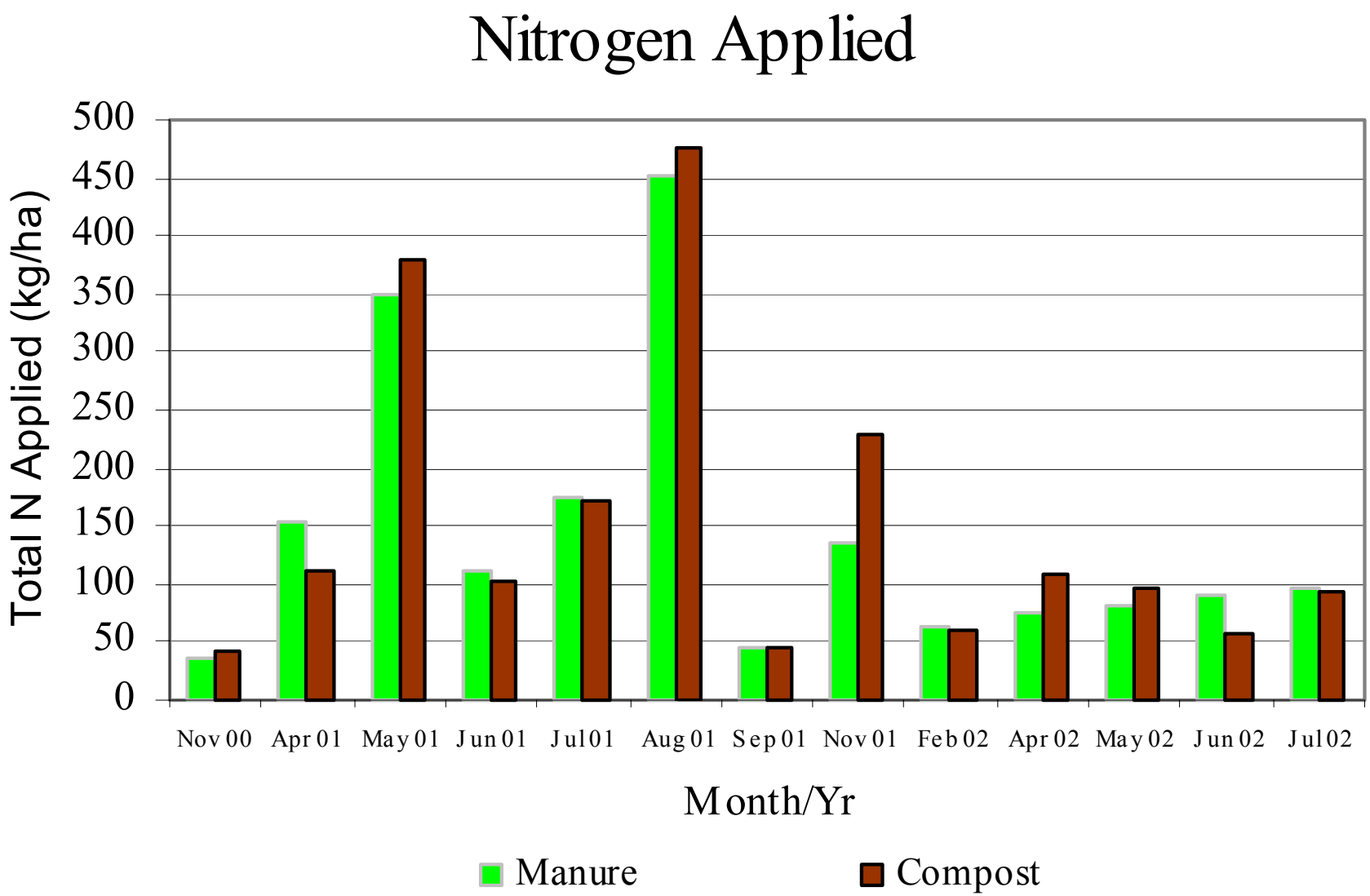
- More ammonium was applied to the manure plots.
- More nitrate was applied to the compost plots.
- About equal amounts of total nitrogen was applied to all treatment plots.

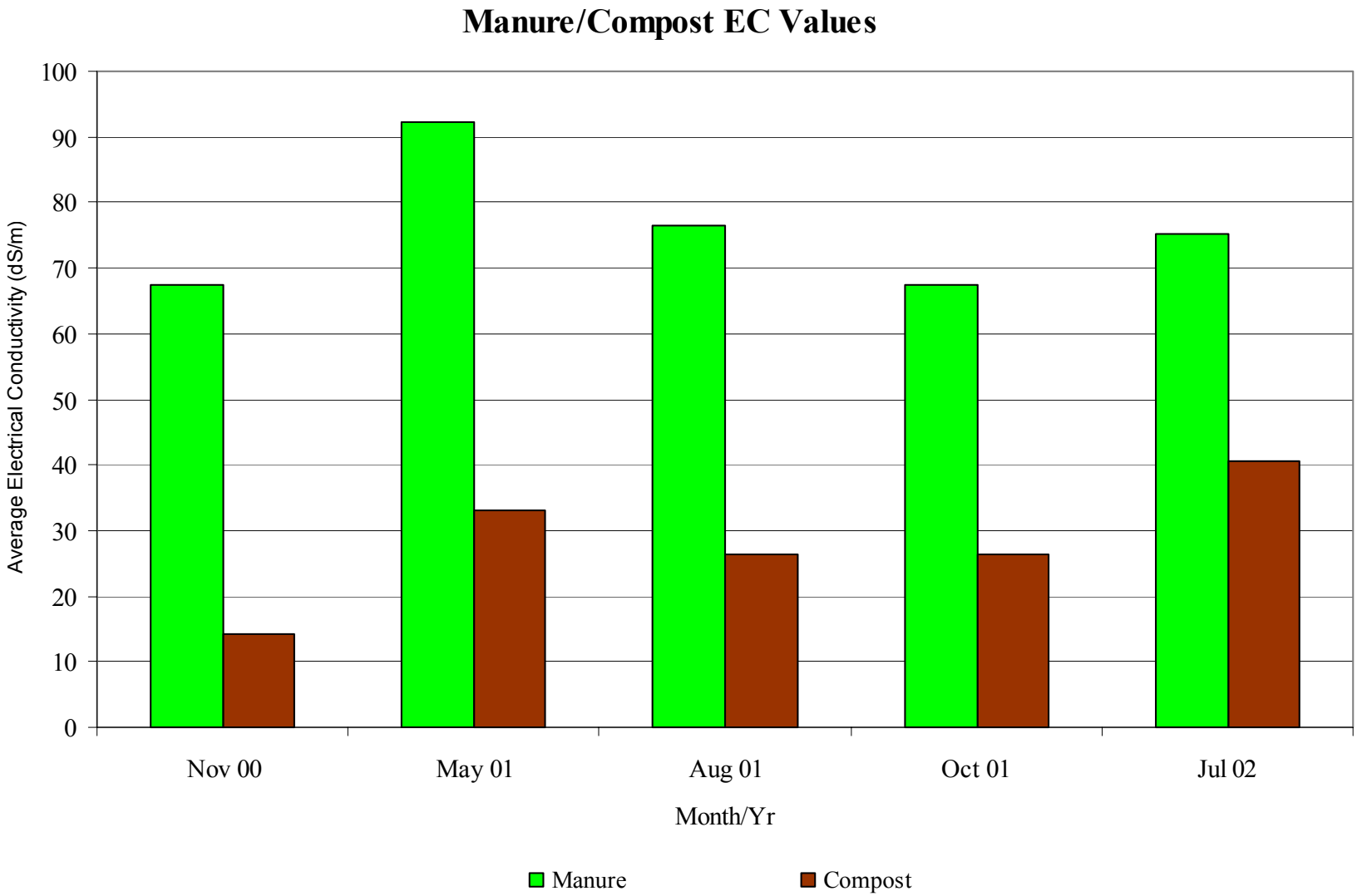
Manure and Compost Composition

- More phosphorous was applied to manure plots.
- More total dissolved solids were applied to manure plots.

