

**3rd Annual**  
**Midwest Soil Improvement Symposium:**  
**2013**

*Research and Practical Insights into Using Gypsum*

*March 7, 2013*

***Gypsum Curtains:  
Edge-of-field Phosphorus Filtration***

***Dr. Ray Bryant***

*Research Soil Scientist, Pasture Systems and Watershed Mgmt.*

*Research Unit,*

*USDA-Agricultural Research Service, University Park, PA*



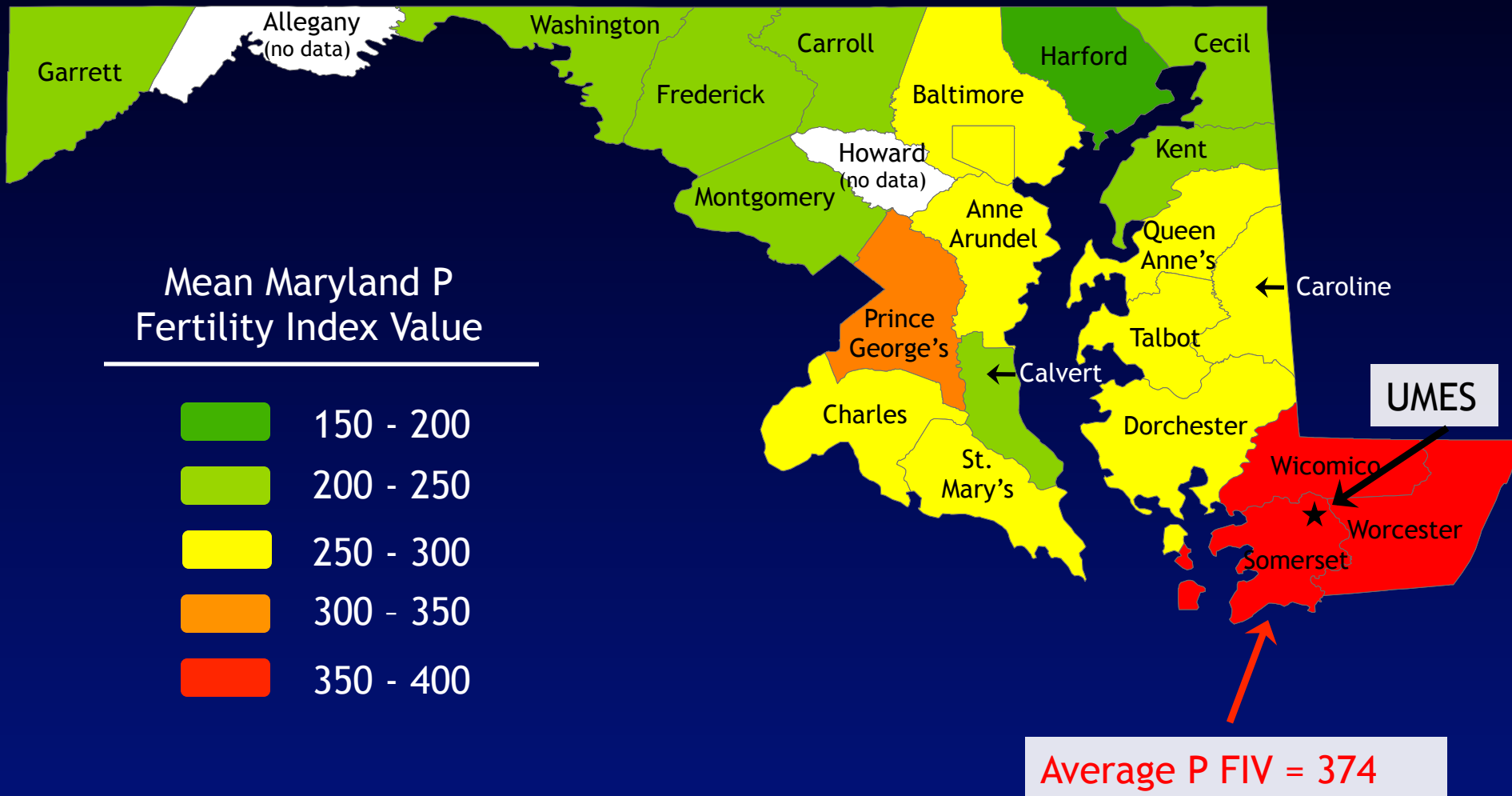


# Gypsum Curtains: Edge-of-field phosphorus filtration

R.B. Bryant, A.R. Buda, P.J.A. Kleinman, C.D. Church  
J.M. McGrath, K.L. Grubb, S. Bose, A.L. Allen

