Reducing Risk of Phosphorus Pollution of Surface Waters in Crop-Ethanol-Livestock Ecosystems of the Midwest

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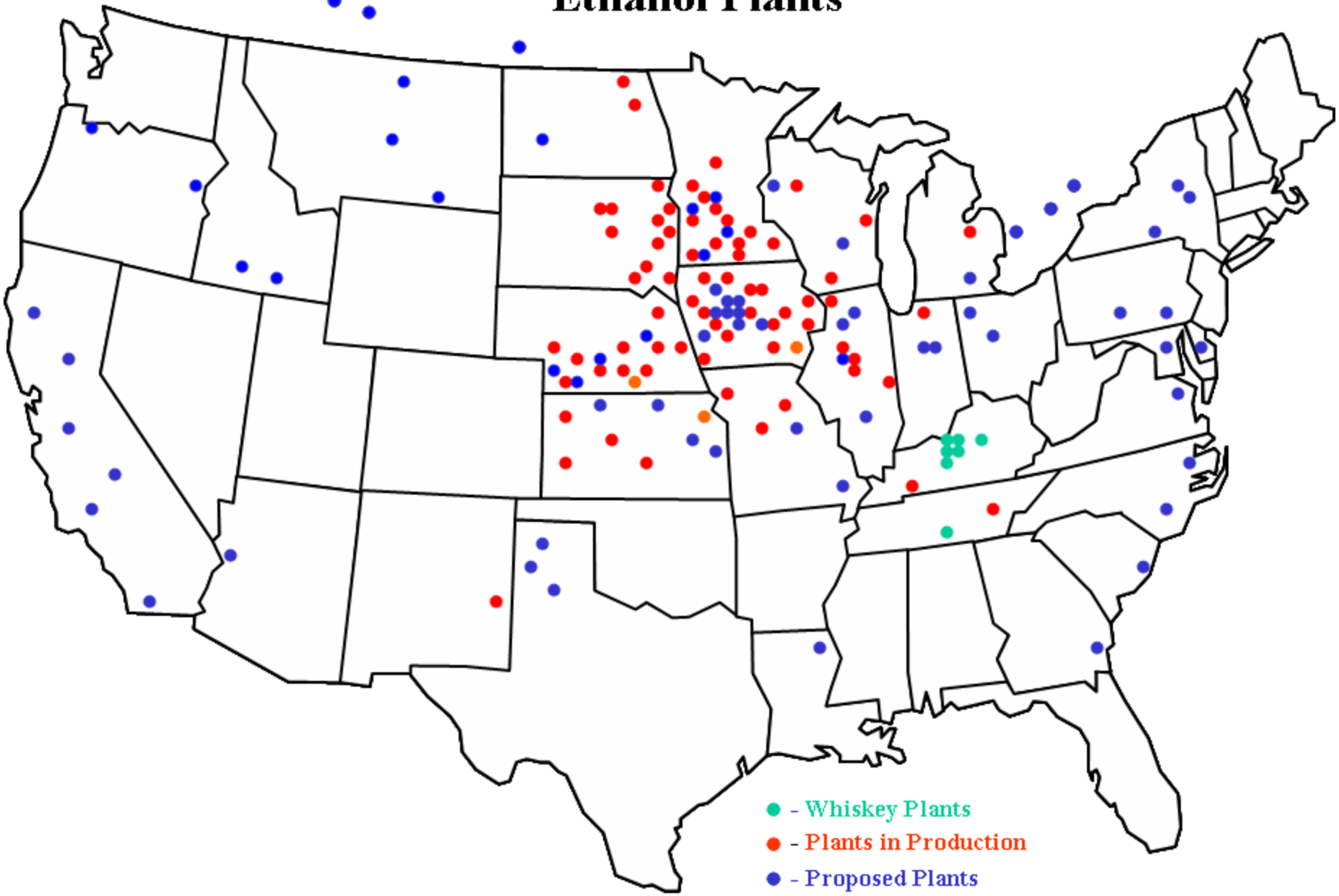
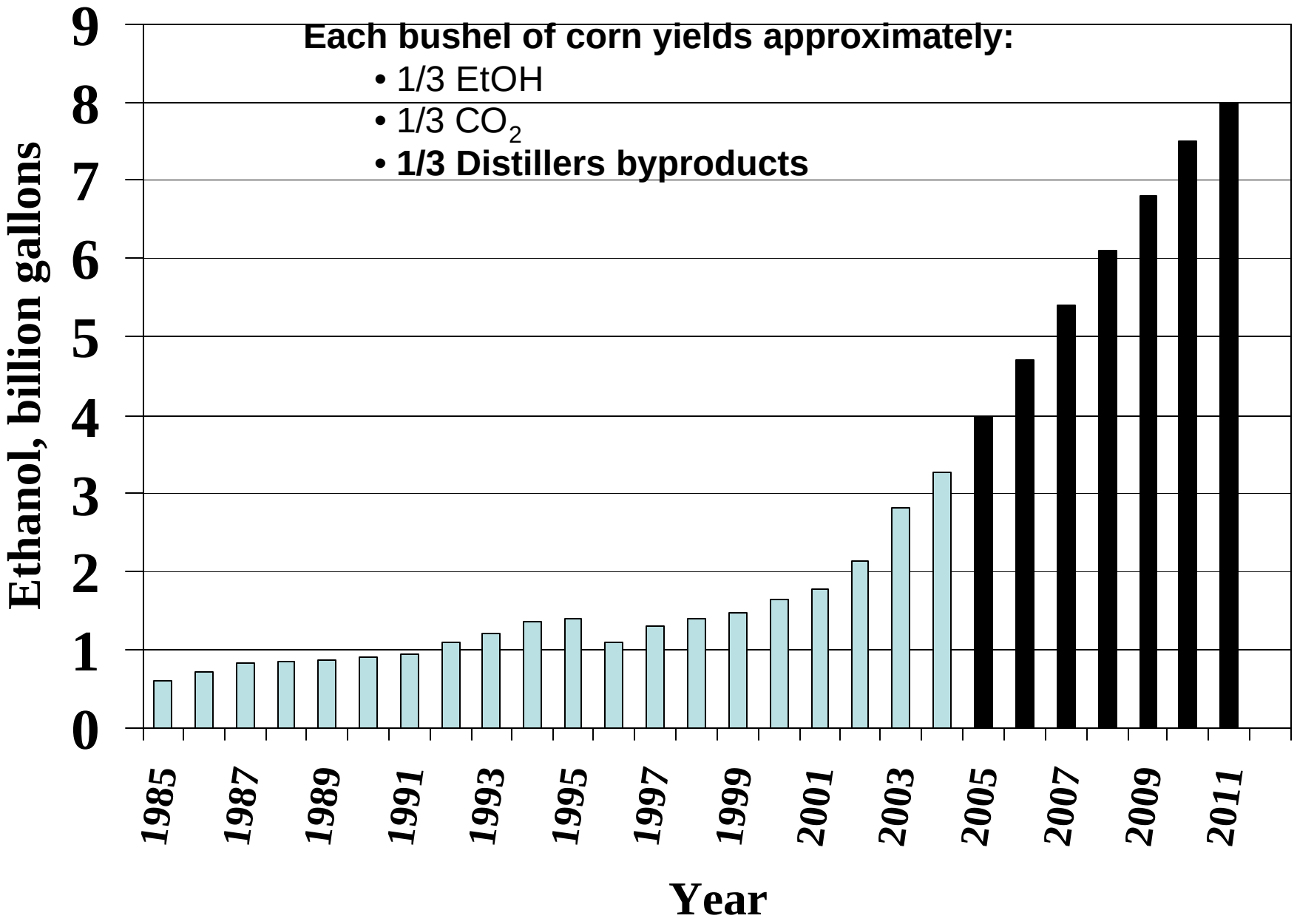
H. Nourdenni: Chemical Engineering
G. Erickson: Animal Science
T. Franti, D. Schulte: Biological Systems Engineering
D. Jose: Agricultural Economics
K. Brunkhorst: Nebr. Corn Board