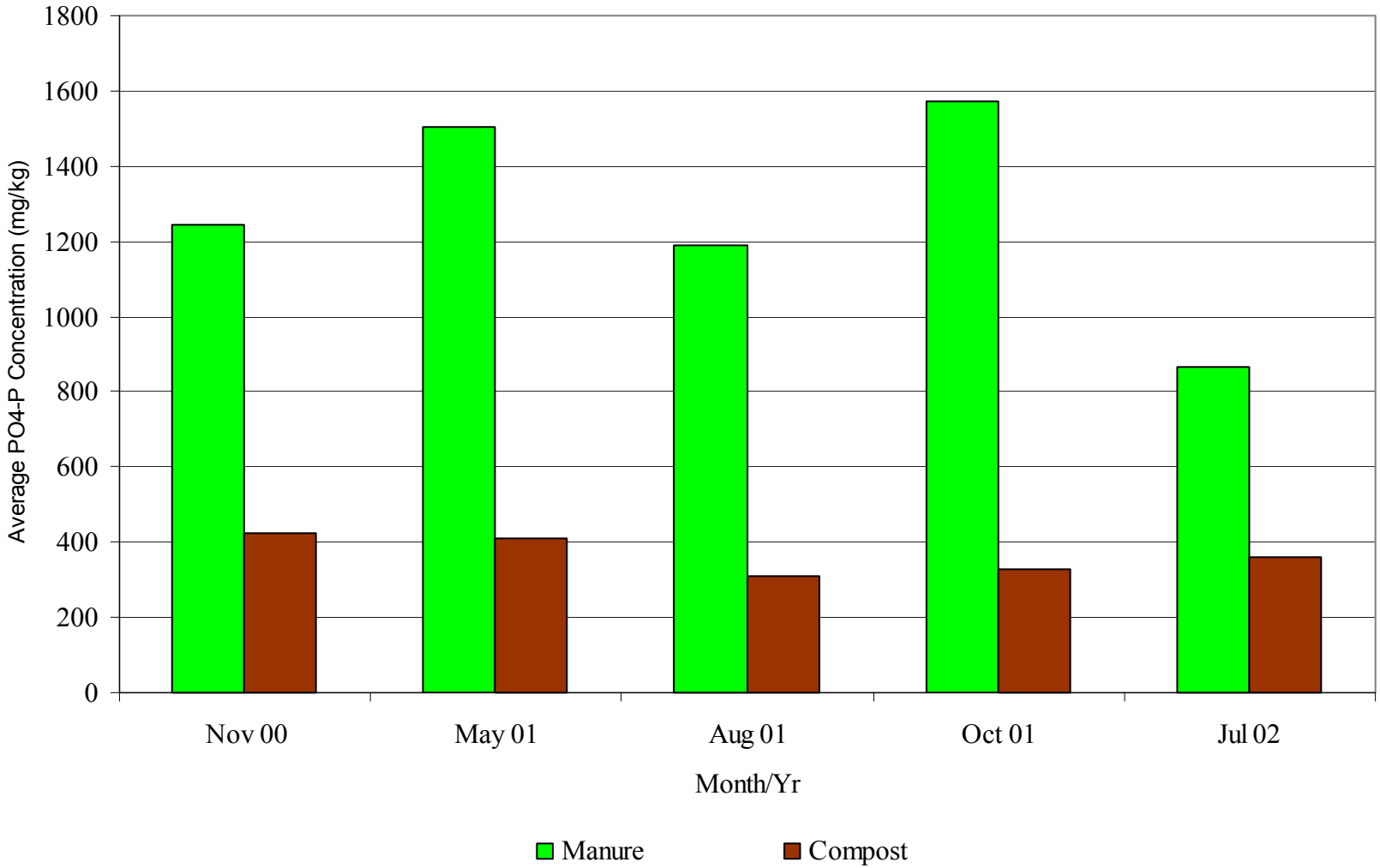

Manure/Compost NO3-N Content
Average NO3-N Applied (kg/ha)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Nov 00
Apr 01
May 01
Jun 01
Jul 01
Aug 01
Sep 01
Nov 01
Feb 02
Apr 02
May 02
Jun 02
Jul 02
Month/Yr
Manure
Compost


Manure/Compost NH4-N Content
Average NH4-N Applied (kg/ha)
16
14
12
10
8
6
4
2
0
Nov 00
Apr 01
May 01
Jun 01
Jul 01
Aug 01
Sep 01
Nov 01
Feb 02
Apr 02
May 02
Jun 02
Jul 02
Month/Yr
Manure
Compost


Nitrogen Applied
Total N Applied (kg/ha)
500
450
400
350
300
250
200
150
100
50
0
Nov 00
Apr 01
May 01
Jun 01
Jul 01
Aug 01
Sep 01
Nov 01
Feb 02
Apr 02
May 02
Jun 02
Jul 02
Month/Yr
Manure
Compost


Manure/Compost EC Values
Average Electrical Conductivity (dS/m)
100
90
80
70
60
50
40
30
20
10
0
Nov 00
May 01
Aug 01
Oct 01
Jul 02
Month/Yr
Manure
Compost

