Managing Legacy Phosphorus to Sustain Agriculture and Protect Water Quality

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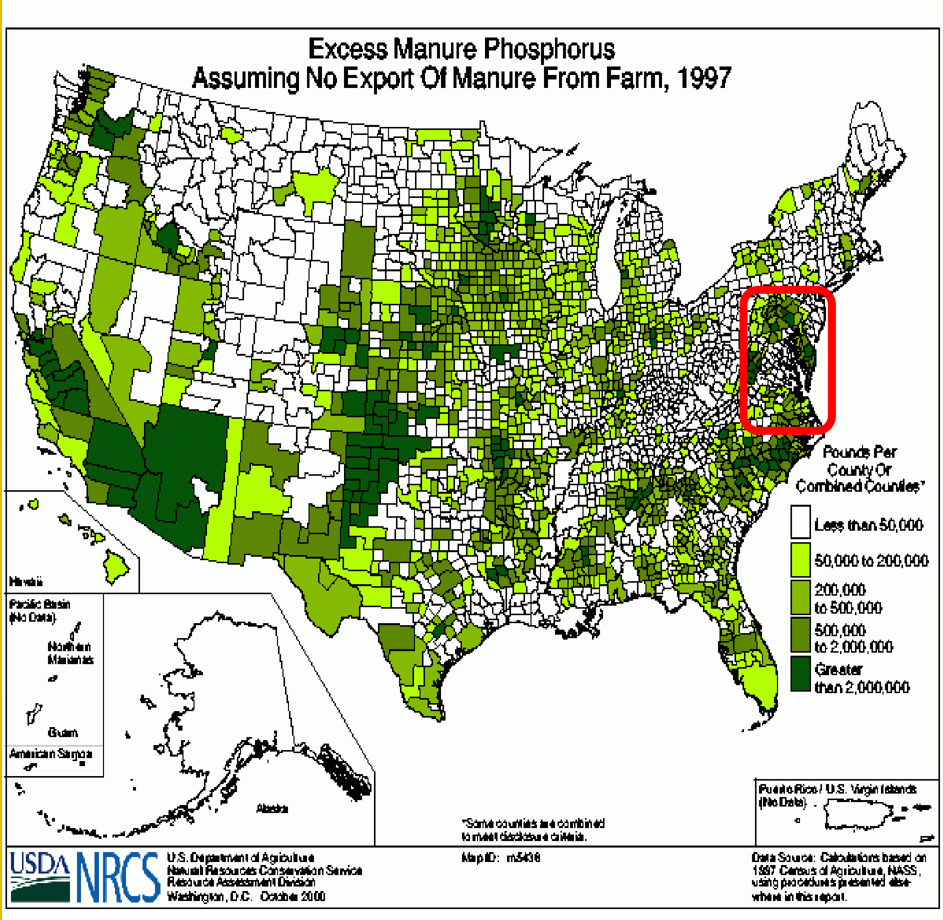
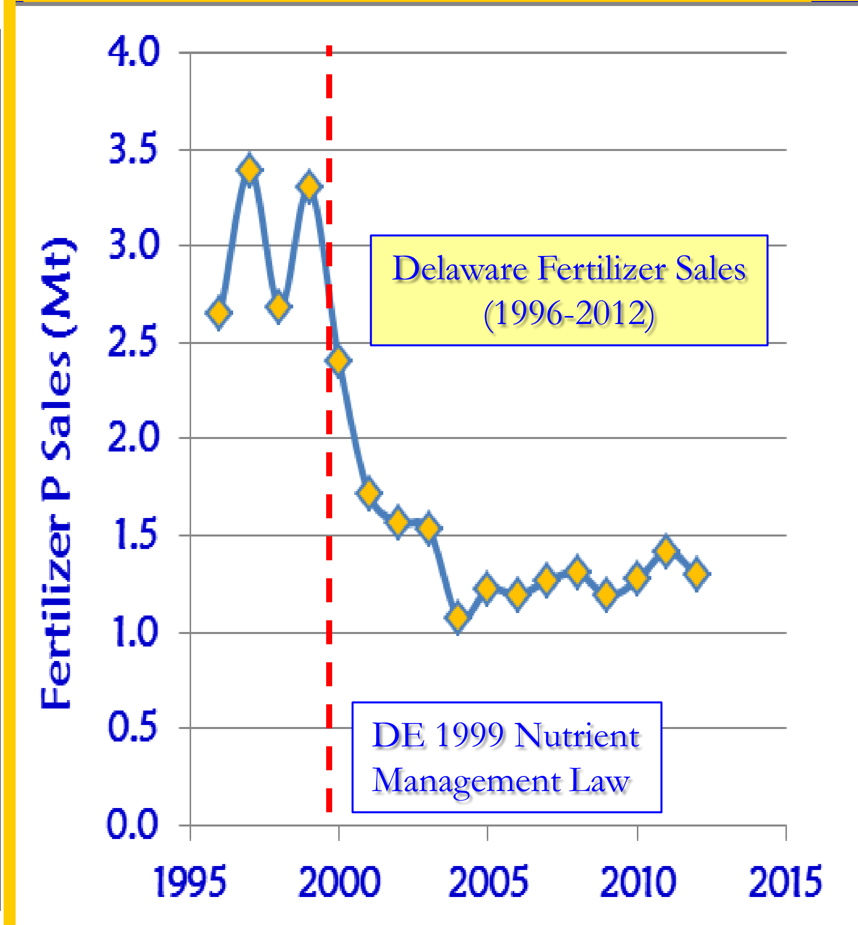
Agriculture and “Legacy Phosphorus”