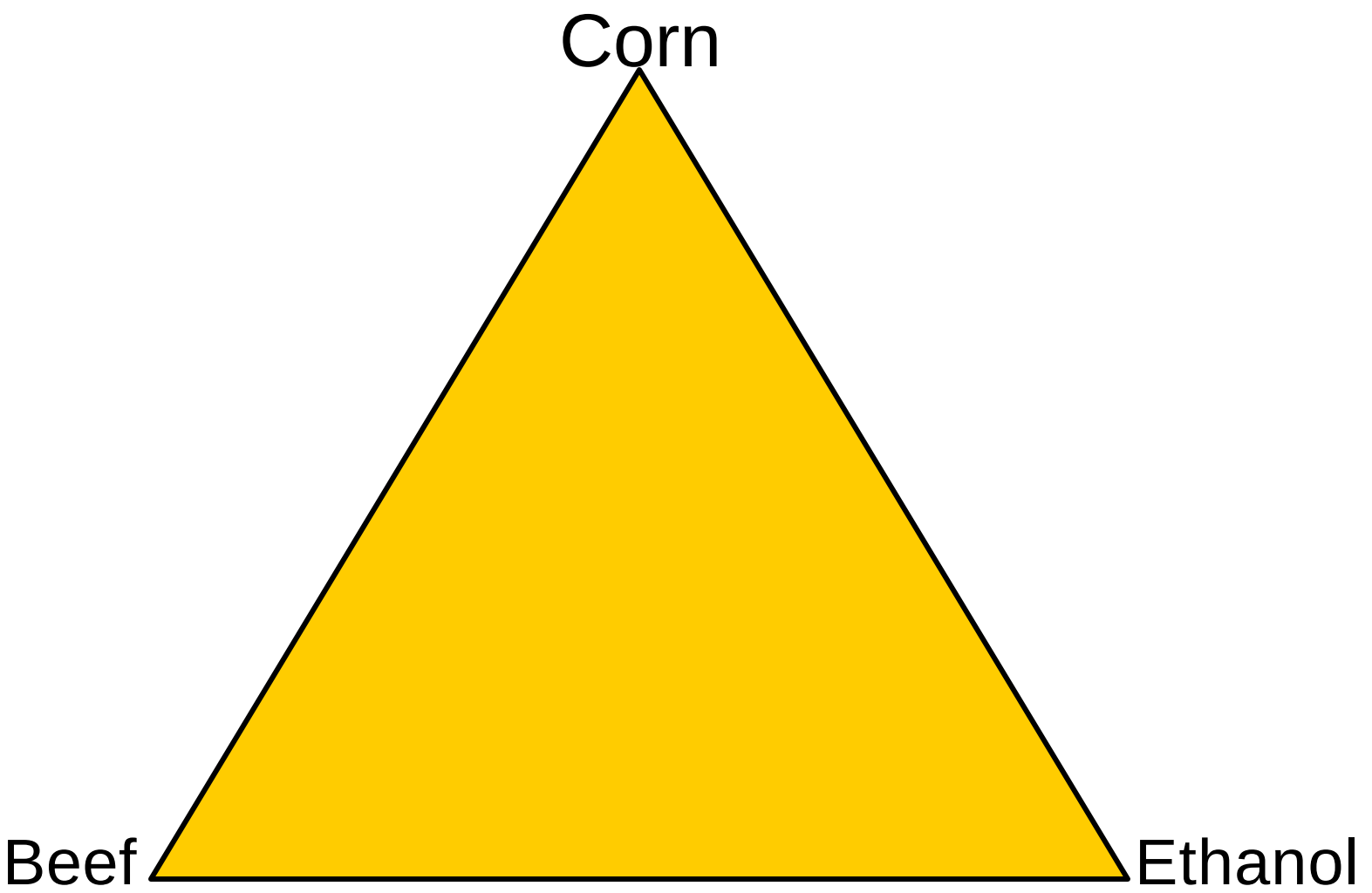
USDA-CSRESS Managed Ecosystems/Nebraska Corn Board

Ethanol Plants

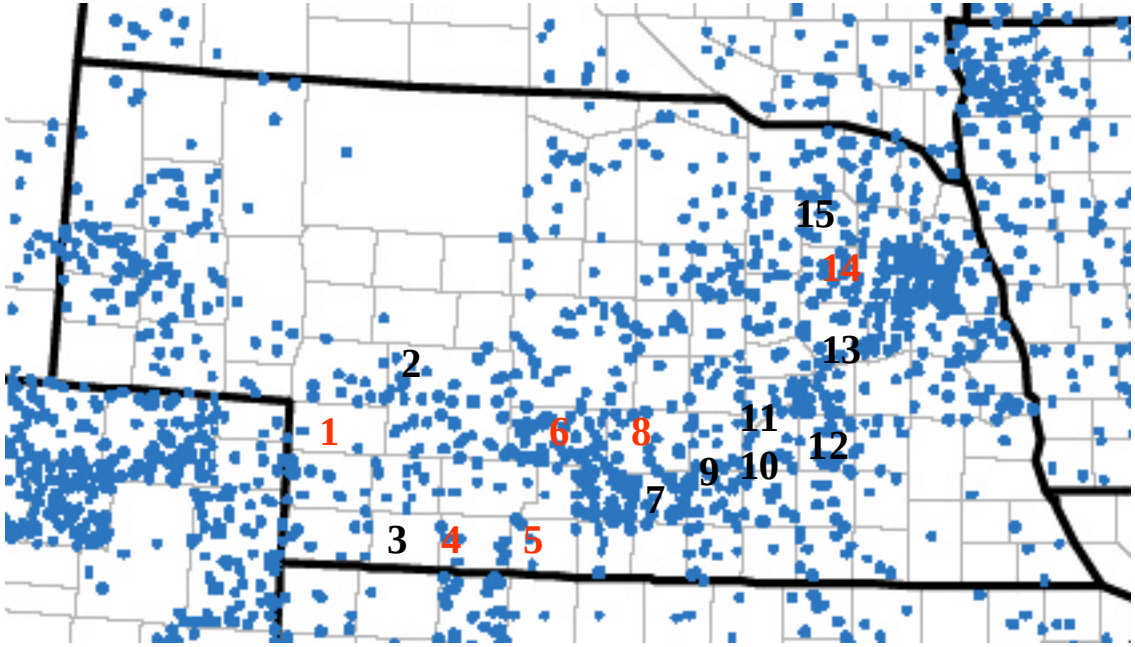


Minnesota Distillers Website: http://www.ddgs.umn.edu/


Each bushel of corn yields approximately:
• 1/3 EtOH
• 1/3 CO_2
• 1/3 Distillers byproducts
Ethanol, billion gallons
0
1
2
3
4
5
6
7
8
9
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
Year

