Technologies for Addressing Phosphorus Associated with Livestock Operations

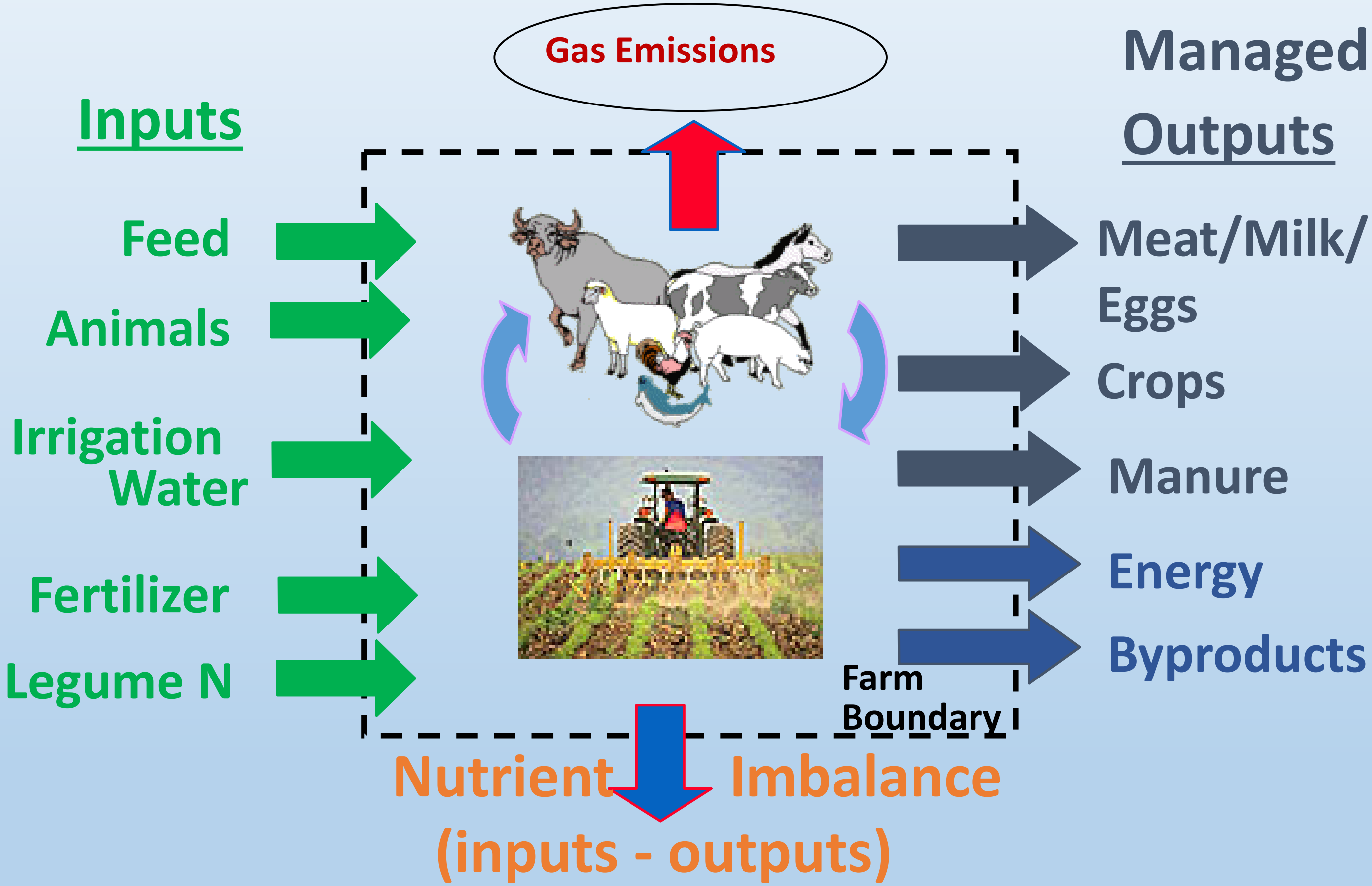
Presenters

Dr. Rory O. Maguire
Associate Professor
College of Agriculture and Life Sciences
Virginia Tech University

Virginia A. Ishler
Extension Specialist
College of Agricultural Sciences
Penn State University

Jeff Porter
Manure Management Team Leader
USDA-NRCS

Whole Farm Nutrient Balance



Phosphorus Technologies

- Impact on phosphorus with technologies applicable to the Farmstead (Production Area)
- Impact on phosphorus with technologies applicable to Crop, Pasture, Range, Other Lands (Land Application Area)

Virginia Ishler

Extension Specialist

FEED MANAGEMENT-IMPLEMENTATION AND INVESTIGATION

(Acknowledgement to Dan Ludwig with USDA-NRCS in Pennsylvania as a collaborator in the feed management educational program)

Feed Management
NRCS Practice Standard 592

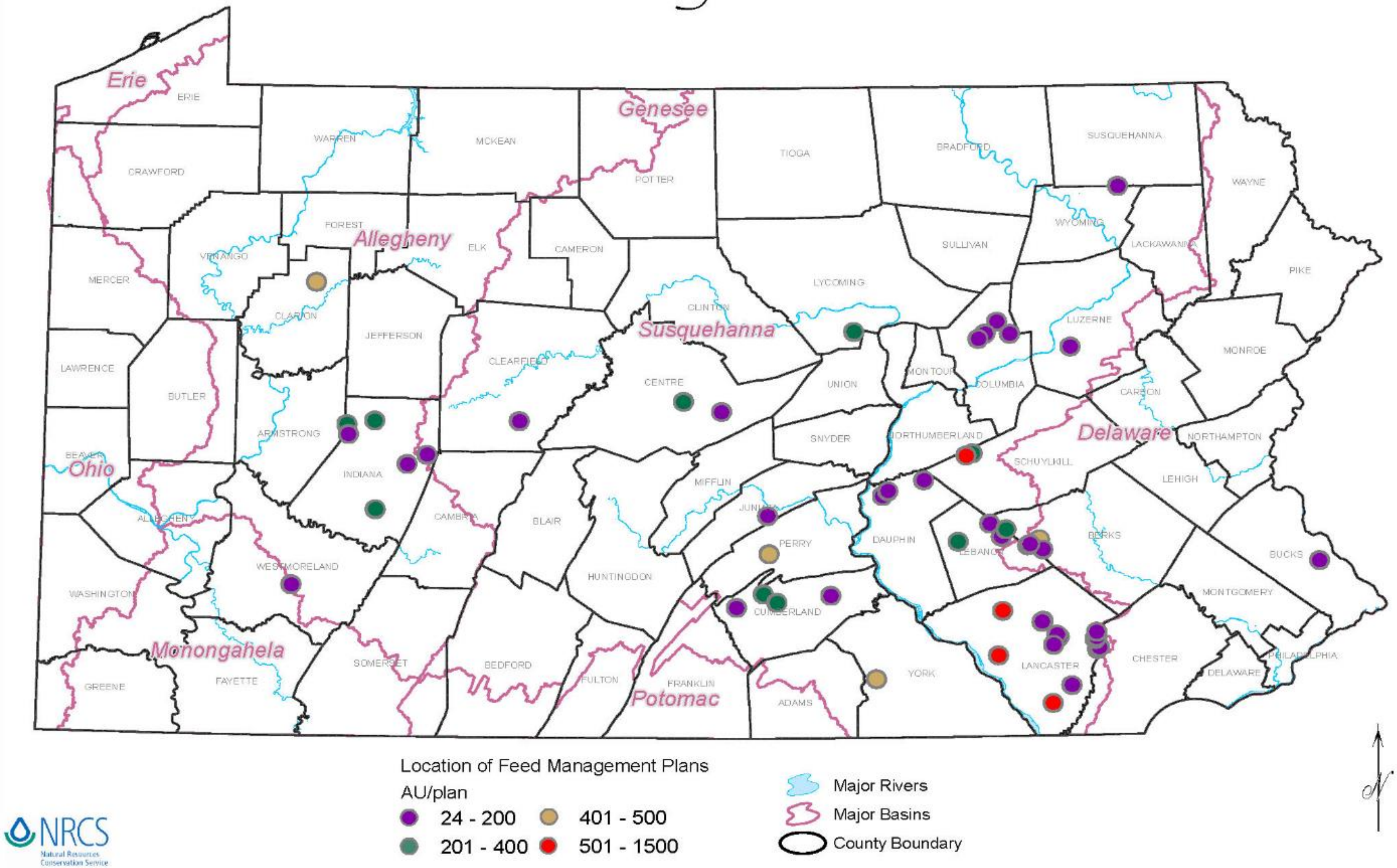
- Used to reduce the nutrient content of manure at the farm
- Used to reduce manure volumes generated
- Maintain production, performance, and reproduction of the dairy herd
- Improve farm net income by feeding more efficiently

