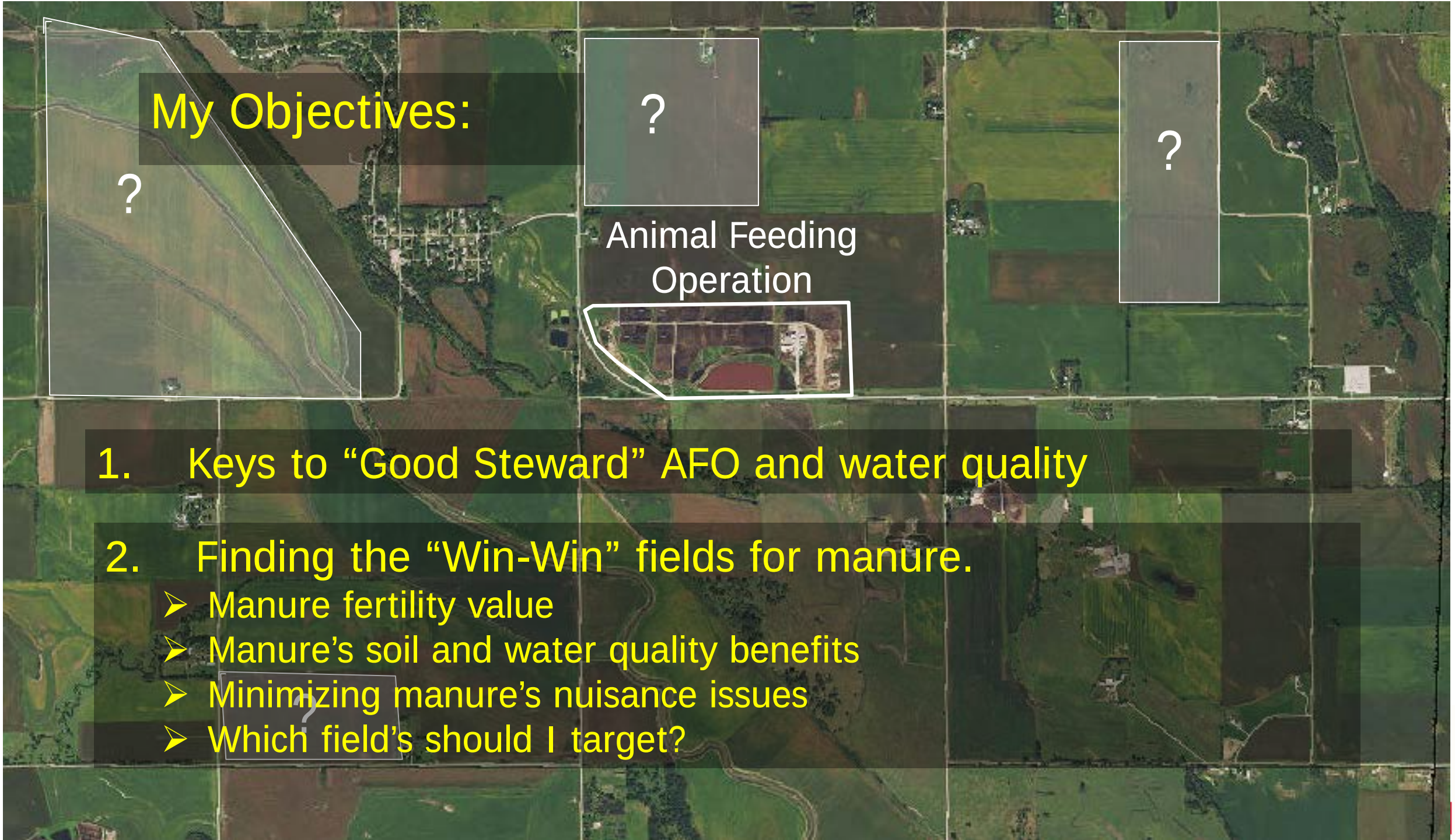
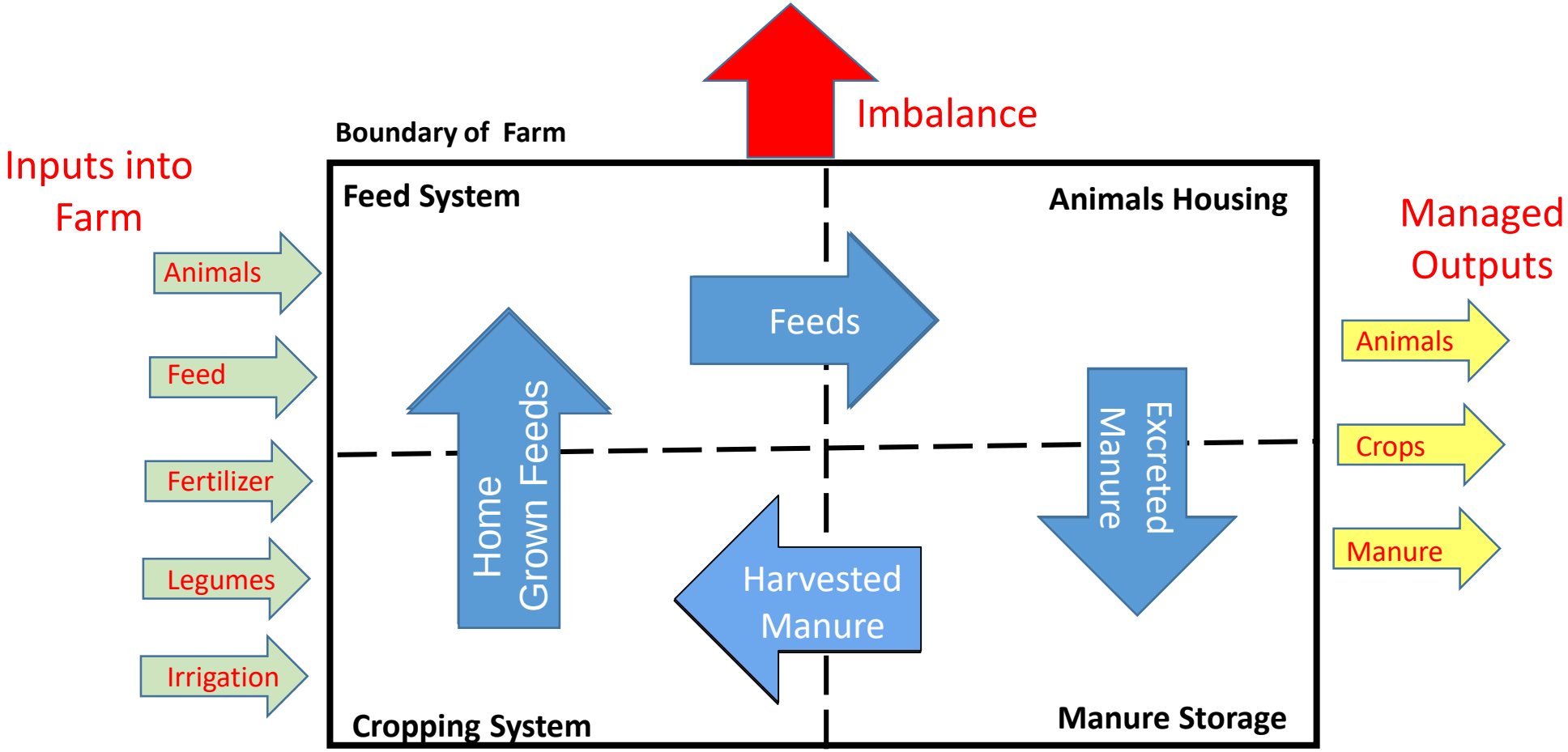
Transforming Manure from "Waste" to "Worth":