Phosphorus that has accumulated in soils to values that are of concern for water quality <u>and</u> agricultural sustainabilty - from historic applications of inorganic fertilizers and organic residuals (manures, biosolids composts…)



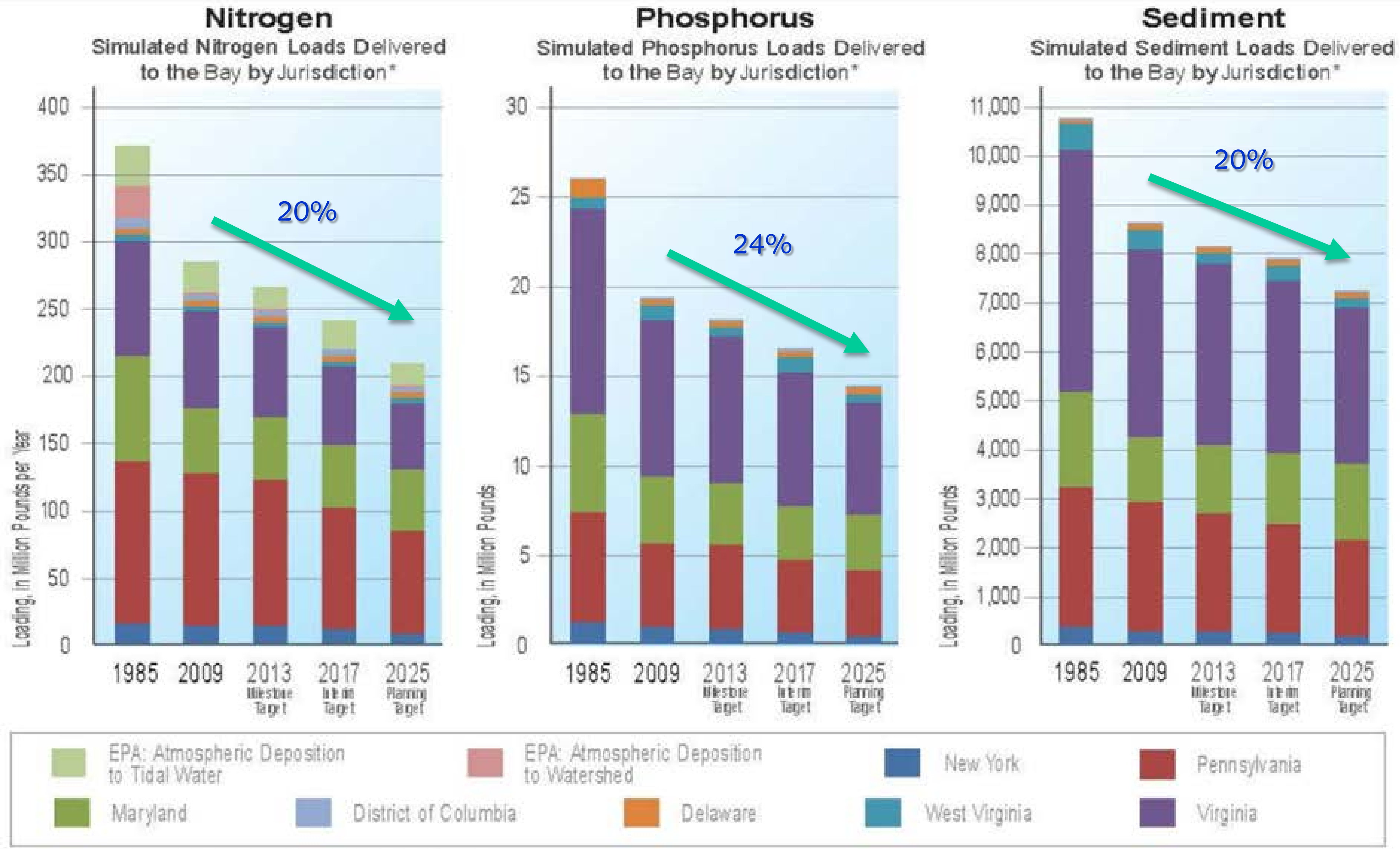


Source: EWG, 2010

Driving Forces to Address the Legacy P Challenge

- **Environment (water quality):**
  - ✓ increasing regulation of P (TMDLs)
  - ✓ growing pressure to eliminate P Index, replace with STP as regulatory tool
- **Food security:**
  - ✓ Agricultural profitability/sustainability
  - ✓ Natural resource utilization ("peak P")

Total Maximum Daily Loads (TMDLs) Chesapeake Bay, USA – 2025 Goals



* Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data report by Bay jurisdictions.

