Agronomic Considerations of Manure Use as Fertilizer

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Livestock Manure Management Workshop




Livestock Production by State

	Poultry (chickens)		Swine		Cattle	
	State	Million egg	State	Thousand head	State	Thousand head
1	Iowa	1,210	Iowa	18,200	Texas	13,800
2	Ohio	629	N. Carolina	9,900	Kansas	6,700
3	Indiana	555	Minnesota	7,200	Nebraska	6,550
4	Pennsylvania	543	Illinois	4,150	California	5,450
5	California	435	Indiana	3,500	Oklahoma	5,400
6	Texas	435	Nebraska	3,150	Missouri	4,300
7	Georgia	412	Missouri	3,050	Iowa	4,000
8	Arkansas	277	Oklahoma	2,330	S. Dakota	3,700
9	N. Carolina	265	Kansas	1,850	Wisconsin	3,400
10	Florida	248	Ohio	1,760	Colorado	2,750

USDA, National Agricultural Statistics Service, 2007

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Nutrients for Crop Production

- N is almost always needed for corn and wheat.
- P is needed for Kansas low-testing soils and to maintain desirable soil-test levels but many fields test high in P.
- Manure can be used to supply these nutrients for crop production but its management may be difficult.
- Excess movement of N and P from fields can impair water quality.

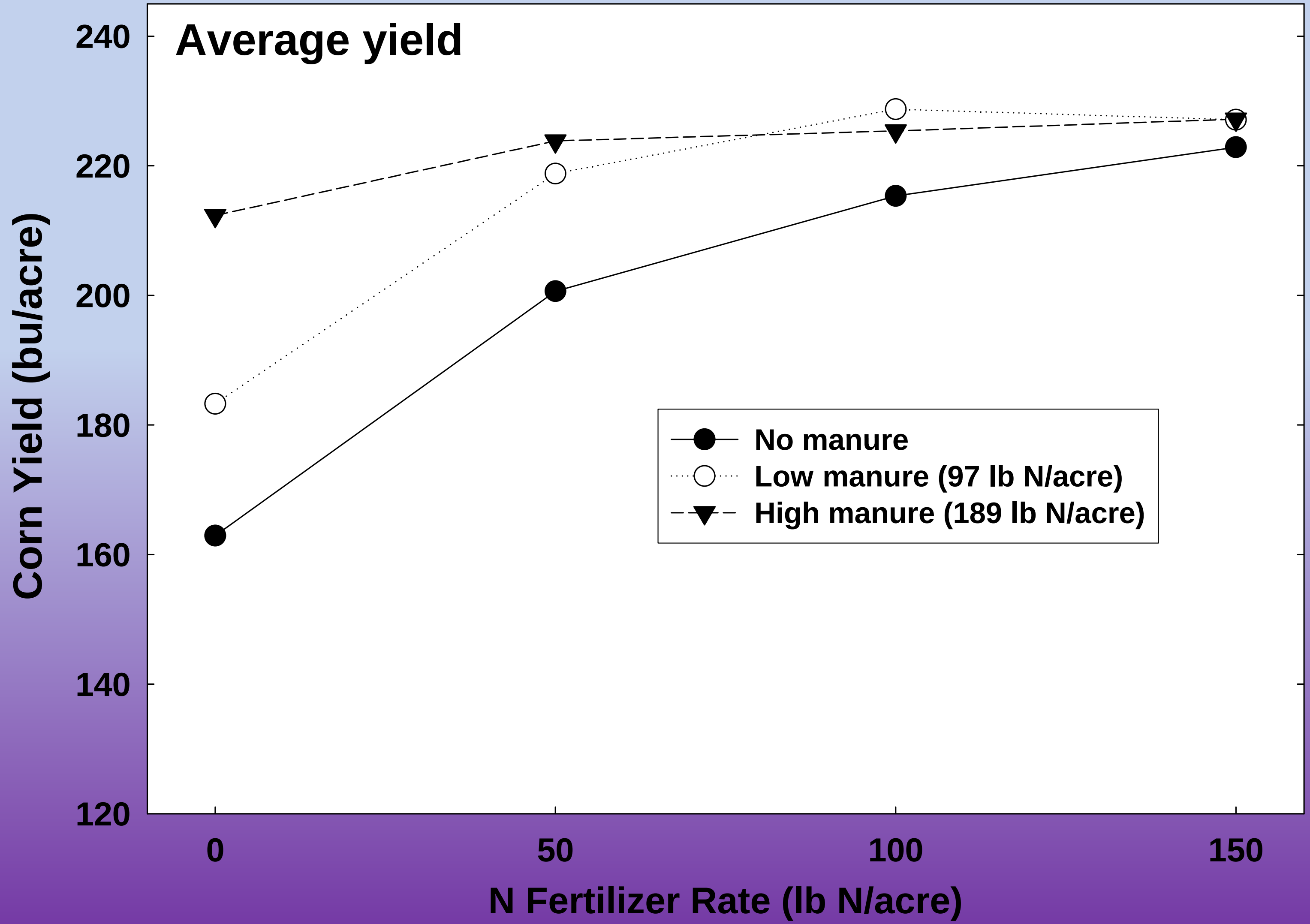
Manure vs Fertilizer Nutrients

- Large concentration variability.
- N-P-K content and crop needs.
- Amount of N and P availability shortly after application.
- Expensive storage and handling, difficulty for uniform application.
- Very large soil-test variability.
- Producer's doubts about its value.