NRCS Understanding Organic Agriculture, February 6, 2019

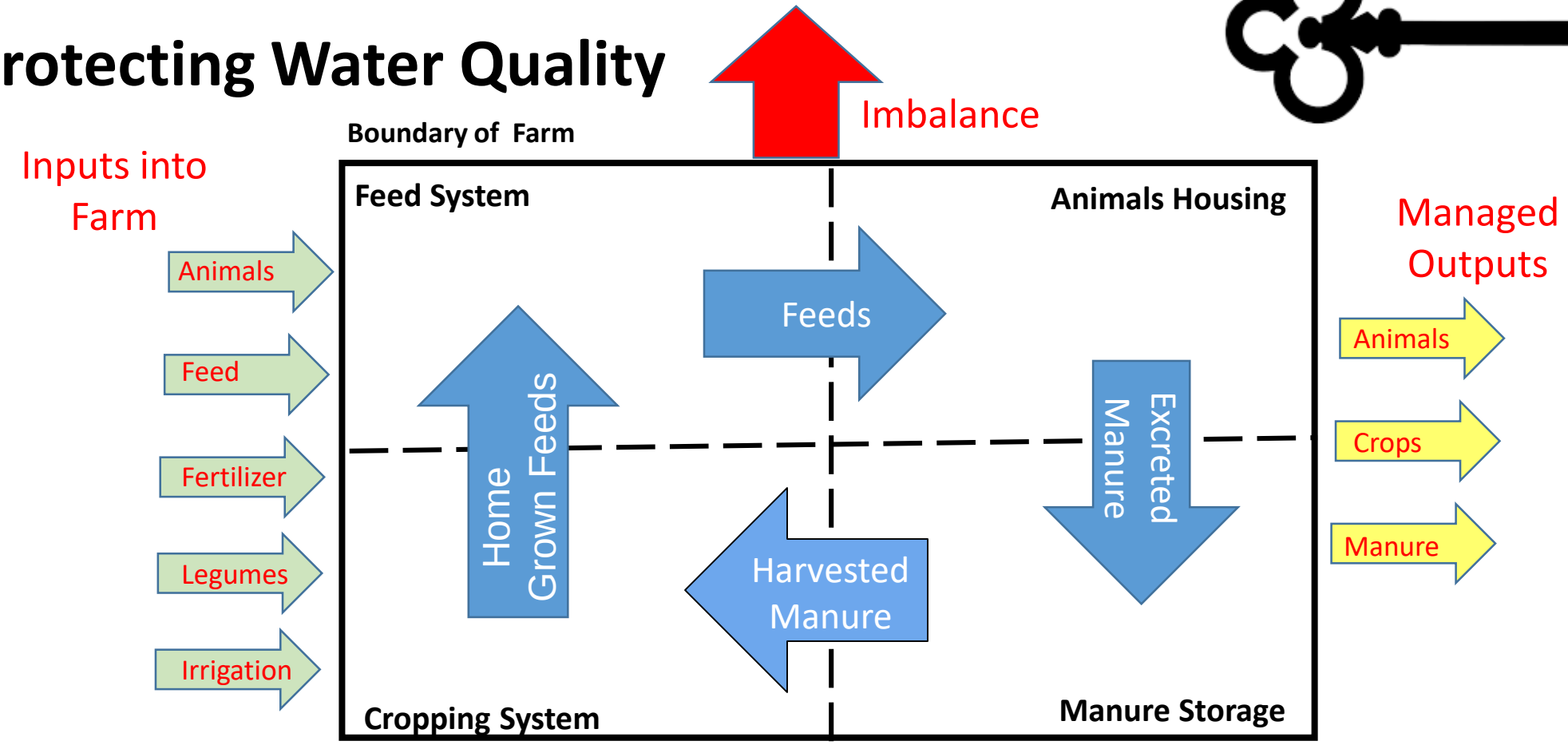
Rick Koelsch
Biological Systems Engineering & Animal Science Department
University of Nebraska - Lincoln


My Objectives:
?
?
?
Animal Feeding Operation
1. Keys to “Good Steward” AFO and water quality
2. Finding the “Win-Win” fields for manure.
Manure fertility value
Manure’s soil and water quality benefits
Minimizing manure’s nuisance issues
Which field’s should I target?

Flows of N and P on an Animal Feeding Operation



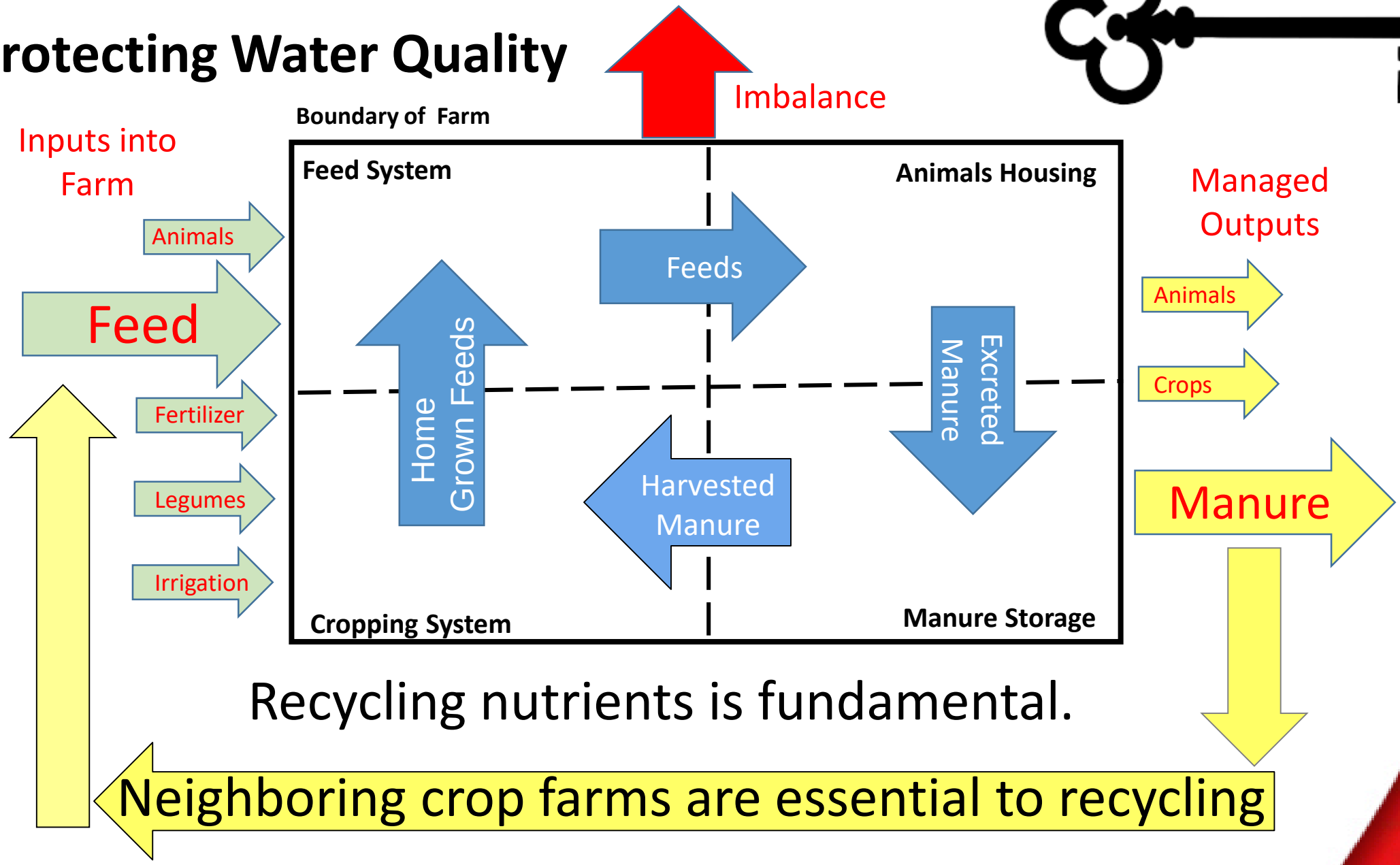
First Key to "Good Steward" AFO & Protecting Water Quality



Recycling nutrients (including manure nutrients) is fundamental.

Smaller AFOs: Focus on Internal Recycling

First Key to "Good Steward" AFO & Protecting Water Quality



Second key to “Good Steward” AFO and protecting water quality

Utilize local manure nutrients in crop production systems prior to importing outside nutrients!

Lesson #1: Origin of "Sh__"

Stow High In Transport

Manure's Value to Crop Farmer…

- Fertility value…
- Soil health value…
- Potential to increase yield

Manure's Fertility Benefit

- Organic Nitrogen
  - Slow release N available as soils warm
- Ammonium – N
  - Soil incorporation is essential to conserve
  - Readily available to plant
- Phosphorus
  - Not mobile if erosion is controlled
- Potassium & micro-nutrients