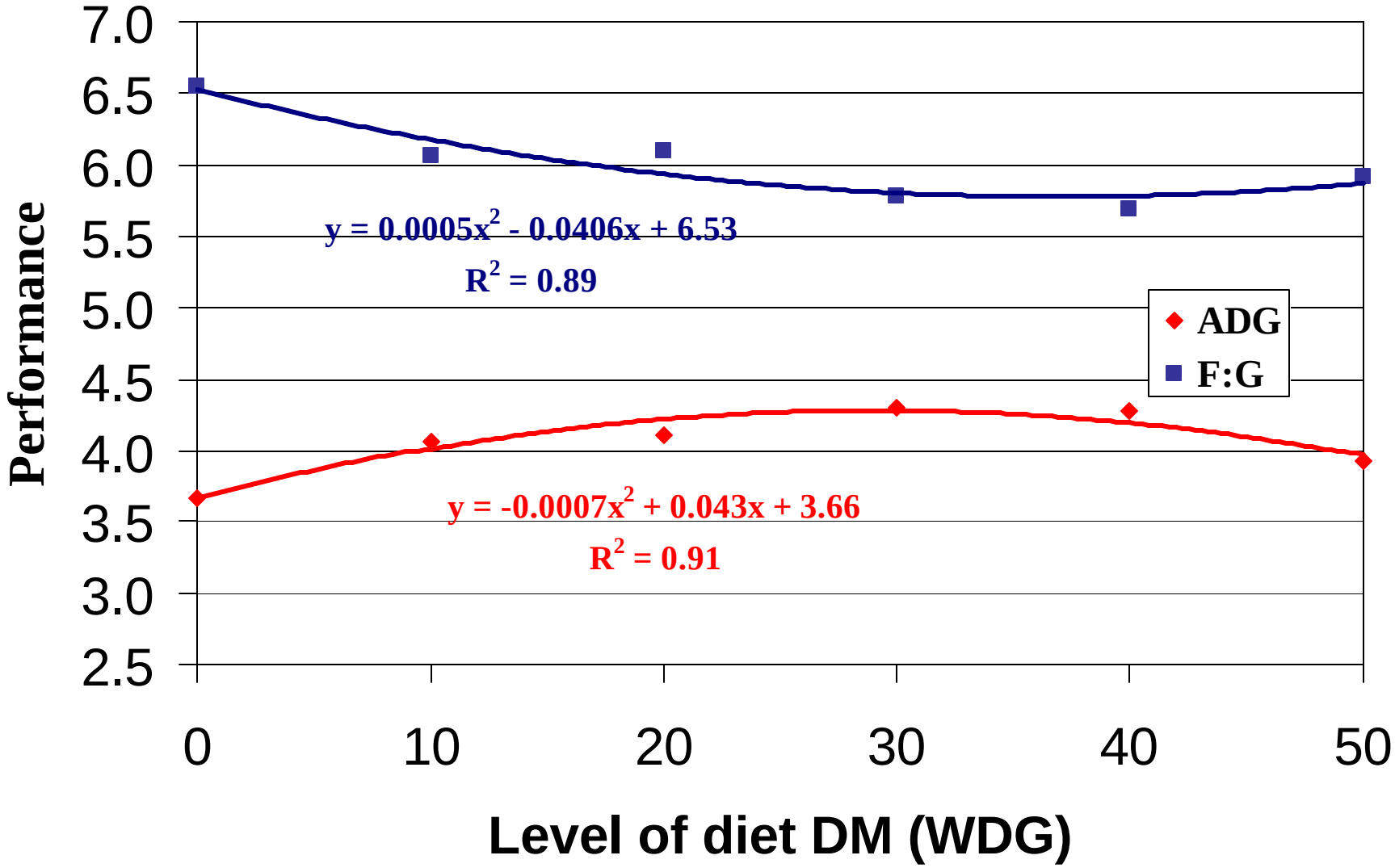

Corn
Beef
Ethanol

Ethanol Plants & Fed Cattle Population



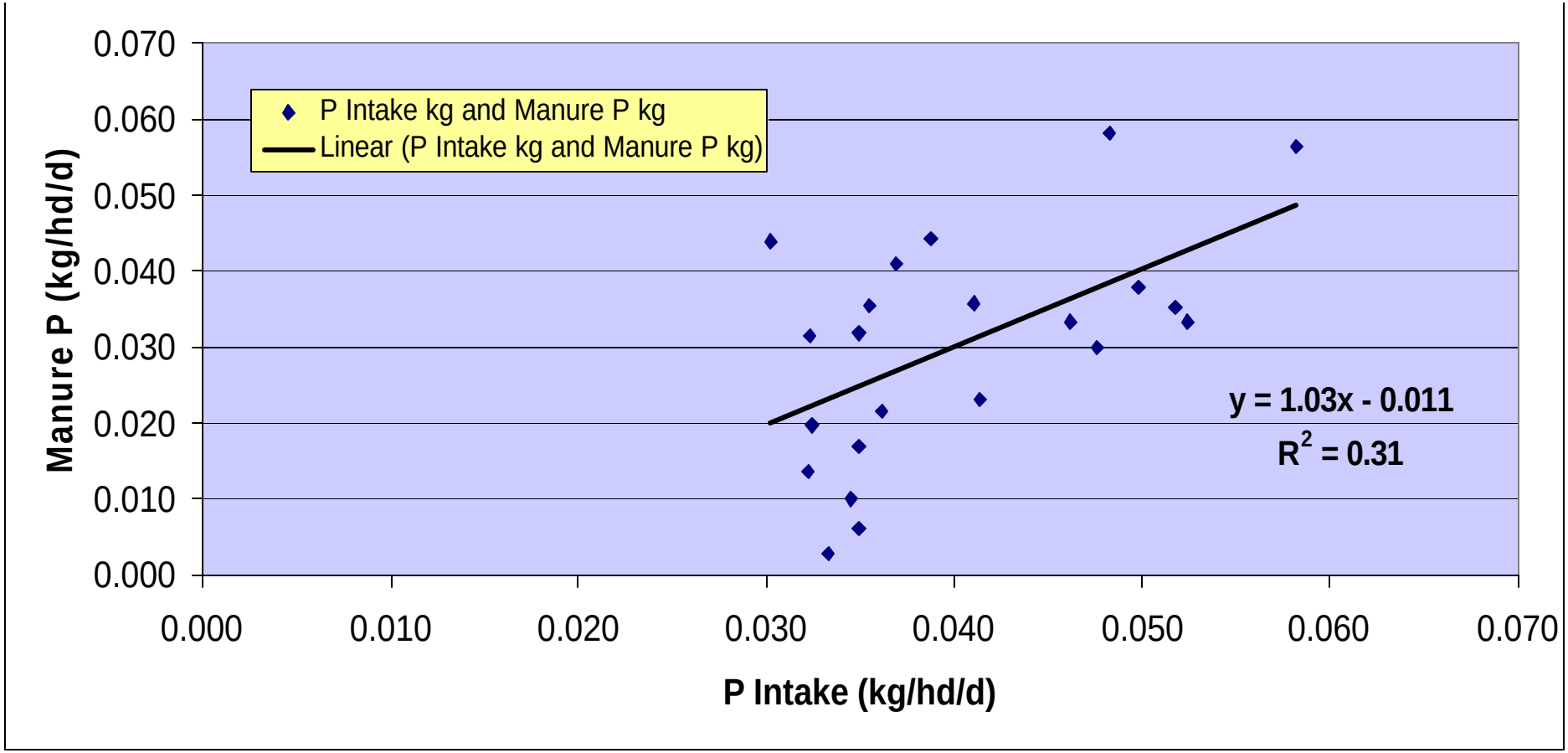
1 – Madrid
2 – Sutherland
3 – Trenton
4 – McCook
5 – Cambridge
6 – Lexington
7 – Minden
8 – Ravenna
9 – Hastings
10 – Aurora
11 – Central City
12 – York
13 – Columbus
14 – Norfolk
15 – Plainview

Utilization efficiency of co-products by beef cattle: (from Erickson and Klopfenstein)