Legacy P and Water Quality -Delaware

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Delmarva farm fields hide a pollution time bomb for Chesapeake Bay

May 26, 2013 | 1 Comments

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Written by
Jeremy Cox
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Farmers grow corn and soybeans to feed their chickens. The birds, in turn, create the manure that fertilizes the corn and soybeans.

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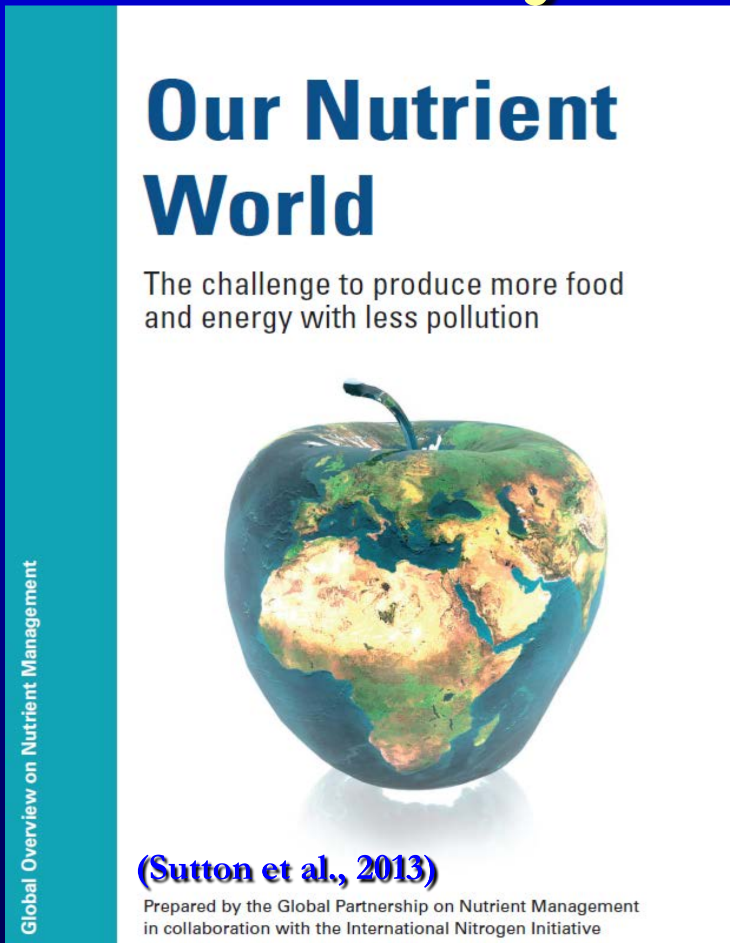
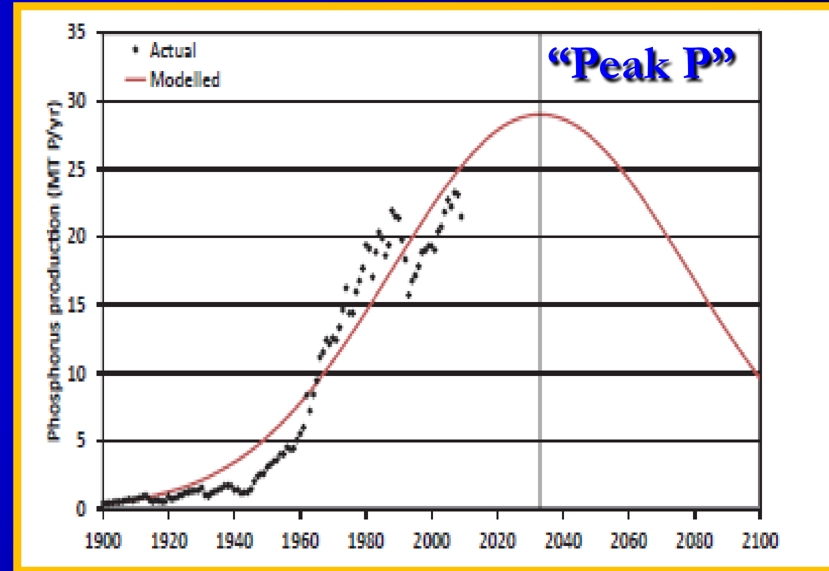
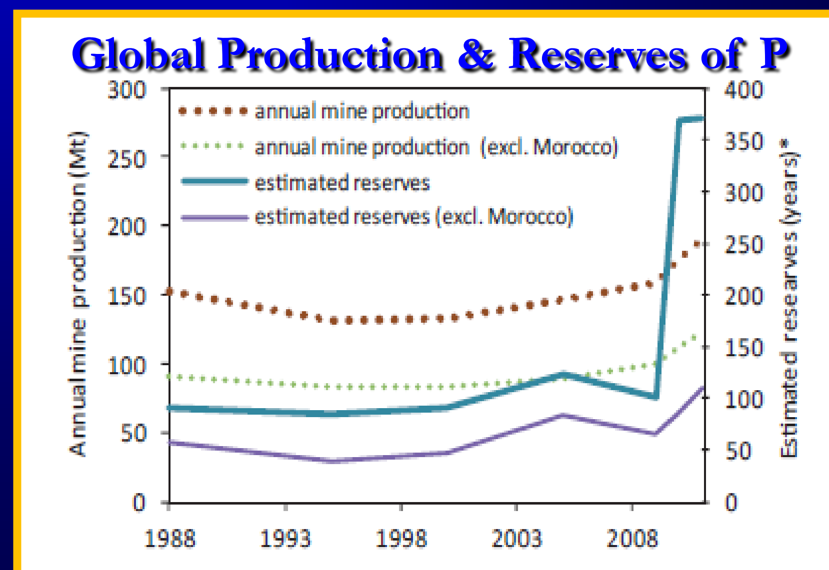