Contracting Feed Management Plans

- Animal production groups: 1 – 5
- Contract length: 1 – 3 years
- Payments are designed to help cover the cost of implementing the plan
  - **Plan development costs**
  - **Increased feed costs**
  - **New infrastructure (mixers, pens, etc.)**

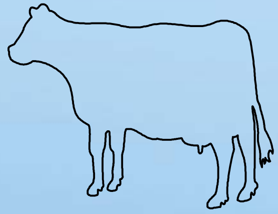
FY 2011

Feed Management Plans



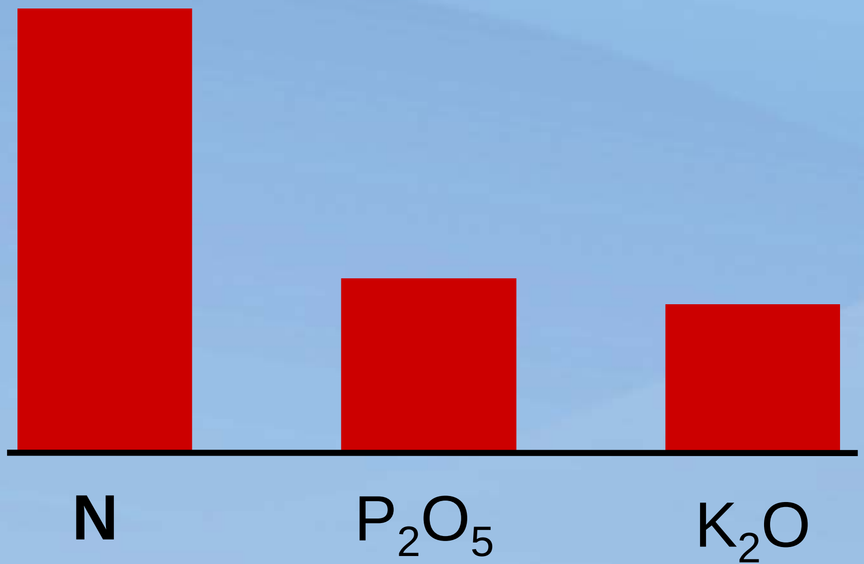
Goals of Feed Management

- Reduce over supplementation of inorganic/organic phosphorus in rations
  - **Reduce amounts of phosphorus excreted**
- Increase productivity and cash surplus
- Utilize nutrients efficiently
- Manage volumes of manure produced

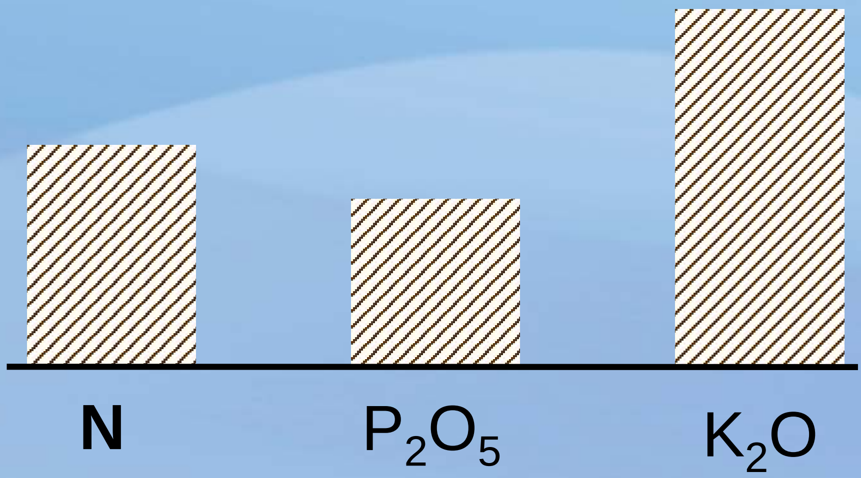


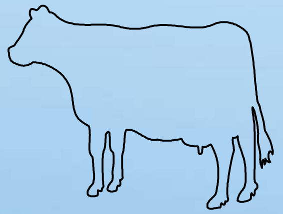
Farm Nutrient Imbalances

Corn Crop Requirement



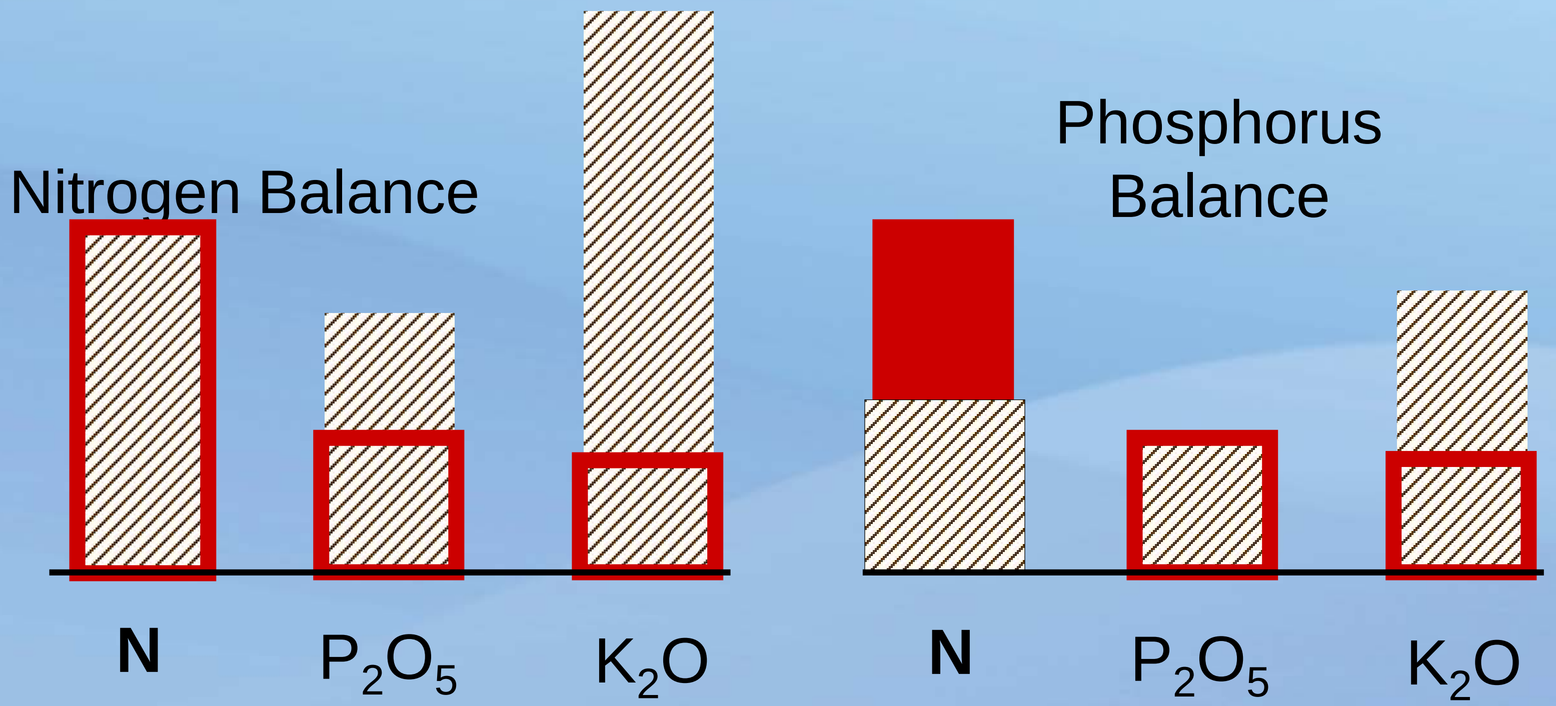
Nutrients in Dairy Manure





Farm Nutrient Imbalances

Mismatch between manure nutrients and crop requirements



P Based: 2 to 4 times as much land required & N Fertilizer

Dry Matter Intake

- Track Actual vs. Formulated levels
  - Compare ration sheet to batch weights/feeding records
  - Correlate actual intake to production level of animals
    - **46 lbs DMI to 60 lbs of fat corrected milk (FE = 1.30)**
    - **42 lbs DMI to 60 lbs of fat corrected milk (FE = 1.43)**
  - Impacts feed costs and volumes of manure generated
    - **Excess feed consumed = Excess manure generated**