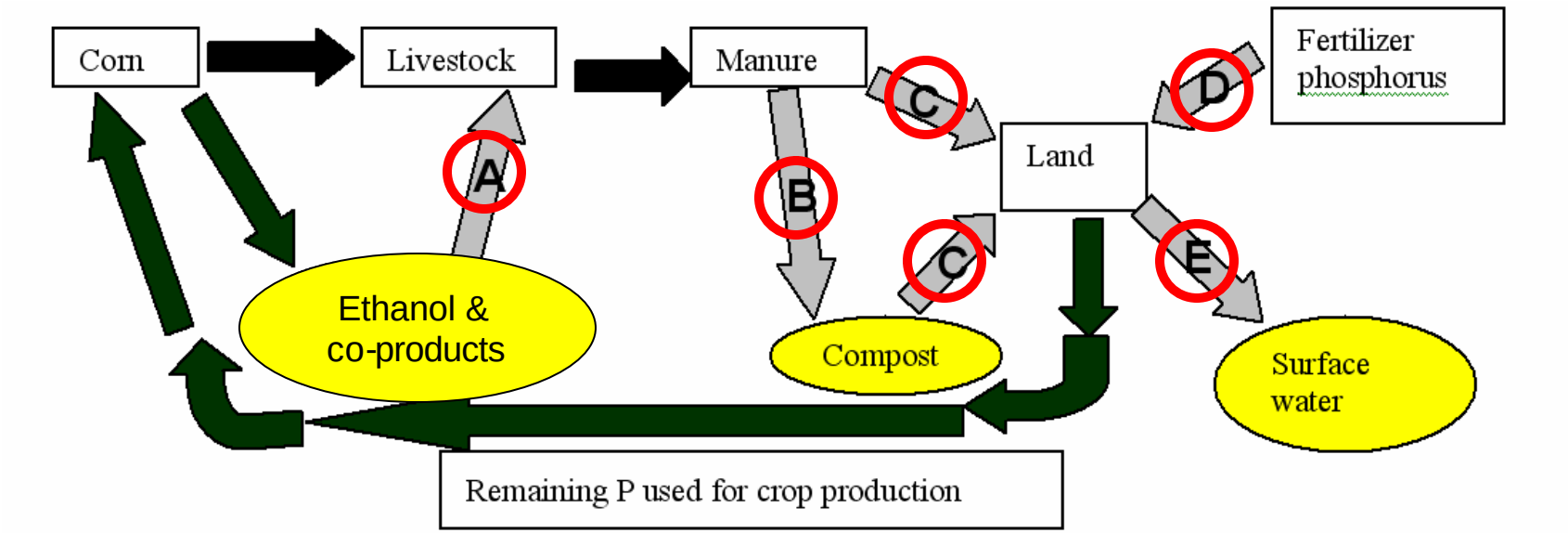
Vander Pol et al., 2006 Nebraska Beef Rep. and 2005 Midwest ASAS

Feeding co-products: P intake and excretion by beef cattle



Kissinger et al., 2006 NE Beef Report

P reduction project, Oct. 05 - 09: feeding beef a ration of 40% bi-products results in 100% more P excretion (and >75% more NH_3 volatilization)



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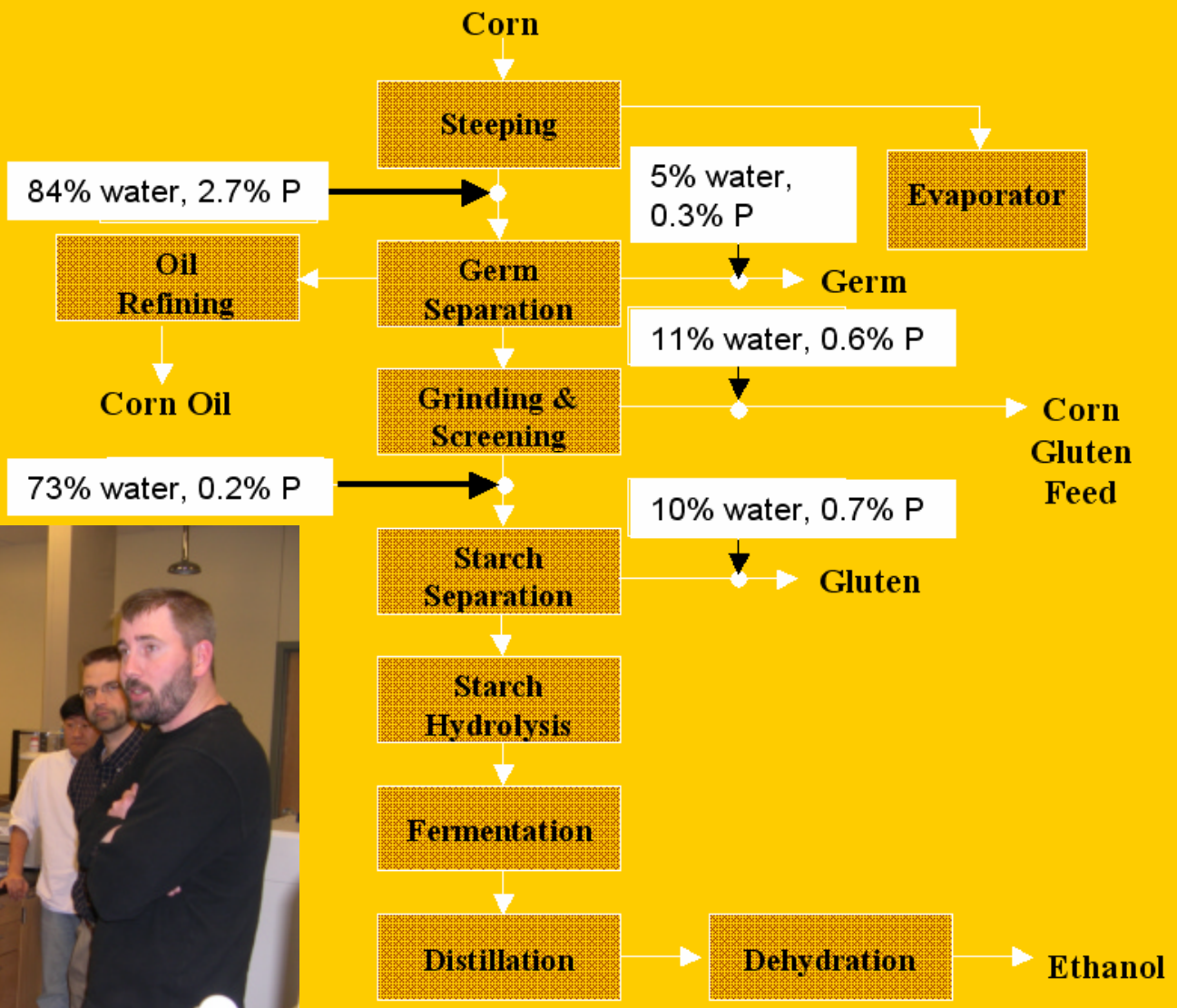
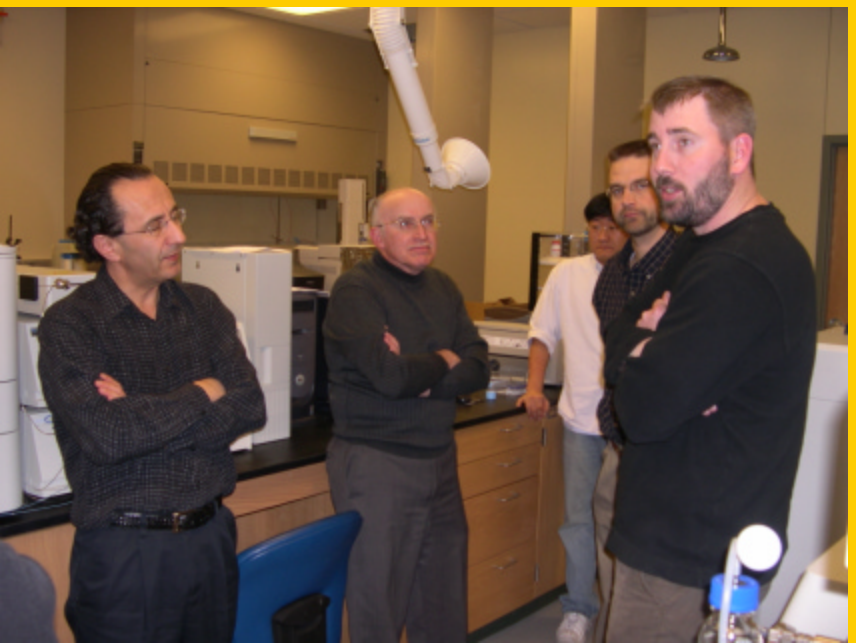
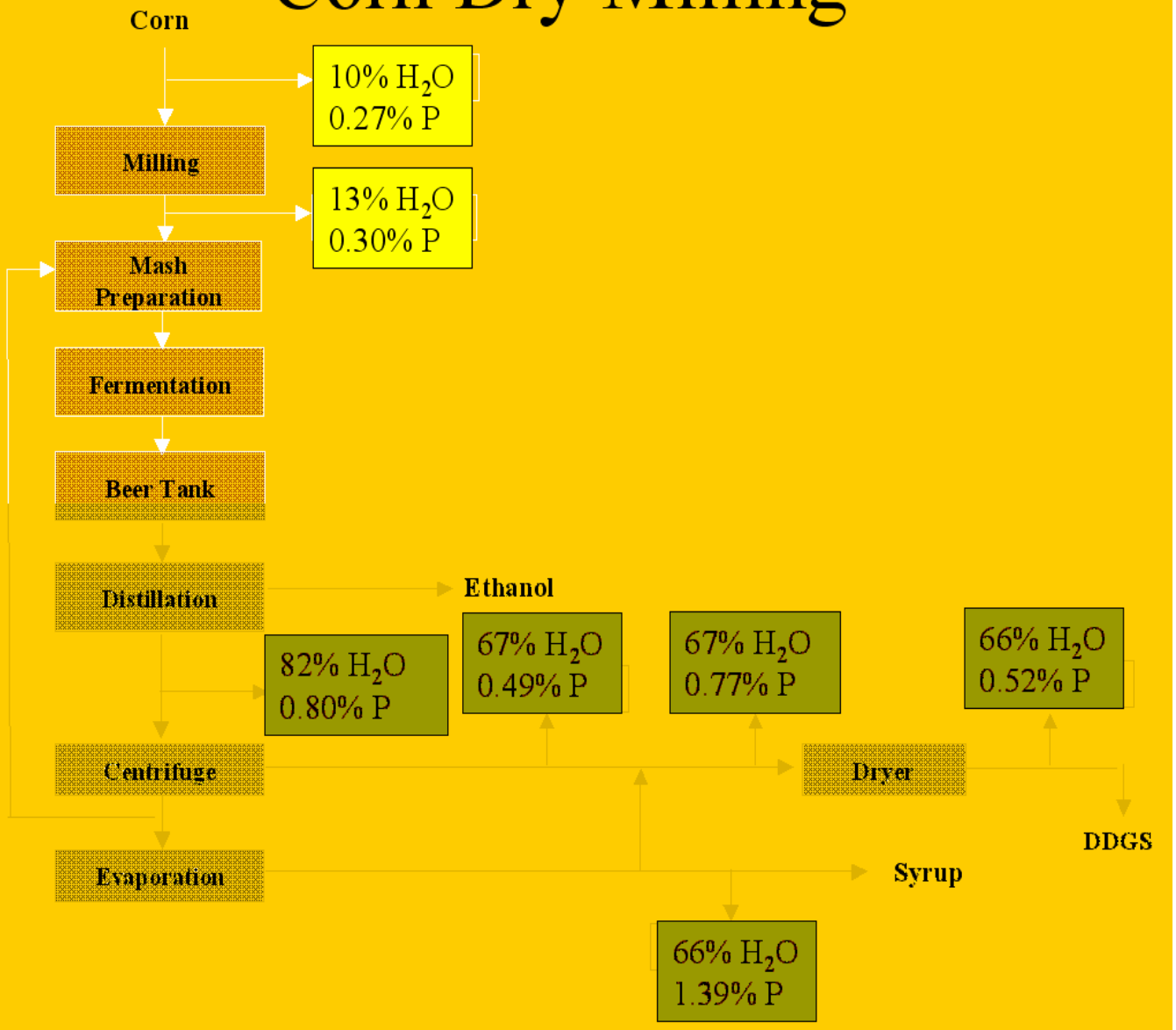
P removal from ethanol stream