# Soil test P levels are high on the Eastern Shore of Maryland

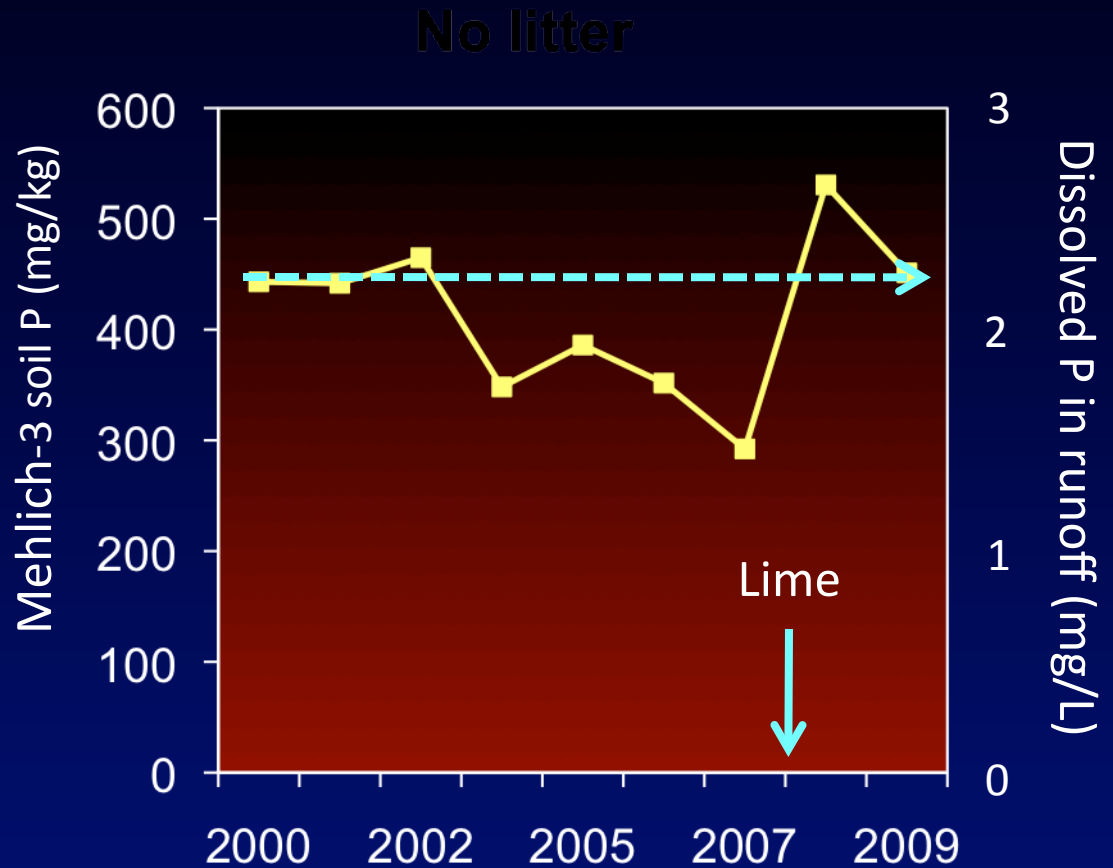
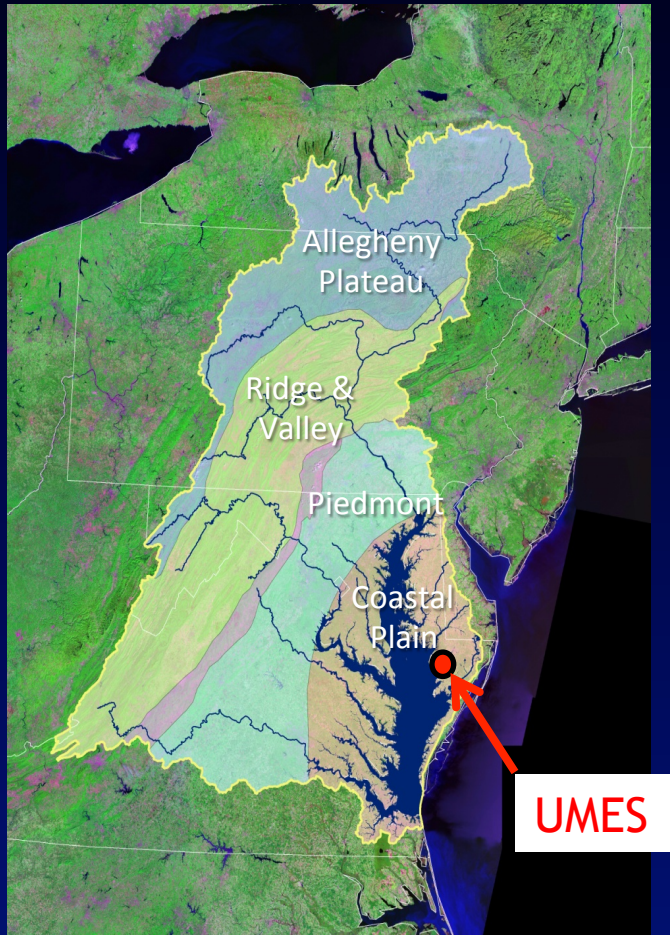
*Restricted to fields where the Maryland P Index was run (FIV > 150 only)*





# No change in soil test P after one decade of continuous corn : Zero P additions

*High soil P has water quality consequences*



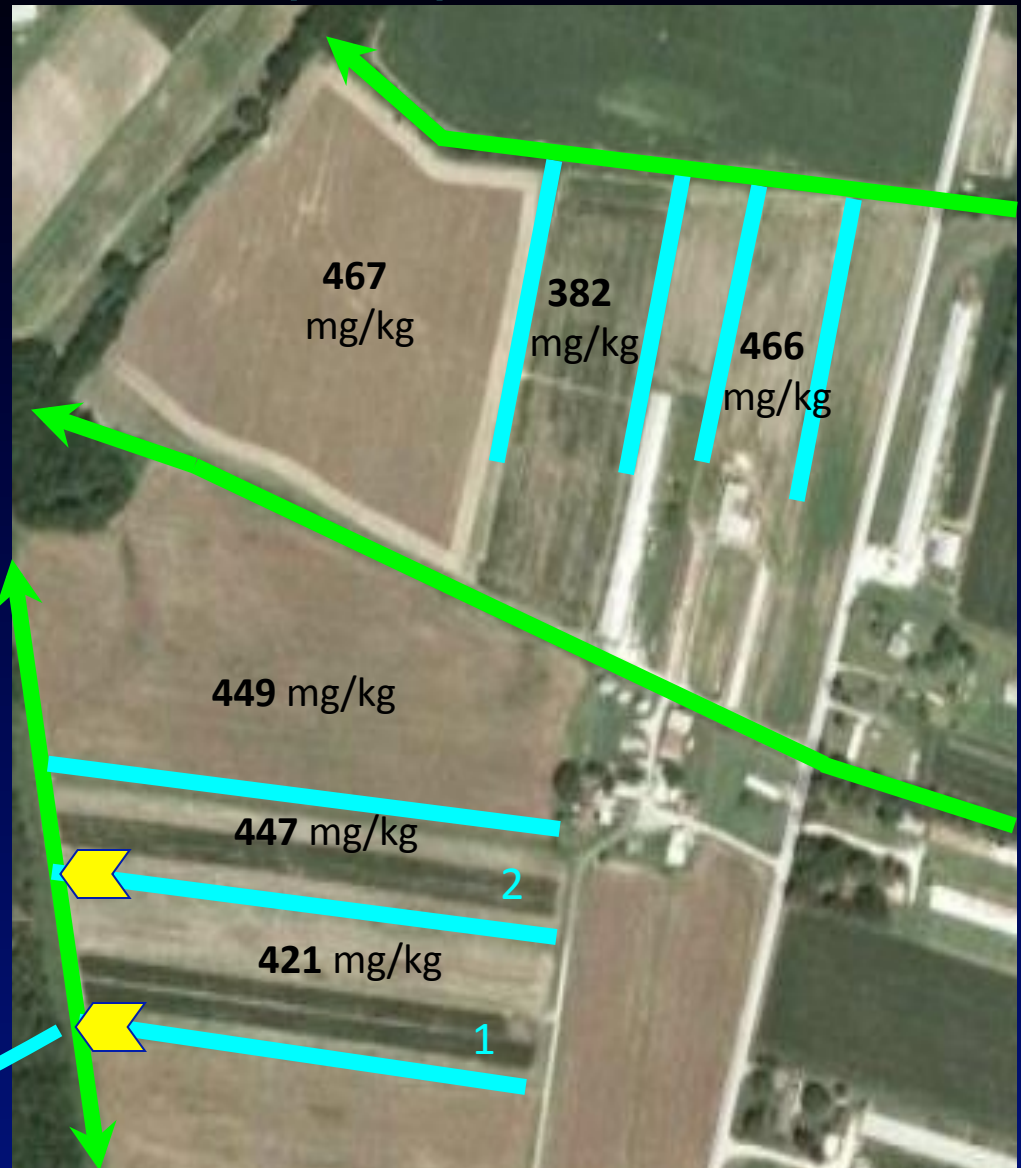
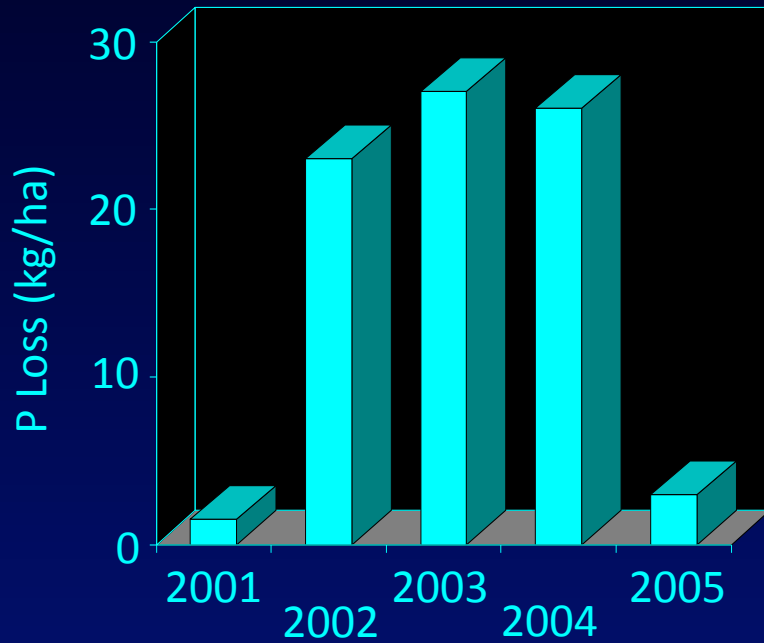
Maryland, USA (Kleinman et al., 2010)