Manure/Compost Phosphorus Concentration

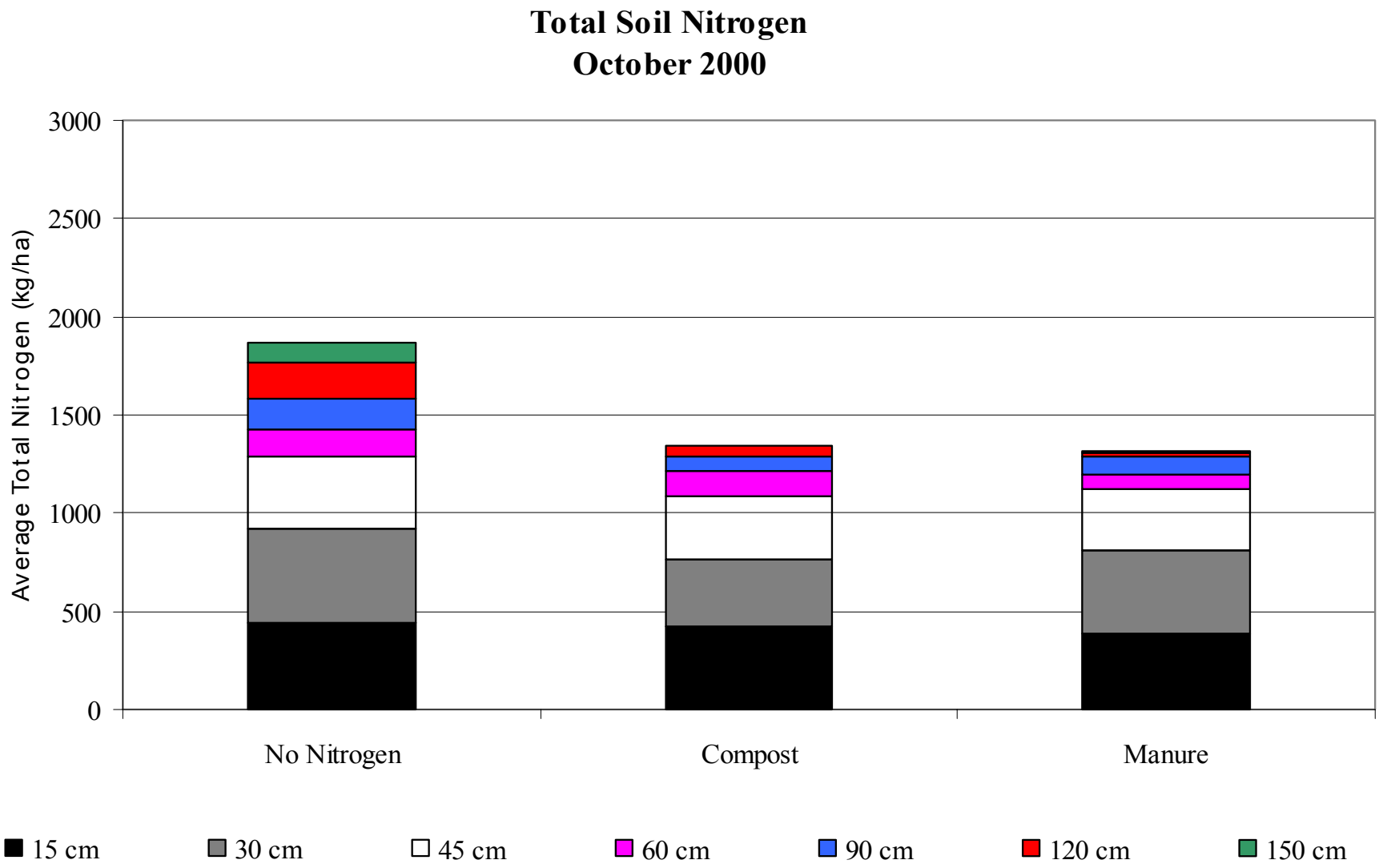


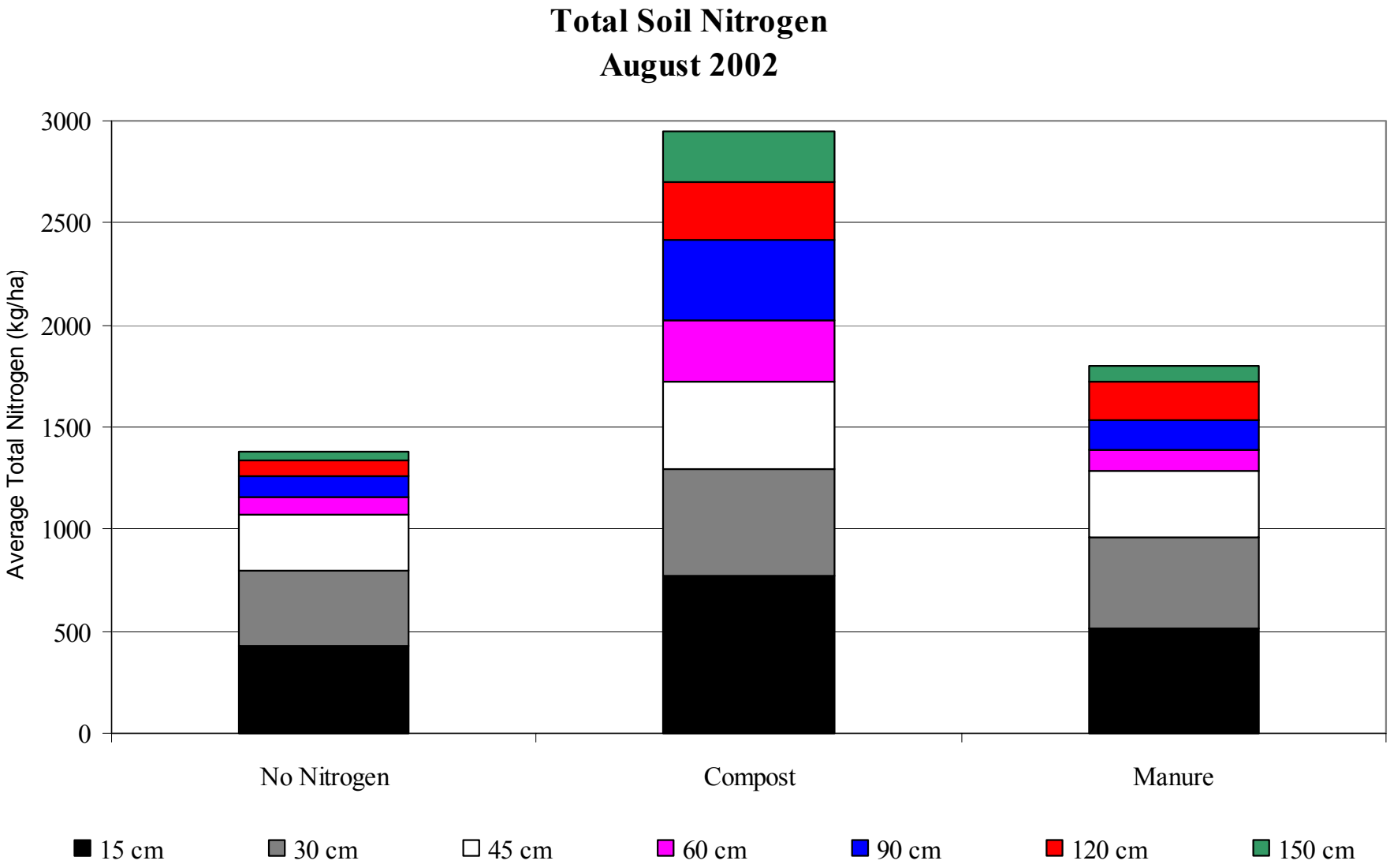
Soil Composition

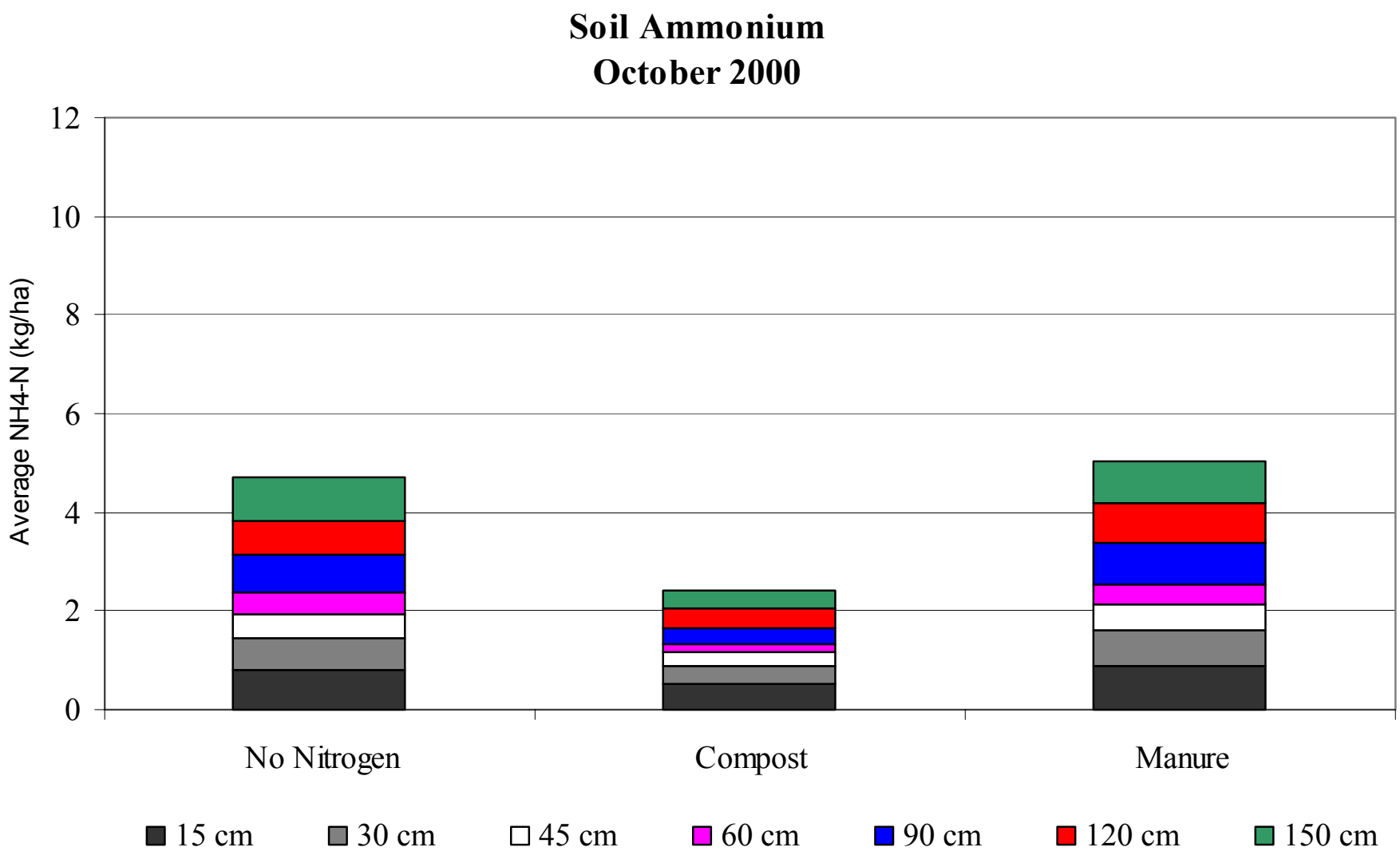
- Compost plots were higher in total nitrogen.
- All plots were similar in ammonium.
- Manure and compost plots were higher in nitrate.