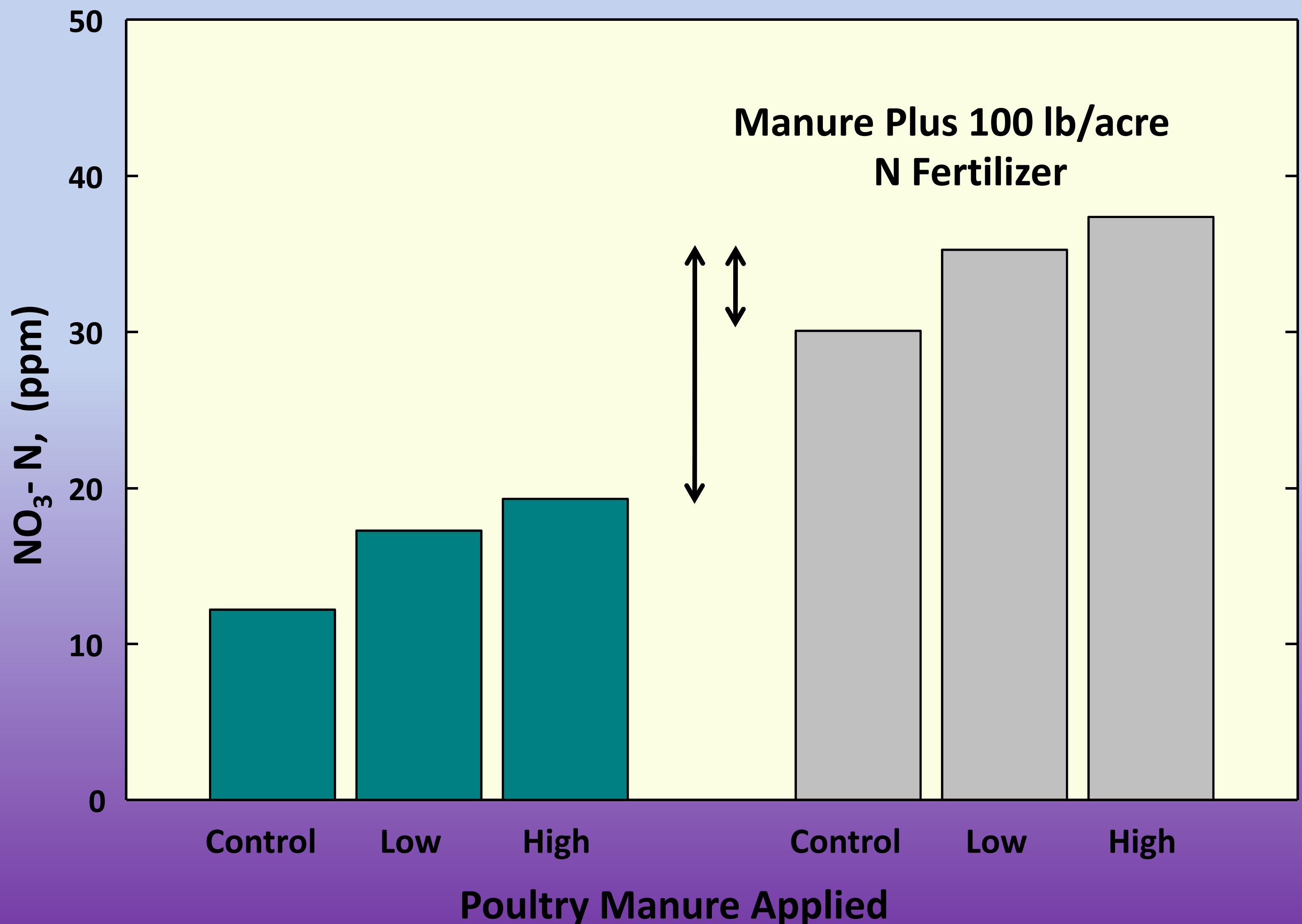
Manure vs Fertilizer Nutrients

	% Dry Matter	Total N	NH_4	P_2O_5	K_2O
		- - - - - - - - lbs/ton - - - - - - -			
Dairy	21	9	5	4	10
Beef	50	21	8	18	26
Swine	18	8	5	7	7
Poultry	75	56	36	45	34