UNEP Global Partnership
Nutrient Management, 2013



(Cordell et al, 2009)



(Scholz and Wellmer, 2013)

Management/Remediaton Options for Legacy Phosphorus

Option #1:

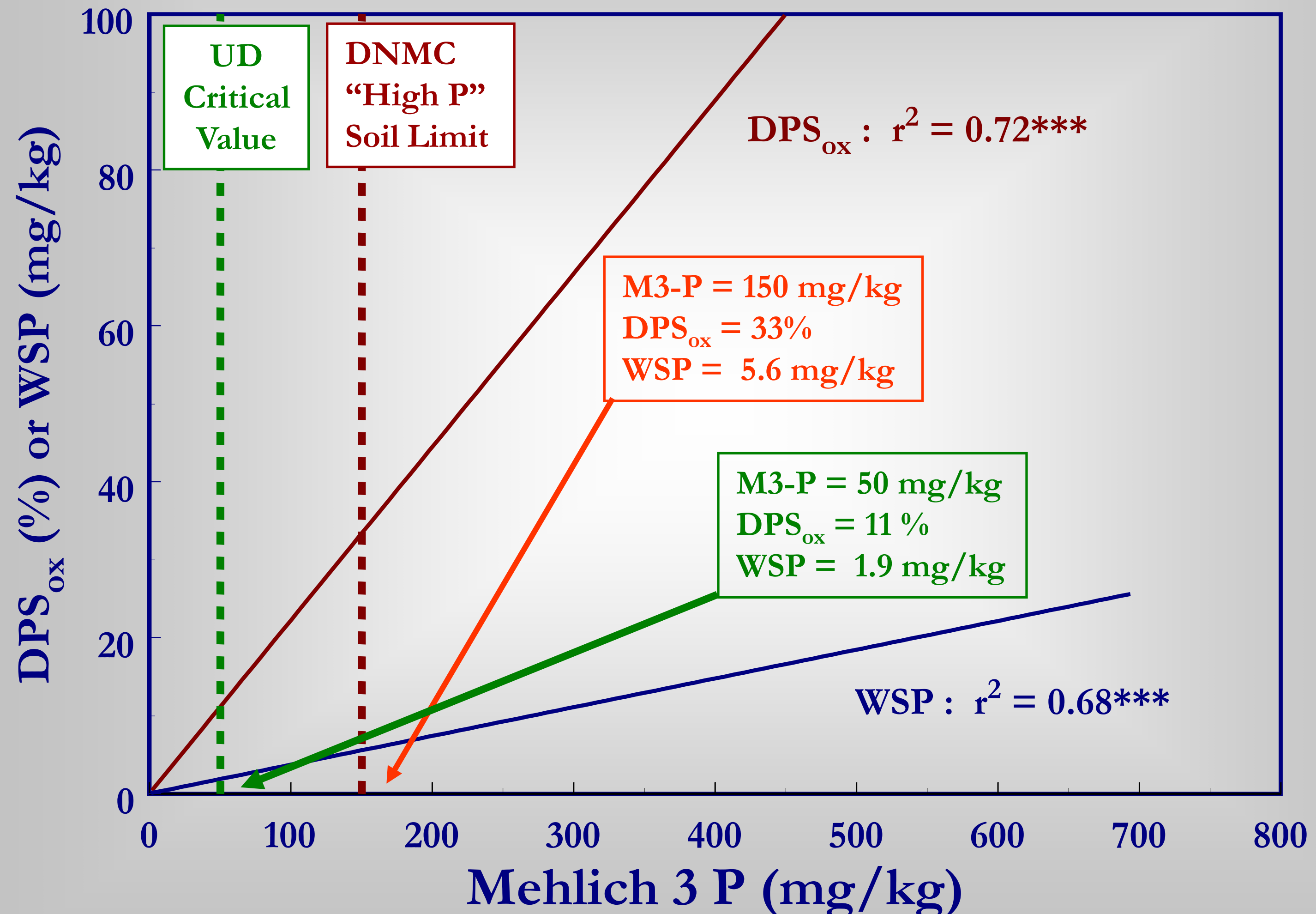
Cease P applications to "high P" soils, rely on crop removal to slowly deplete "soil P" to acceptable values. Use conservation practices to minimize soil loss, and:

- ✓ Establish soil P criteria for problem/success
- ✓ Quantify timelines to achieve success, as function of soil type, cropping systems…
- ✓ Focus incentives and/or mandates that foster soil P depletion on high P loss areas

Criteria for Success

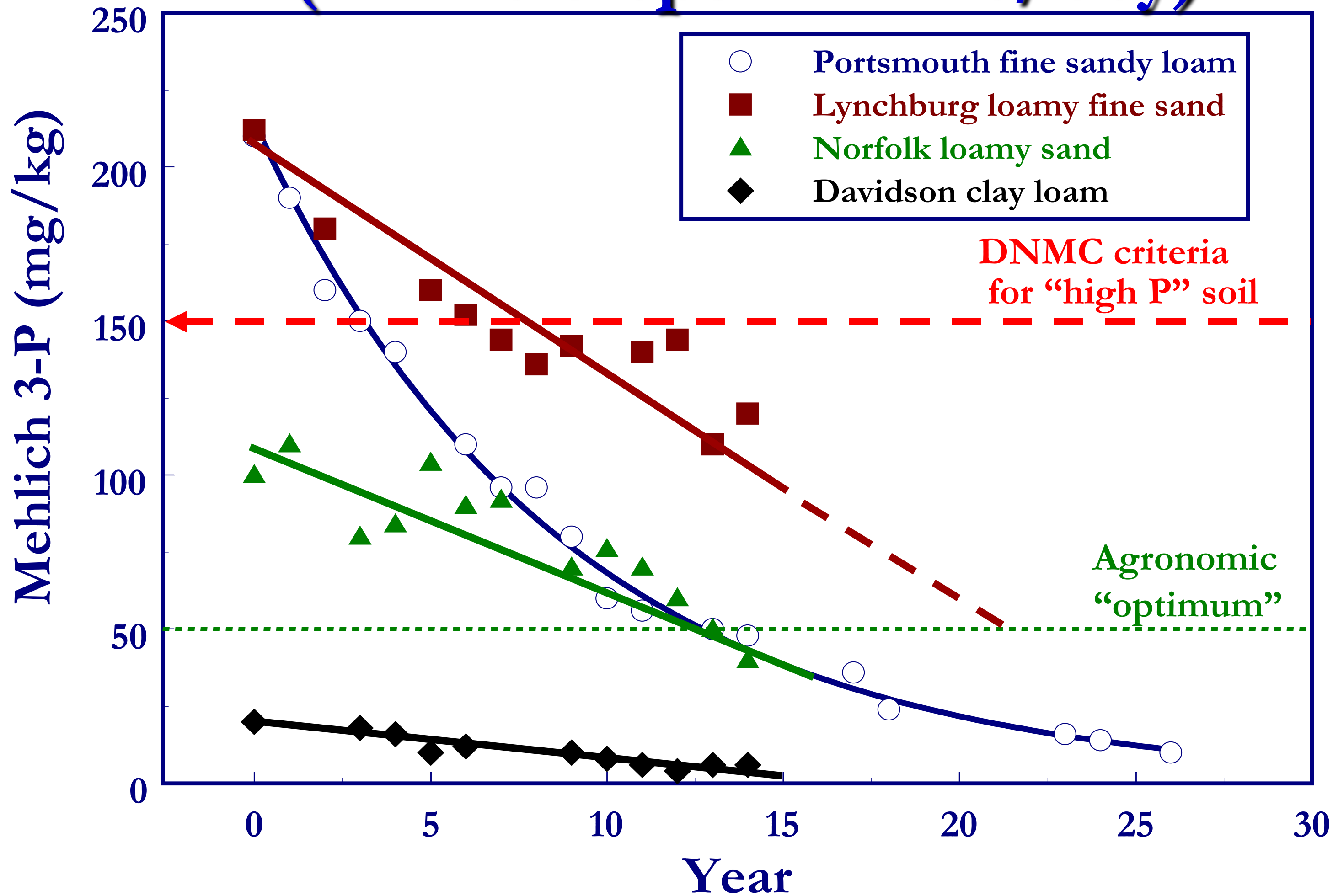
- **Agronomic:** clear scientific consensus on soil P values needed for economically optimum crop production, with low environmental risk
- **Environmental:** continue to be mixed views (scientific, regulatory) on best use of soil P criteria to assess risk of P loss to water
  - ✓ Approaches:
    - "Soil test" P (upper limit; e.g., DE = 150 mg M3P/kg)
    - "Soil P saturation" (threshold %)
    - Water soluble P (critical values?)
    - "P Site Index" (site, transport, soil, management)

Cease P Applications ?