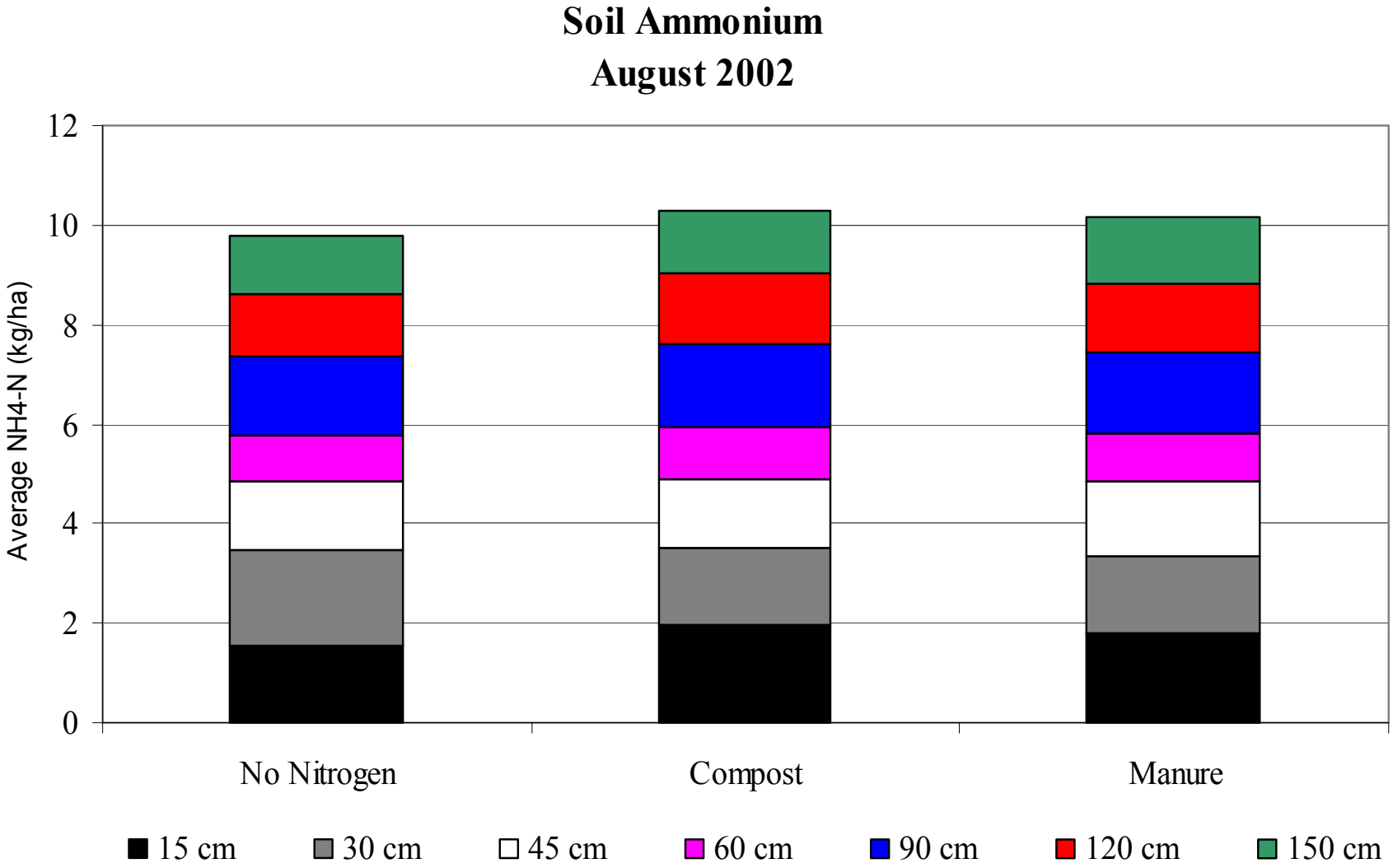
Soil Composition

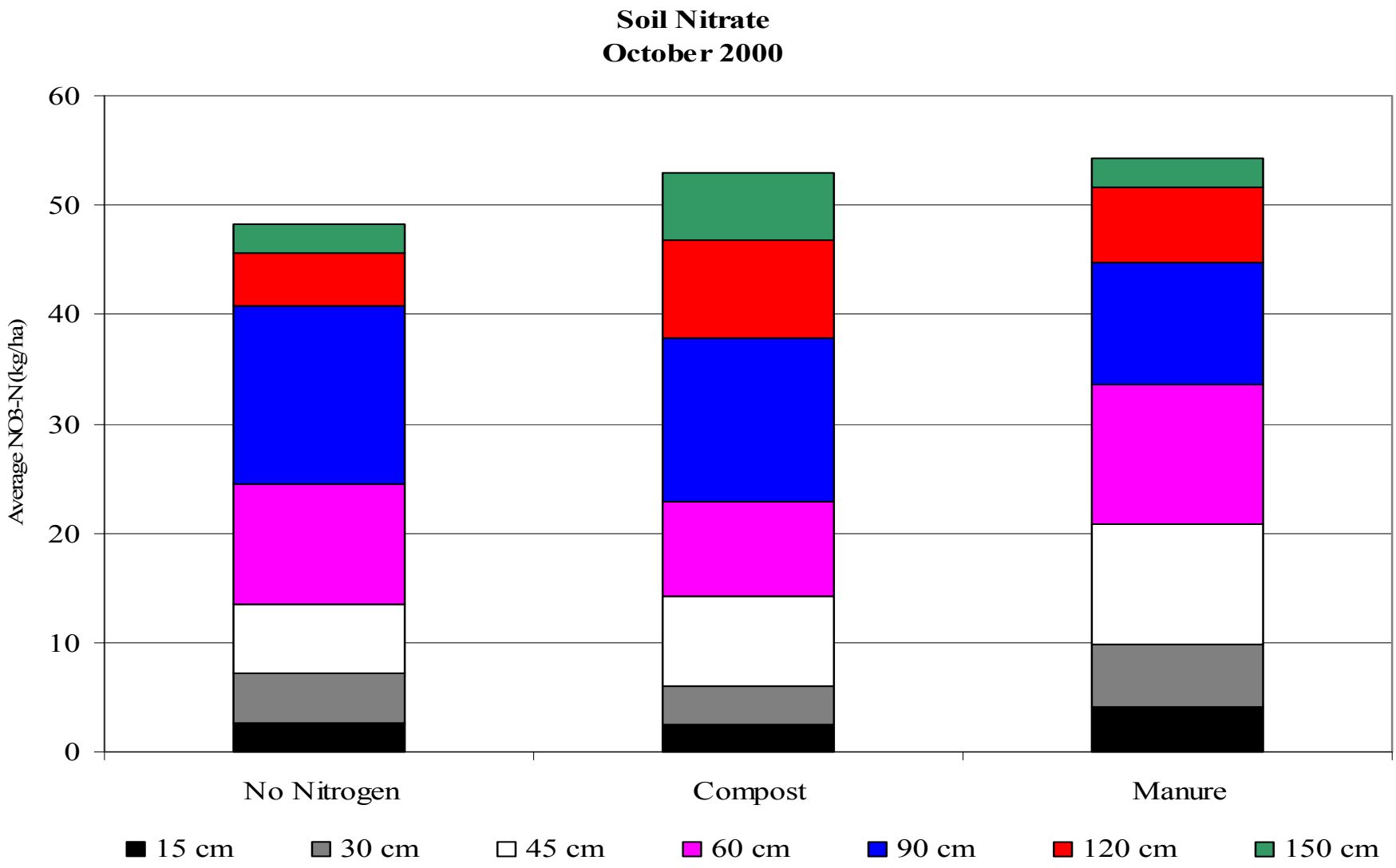
- Manure and compost plots were higher in phosphorus.
- All plots were similar in electrical conductivity.


