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.
Irrigation Ditch

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

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

Month/Yr

April 01, May 01, June 01, July 01, August 01, September 01, November 01, February 02, April 02, May 02, June 02, July 02, August 02

Average Yield (kg/ha)

- No Nitrogen
- Compost
- Manure

Graph showing the average yield over time with different treatments.
Alfalfa Yield

Total Yield (kg/ha)

- No Nitrogen
- Compost
- Manure
Nitrogen Removed

Average N Removed in Harvest (kg/ha)

Month/Yr

- No Nitrogen
- Compost
- Manure
Total N Removed for the Entire Study Period

No Nitrogen | Compost | Manure
---|---|---
1200 kg/ha | 1200 kg/ha | 1200 kg/ha
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)

Month/Yr

Manure

Compost
Manure/Compost EC Values

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- **Manure**
- **Compost**
Manure/Compost Phosphorus Concentration

Month/Yr:
- Nov 00
- May 01
- Aug 01
- Oct 01
- Jul 02

Average PO4-P Concentration (mg/kg):
- Manure
- Compost
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.
Soil Ammonium
October 2000

Average NH$_4$-N (kg/ha)
Soil Ammonium
August 2002

Average NH4-N (kg/ha)

15 cm  30 cm  45 cm  60 cm  90 cm  120 cm  150 cm

No Nitrogen  Compost  Manure
Soil Nitrate
October 2000

Average NO3-N (kg/ha)

No Nitrogen

Compost

Manure

15 cm  30 cm  45 cm  60 cm  90 cm  120 cm  150 cm
Soil Nitrate
August 2002

Average NO₃-N (kg/ha)

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)

0 20 40 60 80 100 120 140

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.
Soil Phosphorus
August 2002

Average PO4-P (kg/ha)

No Nitrogen
Compost
Manure

15 cm 30 cm 45 cm 60 cm 90 cm 120 cm 150 cm
Manure/Compost Phosphorus Concentration

Average PO4-P Conc. (mg/kg)

- **Manure**
- **Compost**

Month/Yr:
- Nov 00
- May 01
- Aug 01
- Oct 01
- Jul 02
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?