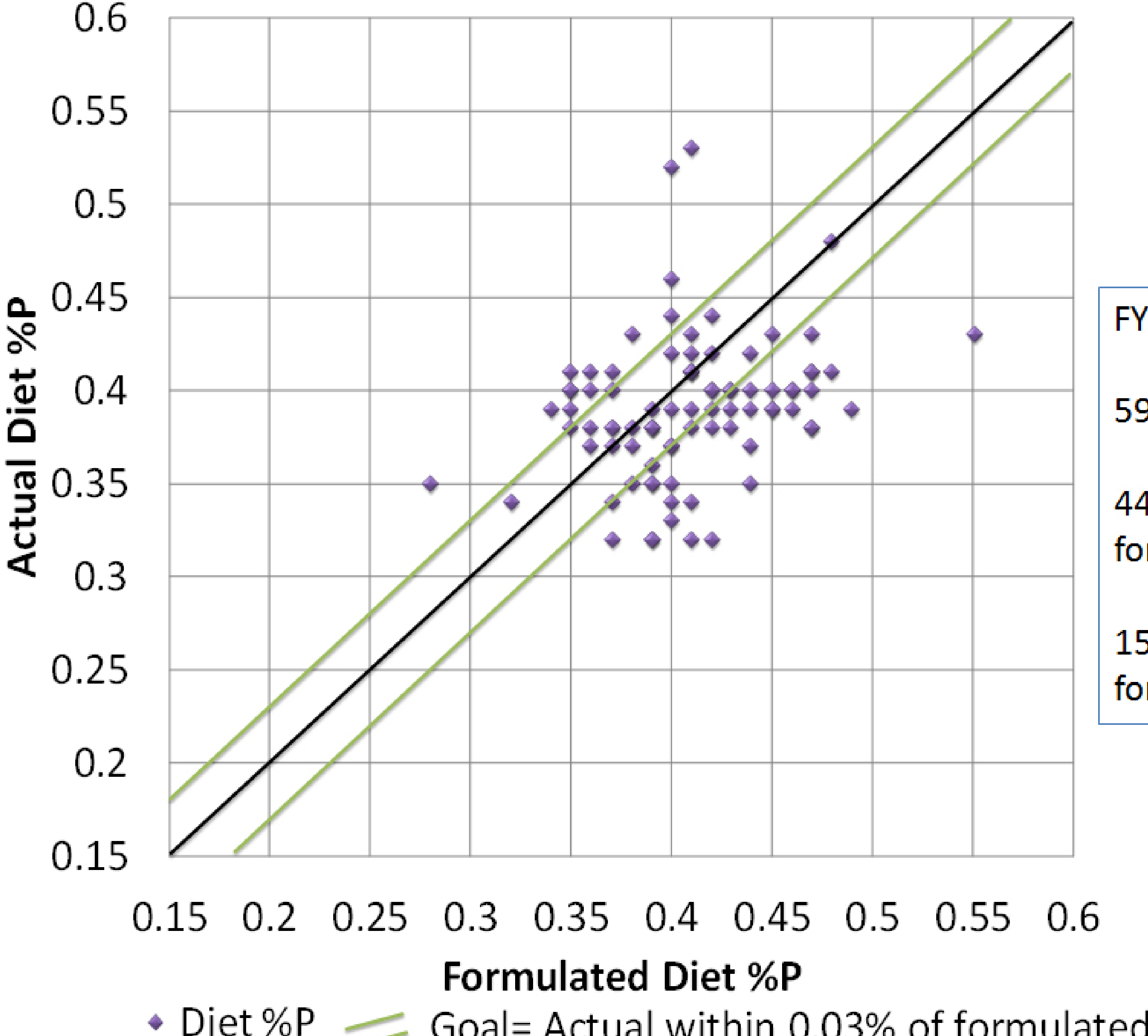
Tracking Ration and Milk Protein

- Collect milk production data
  - **Bulk tank and Cooperative data**
  - **DHIA reports**
- Collect Milk Urea Nitrogen (MUN) data
  - **Goal range: 8-12 mg/dL**
  - **Cooperative reports**
  - **DHIA reports**
- Calculate Milk Nitrogen Efficiency
  - **Uses DMI, ration protein levels, milk production, and milk protein**
  - **Ideal is >30%**

Ration Phosphorous

- Track Actual vs. Formulated levels
  - Evaluate fresh fecal samples for excreted P
  - Compare to animal requirements
  - Adjust rations to meet requirement