Yields and Manure or Fertilizer N



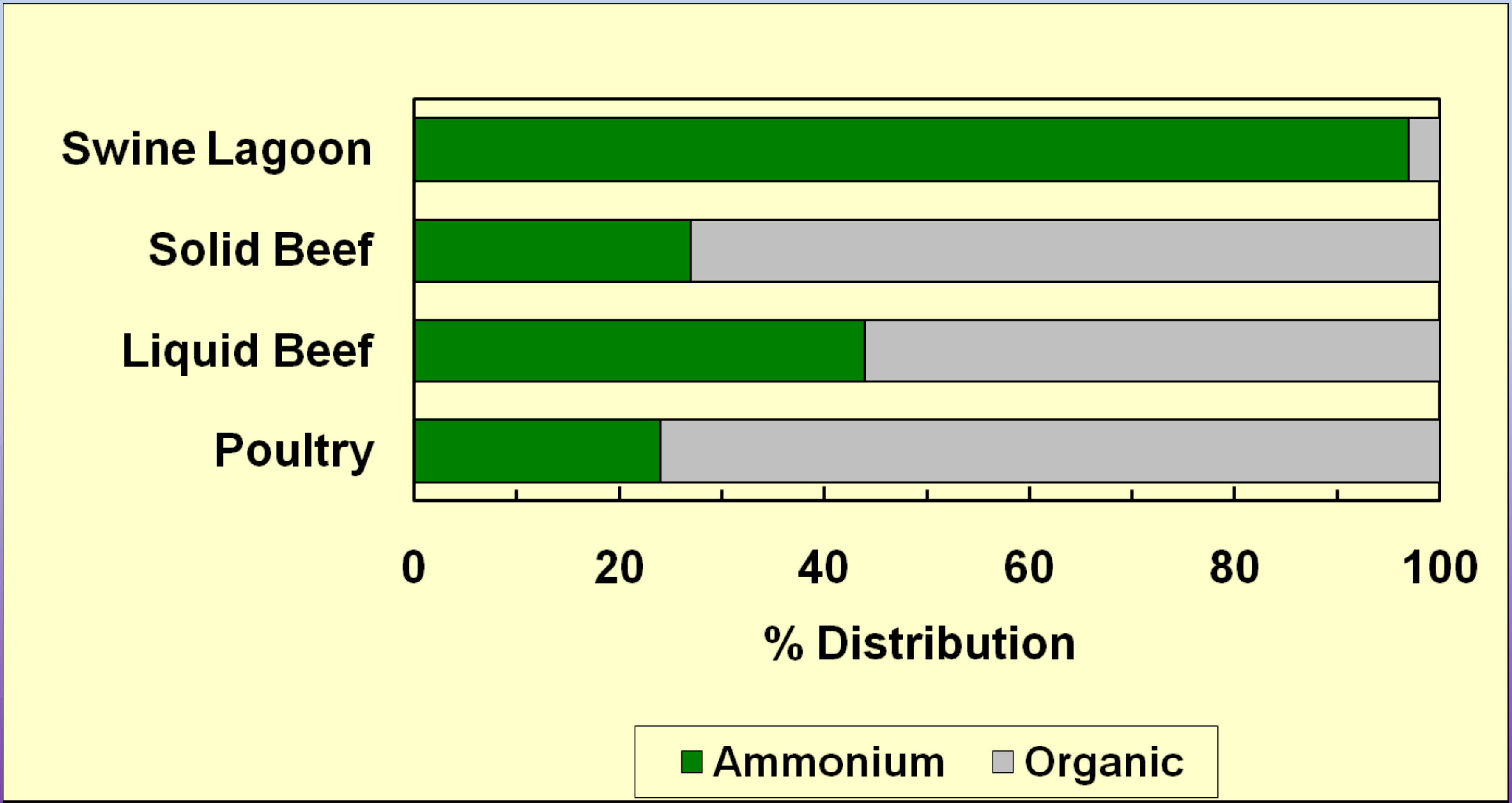
Early spring soil nitrate-N



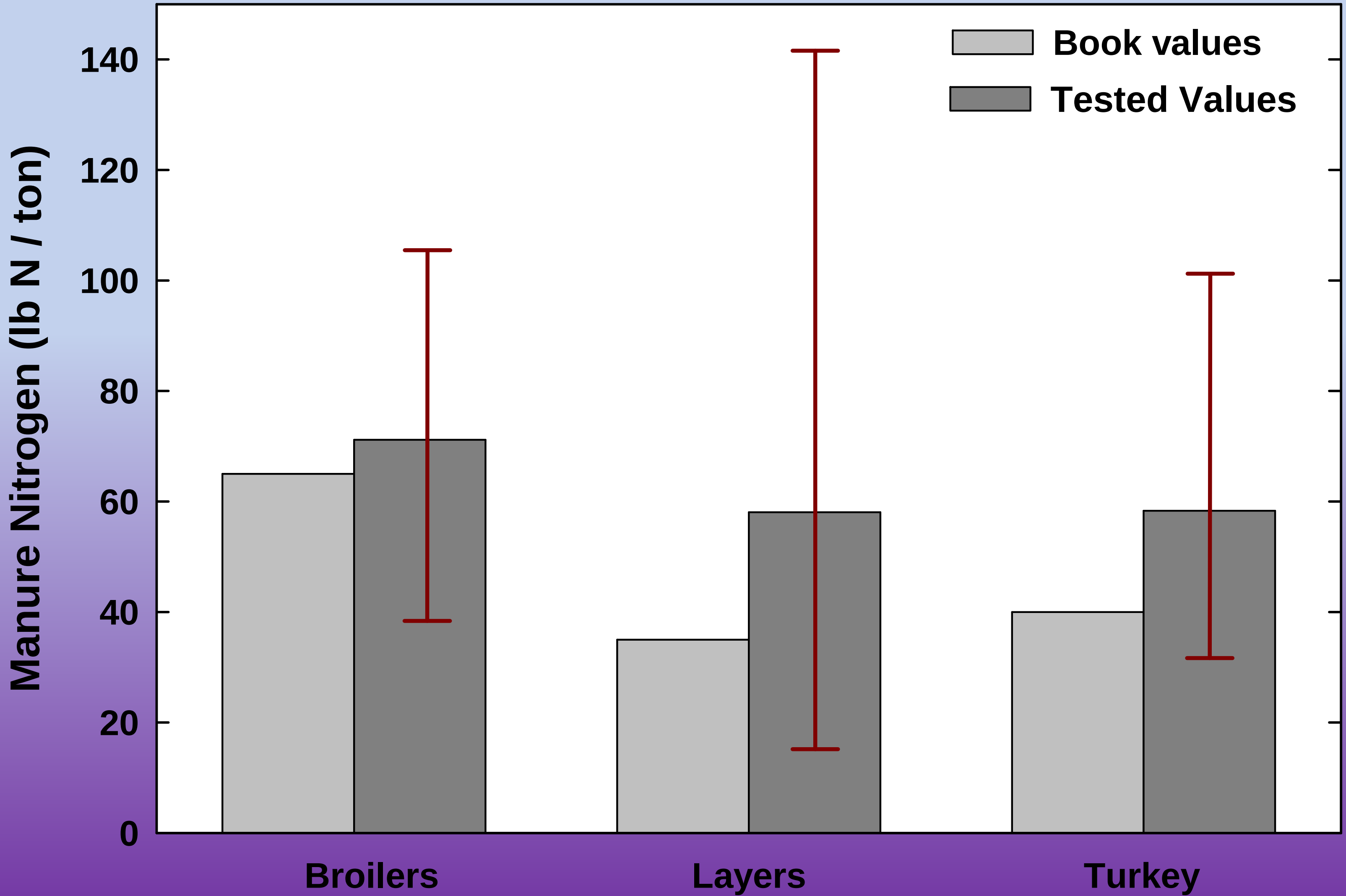
Manure Nitrogen Availability

- Organic N available the first year compared with fertilizer (MF-2562):
  - Liquid manure: 30%
  - Solid manure: 25%
  - Compost: 20%
- As for fertilizers, these numbers indicate potential availability.
- Assumes injection or incorporation and "best management practices".

Ammonium - Organic N in Manures



Manure Nitrogen Concentration



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Time of Manure Application

- Need to mineralize organic N?
  - fall application allows more time
  - puts inorganic nitrate-N at risk
- High ammonium-N content?
  - spring reduces N loss potential
  - fall application: soils cold enough to slow nitrification (< 50 ºF)
- Avoid application to frozen/snow soil with risk of runoff (sloping ground).