Total Soil Nitrogen
October 2000
Average Total Nitrogen (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
150 cm

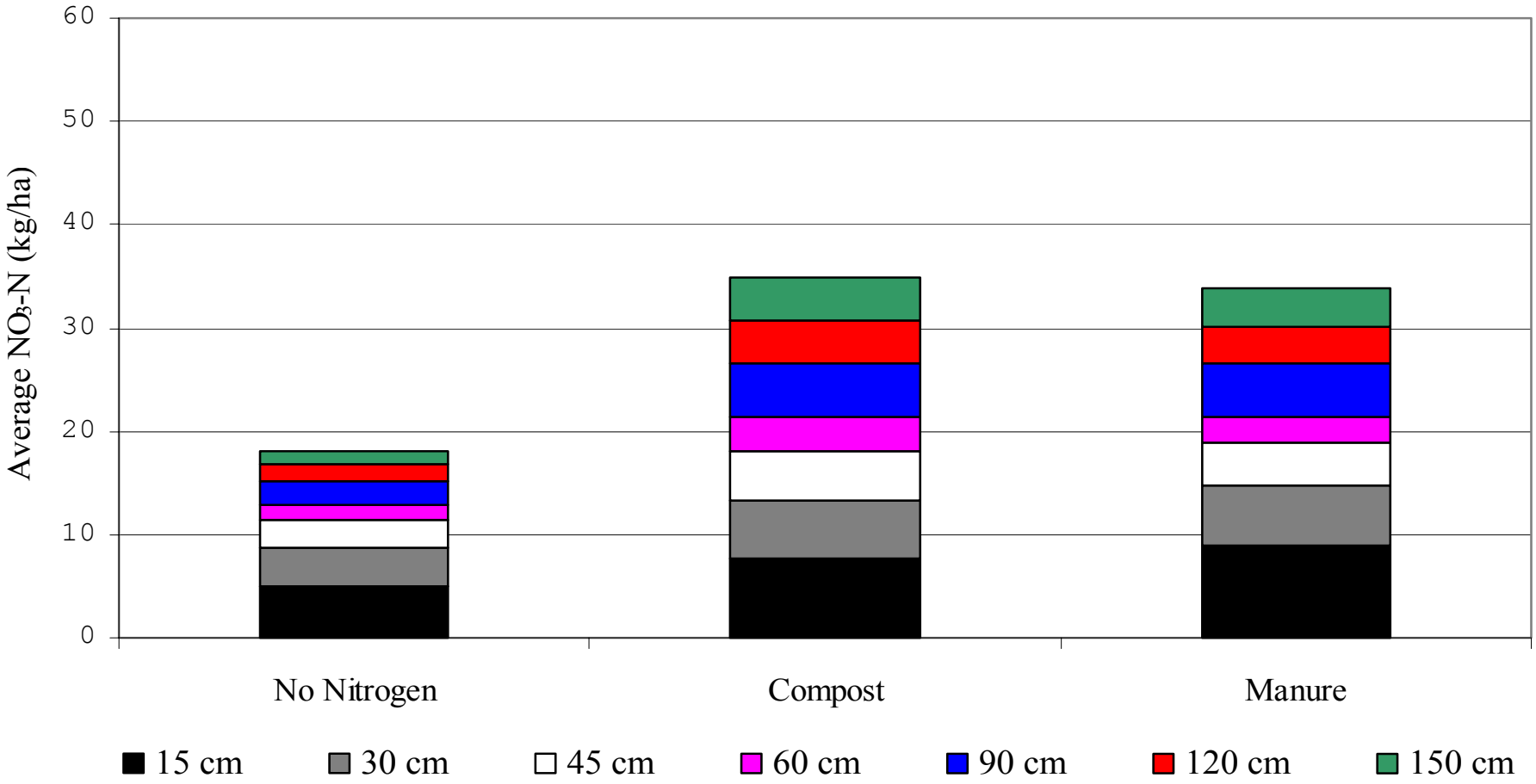

Total Soil Nitrogen
August 2002
Average Total Nitrogen (kg/ha)
3000
2500
2000
1500
1000
500
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm

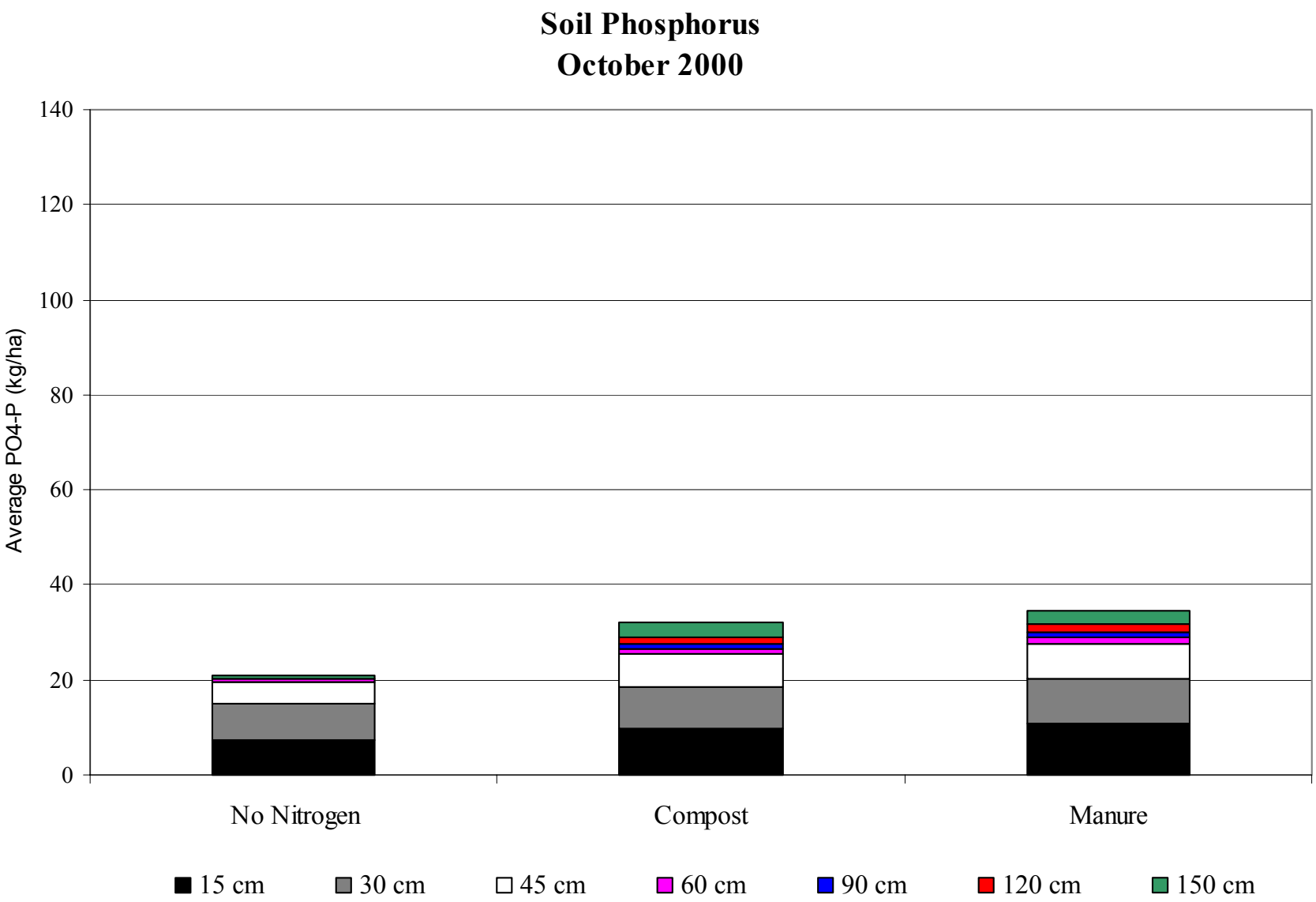

Soil Ammonium
October 2000
Average NH4-N (kg/ha)
12
10
8
6
4
2
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm

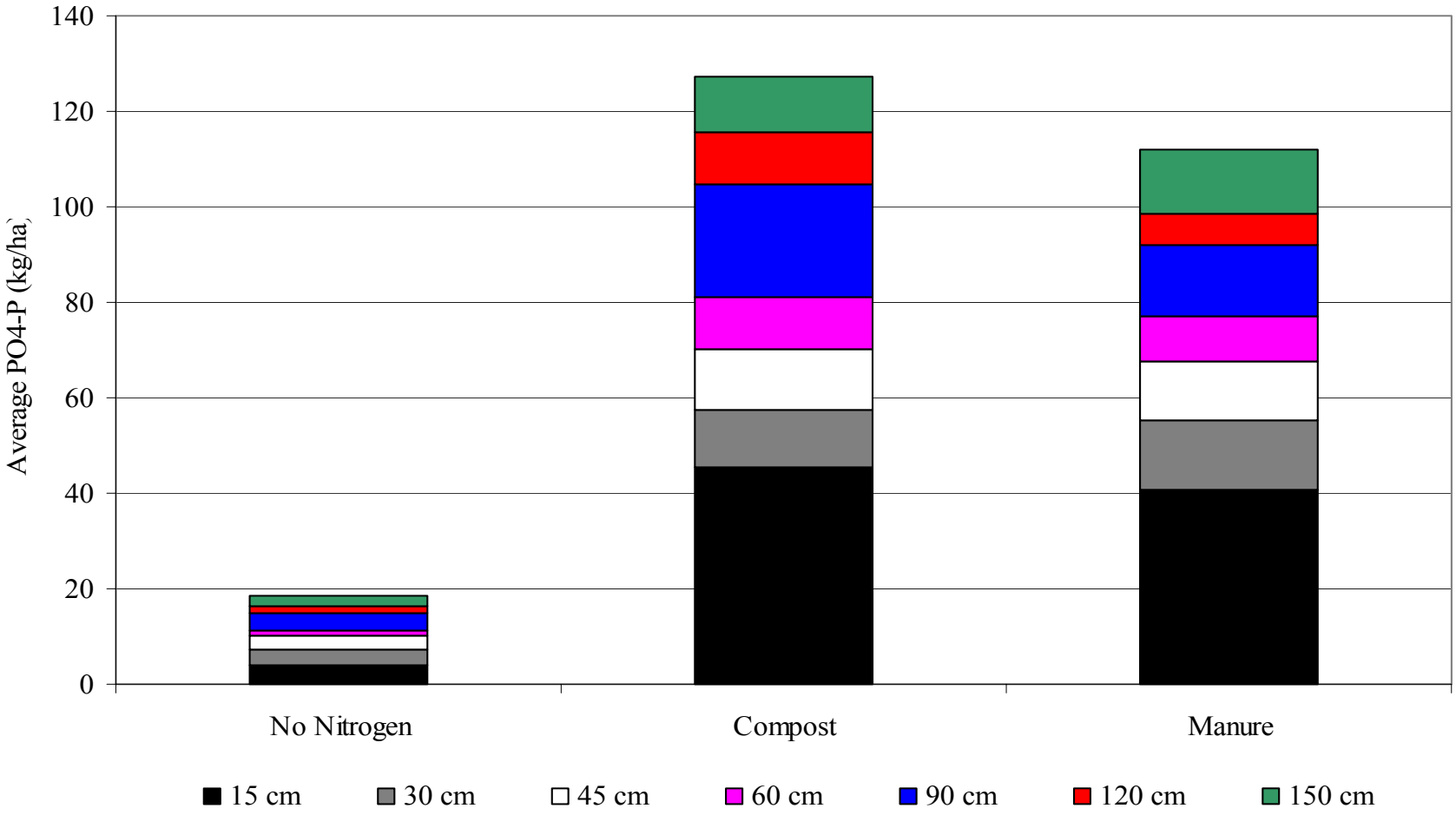

Soil Ammonium
August 2002
Average NH4-N (kg/ha)
12
10
8
6
4
2
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm

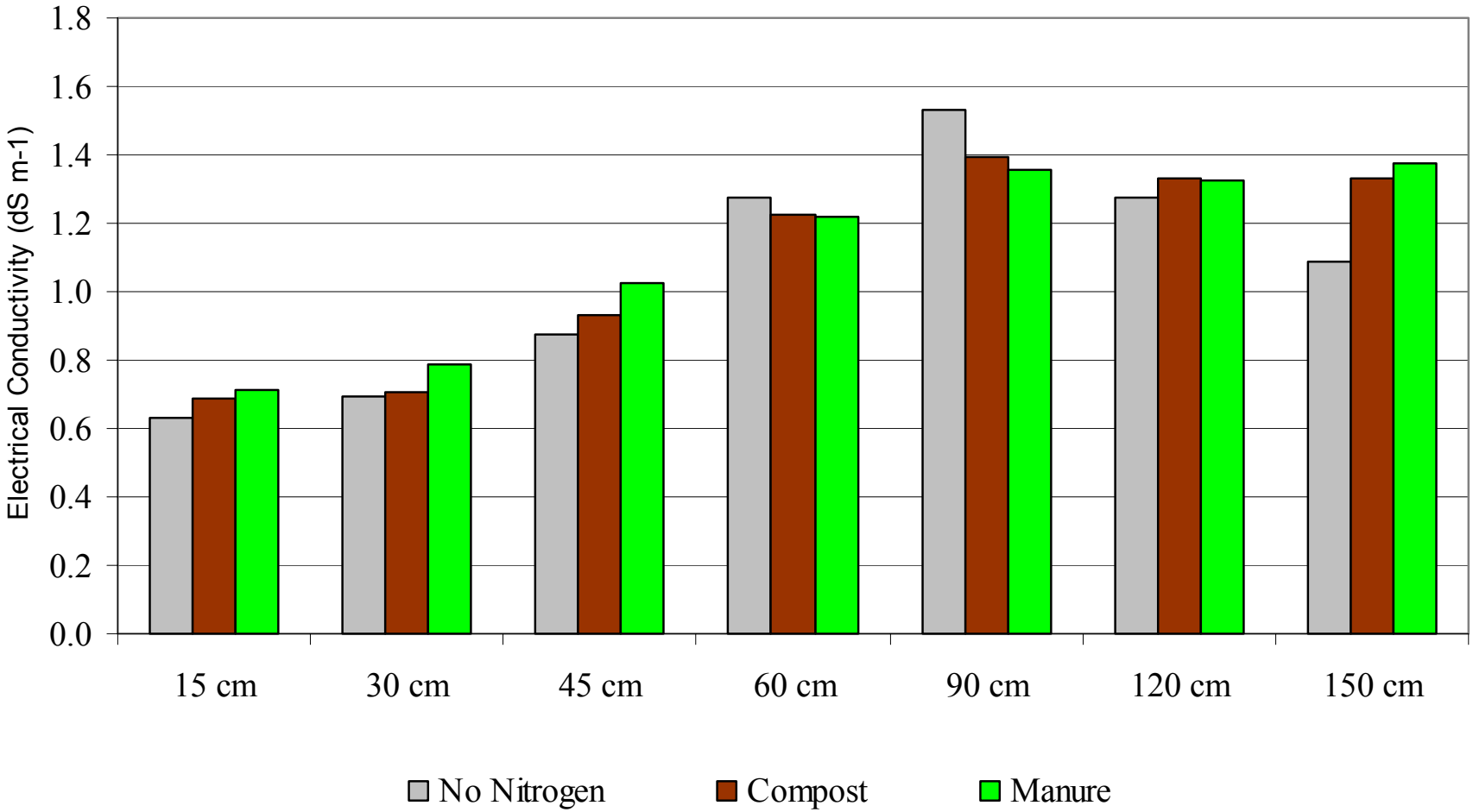

Soil Nitrate
October 2000
Average NO3-N (kg/ha)
60
50
40
30
20
10
0
No Nitrogen
Compost
Manure
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm

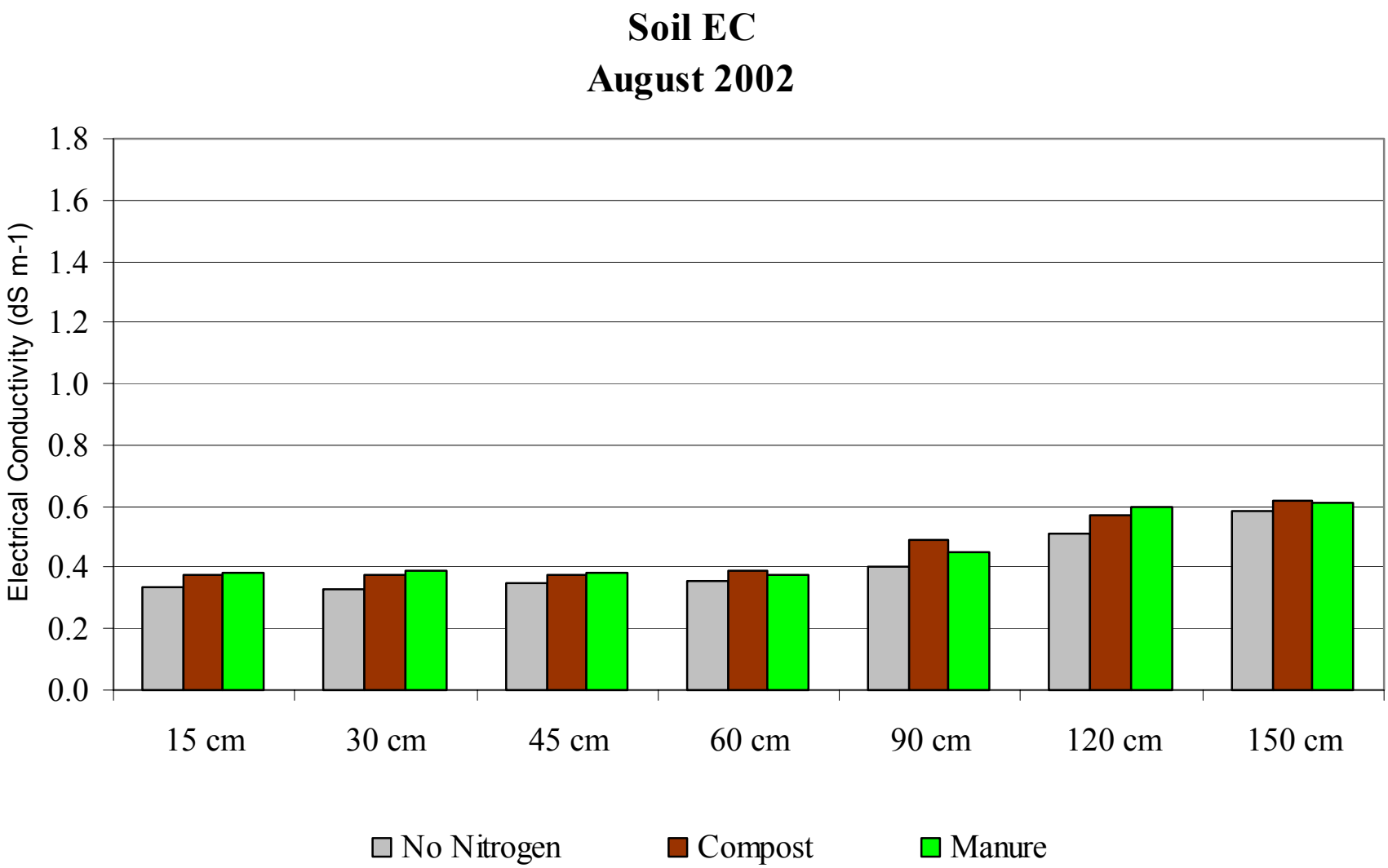
Soil Nitrate
August 2002




Soil Phosphorus
October 2000
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


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


Soil EC
October 2000
Electrical Conductivity (dS m-1)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm
No Nitrogen
Compost
Manure


Soil EC
August 2002
Electrical Conductivity (dS m-1)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
15 cm
30 cm
45 cm
60 cm
90 cm
120 cm
150 cm
No Nitrogen
Compost
Manure

Lysimeter Results

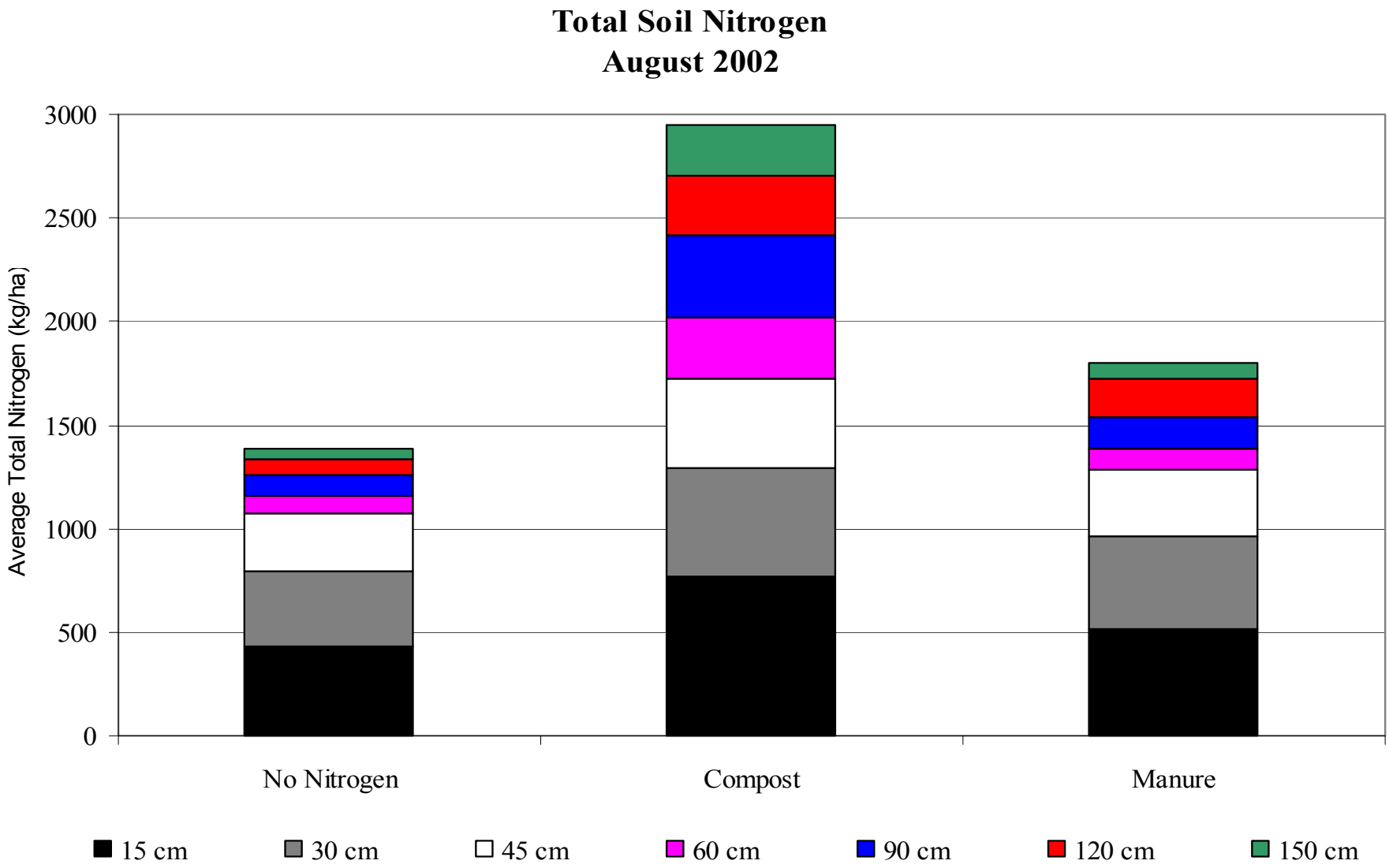
- Little drainage was obtained during the study.
- No detectable nitrate or phosphate was found in the drainage water.