Diet %Phosphorus for Lactating Cows

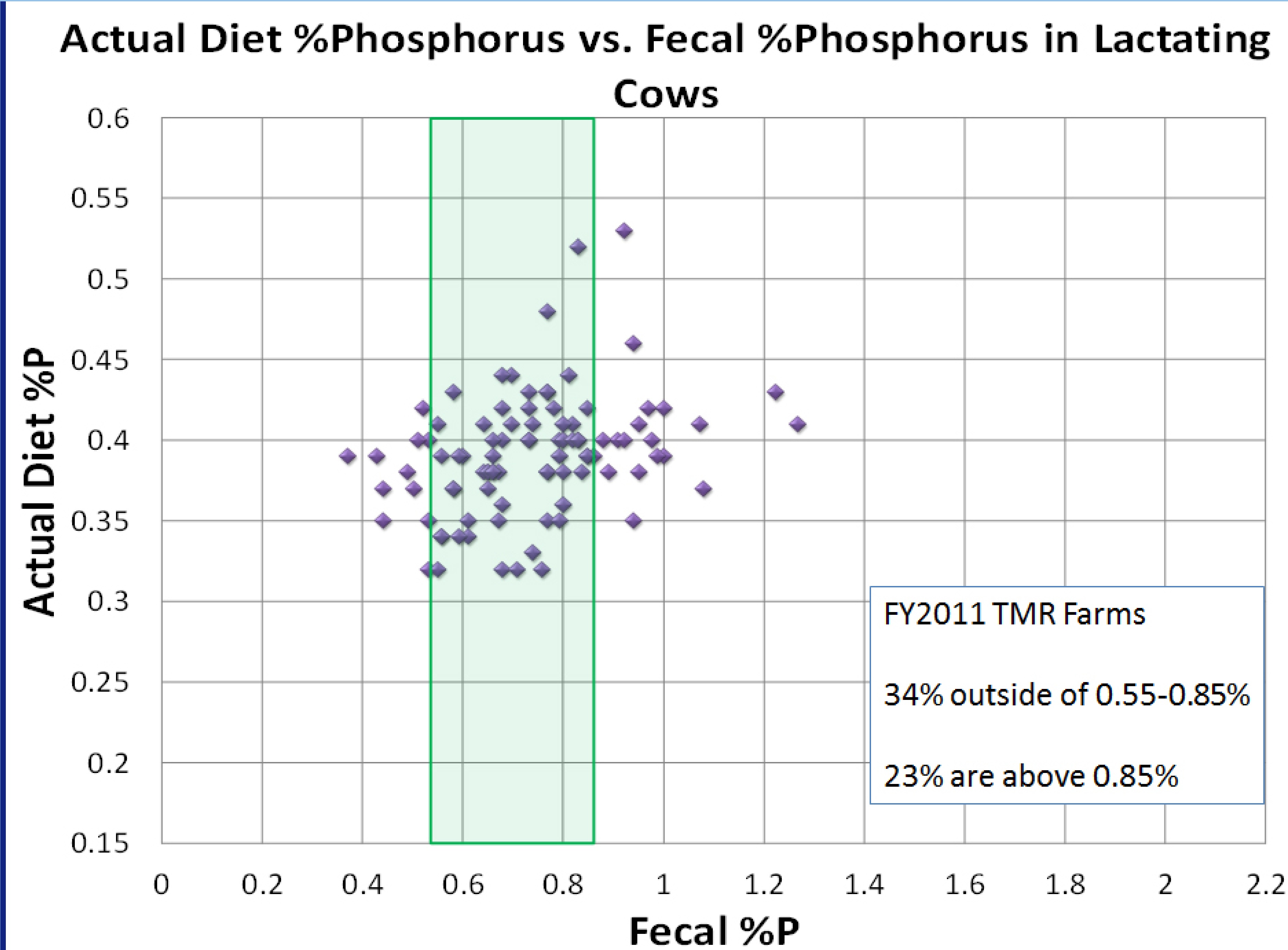


FY2011 TMR Farms

59% outside of 0.03%

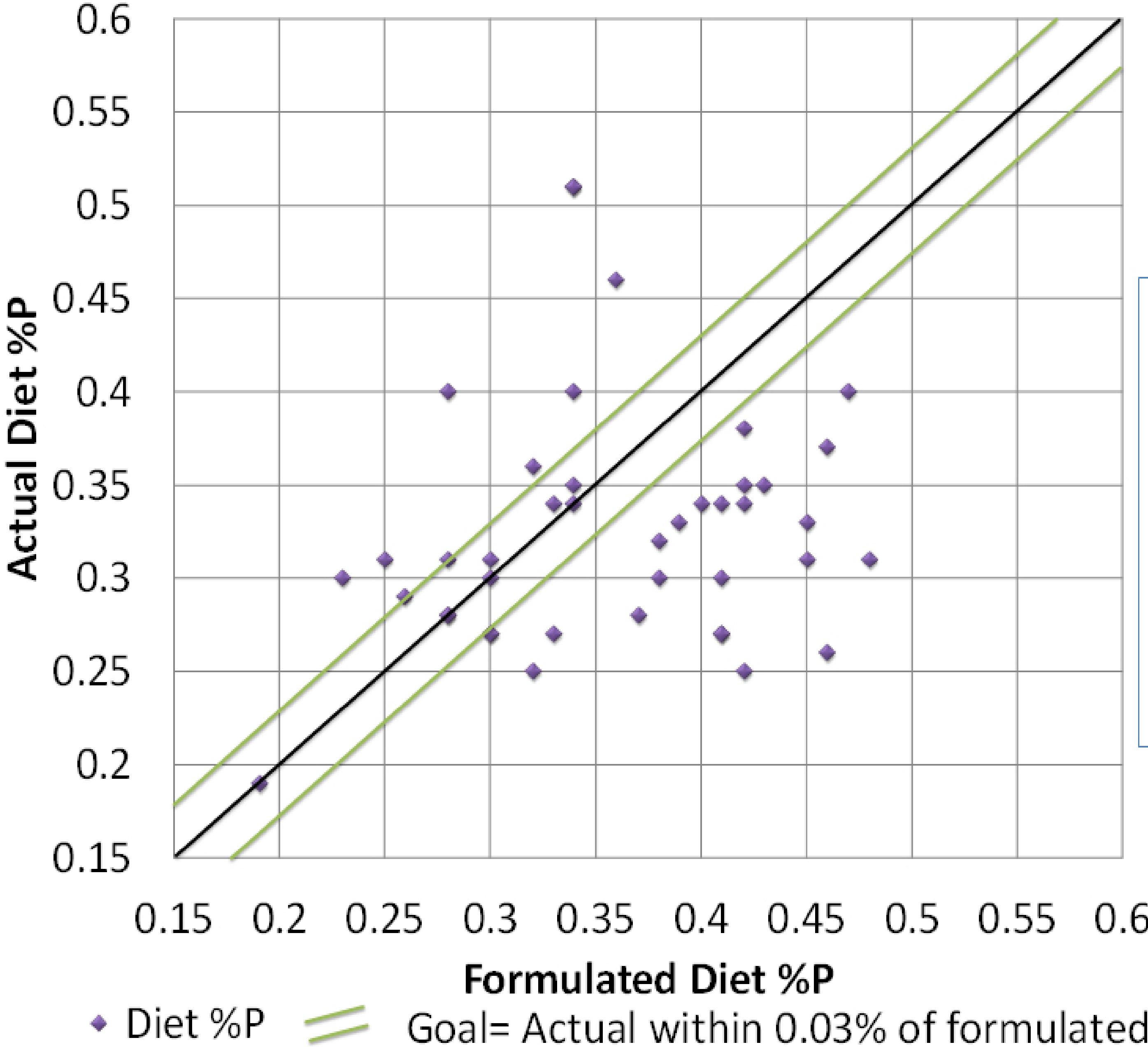
44% are below formulated levels

15% above formulated levels



Actual Diet %Phosphorus vs. Fecal %Phosphorus in Lactating Cows
Actual Diet %P
Fecal %P
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
FY2011 TMR Farms
34% outside of 0.55-0.85%
23% are above 0.85%