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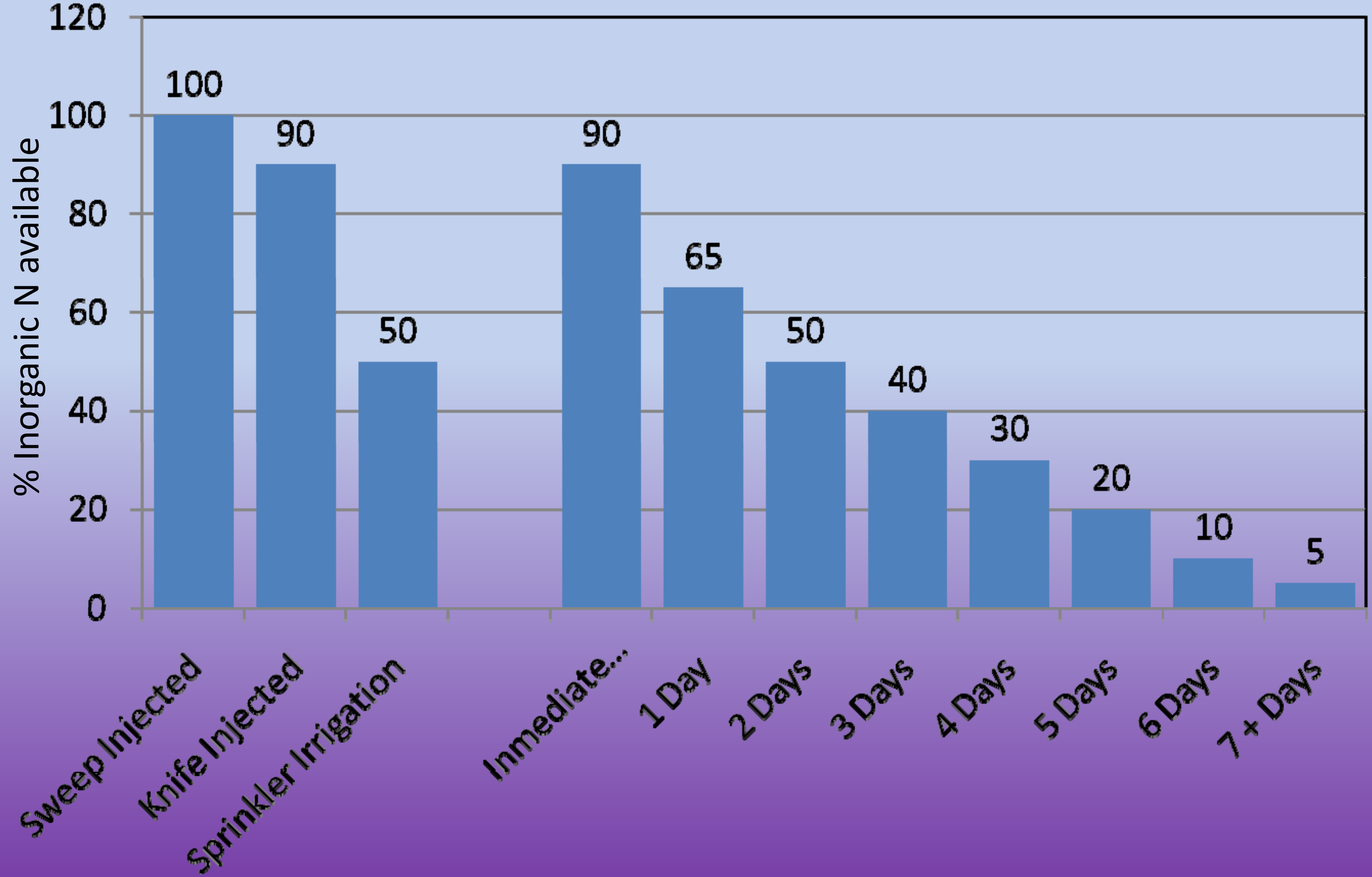
Manure Nitrogen Volatilization



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Is Manure N Enough ?

- Manure N availability is difficult to predict: analysis variation, organic N release, climate, uneven application.
- In-season assessment for more N
  - crop sensing with emerging technologies still being evaluated, such as aerial photos, hand-held chlorophyll meters.
  - late spring soil nitrate level.

In-season N application

- Good for Nitrogen management.
- Calibrations available using SPAD and reflectance for some crops.