Corn Wet Milling





Corn Dry Milling



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Composting vs. stock-piling feedlot manure

- Development of decision guide
  - ? To evaluate the economics of composting vs. stockpiling
  - ? Research on N loss with composting

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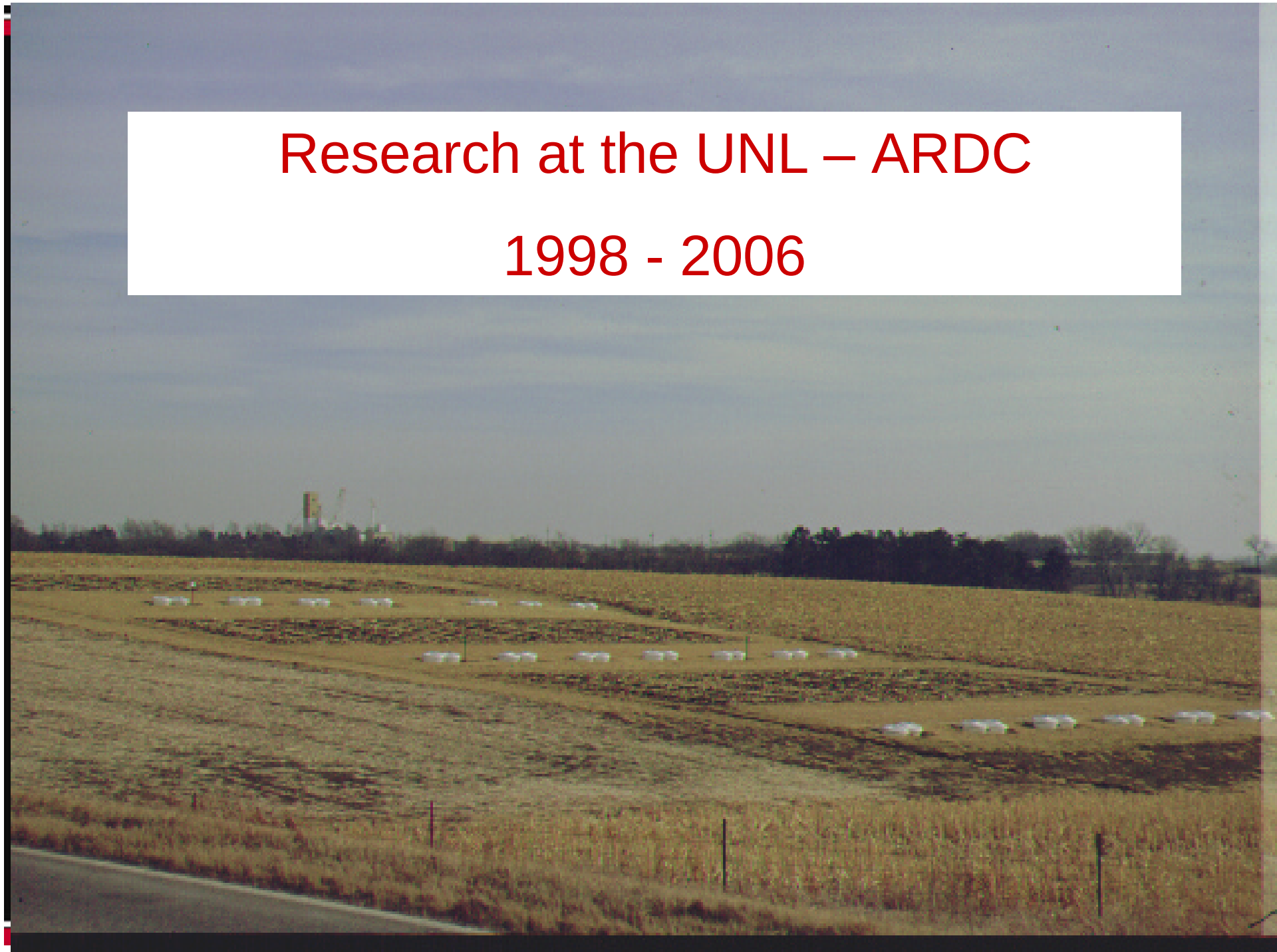
Research at the UNL – ARDC