Diet %Phosphorus for Heifers and Dry Cows

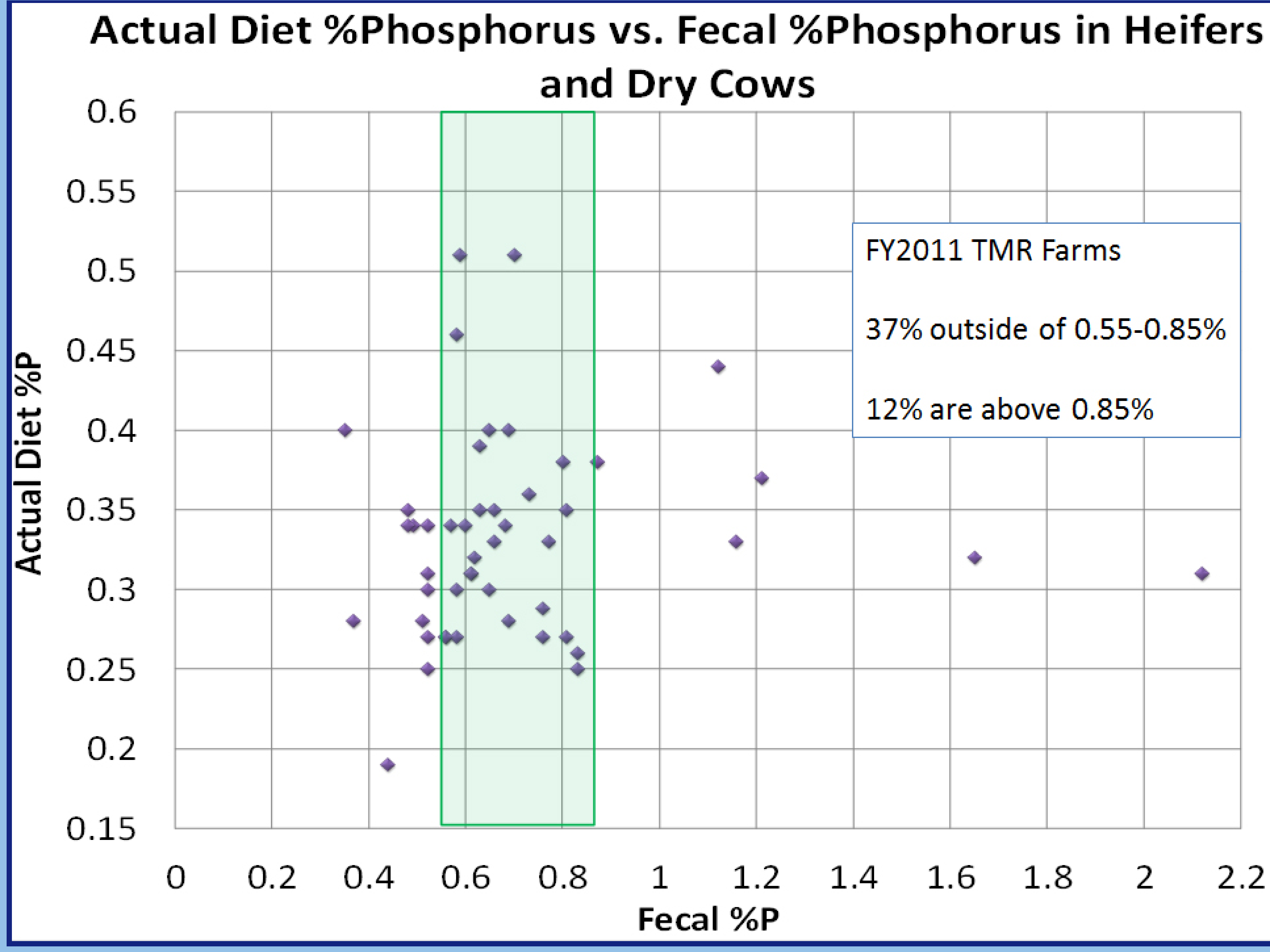


FY2011 TMR Farms

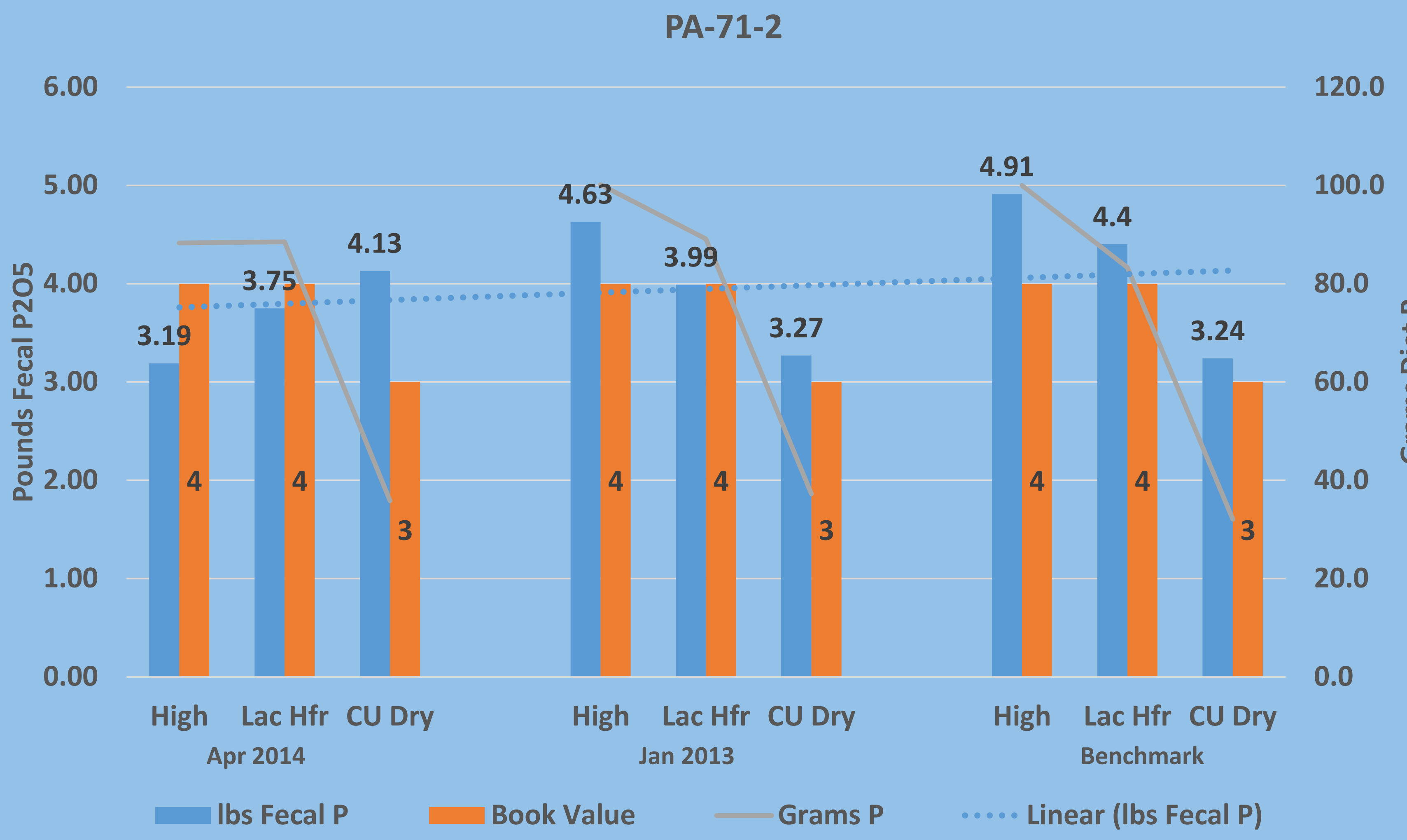
74% outside of 0.03%

55% are below formulated levels

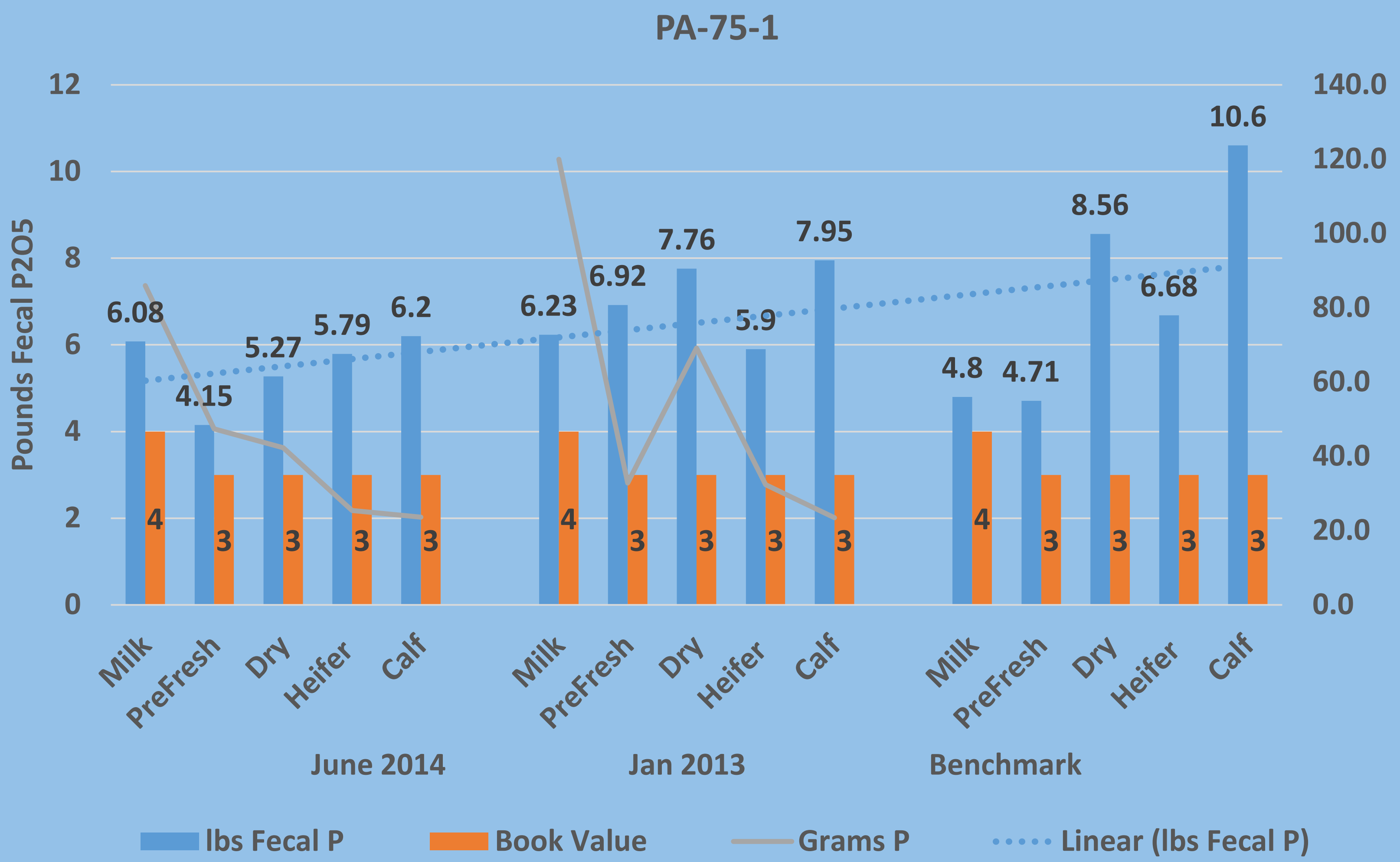
19% above formulated levels


Actual Diet %Phosphorus vs. Fecal %Phosphorus in Heifers and Dry Cows
Actual Diet %P
Fecal %P
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
FY2011 TMR Farms
37% outside of 0.55-0.85%
12% are above 0.85%

Farm Data- Fecal P vs Book Values



Farm Data- Fecal P vs Book Values



United States Department of Agriculture

Penn State **Extension**

Summary

- Most rations meet phosphorus requirements without supplementation
  - **Inorganic P could be removed from rations w/o any detrimental affect to the animal.**
- Some nutritionists have embraced changing their approach to ration development
  - **However, still too many nutritionists from the old school approach.**

Summary

- Producers rely very heavily on consultant recommendations on P supplementation, especially related to reproduction
- Producers not as engaged in this process as we would have liked
  - **Lactating cow diets have improved, but a lot of work to be done with dry cows and heifers.**

http://extension.psu.edu/animals/dairy/nutrient-management

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- **Nutrient and Feed Management**

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Nutrient and Feed Management

Animal nutrition and feeding management are the essential components to controlling nitrogen and phosphorus levels in manure.

Feed Management for Producers

Certified Feed Management Planners: Dairy

Courses and Workshops

- Advanced Topics in Feed Management Conference
- Feed Management by the Numbers
- Feed Management Plan Writing
- Feed Management Planner Certification

Questions?