Reflectance meter

Chlorophyll meter- SPAD

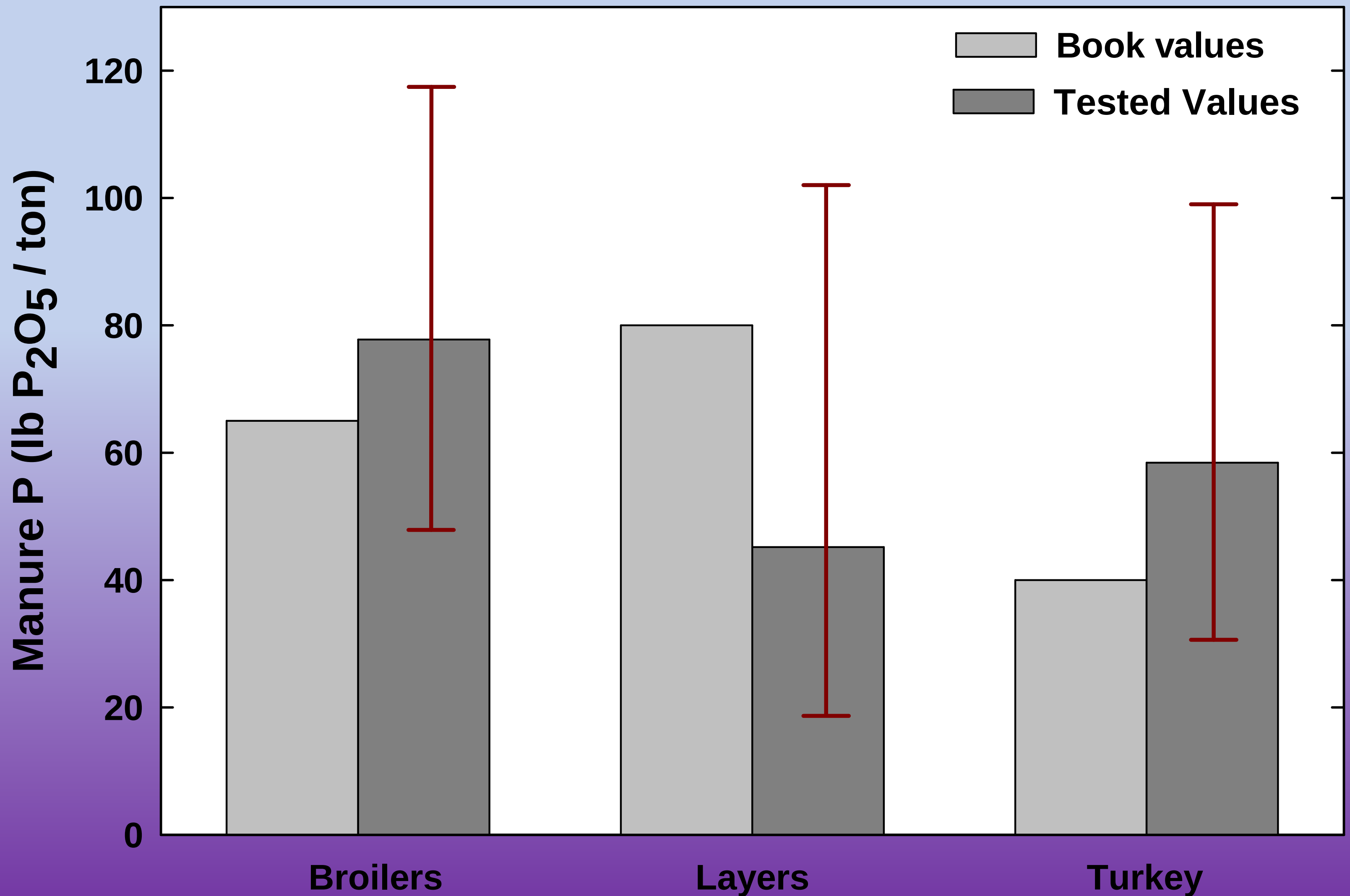
Maximizing Efficiency of Manure N

- Use manure analysis.
- Mineralize the most of organic N:
  fall may allow more time but puts inorganic nitrate-N at risk of loss.
- Minimize ammonium volatilization:
  immediate incorporation into the soil.
- Minimize nitrate N loss:
  apply near planting time or late in the fall when soils are getting colder.

Phosphorus in Animal Manures

- 40 to 95% can be inorganic or simple organic readily available P.
- Higher values for liquid swine and poultry manure, lowest for beef.
- No easy or certain method found yet to measure amount of soluble or available P.
- Simple forms insoluble in water become available when applied to the soil.

Manure Phosphorus Concentration



Phosphorus in Animal Manures

- P availability from manures is equal or less than fertilizer P.
- Manure P availability is influenced by:
  - Organic P mineralization.
  - Initial microbial immobilization.
  - Reaction of P with manure constituents.
  - Manure soluble P content.

Phosphorus in Animal Manures

- Recommendations for crediting manure P recognize possibility of lower availability.
  - 60-75% of manure total P considered available.
- Evidence for higher P availability with manure vs. fertilizer exists.
  - Mechanisms may involve prevention of reactions converting available P to slowly soluble inorganic forms.

P Availability in Animal Manures

- Midwestern states: 40 to 100% of P is comparable to fertilizer for a first crop. Highest values for liquid swine and poultry manures. Assume 100% availability for maintenance.

- Kansas: 50% availability for all manures in low-testing soils and 100% for maintenance.

- Research: near 100% P availability in liquid swine manure and poultry manure.

Crop Availability of Manure Nutrients

- No organic K, all available, no doubt.
- Variable proportion of inorganic and organic N, P, and S. Organic forms must be mineralized to be absorbed.
- Mineralization rates vary with the handling method, application method, and climate/field conditions.
- N and P availability immediately after application is difficult to predict.