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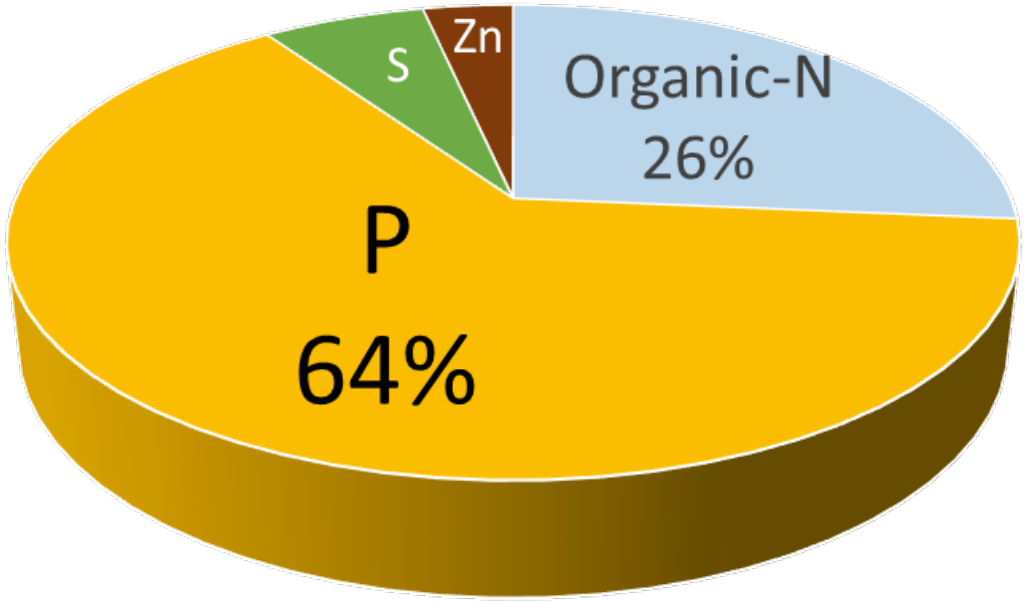
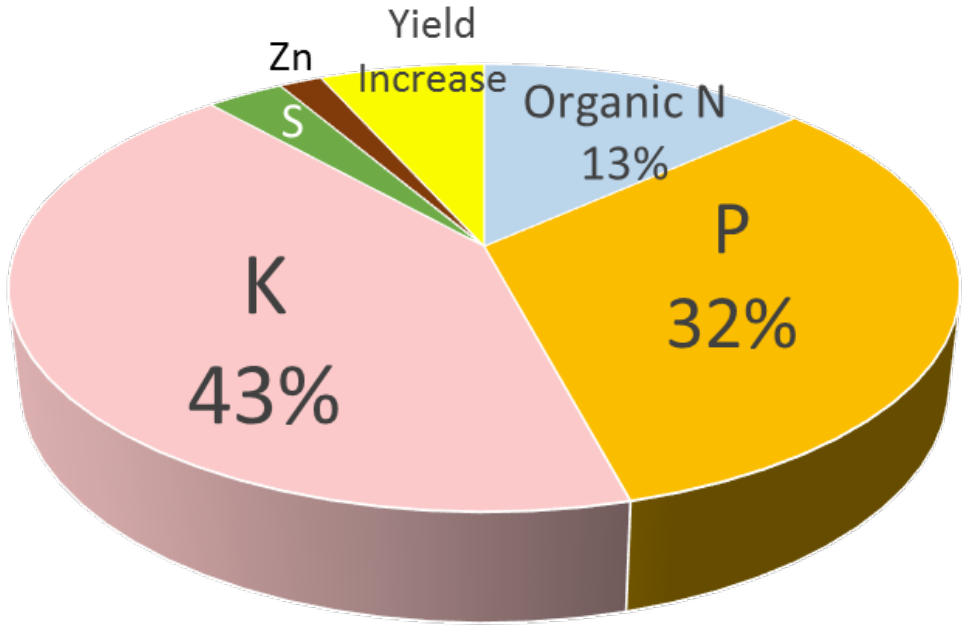
$ Value/ton ???

Nutrient Value of Beef Feedlot Manure

Lower Estimate[1]
$ 14 per ton



Higher Estimate[2]
$28 per ton



1. 2017 fertilizer prices

2. 2017 fertilizer prices + value for potash + 5% yield increase

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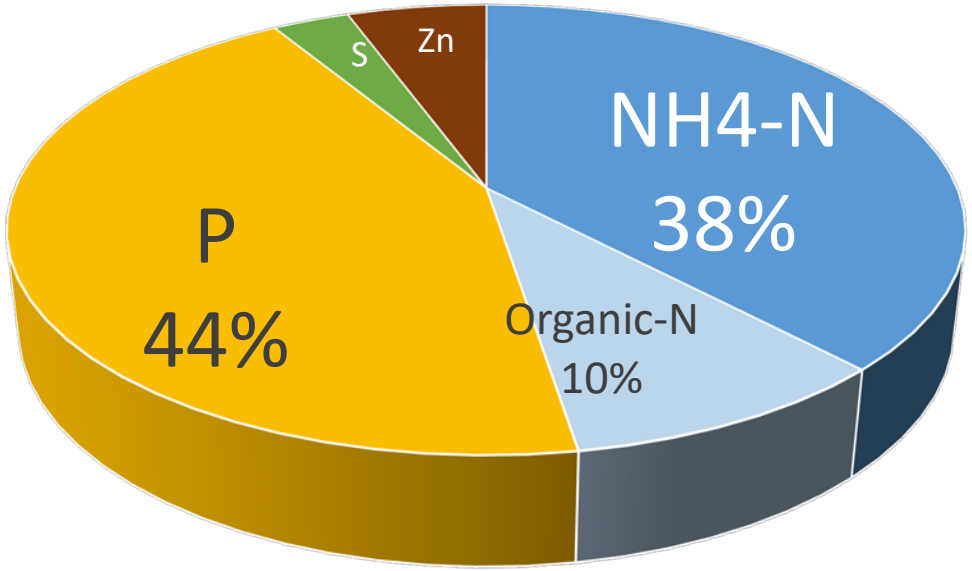
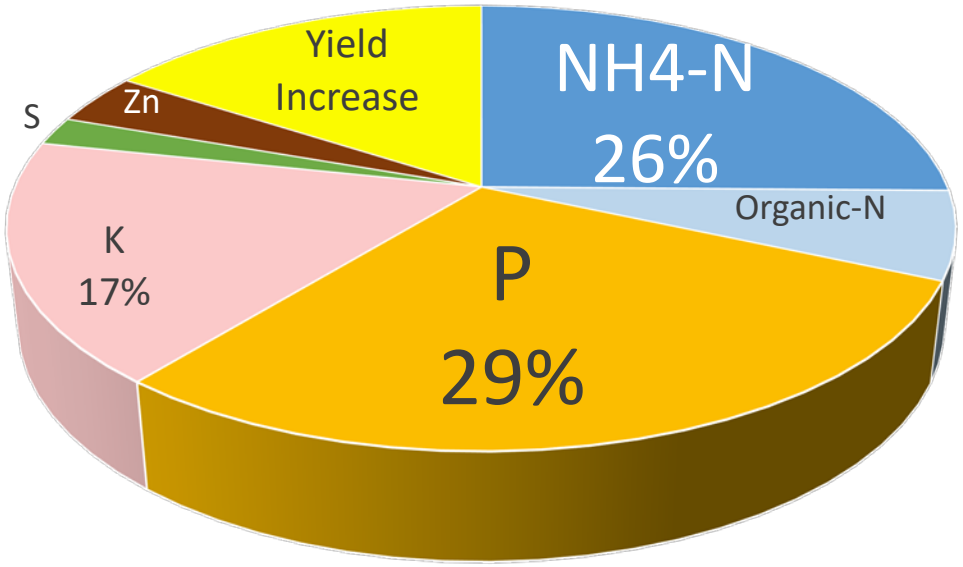
Nutrient Value of Swine Slurry

Lower Estimate[1]
$19 per 1,000 gal.



Higher Estimate[2]
$39 per 1,000 gal.



1. 2017 fertilizer prices

2. 2017 fertilizer prices + value for potash + 5% yield increase

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Which Fields Benefit Most From Manure?

Threshold Soil Test Levels for Recommending Broadcast P & K…

Crop	P	K
Corn	20 ppm	125 ppm
Soybeans	12 ppm	125 ppm
Wheat	30 ppm	125 ppm

Which Fields Win from Manure's Fertility Value?

Which Fields Win from Manure's Fertility Value?

Phosphorus. Target fields/crops:

- With < 20 PPM P Bray
- Benefitting from higher soil P requirements such as wheat
- With higher P uptake (corn silage, irrigated alfalfa)

Most manure applications deliver P needs for multiple years - Delay returning to the same field.

Which Fields Win from Manure's Fertility Value?

Next,
target fields/crops needing:

- Potassium
- Nitrogen (apply ahead of non-legume crops)

Manure benefits “Soil Health”

Manure improves soil physical properties and biological properties.

Soil photo courtesy of USDA NRCS Soil Health flickr collection.

Manure effects on soil organisms and soil quality

Authors:

- Elizabeth Graham, Michigan State University Department of Crop and Soil Sciences
- Stuart Grandy, Michigan State University Department of Crop and Soil Sciences

OVERVIEW:

Soil quality was first defined by the Soil Science Society of America in 1997 as "the capacity of a specific kind of

"When manure … is added to the soil it is quickly colonized by millions of bacteria…bacteria producing large quantities of polysaccharides. These polysaccharides function like sticky glue in the soil and can actually stick particles together into aggregates."

cal characteristics that determine soil quality include: mobilization of nutrients, microbial and enzyme activity, effects of soil fauna and suppression of plant disease. Physical characteristics include aggregate structure, poros-

for the variety of ways soils respond to manure additions. Studies have shown that adding organic amendments such as manure results in increased microbial biomass (soil bacteria and fungi) and

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a key role
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mineralize the organic nitrogen (N) and phosphorus (P) contained in manures into plant-available inorganic forms.