# Total P loads from drainage ditches

*Annual loads vary with precipitation*

UMES Experiment  
Station  
Former Poultry Farm



# BAY JOURNAL

## EPA finds flaws in most states' plans to clean up waterways

### Initial Findings: Agricultural

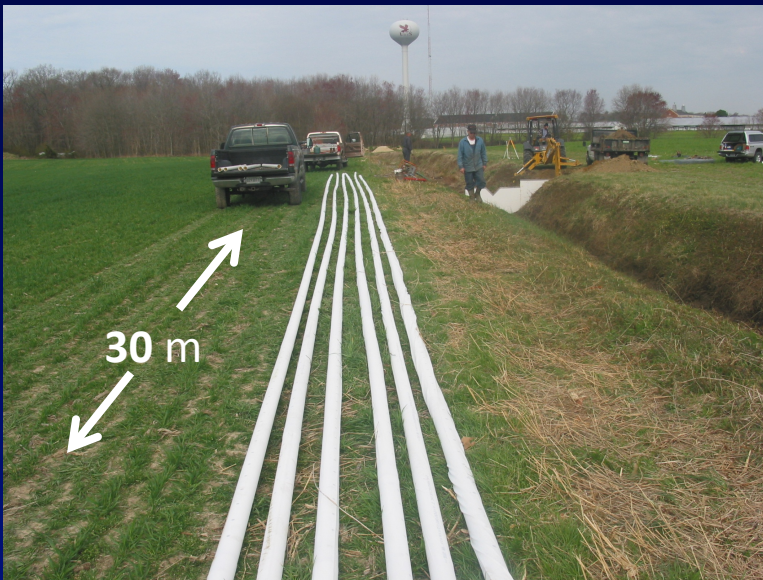
- Limited assurance that agricultural reductions will be met, given little to no detail on plan for building technical assistance, leveraging financial incentives and verifying implementation of practices
- Implementation rates of proposed conservation practices are unrealistic to achieve by 2025 unless incorporated into state technical standards or other regulatory programs
- No or limited commitment to improving phosphorus (P) management to address high P in soils and related excess manure
- Additional reductions may be possible through new technologies (e.g., manure incorporation)
- Compliance/enforcement strategies inadequate

Source: Chesapeake Bay Draft TMDL, September 2010



# FGD gypsum filter - 1<sup>st</sup> generation

120 tons of FGD gypsum (5 truck loads)