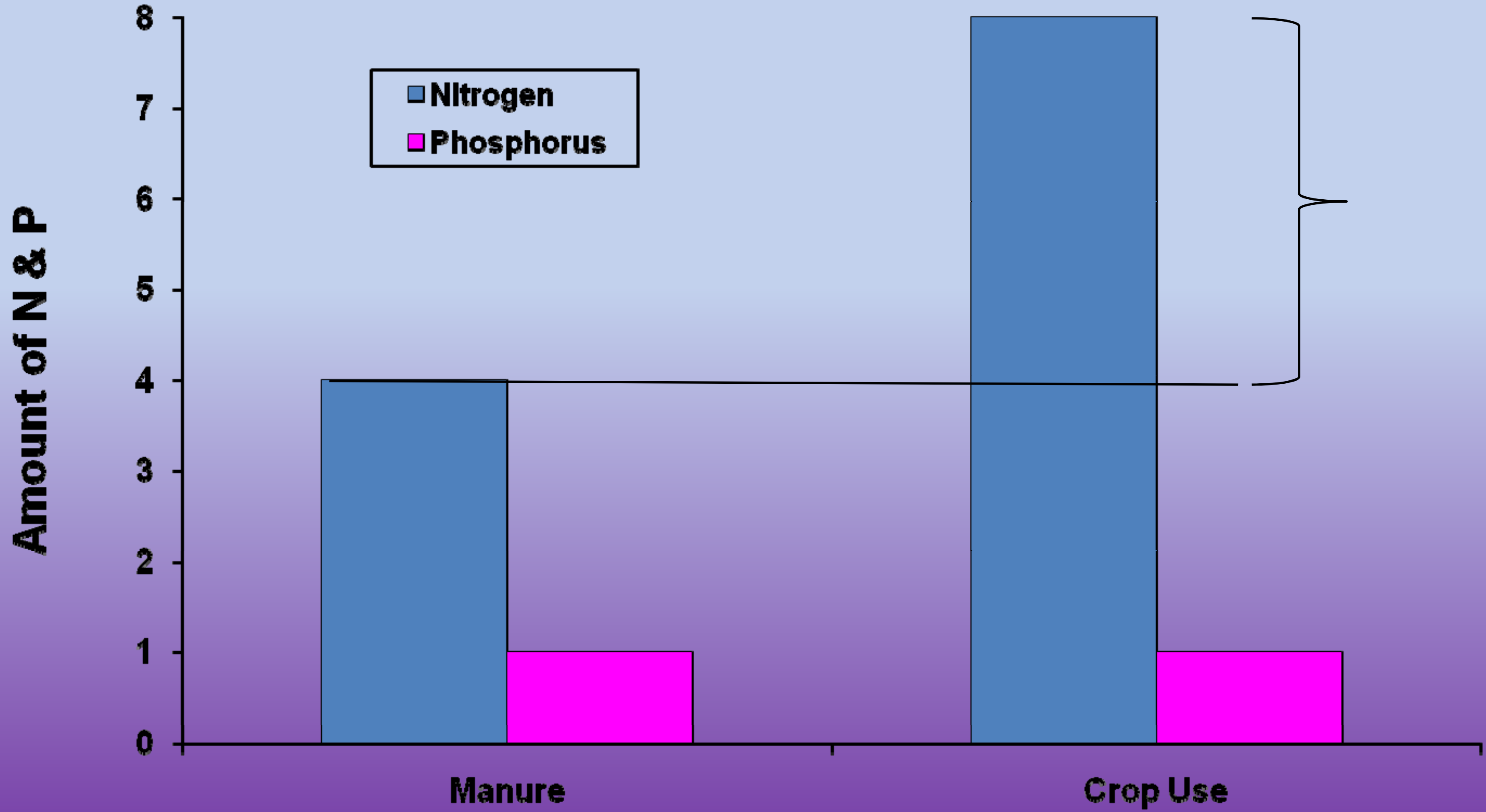
Nutrient Availability in Practice

- All manures are heterogeneous materials, difficult to handle.
- High nutrient variability, difficult to apply uniformly at precise rates, uncertain climatic conditions, high soil-test variability in manured fields.
- This may reduce manure nutrients efficiency compared with fertilizers.
- But careful management pays back.

Maximizing Manure P and K Use

- Use manure and soil analyses.
- Manure P availability not an issue when using ½ to full N-based manure rates (apply P for 2 or more crops?).
- Full N-based rates applies excess K but typically about right K for two crops.
- Corn after corn: Large P & K excess.

Relative amount of N and P in manure and used by crops



Manure N-P Ratios and Crop Needs

- N-based manure application often results in soil P build-up over time.
- Corn-soybean rotation:
  - Dairy & beef: small or no P buildup.
  - Swine: small or no P buildup, may be short of P when phytase is used.
  - Poultry: large P buildup, larger for egg layers, less with phytase.
- Corn after corn: very large buildup.

Relative amount of N and P in manure and used by crops

Crop	$N:P_2O_5$ needed	Livestock	$N:P_2O_5$ excreted	$N:P_2O_5$ available*
Corn grai				
Soybeans				d)
Alfalfa				
Bromegra				
Corn silag				

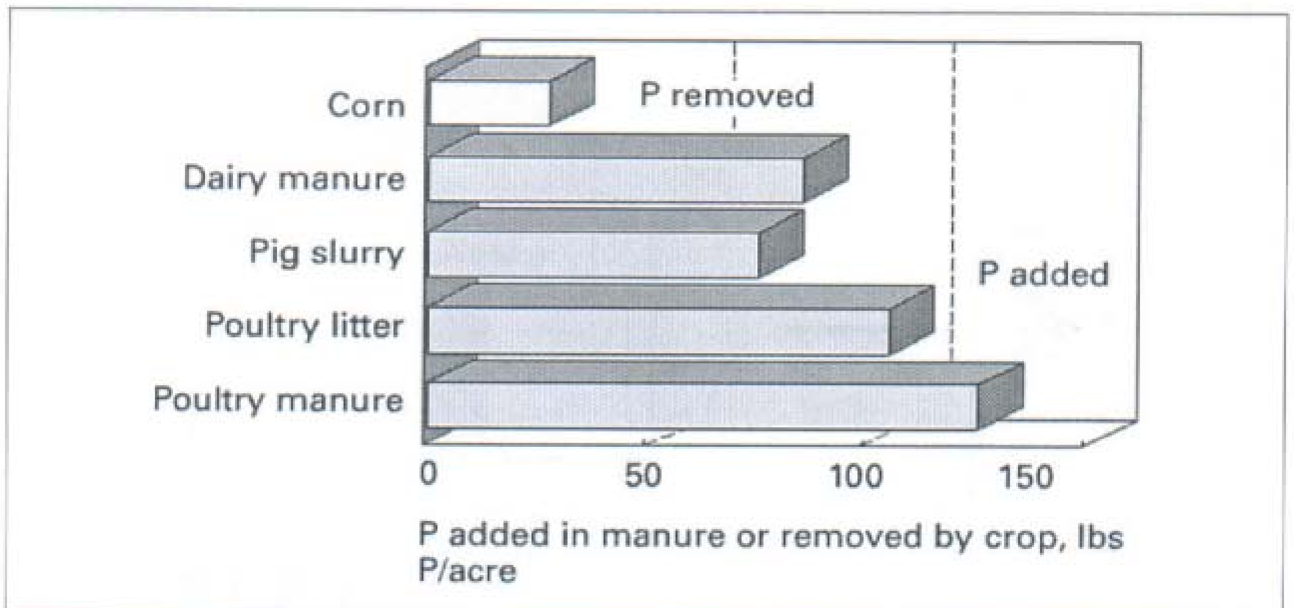


Figure 34-8. Applying manure to meet crop N needs (about 200 lbs available N/acre) will add much more P than corn uses annually.