Soil enzymes are also crucial to nutrient cycling and the decomposition of soil

Organic matter value of manure

Manure

Soil Microbial Activity

Infiltration

Runoff

Erosion

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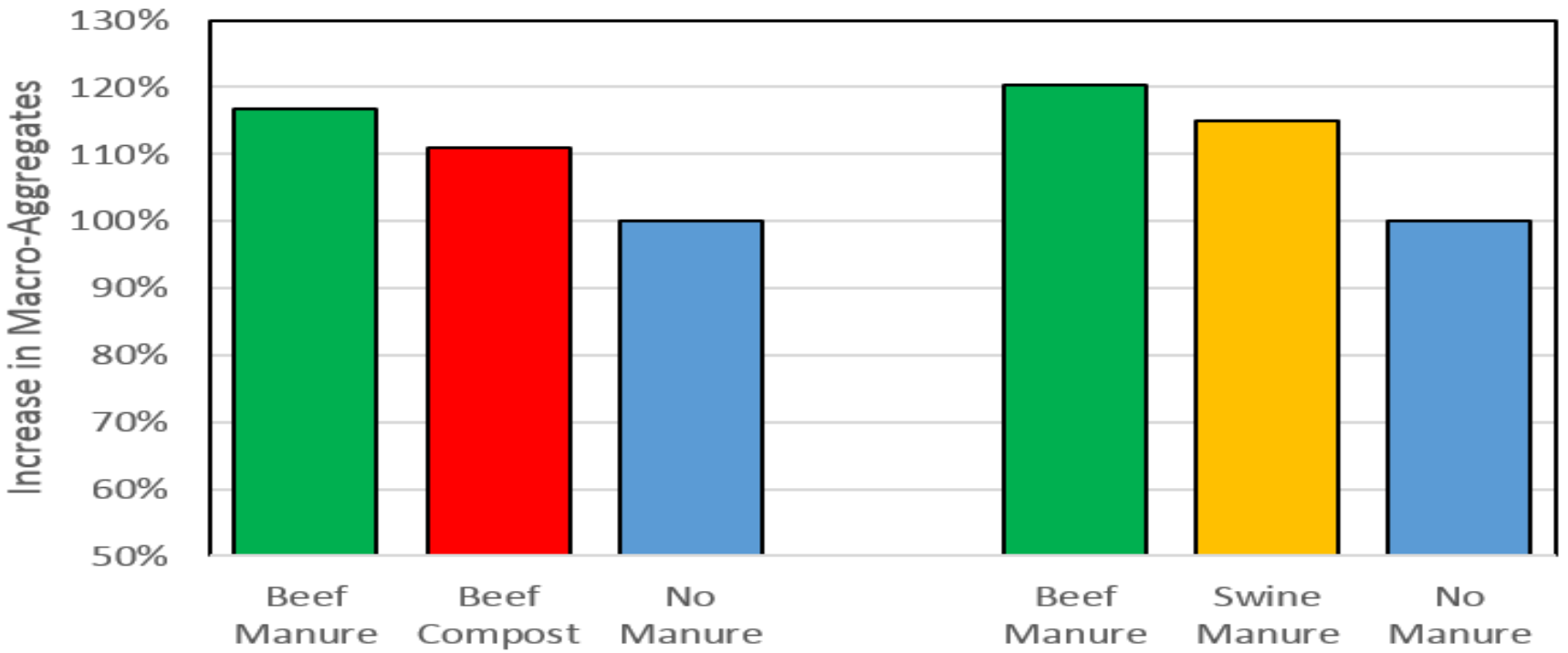
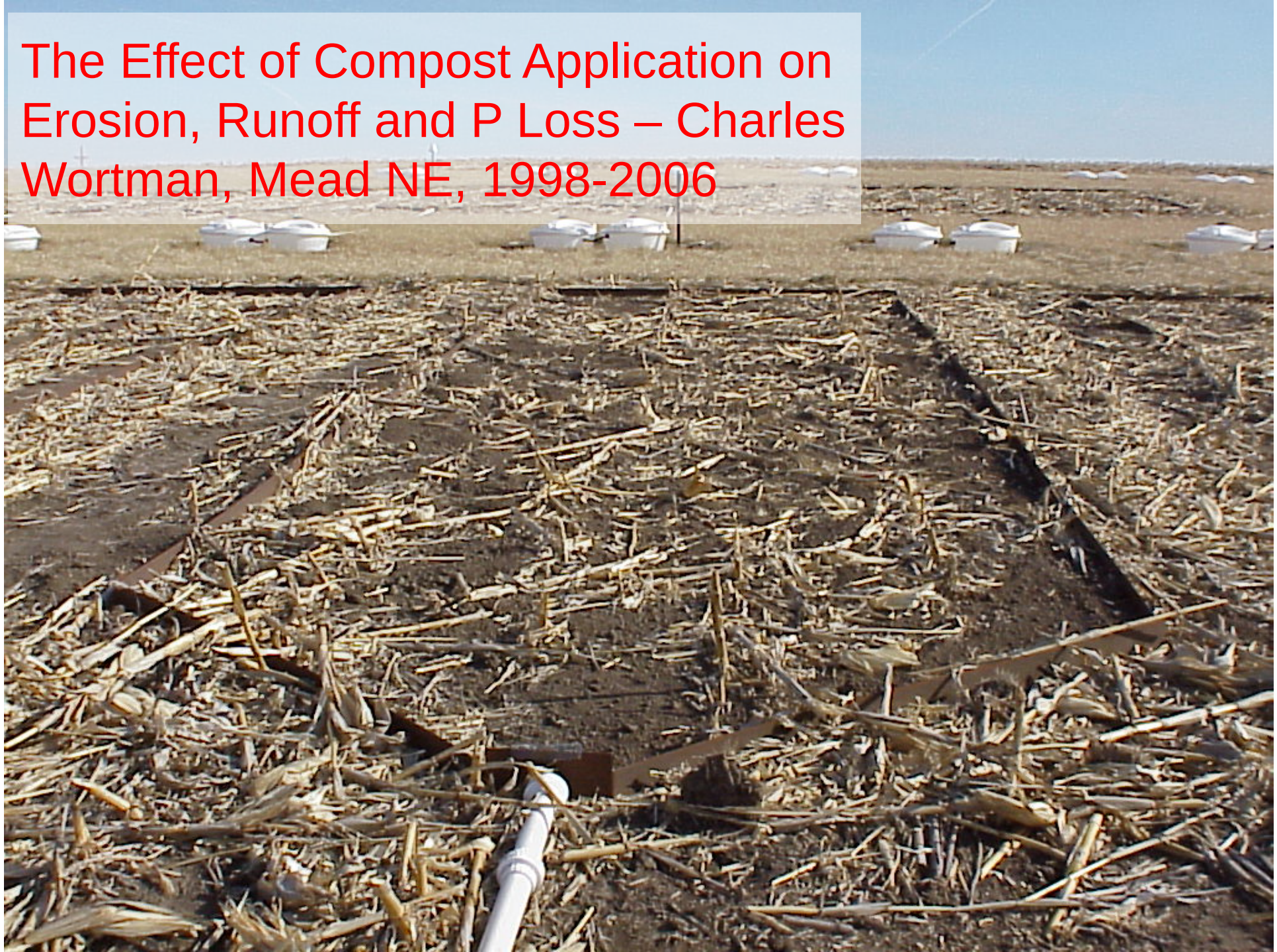
Conclusions from Wortmann & Shapiro research in Nebraska:

1. All manures increased macro-aggregates.
2. Aggregates form quickly & persist through crop season.

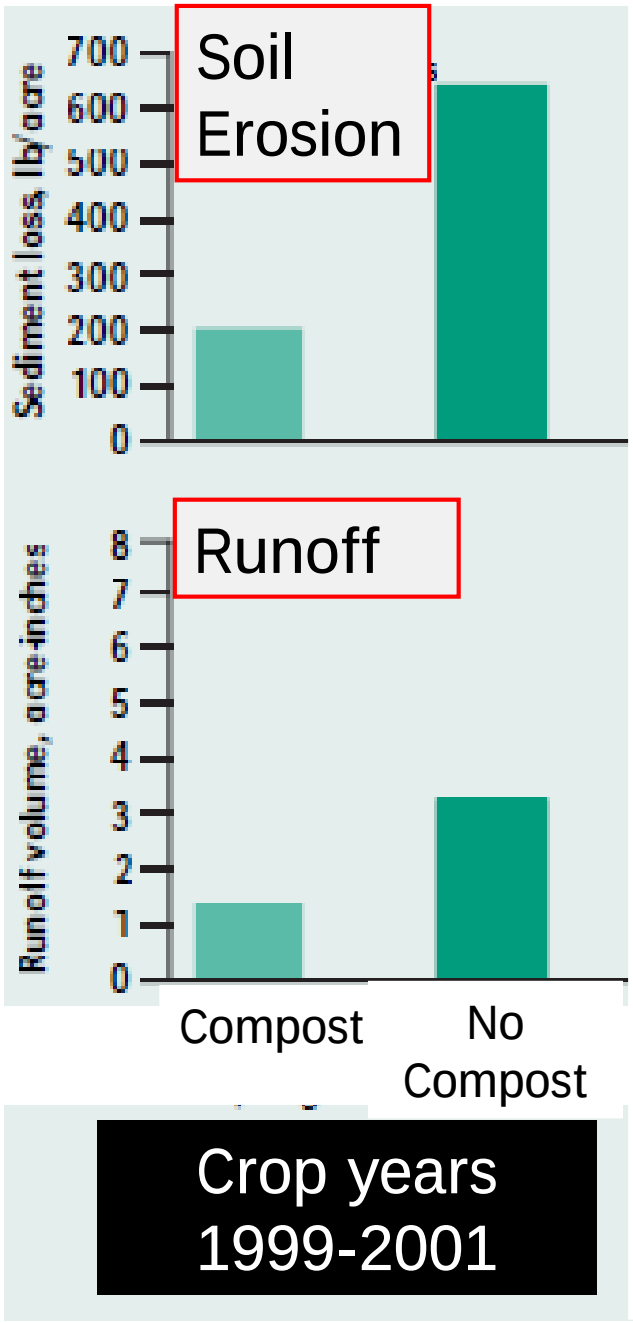


The Effect of Compost Application on Erosion, Runoff and P Loss – Charles Wortman, Mead NE, 1998-2006



Impact of Compost on Runoff and Erosion

- Composted feedlot manure;
- Applied - 1998, 1999, 2000 at crop N rate.



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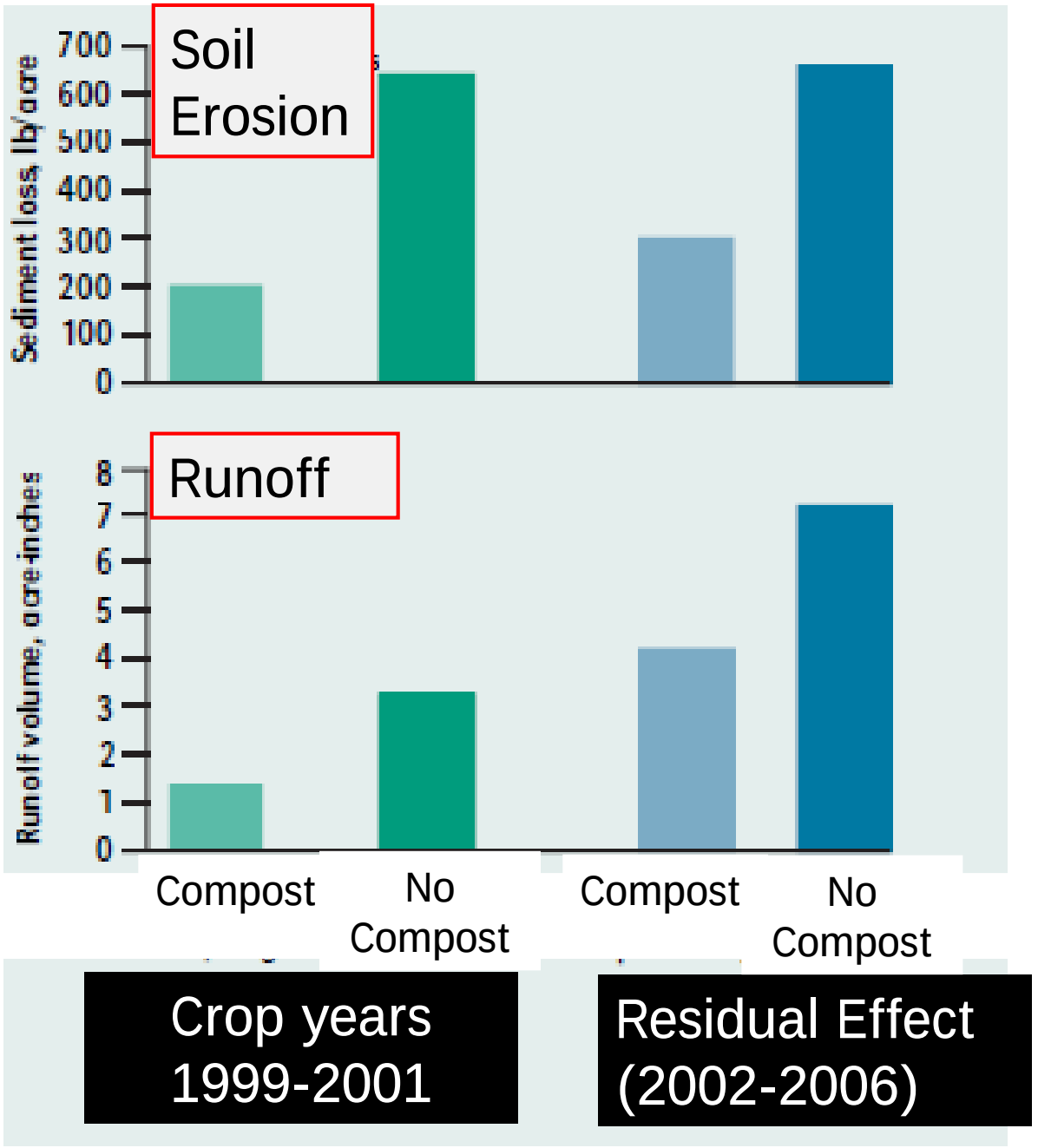


Which Fields Win from Manure's Organic Value?

Target Fields with:

- Finer texture soils.
- Lower organic matter.
- Crusting
- Low biological activity - earthworms
- Fields commonly experiencing ponding and drown out.

Additional Benefits of Manure

Feedlot Manure typically produces liming effect:

- Bauer; Eghball et al.

Treatment	0-2"	2-4"
	Soil pH	
Compost	7.4	6.9
No compost	5.8	5.5

Additional Benefits:

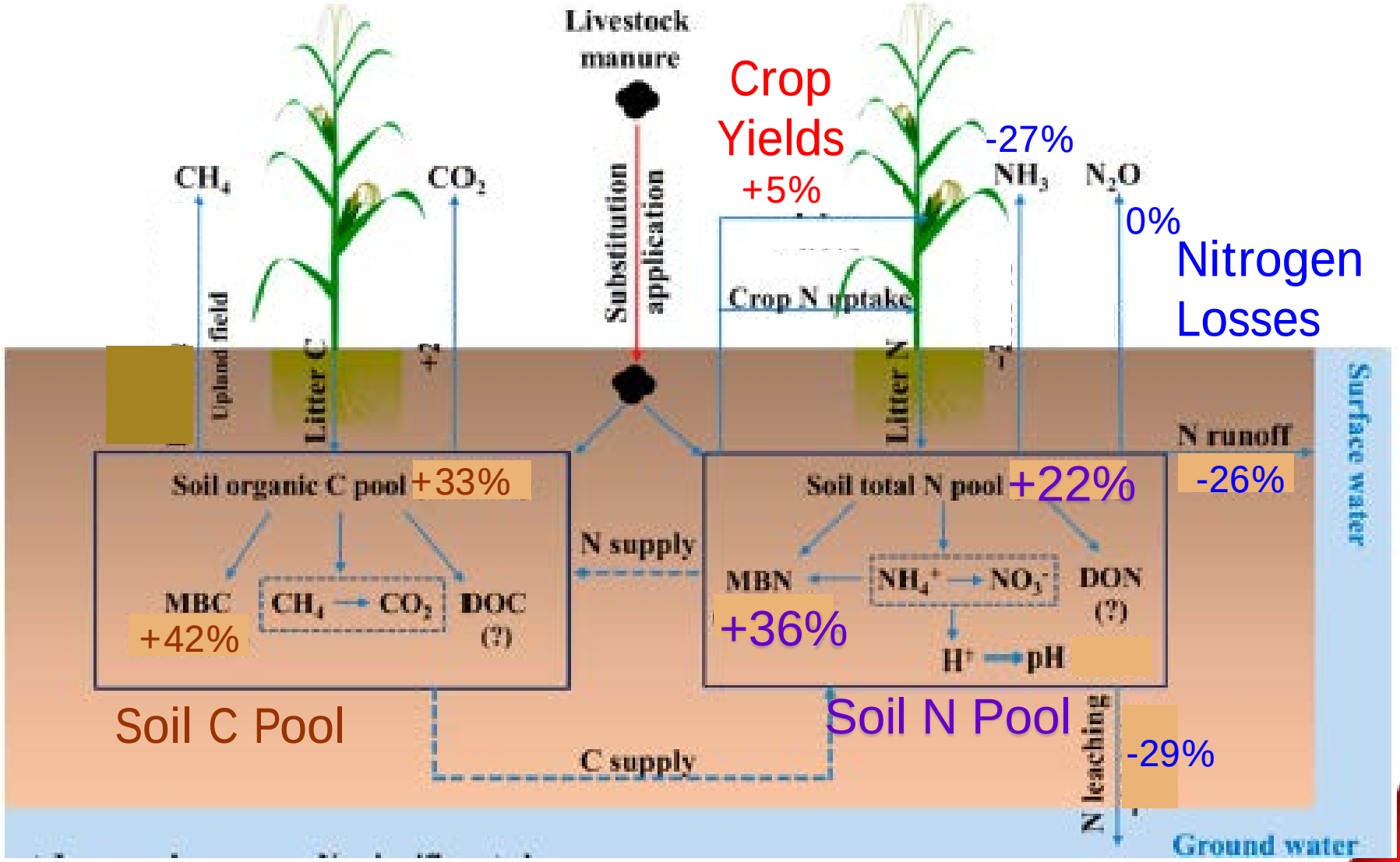
- > diversity of soil organisms
- > nutrient cycling
- > disease suppression

Manure's Value: Summary of 141 Studies Reviewing Substitution of Manure for Fertilizer:

L. Chen, et al. 2017. How Does Recycling of Livestock Manure in Agroecosystems Affect Crop Productivity, Reactive Nitrogen Losses, and Soil Carbon Balance? Environmental Science & Technology.