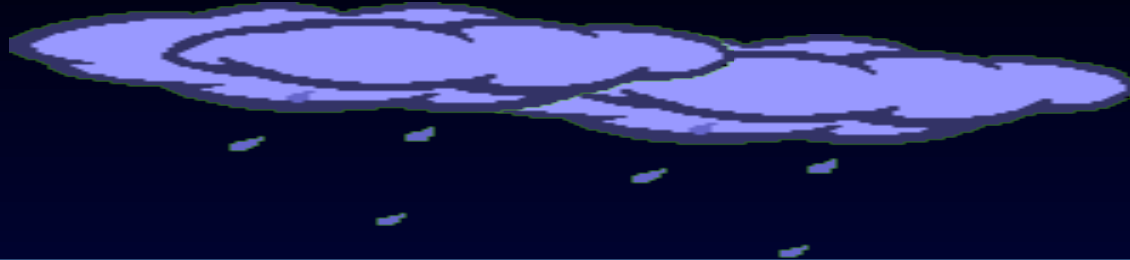


# P Removal by filtration





# Dissolved P, As, and pH



AsP=0.4003 mg L<sup>-1</sup>  
pH=7.3

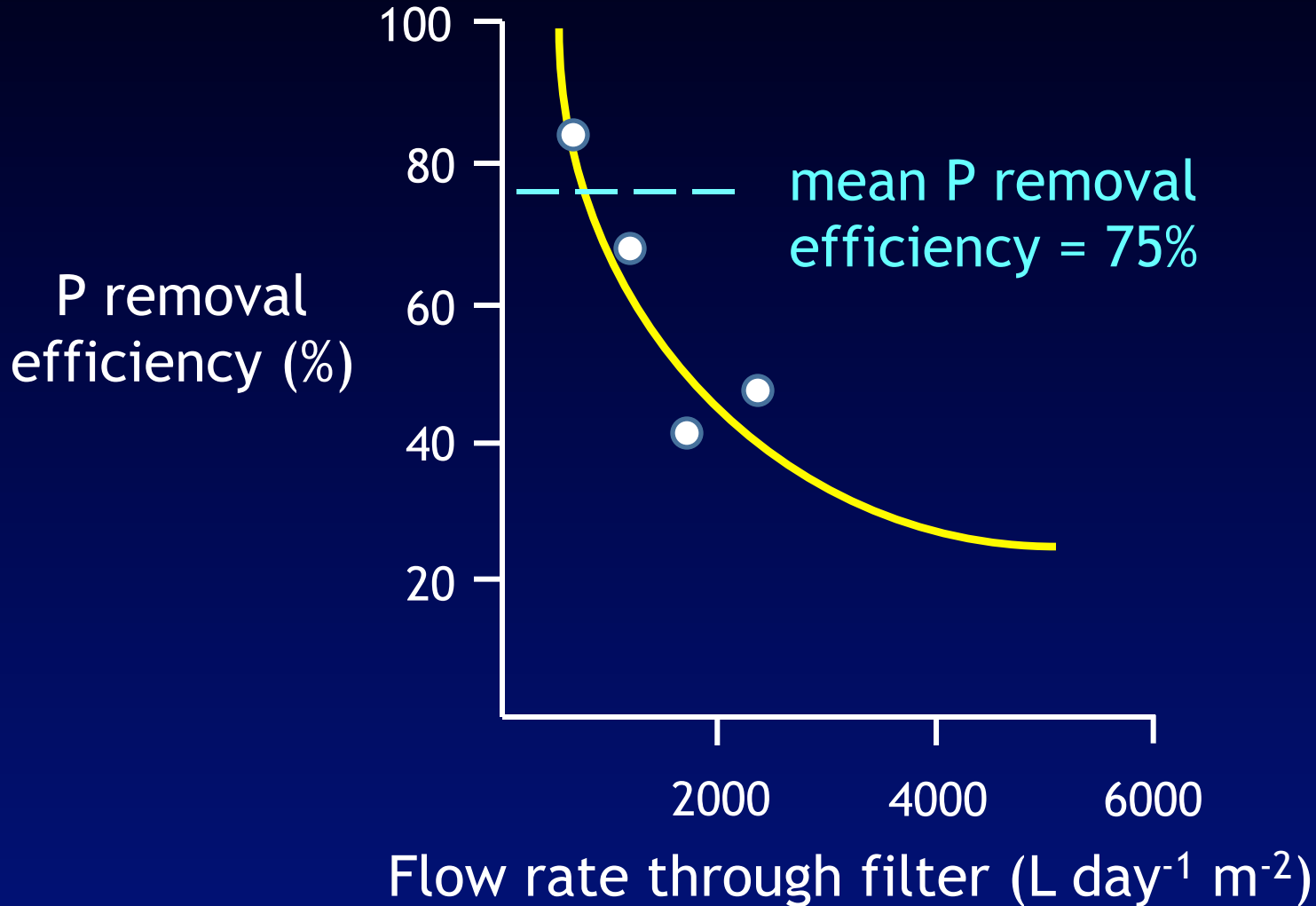
Gypsum

AsP=0.4003 mg L<sup>-1</sup>  
pH=7.3  
(non detect)

Gypsum



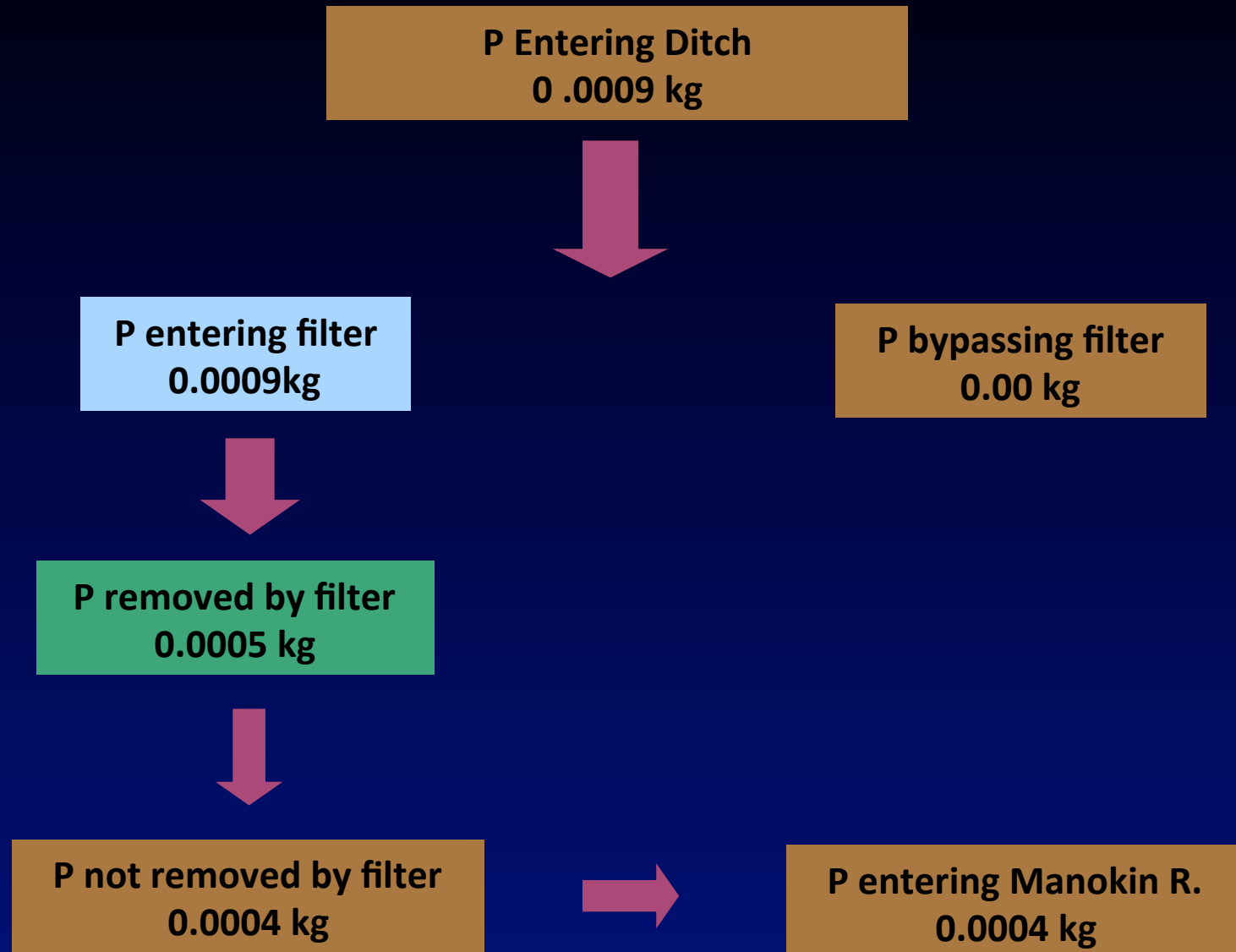
# P removal efficiency is greatest at low flow rates