(Sims et al, 2000; n=465)

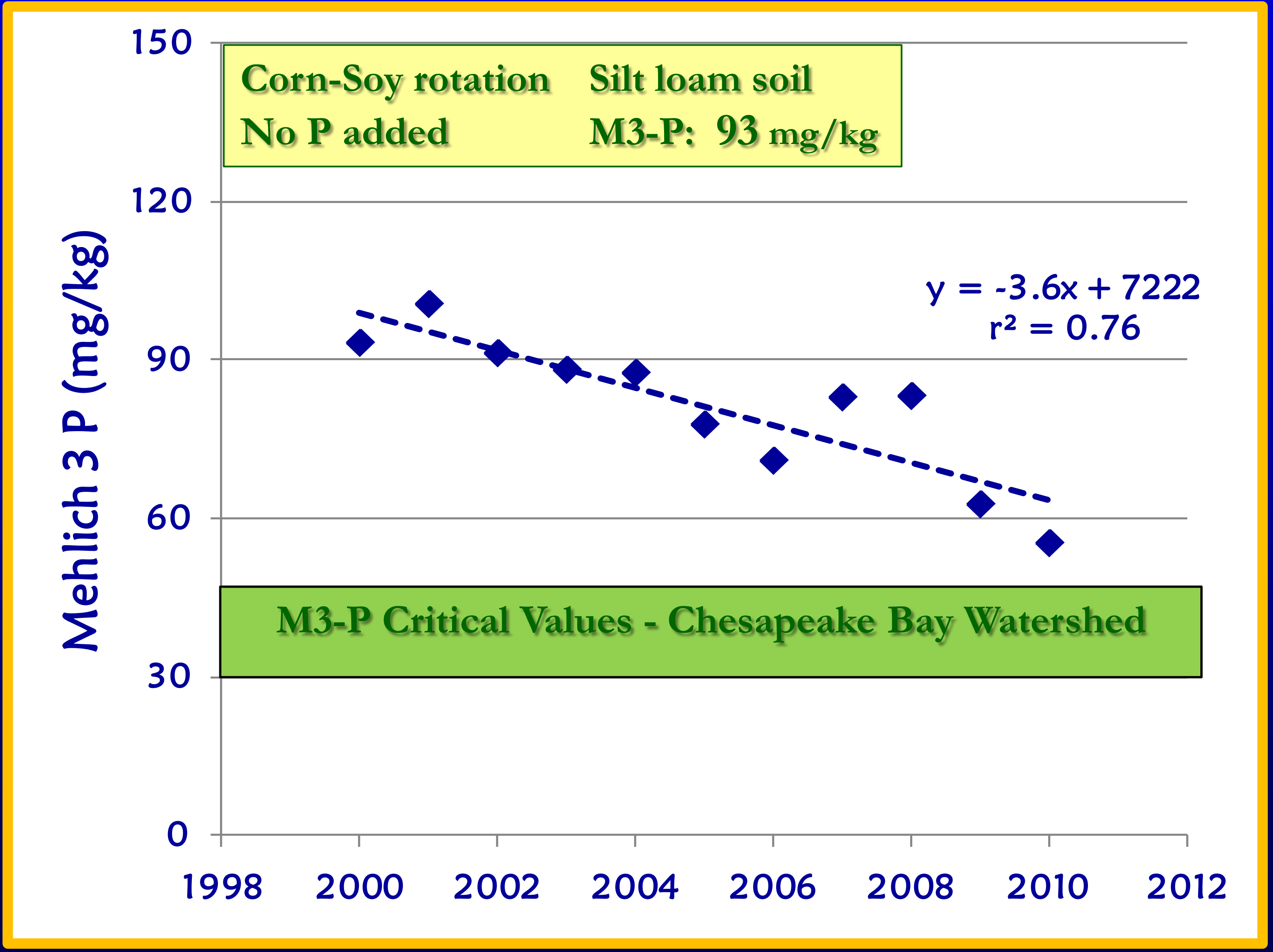
Cease P Applications ?
(Arable crops – Maize/Soy)



Soil P depletion slopes based on 14 and 30 year NC field studies with maize and soy.
Average annual crop P removal of ~ 15 kg P/ha/yr. (Kamprath, 1999; McCollum, 1991)