1998 - 2006



Objectives

Determine the effects of composted manure application on runoff, sediment loss, and P loss

- During the years of application, 1998-2000
- The residual effects during 2000 to 2004
- **Residual effects during 2004 to 05 and effect of plowing extremely high P soil**
- **Residual effects in 2006 to 07 and effect of filter strips**

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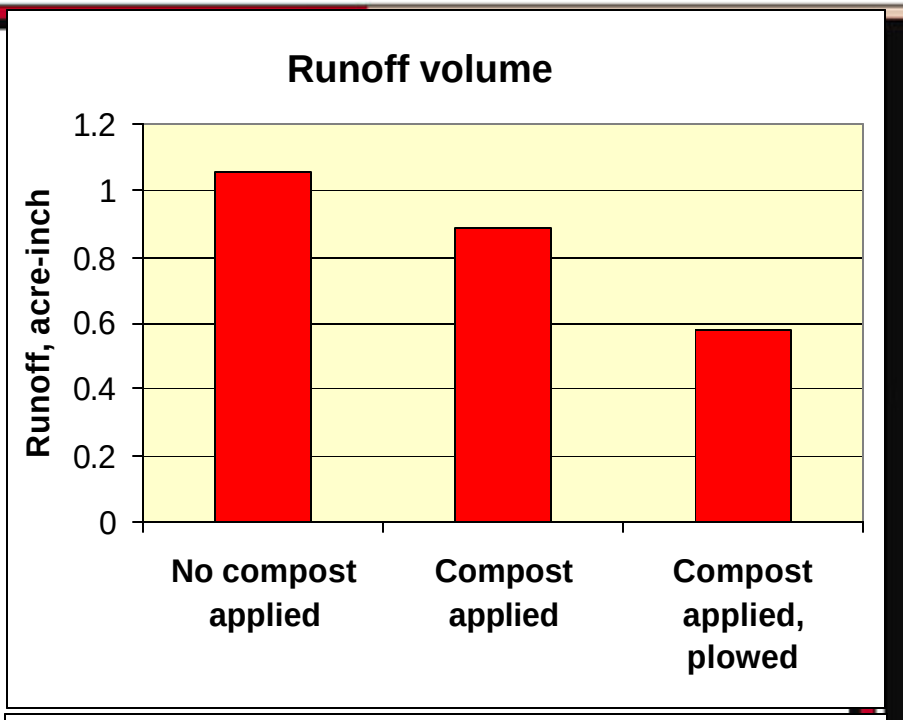
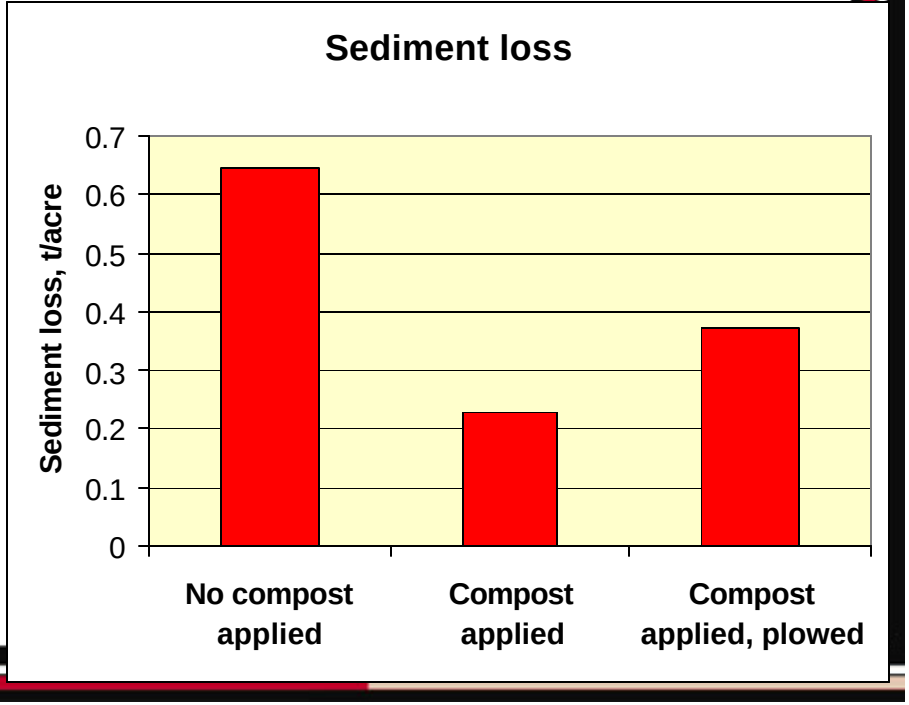
Procedure

- Seven treatments with various practices of applying composted feedlot manure
  - ? annually during 1998-2000
  - ? N basis for irrigated corn
  - ? 750 to 1150 kg ha^{-1} of P applied
- Some compost-applied plots were plowed to 20-cm depth in March 2004
- Other plots were not plowed to determine the residual effects 4-5 yr after application

Runoff and erosion: 04-05

- The residual effect of compost at 4 – 5 yr after application
  - ? Slightly reduced runoff
  - ? Greatly reduced erosion
- The effect of plowing
  - ? Reduced runoff
  - ? Some increase in sediment loss





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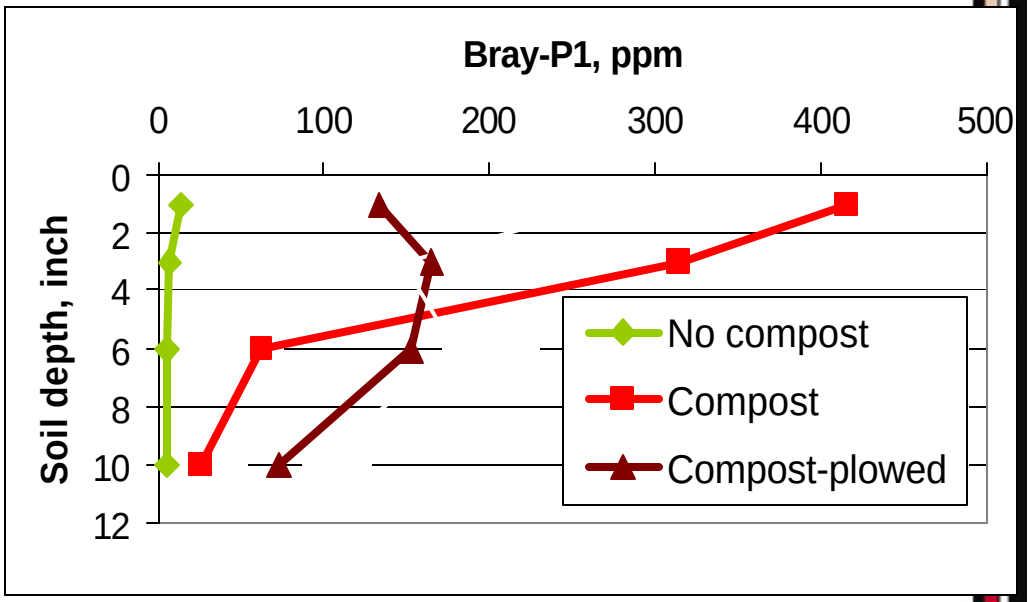
2004-05

- Soil P levels remained very high where compost had been applied 4 years before
- Plowing greatly reduced P at the soil surface.