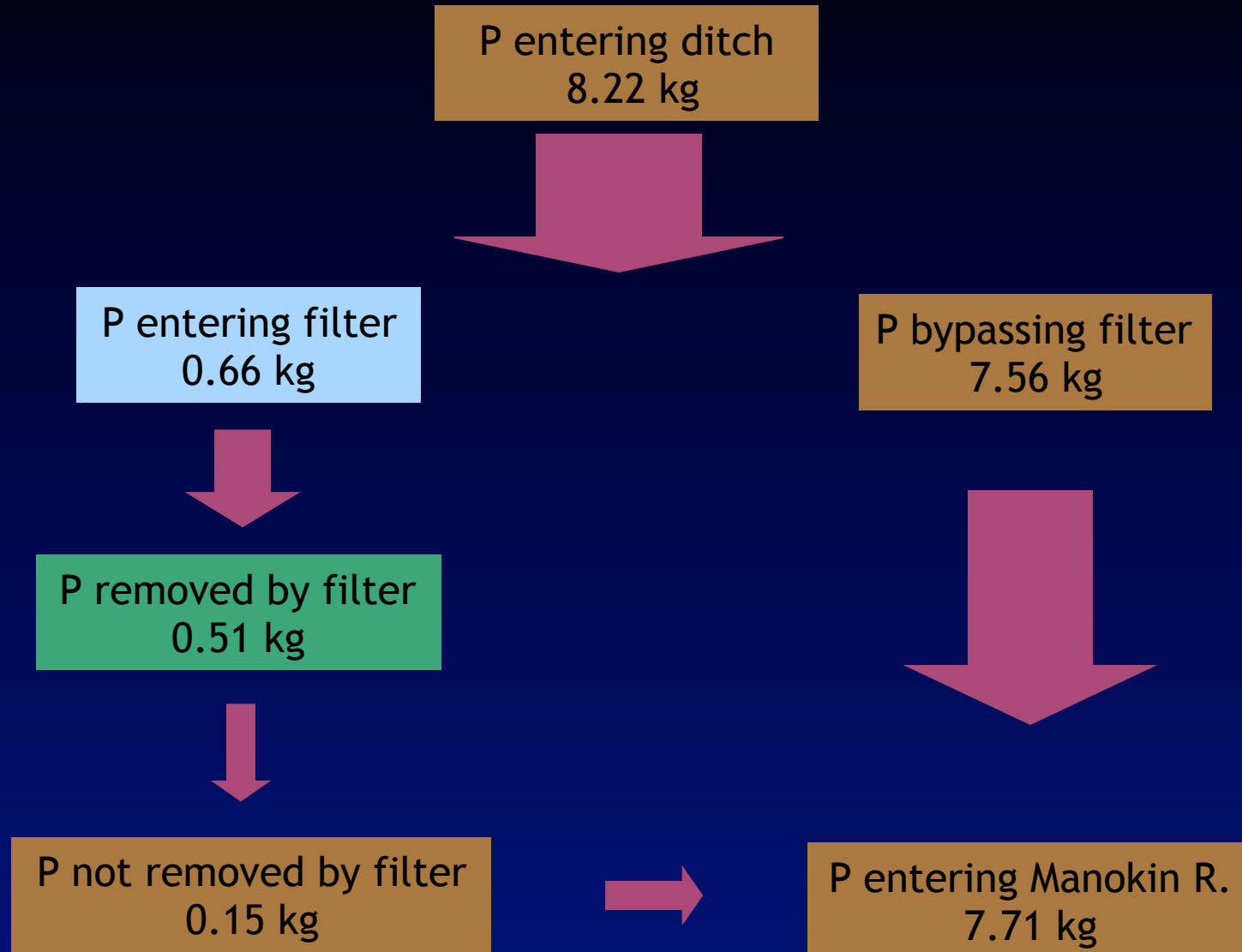
# P removal by gypsum filter for April 13, 2007

Storm event: 0.64 inches of rain in 13 hrs.



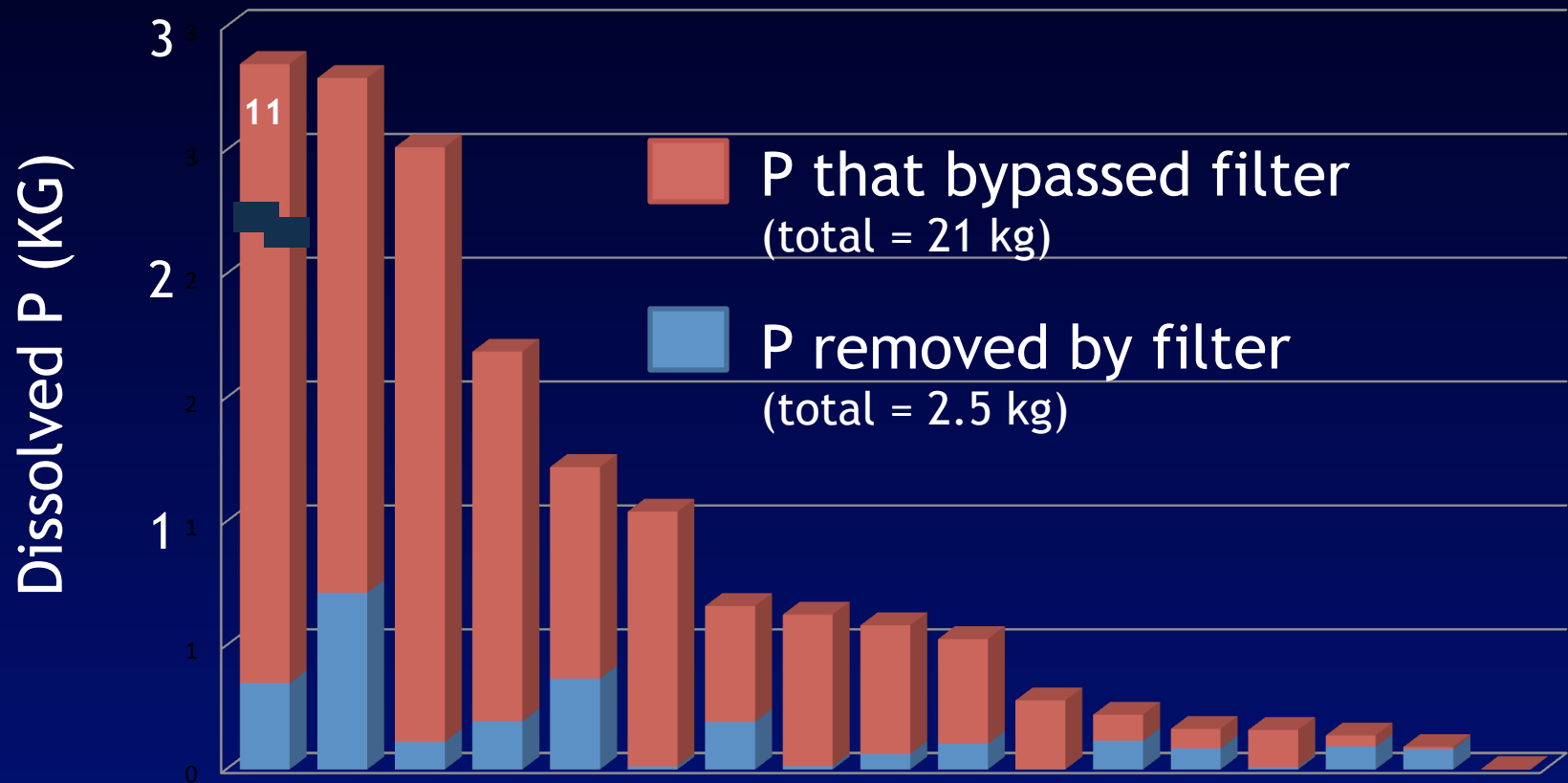
# P removal by gypsum filter for April 18, 2007