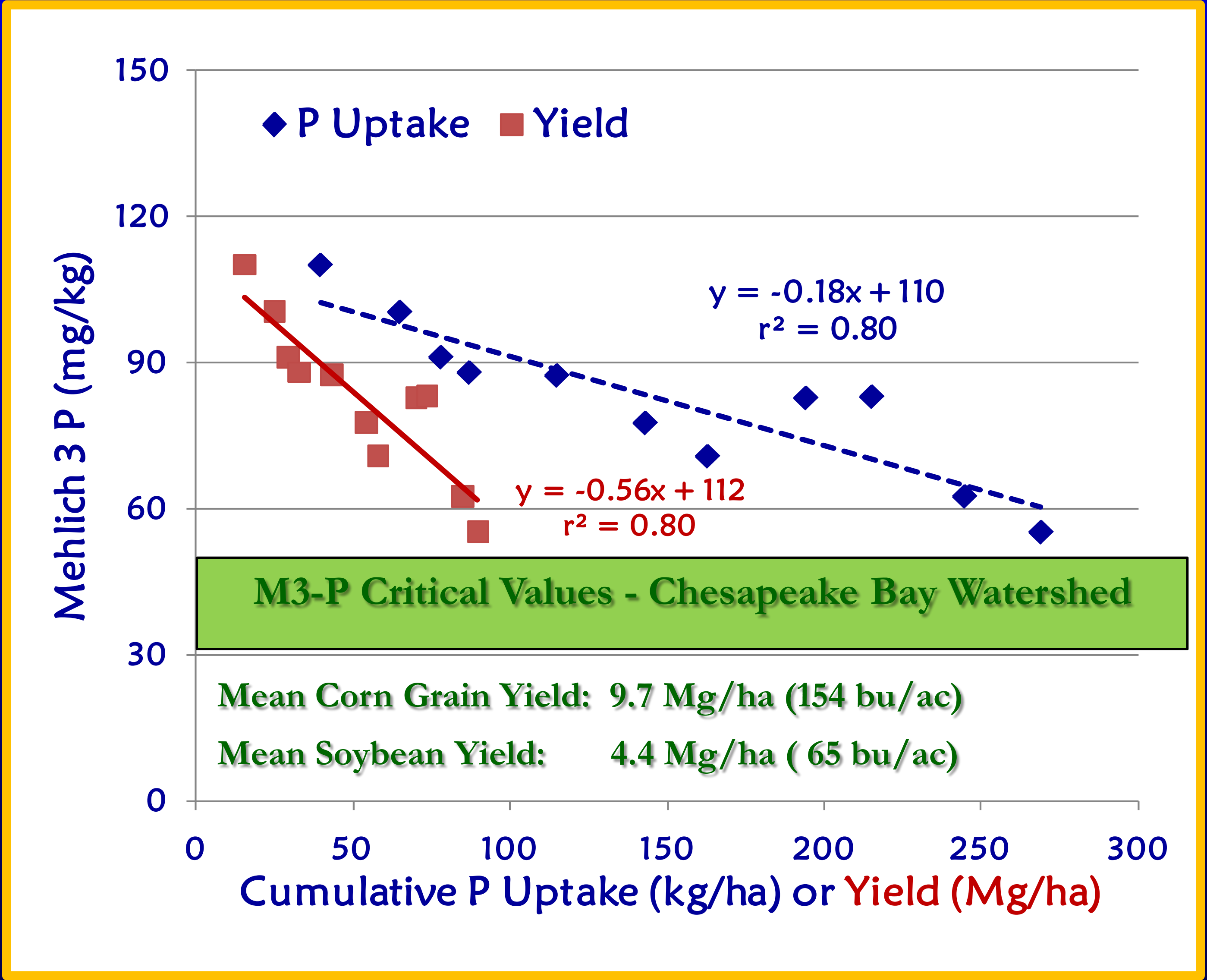
Managing Legacy Soil Phosphorus in Irish Grassland Soils (Murphy et al., 2013)