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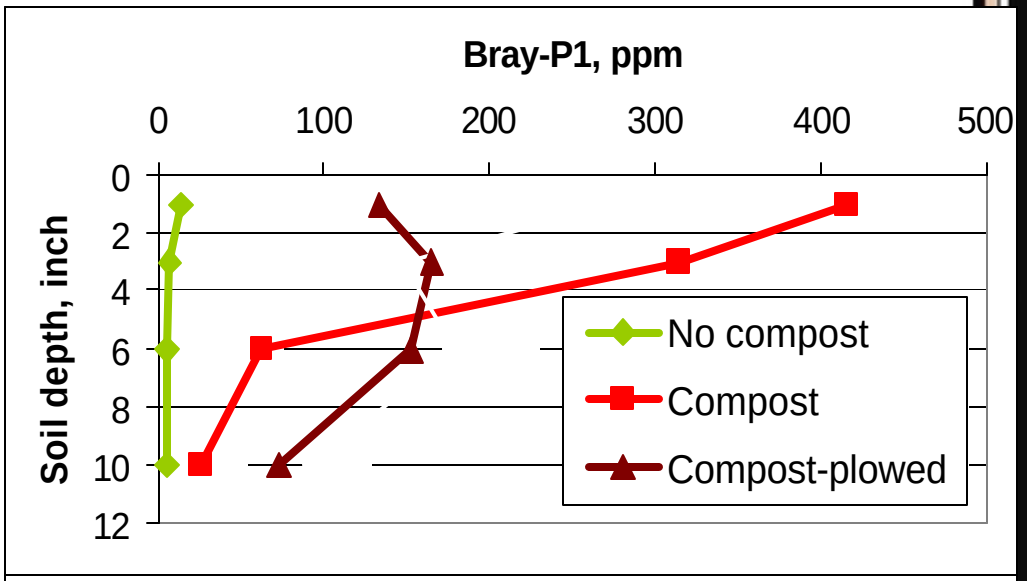

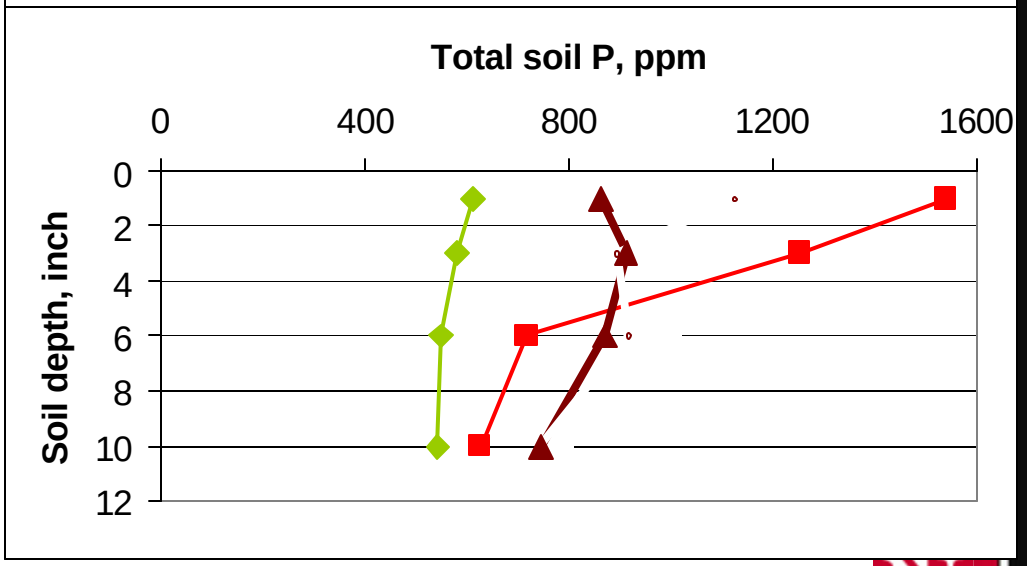

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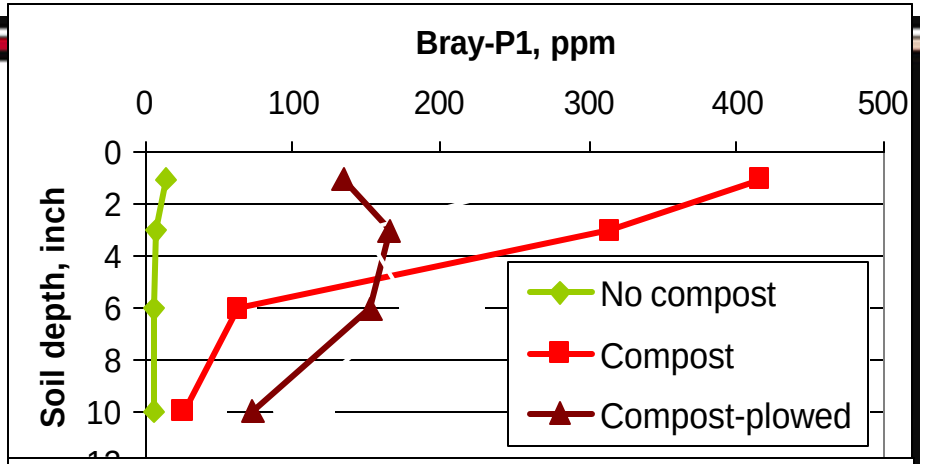