Phosphorus Technologies

- Farmstead (Production Area)
  - Solid/Liquid Separation
  - Manure to Energy (Thermochemical)
  - Dried Manure Solids Bedding

Solid-Liquid Separation: What is it?

- Solid separation is simply the removal of manure solids (manure, bedding, other material) from the liquid waste stream

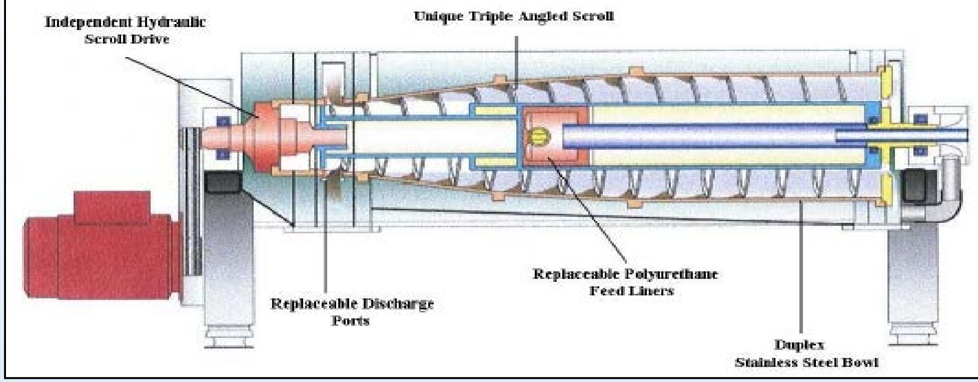
Goal – To partition solids, liquids and nutrients

Waste Separation Facility Standard (632)

Solid/Liquid Separators Efficiency	Total Solids Capture
Static Inclined Screen	10-20%
Inclined Screen with Drag Chain	10-30%
Vibratory Screen	15-30%
Rotating Screen	20-40%
Centrifuge	20-45%
Screw or Roller Press	30-50%
Settling Basin	40-65%
Weeping Wall	50-85%
Dry Scrape	50-90%
Geotextile Container	50-98%

Screw Press


C4E
Flottweg
Separation Technology
DECANTER CENTRIFUGE SOLIDS

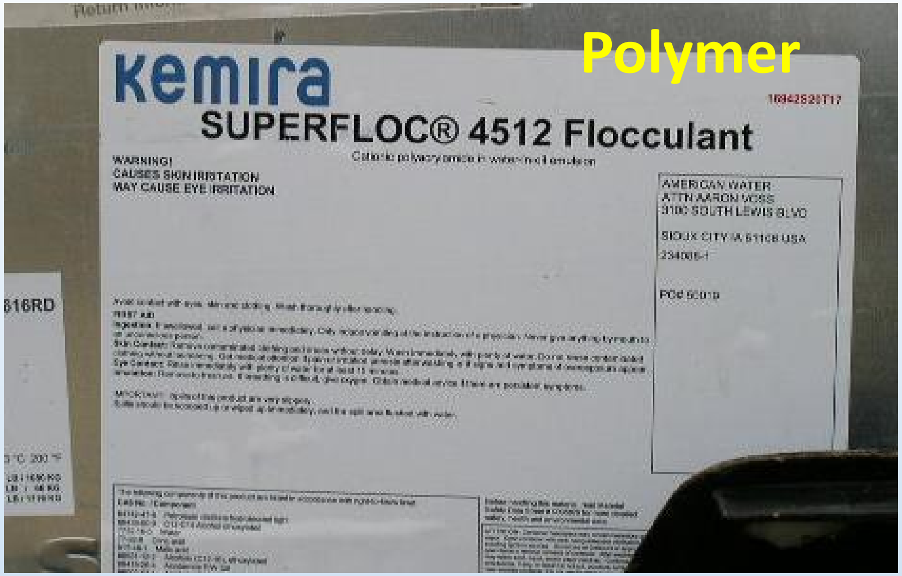

Independent Hydraulic Scroll Drive
Unique Triple Angled Scroll
Replaceable Polyurethane Feed Liners
Replaceable Discharge Ports
Duplex Stainless Steel Bowl

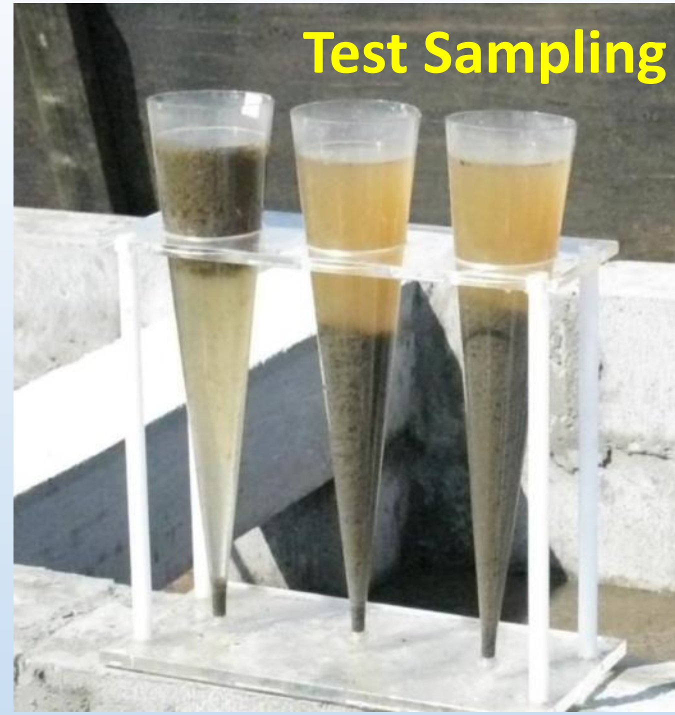
Centrifuge


G2
Vomark
419.658.8675

Chemicals To Enhance Solid-Liquid Separation

1. Use of a variety of chemicals can increase concentration reductions of TS, VS, P to 70% to 90%.
2. Cost of chemical and proper injection are main concerns.
3. Land and containment cost should be considered in the economics.


Polymer
kemira
SUPERFLOC® 4512 Flocculant
WARNING!
CAUSES SKIN IRRITATION
MAY CAUSE EYE IRRITATION


Test Sampling


Treated Dairy Manure


Ferric Sulfate
CORROSIVE
8
UN3264

Metal Salt

Geo-Bag

Centrifuge Results

Solid Separation Trials

NUTRIENT REDUCTIONS IN SEPARATED LIQUIDS ~174K gallons processed

											SOLIDS
TYPE	Species	TKN	NH3N	TP	COD	TS	TSS	K	CU	ZN	Moisture
Lagoon	Swine	62%	31%	85%	85%	81%	99%	38%	99%	99%	61%
Lagoon	Dairy	64%	35%	87%	90%	83%	99%	36%	93%	99%	63%
Fresh	Dairy	70%	56%	91%	91%	81%	97%	42%	90%	99%	72%
Fresh	Swine	71%	40%	93%	97%	85%	99%	51%	99%	99%	72%

Averaged Reductions	TKN	NH3N	TP	COD	TS	TSS	K	CU	ZN	Moisture
	67%	39%	90%	92%	82%	99%	40%	95%	99%	67%

Source: Agricultural Waste Solutions

Belt Press Nutrient Capture

		Polymer	Total Solids	Total P	TKN
VT	Raw	N	65%	50%	32%
NY	Digested	N	27%	23%	19%
NY	Raw	Y	98%	93%	77%
NY	Digested	Y	99%	99%	46%

Dairy Manure

Source: Animal Waste Solutions

BioBag Nutrient Capture
Deep Pit

	Raw Manure %	Filtrate %	Reduction %
Total Solids	1.75	0.78	56
Total N	0.49	0.17	65
Phosphorus	0.09	0.01	89
Potassium	0.21	0.19	10

Swine

Source: EnviroWaste

Thermochemical

- Incineration
  - Fuel + Oxygen → Heat (~3,600 F)
- Gasification
  - Fuel + Limited Oxygen → Fuel Gas (syngas) + Heat + Char (1,100 – 1,800 F)
- Pyrolysis
  - Fuel + Heat → Fuel Gas (syngas) + Char + Bio-oil (390 – 1,100 F)

Combustion W. Virginia

Gasification Unit in California

Gasification Unit in Ohio

Gasification Unit in Pennsylvania

Opportunities for Farm Scale Systems

- Ash and biochar are valuable plant nutrients
  - Nutrient plant availability ranges from 80-100%
  - Poultry litter ash contains
    - 14-18% P_2O_5
    - 13-24% K_2O
  - Material handling needs to be addressed