MBC:
Microbial Biomass Carbon

MBN:
Microbial Biomass Nitrogen



Achieving Win/Win?

Use where value is given to P first, then fields benefitting from K and/or N.

Recognize value of manure's organic matter and fields that will benefit.

Minimize Neighbor Concerns

Odor Nuisances

What conditions cause a smoke plume to:

- Rise and disperse?
- Hang near ground level?

Same conditions cause odors to disperse or remain near ground level.

Importance of Wind Direction

Edge of field and direction of wind define the edges of the odor plume

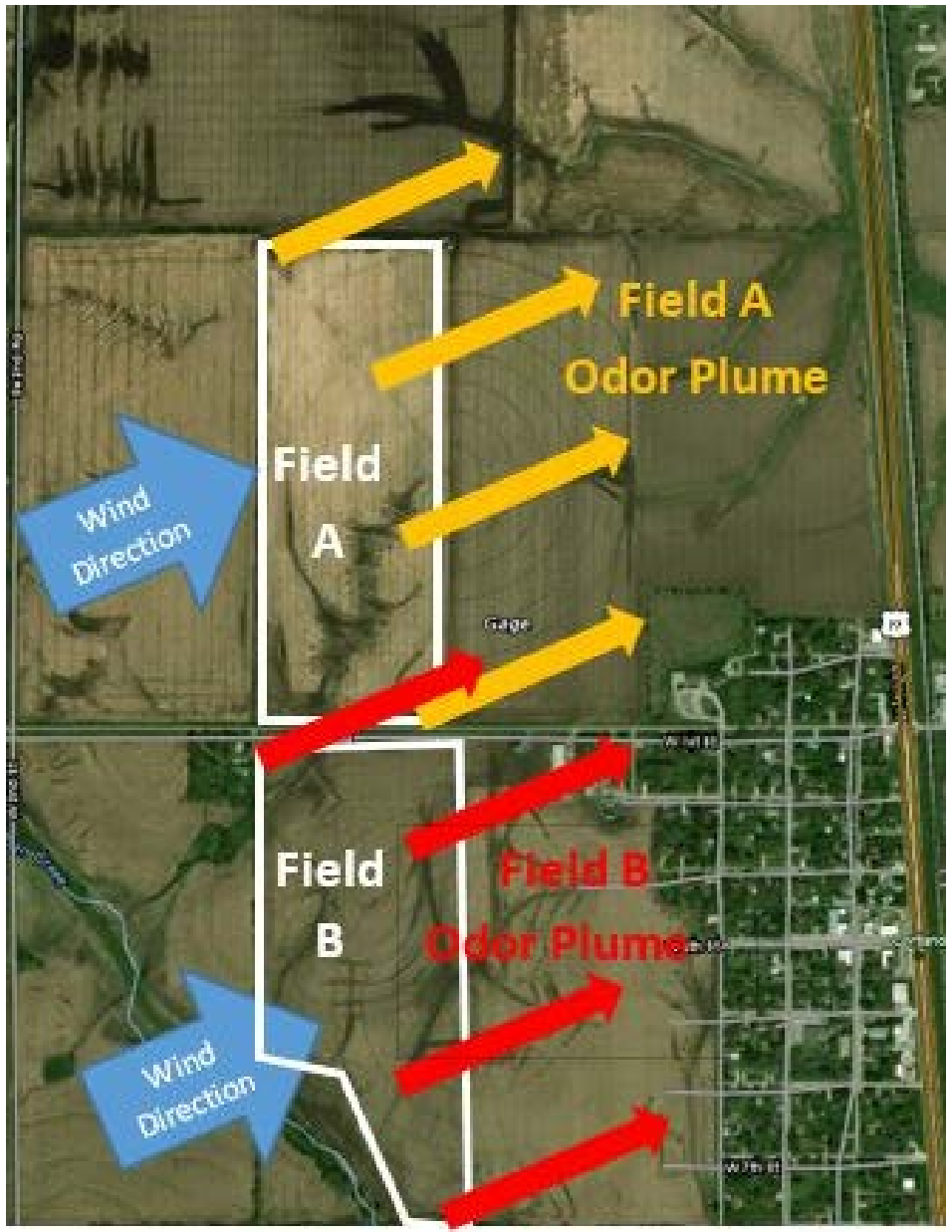
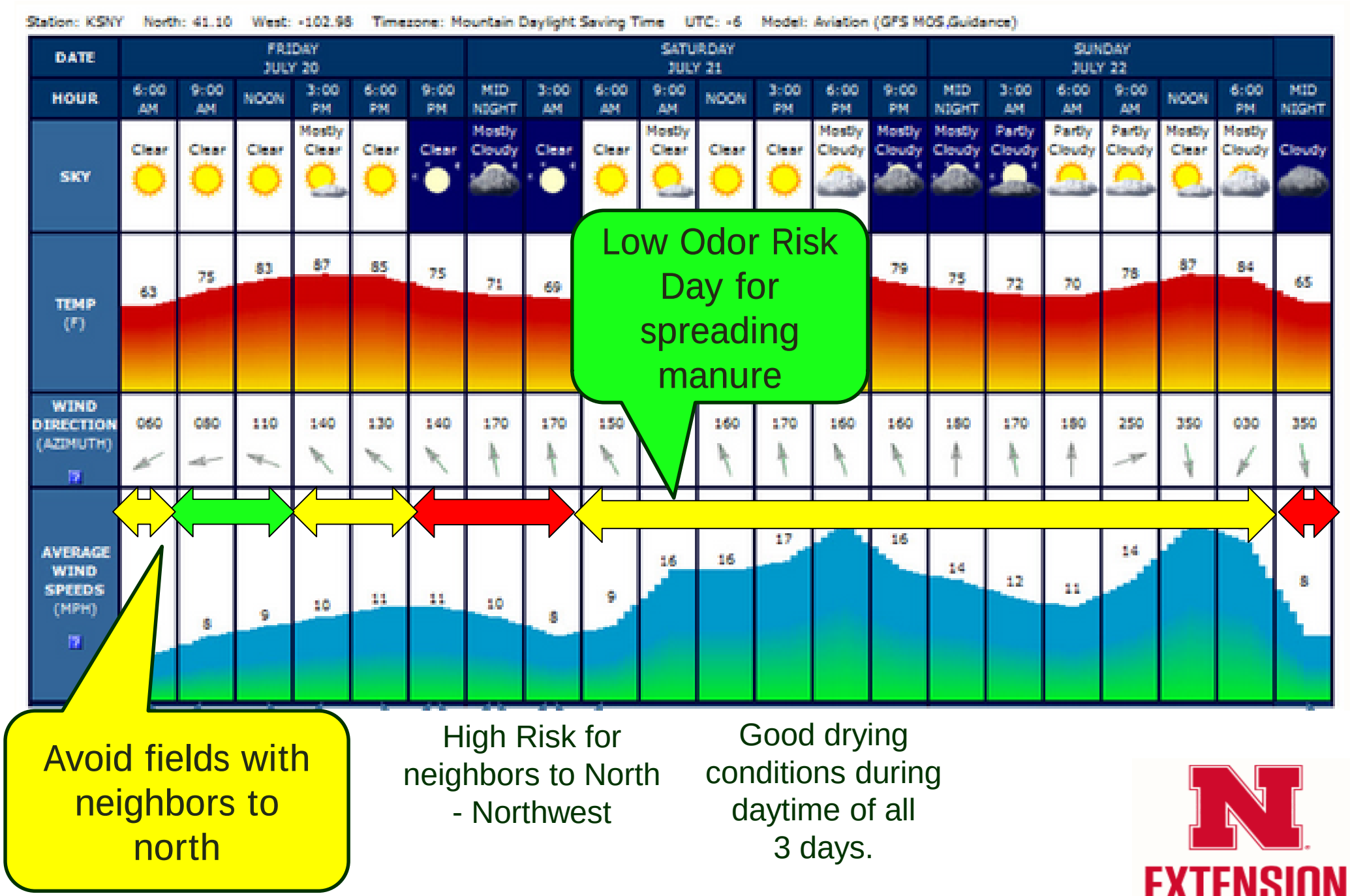


Table 1. Atmospheric conditions and their risk of holding odors near the ground.[1]

SURFACE WIND SPEED (MPH)	DAYTIME SOLAR RADIATION			NIGHTTIME CLOUD COVER	
	STRONG	MODERATE	SLIGHT	>50%	<50%
<4.5	Very Low Risk	Very Low Risk	Very Low Risk	High Risk	High Risk
5 to 7	Very Low Risk	Very Low Risk	Low Risk	High Risk	High Risk
7 to 11	Very Low Risk	Low Risk	Low Risk	Low Risk	High Risk
> 11	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

Avoiding Nuisance Odors: Review 48-hour weather forecast



Which fields should I avoid? Target?