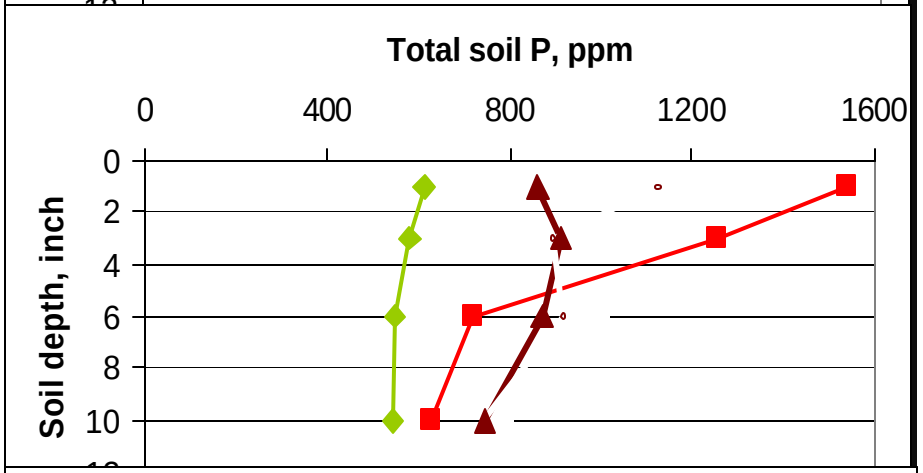

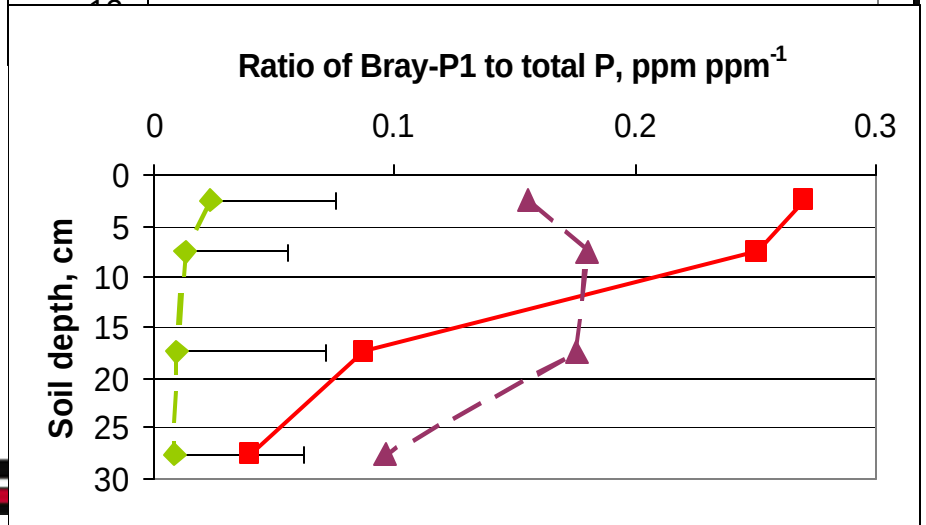

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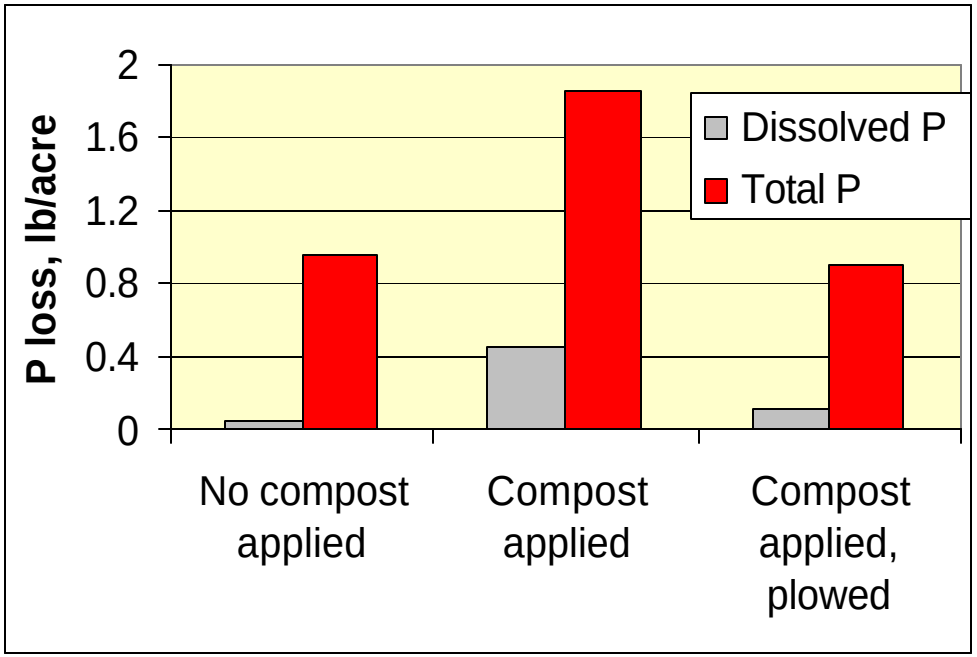
2004-05 P loss

- The residual effect of compost at 4 – 5 yr after application
  - ? Much more dissolved P loss
  - ? About 100% more total P loss
- The effect of plowing
  - ? Greatly reduced dissolved and total P loss



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Phase IV, 2006-2007

- Continued study of residual effects
- Vegetative filter strips occupying 1 or 4% of the plot area

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Summary

- For 5 yr after application, composted manure:
  - ? Reduced volume of runoff and erosion
  - ? Greatly increased soil test P
  - ? Increased runoff P loss

Summary

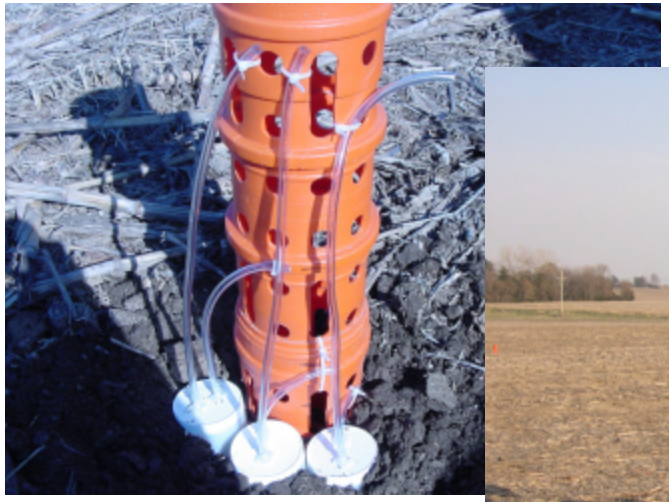
- For 5 yr after application, composted manure:
  - ? Reduced volume of runoff and erosion
  - ? Greatly increased soil test P
  - ? Increased runoff P loss
- Runoff P loss was more affected by change in erosion and runoff rates compared to soil test P

Summary

- Plowing soil with excessively high surface P reduced:
  - ? runoff with no increase in erosion;
  - ? P concentration in runoff; and
  - ? P loss.
  - ? However, erosion needs to be prevented.
- Well-placed vegetative filter strips occupying 1% of the land area are reducing runoff and P loss

Setback distance ….

- Effect of non-application (setback) distance to concentrated water flow.



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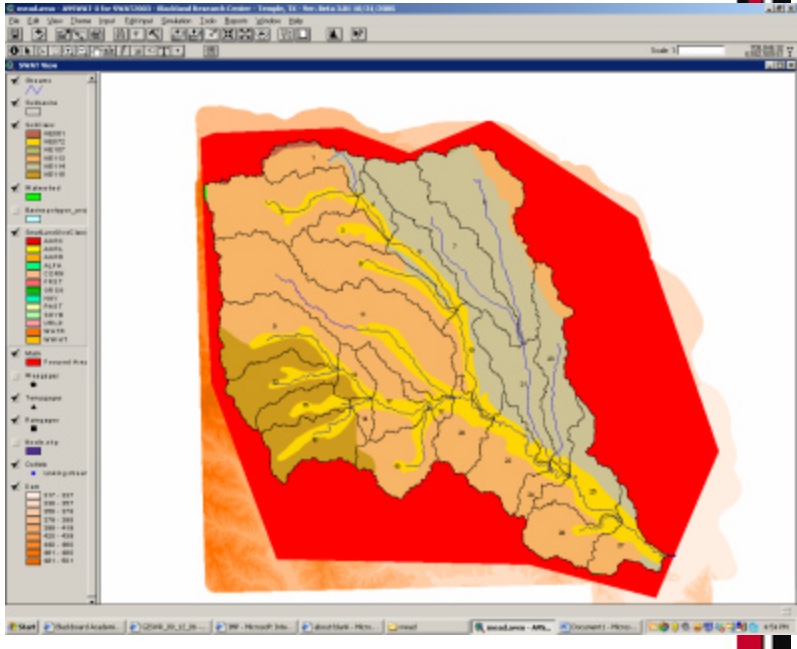
Watersheds: GIS and stakeholders

Link spatial modeling results with local knowledge

- ? Develop criteria for targeting of P BMPs in landscapes
- ? GIS linked with simple tools (e.g. RUSLE1, modified P index) for field-level use by stakeholder groups



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Extension component

- The research planning had much input from extension
- Complementary efforts disseminating information as it develops
- Project supported extension to be developed as more results and decision tool become available
  - ? Ethanol industry
  - ? Livestock feeders
  - ? Crop producers

Thank you!
Questions?

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