Source: technology and fuel feedstock	N	P_2O_5	K_2O	S
	%			
Muriate of Potash	0.0	0.0	60.0	0.0
Triple Super Phosphate	0.0	46.0	0.0	0.0
Fresh commercial broiler litter, VA	3.6	2.1	2.1	1.1
Biochar - N.C. State Pyrolysis, commercial broiler litter	1.4	5.2	1.9	0.4
Biochar - modified Coaltec gasifier, turkey litter	2.5	5.9	5.5	1.3
Ash – BSHL fluidized bed combustion, commercial broiler litter	0.3	19.1	14.3	3.0
Ash – EcoRemedy Gasfier, commercial broiler litter	0.5	13.9	7.0	3.2
Ash - Wayne Combustion, turkey litter	0.3	23.8	12.6	2.3
Ash - Blue Flame Boiler, organic broiler litter	0.1	14.6	9.4	1.5
Ash – Energy Works Layer	0	8	10	40*

* Calcium

Dried Manure Solids

Digested, separated and directly used

Separated and directly used

Sand

Source: Cornell Waste Management Institute

Bacterial Levels in Used Bedding

Bedding	***E. coli***	***Klebsiella***
Drum	0.0 ⟹ 3.8	0.0 ⟹ 13.7
Windrow	0.0 ⟹ 3.2	0.6 ⟹ 9.8
Digested	0.0 ⟹ 6.7	1.0 ⟹ 7.4
Drum	0.5 ⟹ 5.8	1.1 ⟹ 12.3
Sand	0.0 ⟹ 5.6	0.0 ⟹ 10.4
Separated	0.7 ⟹ 2.9	3.8 ⟹ 12.8
Separated	2.7 ⟹ 2.3	4.7 ⟹ 12.8
Separated	3.8 ⟹ 4.3	3.9 ⟹ 8.7

Source: Cornell Waste Management Institute

Conclusions

- Solid separation can be an effective tool for partitioning phosphorus
- Chemical enhancement can greatly increase solid and phosphorus partitioning
- Thermochemical processes reduce solid volume and concentrate phosphorus
- Separated solids can be used for bedding which can reduce the amount of phosphorus to be land applied

Should liquid dairy manure be injected?

Rory Maguire
Associate Professor and Extension Specialist
Virginia Tech

Why Inject Manure?

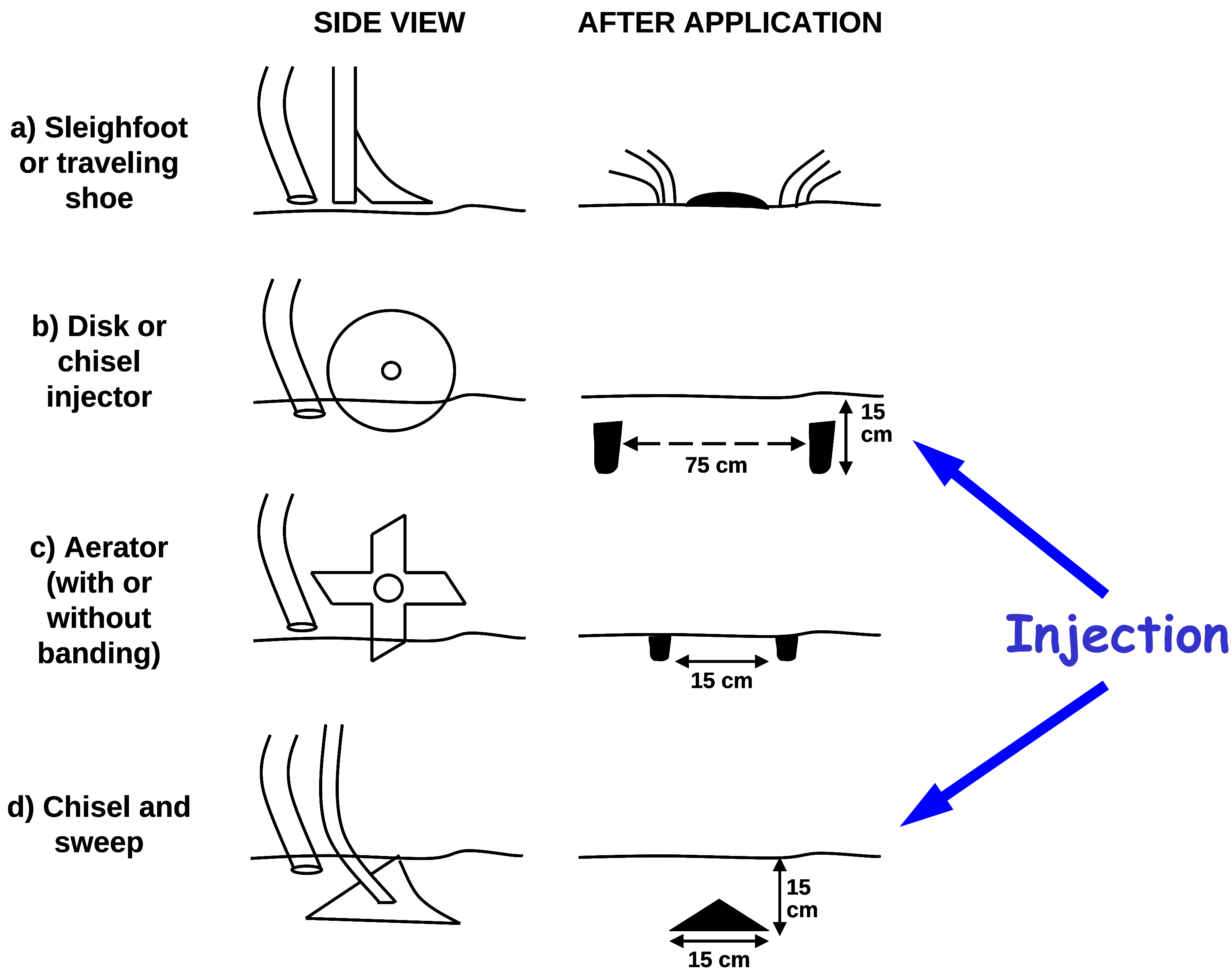
1. Reduce odors, becoming more important with urban sprawl
2. Agronomic - Improve N use efficiency by decreasing ammonia volatilization, but economic importance depends on N prices
3. Environmental - Decrease N and P losses in runoff

A BMP that is cost effective?

Poultry Litter Injector

Current version doesn't work

Types of tool available - Liquid manure




HOULE


Yetter
Yetter
Yetter
Yetter
Yetter
Yetter

Impact on phosphorus lost (very few studies available)

Implement	Total P load lost		Dissolved P lost	
	Row crop	Forage	Row crop	Forage
	% change			
Chisel	<94			
Disc	<0-91	<84	<71-94	
Aerator	<94	<0-88	<96	<13-90

Dairy Manure Plant Available Nitrogen (lbs/1000 gal)

Total N 19.22 – 8.88NH_4 = 10.34 Org N

	Surface	Injected
Organic	(35%)	(35%)
	3.62	3.62
Ammonia	(25%)	(95%)
	2.22	8.44
Total PAN	~6	12