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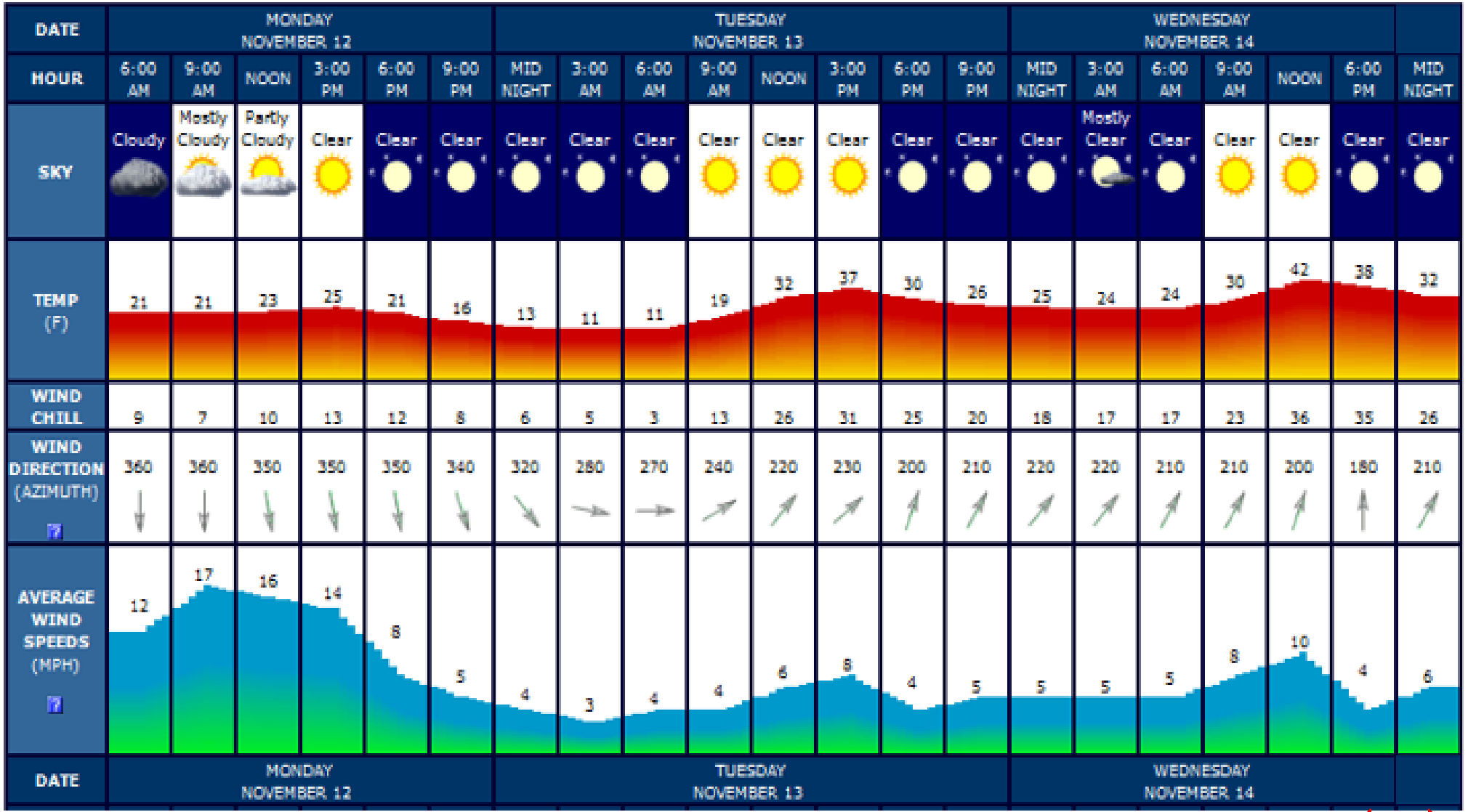
Aviation Weather Forecast at York Municipal Arpt, Nebraska

Station: KJYR North: 40.90 West: -97.62 Timezone: Central Standard Time UTC: -6 Model: Aviation (GFS MOS Guidance)



ID High Risk Periods

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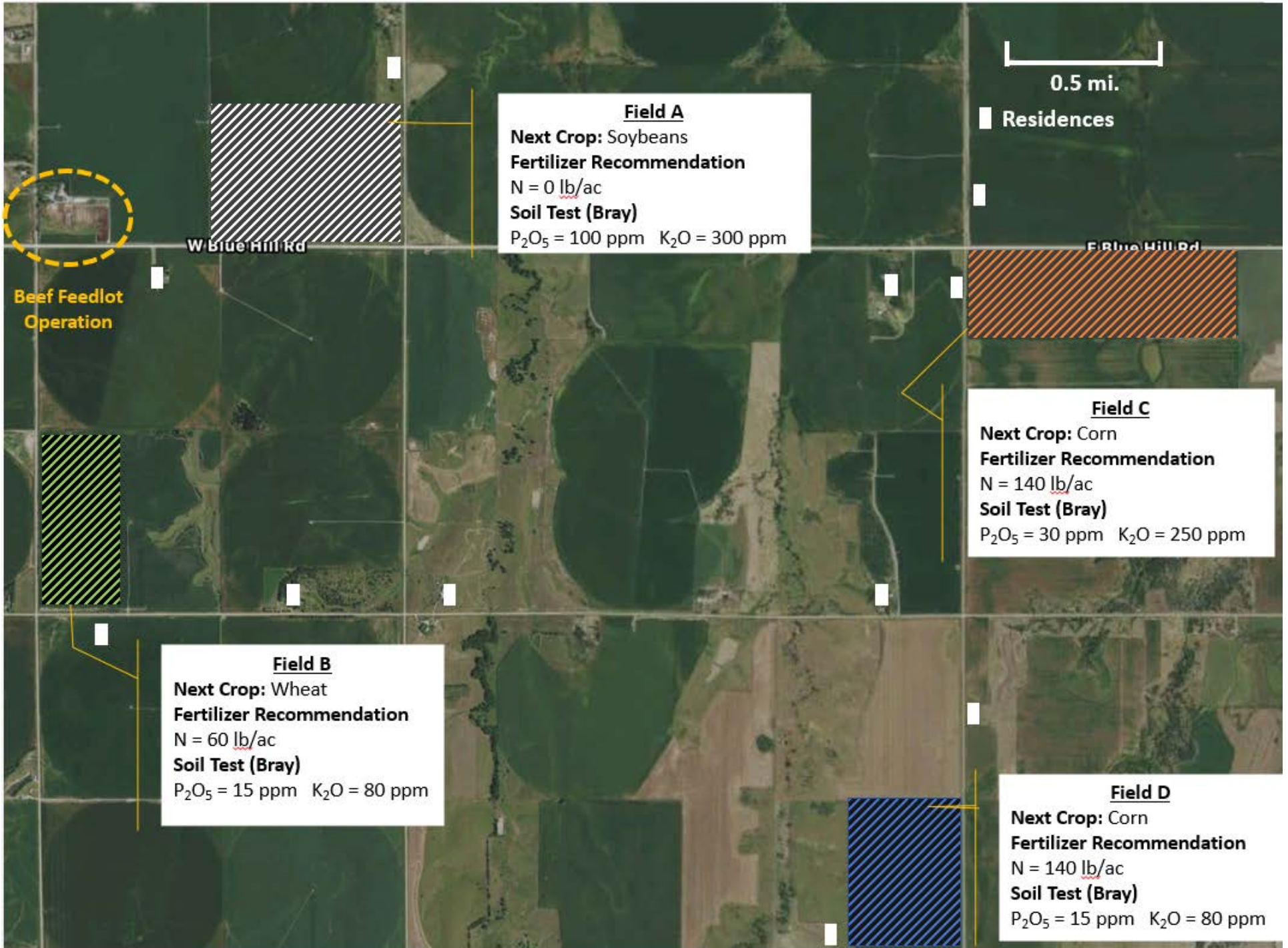