- Results in
  agronomi
  - Problem

Soil test interpretations and recommendations

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Soil Test Interpretations and Fertilizer Recommendations

Department of Agronomy MF-2586 Nutrient Management

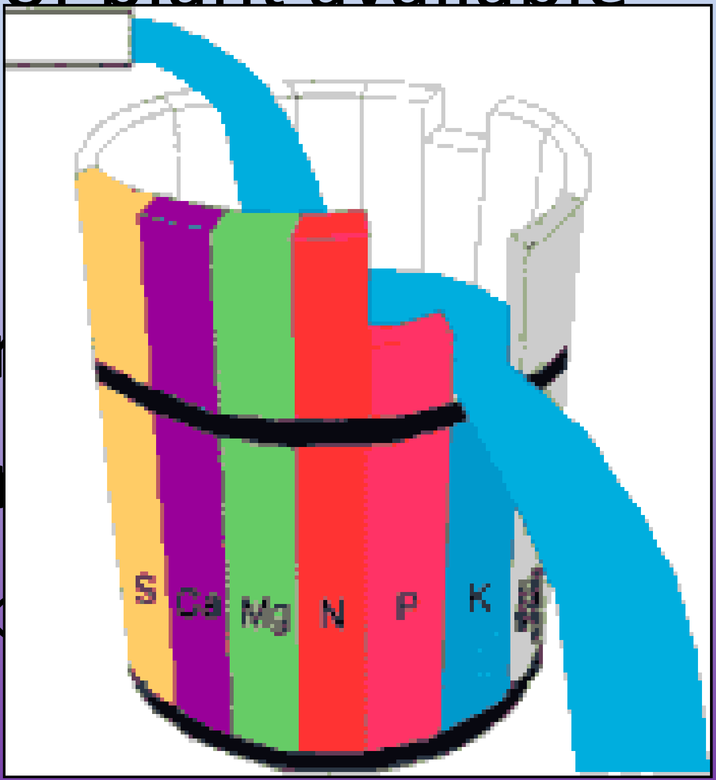
Development of sound nutrient management programs involves knowledge of a wide range of information. Soil test records are an important piece of required information, but other factors such as soil moisture conditions, land ownership/tenure, crop and cropping sequence, pest management, cultural practices, environmental issues, and other management items are vital for developing sound nutrient management programs. It is beyond the scope of this publica-

tions are based on surface soil samples collected to a depth of six inches. We suggest collecting a sample from the 0 to 24 inch depth for N, S and Cl recommendations and a separate 0- to 6-inch sample for pH, P, K, Zn, Fe and B soil test determinations.

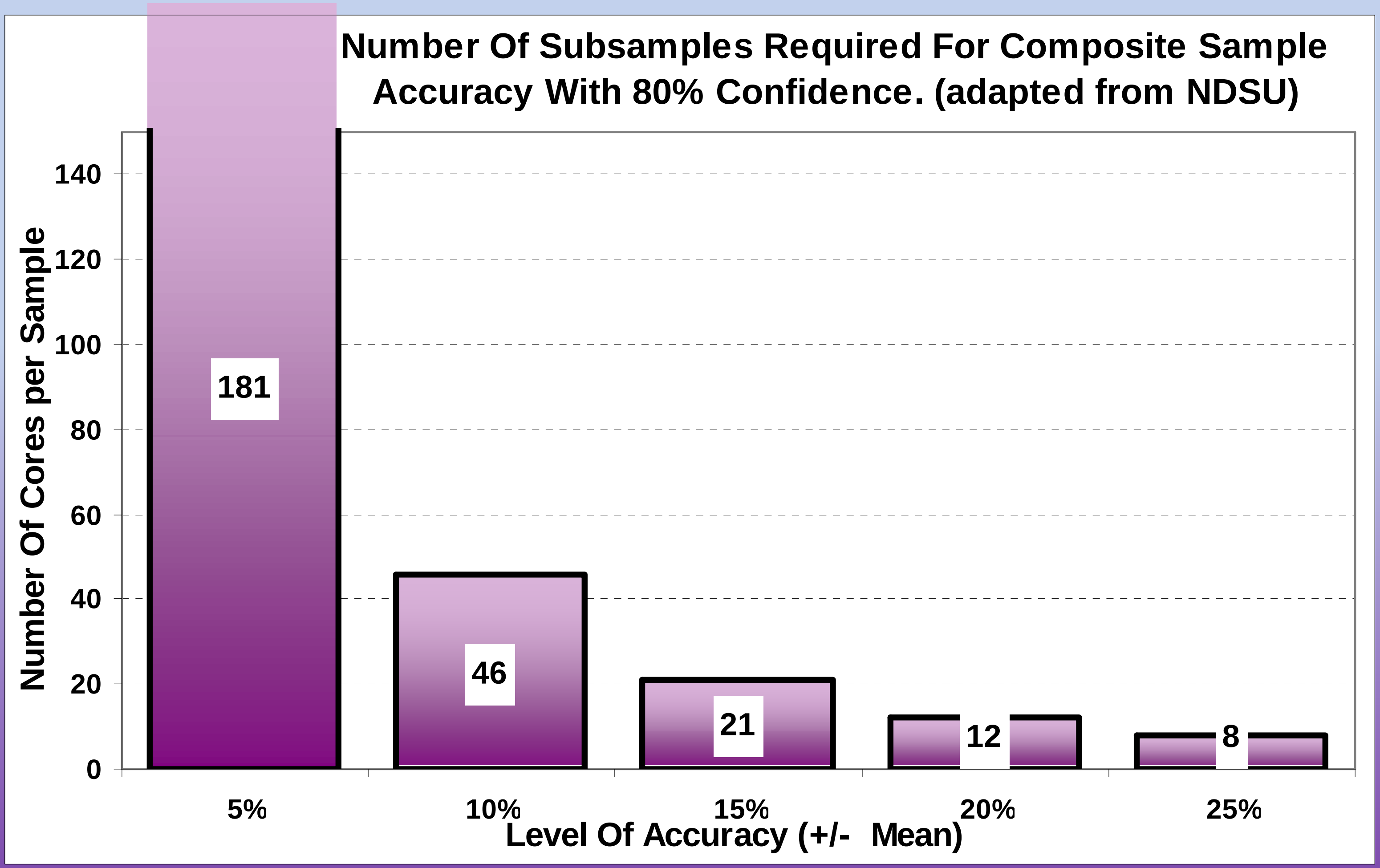
For lime, the recommended lime rate should be adjusted to reflect the depth of lime incorporation, while no-till and perennial crops should assume a depth of 2 inches.