Value of Plant Available Nitrogen

Increased Value due to Injection = ~ 6 lb PAN/1000 gal

@ 50 ¢/lb, added value = $3 / 1000 gal

Increased Nitrogen Value 500,000 gal = $1,500

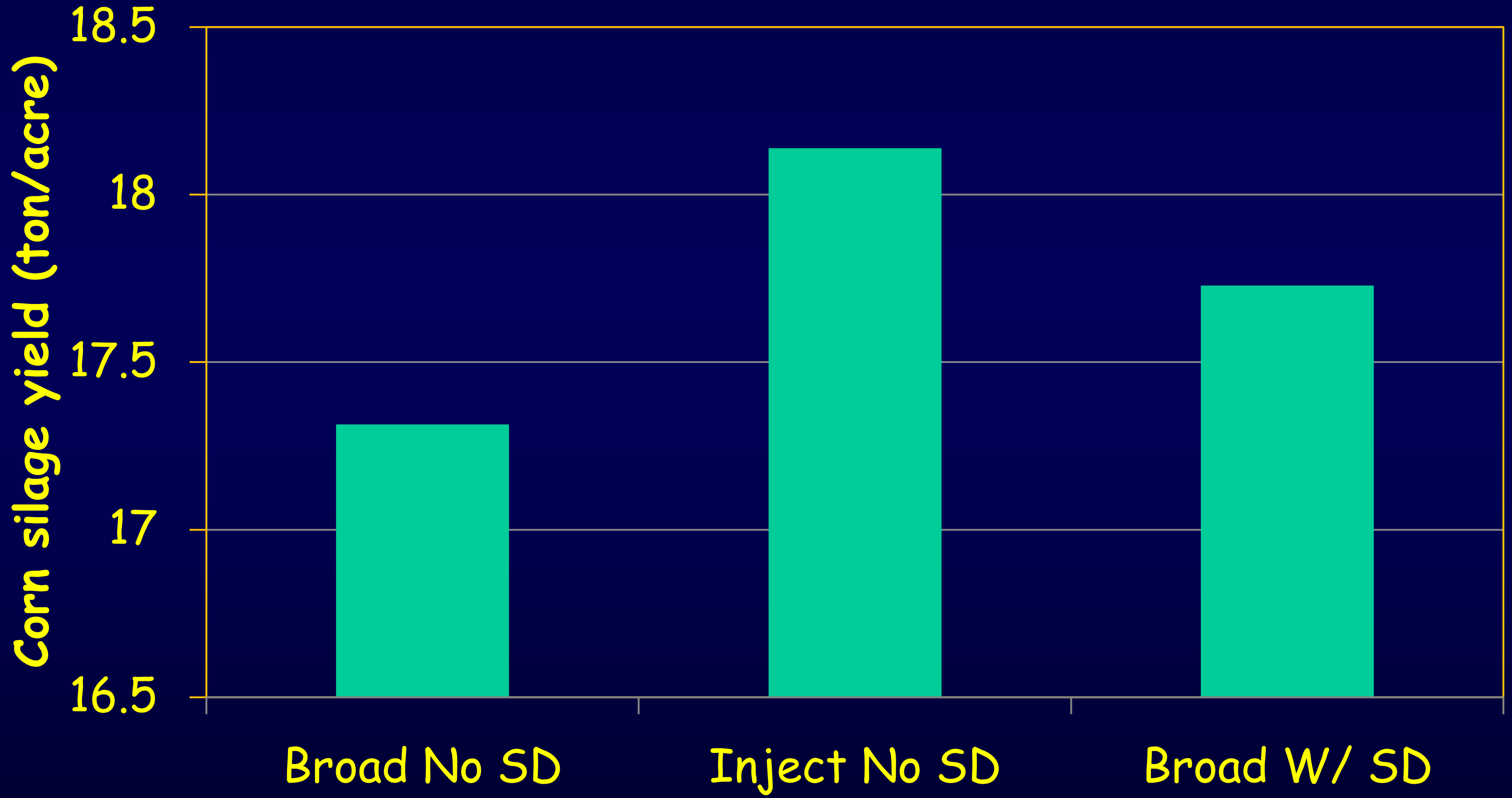
Farmer Manure Injection Experience

1. More uniform/ consistent looking corn
2. No problems with rocks
3. Nursing only effective over larger distances
4. Odor dramatically reduced
5. Still need starter nitrogen for corn at planting

Farmer Manure Injection Experience

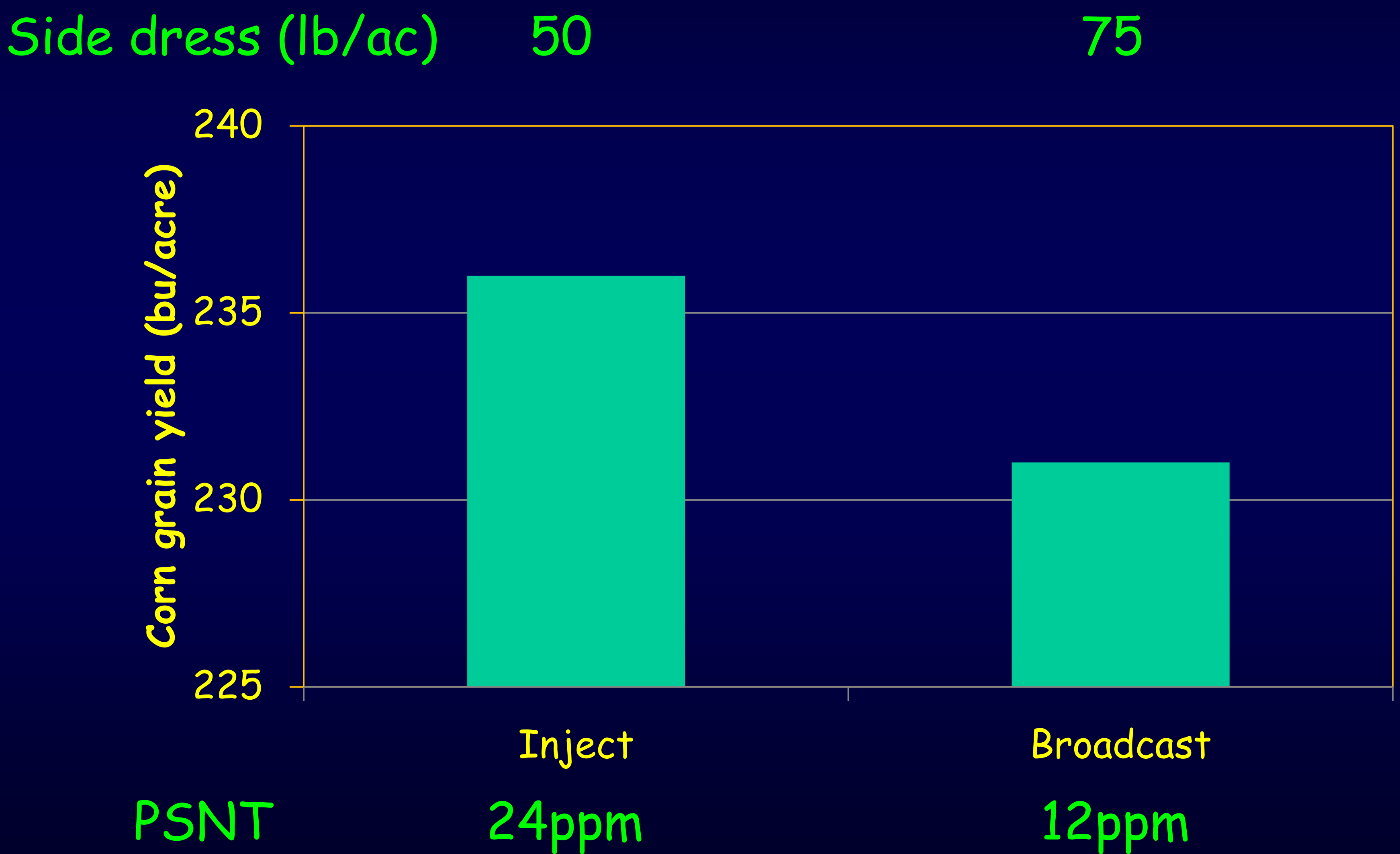
6. Roots proliferated in injection slits
7. NRCS cost share available
8. Lower nutrient runoff
9. Not much slower
10. The extra N from injection will reduce/ remove the need to side-dress

Kyle site 2014



PSNT 28ppm 41ppm 28ppm

Anthony site2014



Value of Nitrogen from Injection

PSNT ppm x 4 = lbs N/ac

Kyle's PSNT

41 – 28 = 13 x 4 = 52 lbs N/ac

Anthony's PSNT

24 – 12 = 12 x 4 = 48 lbs N/acre

Manure injection costs
(6000 gal/acre on 80 acres)

Type	Ac./hr.	Equipment cost/hr.	$/ac.	*N recovery w/ injection	Cost/ac. less N	Net injection cost/ac.
Broadcast	3.3	$105	$32	$0	$32	
Injection w/o nursing	2.6	$150	$58	$35	$23	($9)
Injection w/ nursing	3.3	$255	$77	$35	$42	$10

*N recovered amount 50 lb/acre and valued at $.70/lb.

Increased Carbon Capture?

Conclusions

- Feasible - it can be done in local soils
- Extra N more than covers extra cost of injecting before NRCS cost share
- Odor reduction may open more areas
- May not increase yield, but will reduce/ remove need for side-dress N
- "Soil Health" research with farmers continuing

Questions?

Contact Information

Dr. Rory O. Maguire
Associate Professor
College of Agriculture and Life Sciences
Virginia Tech University
rmaguire@vt.edu

Virginia A. Ishler
Extension Specialist
College of Agricultural Sciences
Penn State University
vishler@psu.edu

Jeff Porter
Manure Management Team Leader
USDA-NRCS
jeffrey.porter@gnb.usda.gov