Storm event: 3.31 inches of rain in 30 hrs.





# Dissolved P loads in 17 storm events



# Maximum flow rate through gypsum over time



# Conclusions

- Gypsum was chemically efficient: 70% P removal from water passing through gypsum
- Total efficiency over the 4 year life of the filter was only 22% P removal due to bypass flow
- Hydraulic conductivity decreased from 4 L min<sup>-1</sup> to < 1 L min<sup>-1</sup> over time
- Maintenance requirements: tillage of the filter surface, dam and spillway inspections and repairs, clean out when gypsum is “spent”



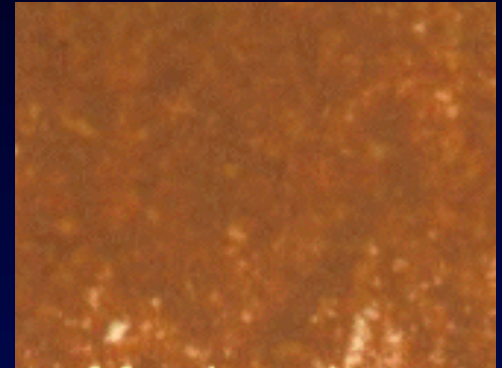
# The future of filtration

Josh McGrath is working with gypsum and other materials in new ditch filter designs.  
\$1M NRCS Conservation Innovation Grant

Aleksandra Drizo, U of Vermont, is working with steel slag in canister filters designed to address point sources such as barnyards.

Meanwhile, back at UMES...

Acid mine drainage  
treatment residuals  
(Fe & Al oxides)



Steel slag



FGD gypsum



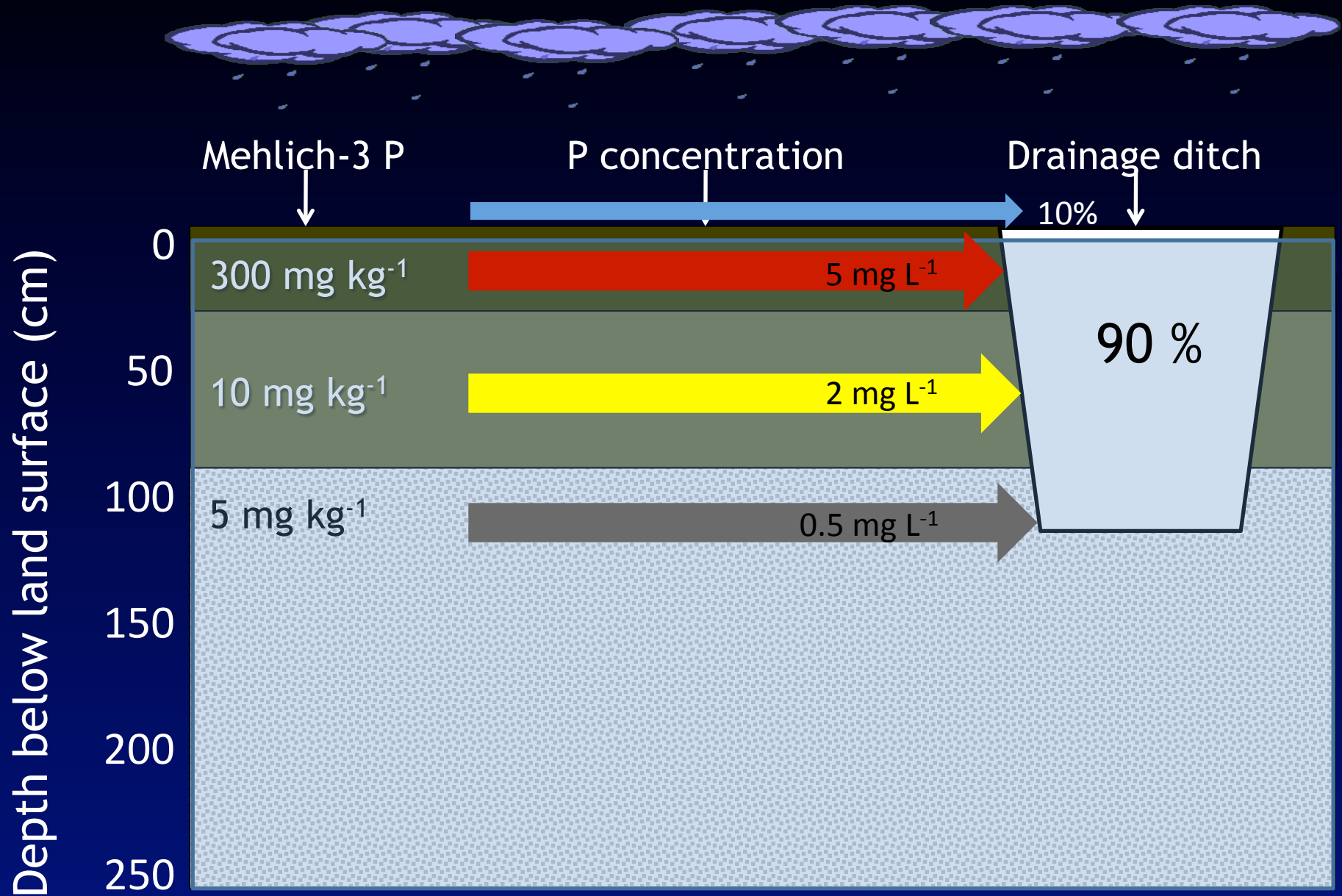
Fly ash



Drinking water  
treatment residuals  
(alum)