Why soil sampling and testing?

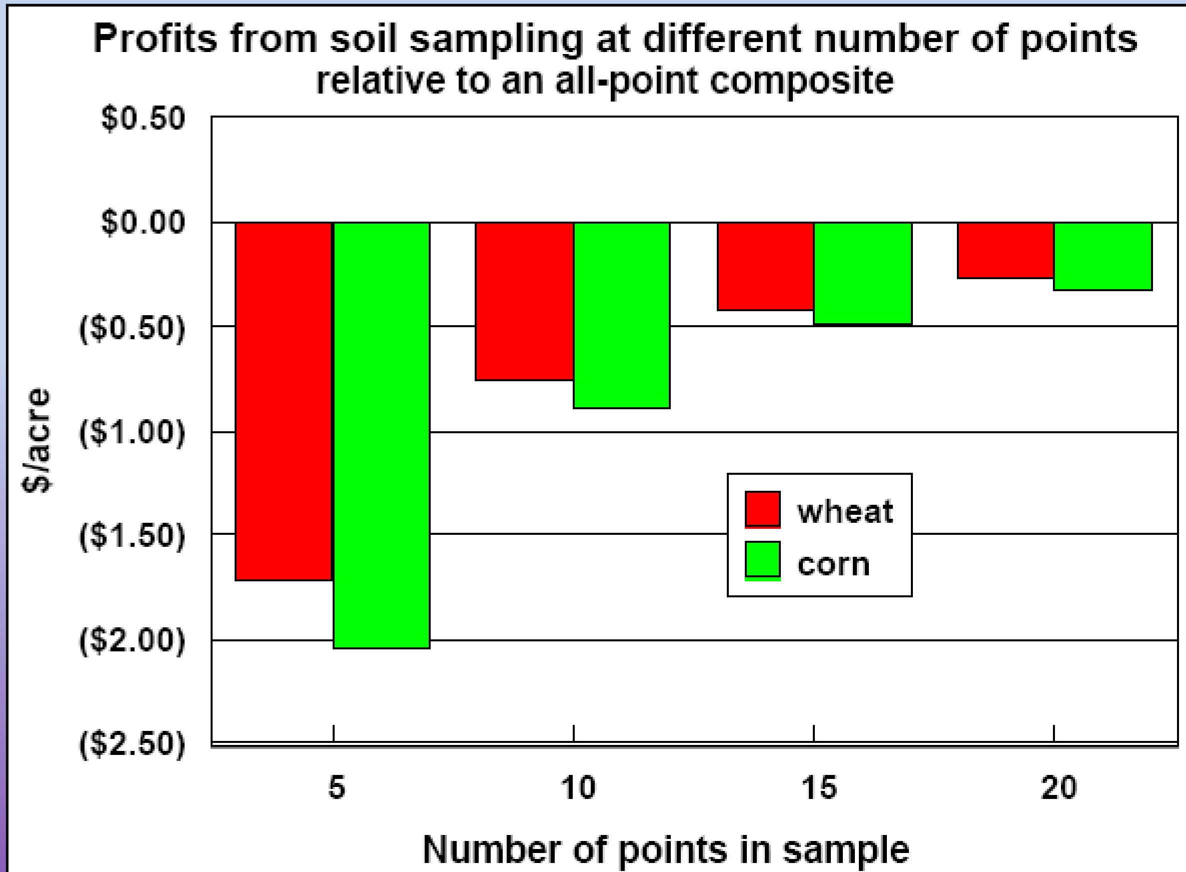
- Estimate probability of nutrient response.
- Determine the amount of plant available NO_3-N.
- Identify fertility trends.
- Estimate long-term nutr
- Estimate long-term aver
- Diagnosing problems / p



Accuracy and number of subsamples



Soil test effect on profits



45 bu wheat
and 75 bu corn

Wheat= 2.31 $/bu
Corn= 3.2 $/bu
N= 0.23 $/lb N
P= 0.25 $/LB P_2O_5

T. Kastens and K. Dhuyvetter, 2004
Agricultural Economics, K-State

Manure is a Good Nutrient Source

- But not all N is immediately available.
- Use of N-based manure rates may applies excess P, highly affected by crop rotation.
- Incorporate manure into the soil.
- The P problem in the long-term:
  - apply less manure N and use fertilizer.
  - reduce manure P: phytase enzyme.
  - use the P index to assess potential impact of P buildup on water quality.

Long-term?

- Manure vs. fertilizer P effects on long-term productivity indicate no clear advantage to manure.
- Long-term manure applications improve many soil characteristic associated with soil quality.
- Potential for adverse effects on water quality may be higher with long-term manure additions.

Summary

- Use “pre-application” manure sample lab analysis, but go back and determine the actual nutrient rates applied.
- Calibrate application equipment.
- Work with N, P, K application rate and not just gal or ton per acre.
- Know the manure nutrient analysis.
- Use total manure N to base application rate.

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Estimating Manure Nutrient Availability

Department of Agronomy **MF-2562** **Nutrient Management**

Manure nutrient management planning has moved into the spotlight in recent years. While crop producers have traditionally considered crop nutrients supplied by manure, increased attention to factors influencing manure nutrient use can improve overall crop production efficiency and profitability. Increasing environmental concerns for surface water and groundwater, and accelerated concentration of livestock production also have increased the need for improved manure nutrient planning. Managing manure for efficient crop production, while minimizing potential environmental concerns, is more complex than simply disposing of the

Proper crediting of estimated nitrogen availability from manure is important to minimize potential problems.

Additionally, manure is an important source of phosphorus, and proper manure application management and nutrient crediting is important in protecting water quality. Non-point phosphorus runoff from agricultural fields is associated with over-enrichment (termed "eutrophication") of some surface water bodies. Eutrophication can result in excessive algal and aquatic weed growth that depletes oxygen in these waters, resulting in fish kills and the need for affected waters to be treated by public water systems. Eutrophication also

Questions?