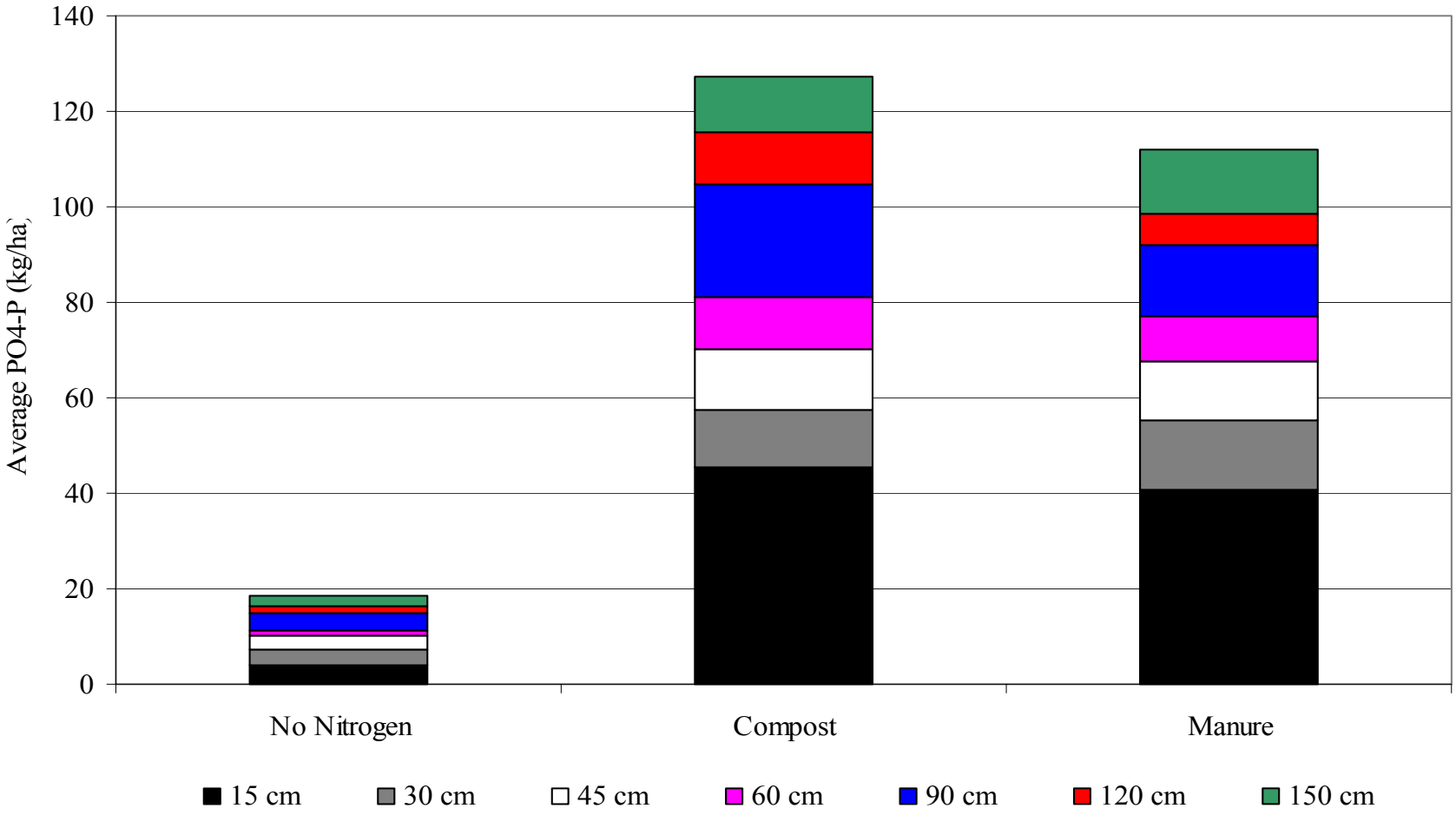
Conclusions

- All treatments had the same yield and N concentrations – Thus the addition of the manure/compost had no effect.
- Although not statistically significant – the no nitrogen treatment had a slightly higher yield, probably due to less surface traffic.

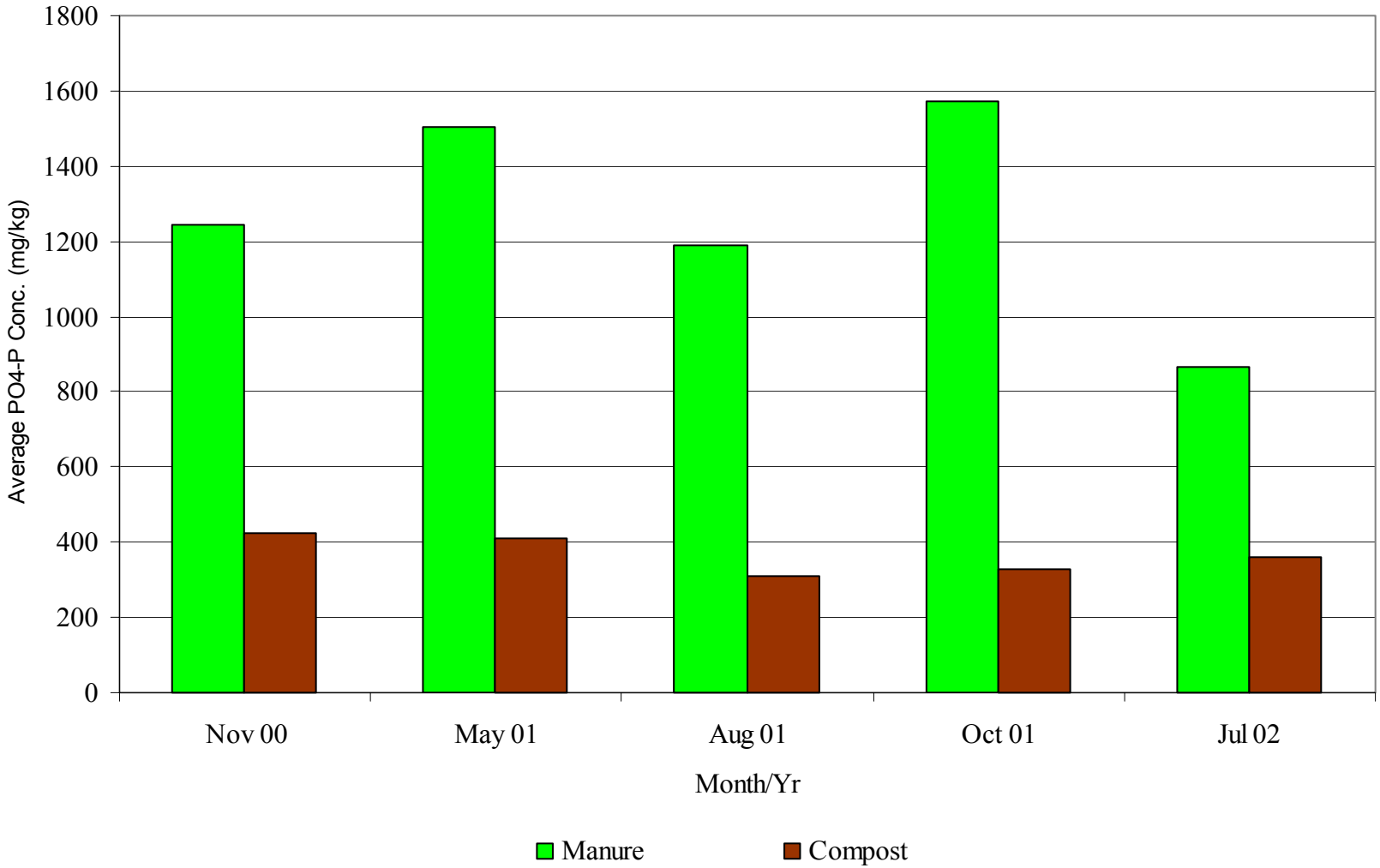
Conclusions

- Nitrogen mass balance showed that a substantial amount of nitrogen in the manure plots were unaccounted for.
- Even the phosphorus readings were low for the manure treatment.


Total Soil Nitrogen
August 2002
Average Total Nitrogen (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
150 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

Manure/Compost Phosphorus Concentration



Manure Discrepancies

- The low values for nitrogen and phosphorus in the soil manure plots suggests that manure was lost somehow.

- Reports from the farm manager indicated that the hay was “dirty” and “not salable” because of the manure chunks in the bales.

Manure Discrepancies

- One theory was that the manure was physically removed from the plots, thus causing lower than expected values.
- The other is that the manure is still there and sitting on the surface.

Long-term Projections

- Nitrogen increases in the treated plots may threaten groundwater quality
- Phosphorous increase may threaten environmental quality

Questions?