High Risk – Nov. 12
Field B

High Risk – Nov. 13
Field A, B (?) & D

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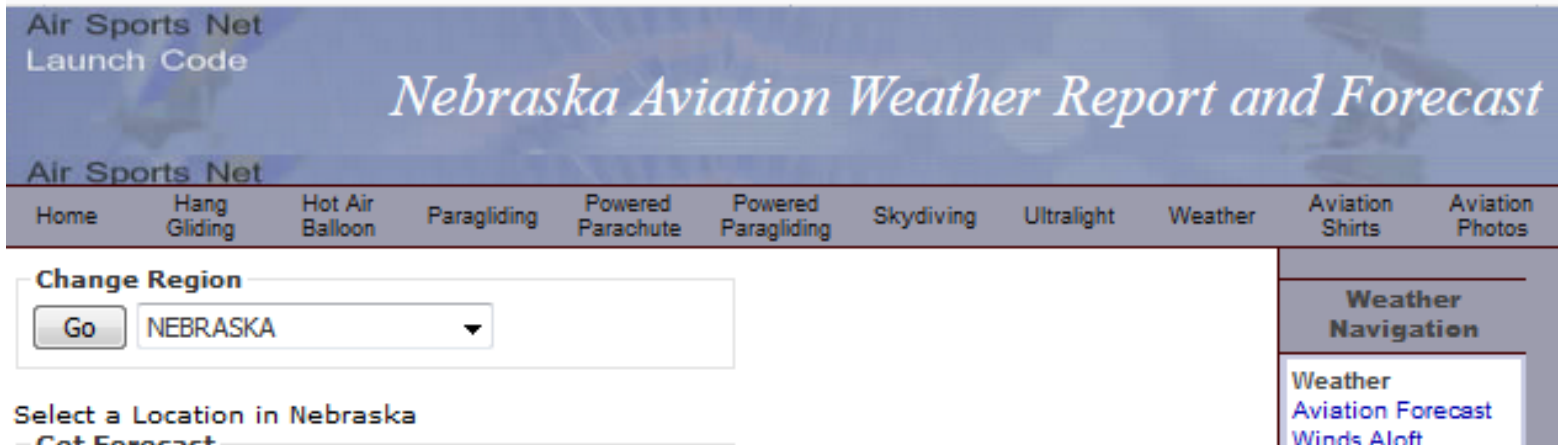
Weather Forecast for Planning Land Application Timing

- Information needed for at least 48 hours for:
  - ✓ Wind direction and speed
  - ✓ Sky conditions
  - ✓ Temperature
- One Example: Web Search on “US AIR Aviation Weather” or http://www.usairnet.com/cgi-bin/launch/



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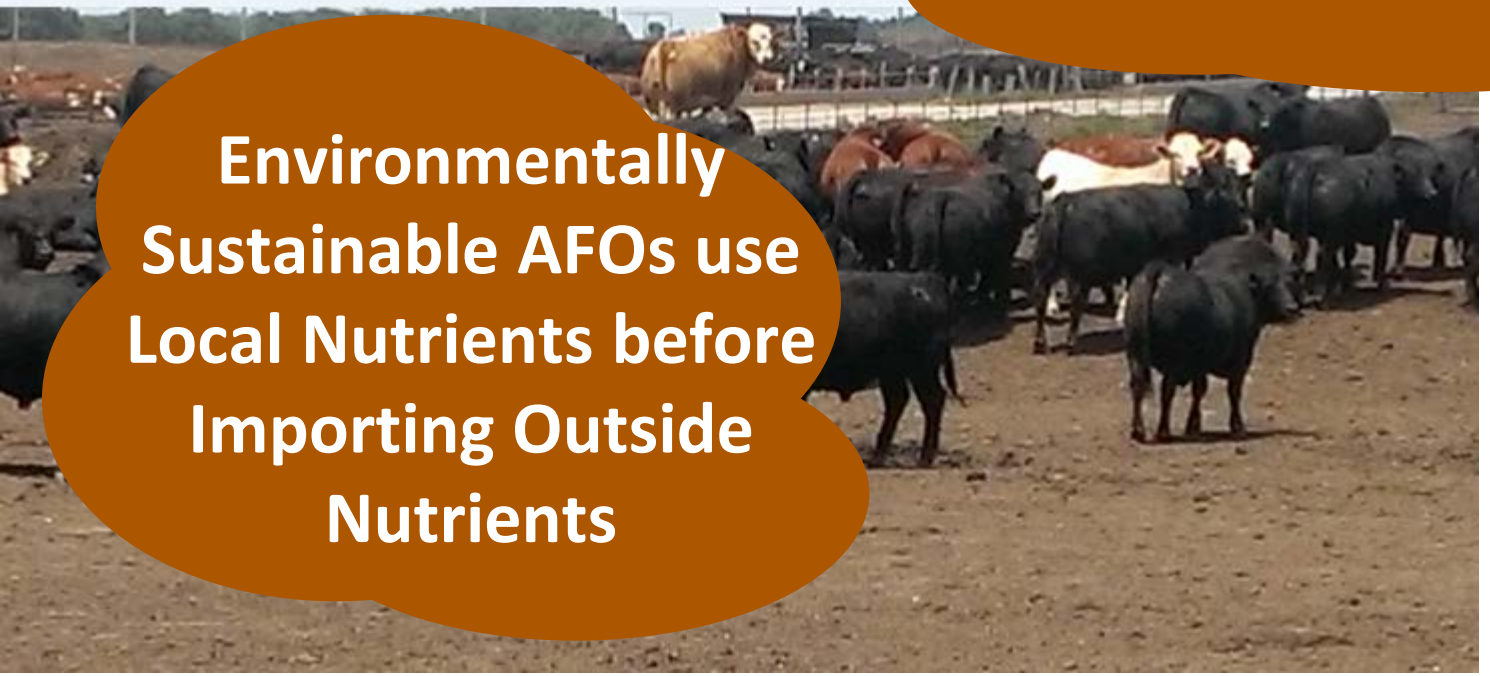
My Big Piles of Manure for Today

Manure has Fertility Value

Environmentally Sustainable AFOs recycle manure nutrients efficiently

Ship High in Transport



Environmentally Sustainable AFOs use Local Nutrients before Importing Outside Nutrients

Manure has Soil & Water Quality Value

Suggested References

Manure & Soil Health Blog:
https://soilhealthnexus.org/category/manure/:

- What is the economic value of manure?
- Manure impact on erosion and runoff
- Manure impact on soil aggregation

Calculating the Value of Manure for Crop Production

- Nebguide … http://extensionpublications.unl.edu/assets/pdf/g1519.pdf
- Spreadsheet: https://unl.box.com/shared/static/nb4wod1oc3m1hy2e6cjvg0id913jcftk.xlsx

Determining Crop Available Nutrients from Manure
http://extensionpubs.unl.edu/publication/9000017123651/determining-crop-available-nutrients-from-manure-g1335/

Manure effects on soil organisms and soil quality – Michigan State Extension publication …
http://msue.anr.msu.edu/uploads/files/AABI/Manure%20effects%20on%20soil%20organisms.pdf

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Suggested References

Nebraska Extension Manure Web Site:
http://Manure.UNL.edu,

search on:
“Timing Manure Application”

for “Timing Manure Application to Avoid Neighbor Nuisances”

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Questions & Comments

Rick Koelsch, University of Nebraska,

rkoelsch1@unl.edu, 402/472-3935

Thank You

Take Home Message

Environmentally sustainable AFOs (with significant land resources) …

Recycle nutrients efficiently within their farm.

Environmentally sustainable AFOs (buying feed grains and forages) are …

linked to neighboring crop farms.

Factors are simplified into lookup tables using your lab analysis as a reference.

Ammonium N (NH_4^+) Table

Organic N Table

Urine

Feces

I. Ammonium-N (NH_4-N) Available this Year

Sidedress application[1]		Preplant application & Incorporated[1]			
Incorporated	1.0	Immediately		0.95	
Sprinkler Irrigation	0.5	One day later	0.50*	0.70†	0.70‡
		Two days later	0.25*	0.55†	0.45‡
		Three days later	0.15*	0.45†	0.40‡
		7 or more days later	0.00*	0.40†	0.00‡
Preplant application &					
Not Incorporated	0.0				

** Solid Manure*
† Liquid Manure Applied when Air Temp is at or below 50° F
‡ Liquid Manure Applied when Air Temp is above 50° F

II. Organic-N Available this Year[2]

Beef/Dairy		Poultry	
Solid (e.g. feedlot)	0.25	Deep Pit	0.45
Stored Liquid	0.35	Solid with litter	0.30
Compost	0.15	Solid without litter	0.35

Swine	
Fresh	0.5
Stored Liquid	0.35

Next year	0.15
2 years from now	0.07
3 years from now	0.04

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Nutrient content and availability is affected by several factors.

- Nutrient availability varies with:
  - Species
  - Liquid/solid
  - Application method, timing
  - Incorporation/weather