# P transport processes in Coastal Plain soils

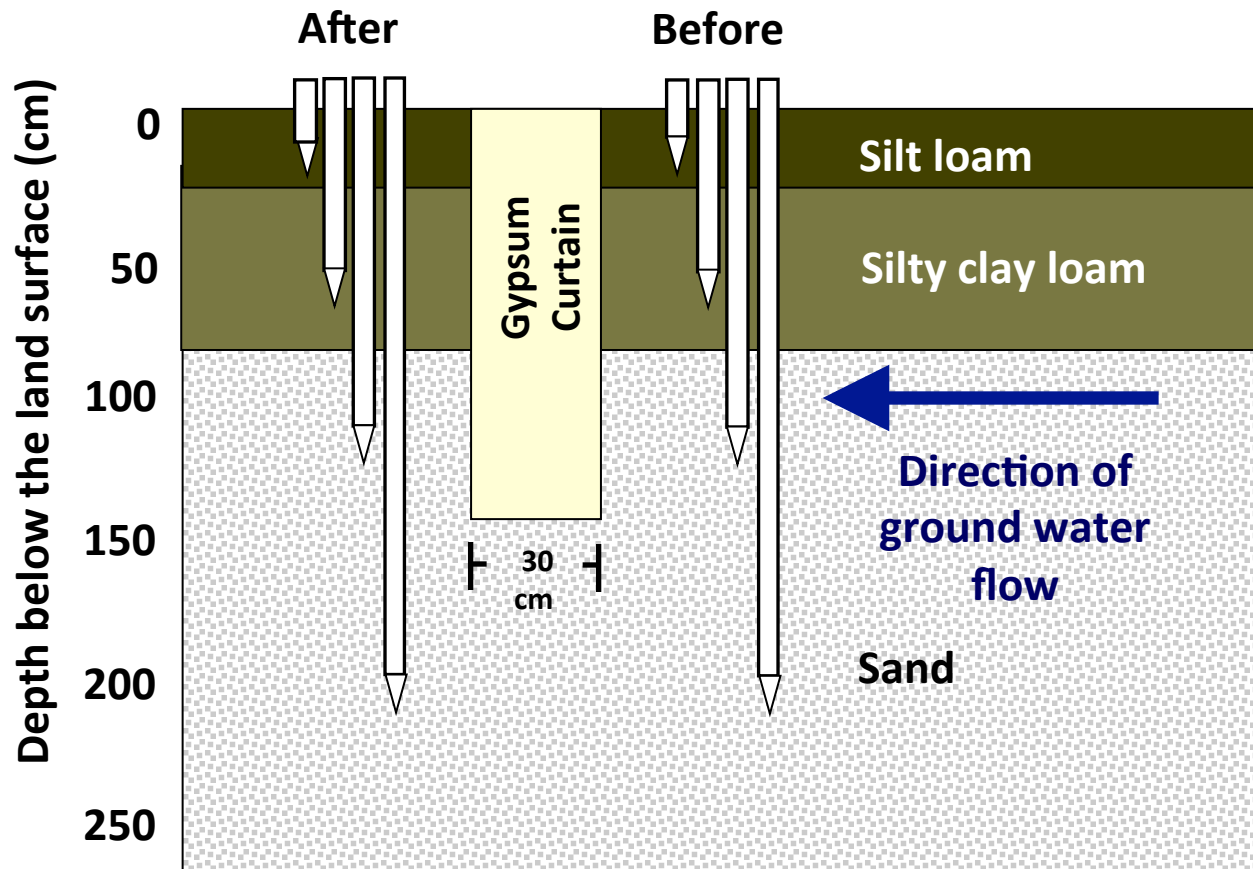




# FGD gypsum "curtain" – 2<sup>nd</sup> generation

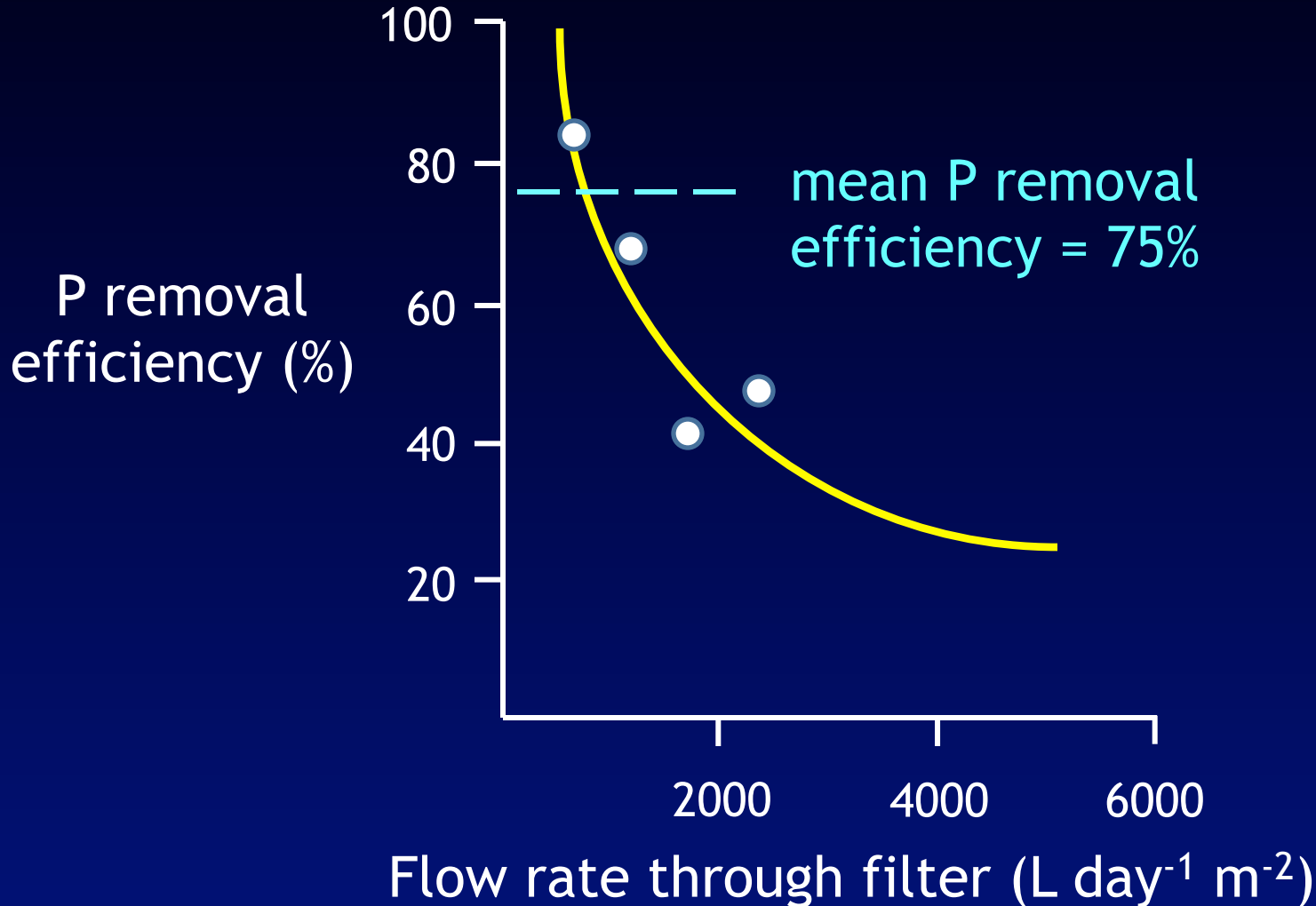


# Nested piezometers for monitoring P concentration

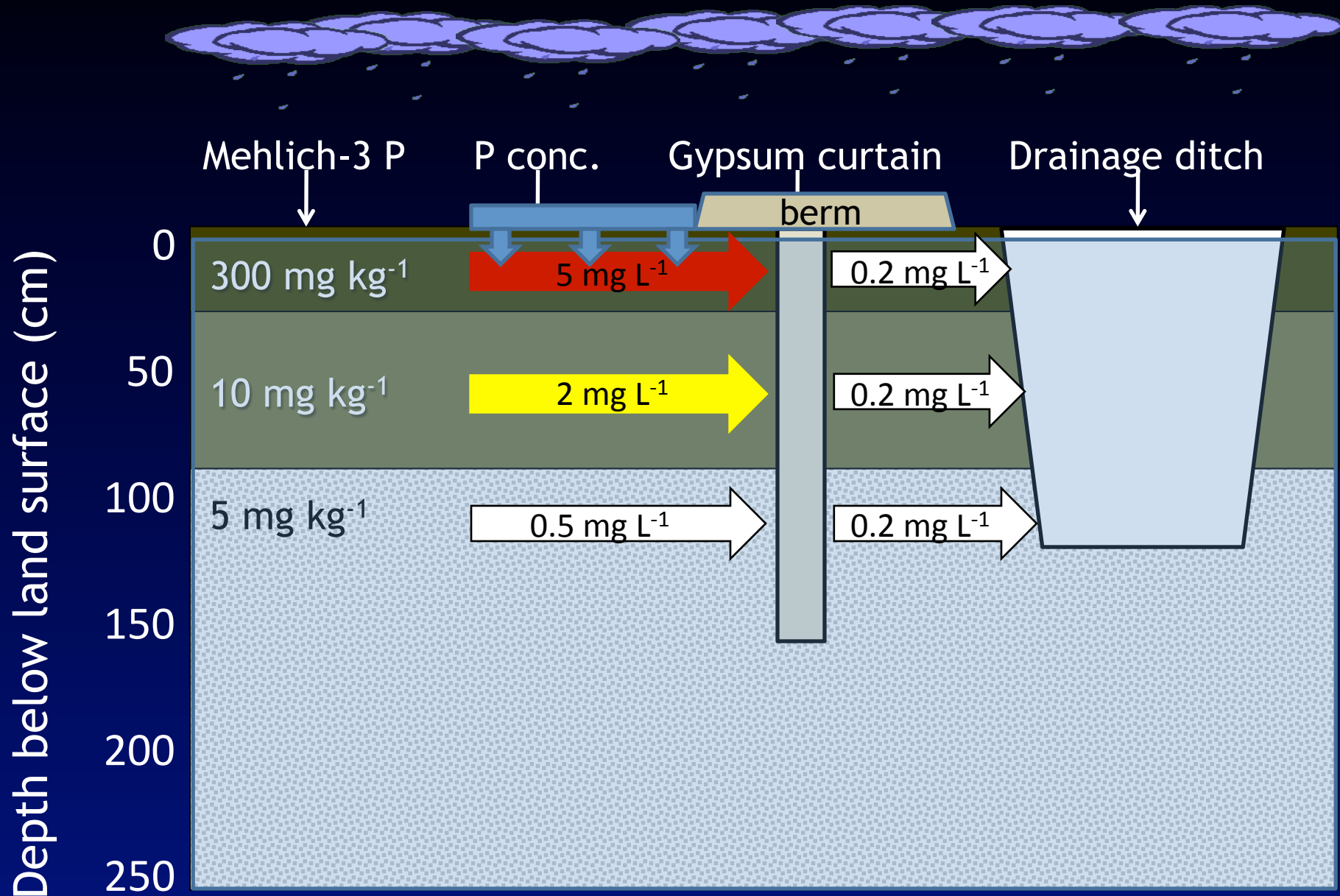




# P removal efficiency should be high (lateral groundwater flow is very slow)



# FGD gypsum “curtain” – 2<sup>nd</sup> generation



# FGD gypsum “curtain” – 2<sup>nd</sup> generation

Conservation Innovation Grant

UMES, ARS, UMCP,  
Constellation Energy



\$1 M Natural Resources Conservation Service

\$1 M Constellation Energy (donated gypsum)

GOAL: Develop standards for gypsum curtains

Establish eligibility for cost share

Evaluate cost effectiveness

# FGD gypsum “curtain” – 2<sup>nd</sup> generation

*Applying the practice at a larger scale*

20,000 tons of gypsum trucked from  
Baltimore



Temporarily stored in litter sheds





# FGD gypsum “curtain” – 2<sup>nd</sup> generation

*Applying the practice at a larger scale*

Trencher with one foot wide belt



Trailer style “Side Shooter”



# FGD gypsum “curtain” – 2<sup>nd</sup> generation

*Applying the practice at a larger scale*

Automated samplers monitor ditch flow



Testing the benefits of land application

Improved infiltration and drainage  
Lower dissolved phosphorus levels  
Increased calcium and sulfur content





# FGD gypsum “curtain” – 2<sup>nd</sup> generation

*Applying the practice at a larger scale*

Double ring infiltrometer measures  
gypsum effect on infiltration



Educating the next generation of water  
quality professionals





# Environmental concerns?

- FGD gypsum contains small amounts of arsenic and mercury
- Arsenic in soil is sequestered by gypsum as Ca arsenate (arsenate behaves similar to phosphate)
- No detectable mercury loss in leachate (below drinking water levels)
- Burial prevents photoinduced mercury volatilization

# Cost?

- No cost to producer / landowner
- Constellation Energy will donate gypsum
  - Value: \$15 per ton plus \$35 for transportation
  - One ton gypsum per 6 to 8 foot of trench
  - In 10 years (estimated life of gypsum curtain) one power plant produces sufficient gypsum to line all ditches in Maryland
- NRCS to cost share installation
  - Cost to be determined (currently \$2.50 / ft)



# Questions?





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**Q & A**  
*with Dr. Torbert and Dr. Bryant*



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*Research and Practical Insights into Using Gypsum*

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*Lunch*



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*United Soybean Board Research Update*

*Randall Reeder*