UD "Long-Term" STP Depletion Studies



Binford, et al., in preparation, 2013

UD "Long-Term" STP Depletion Studies



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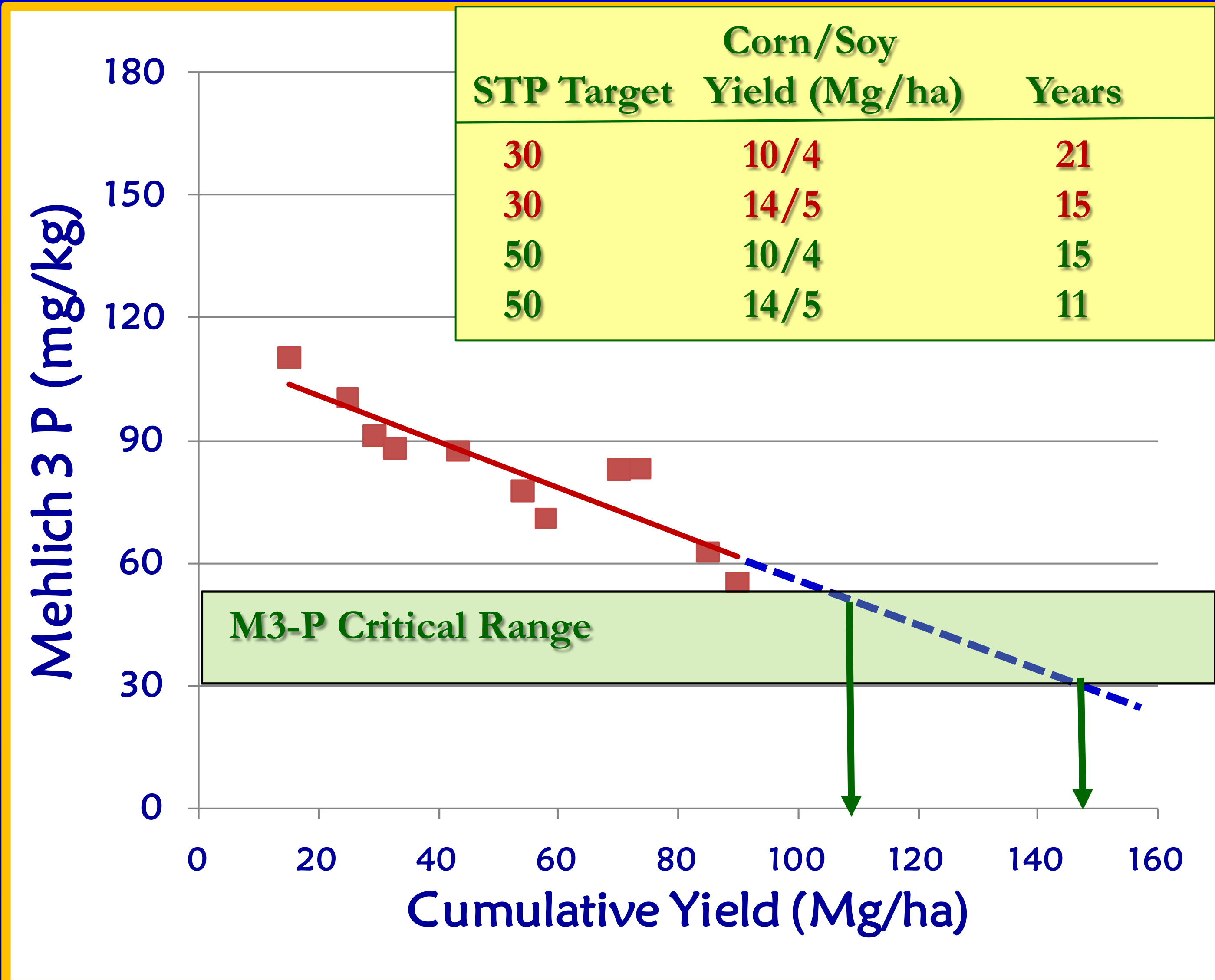
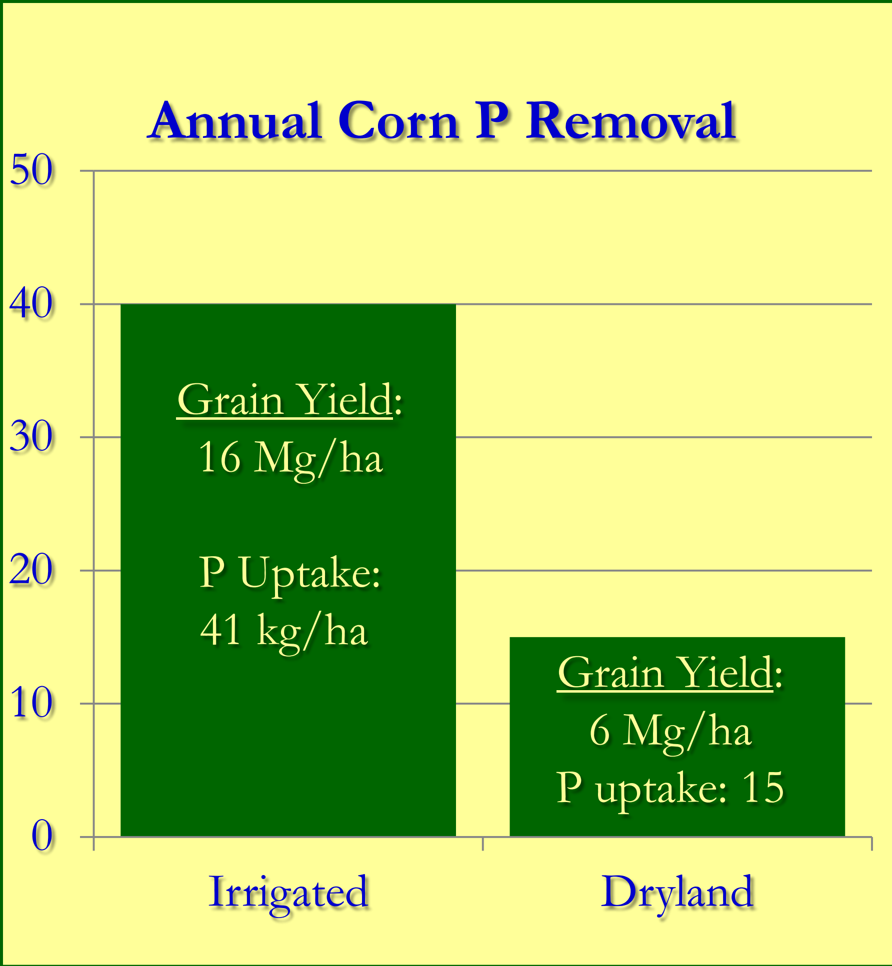
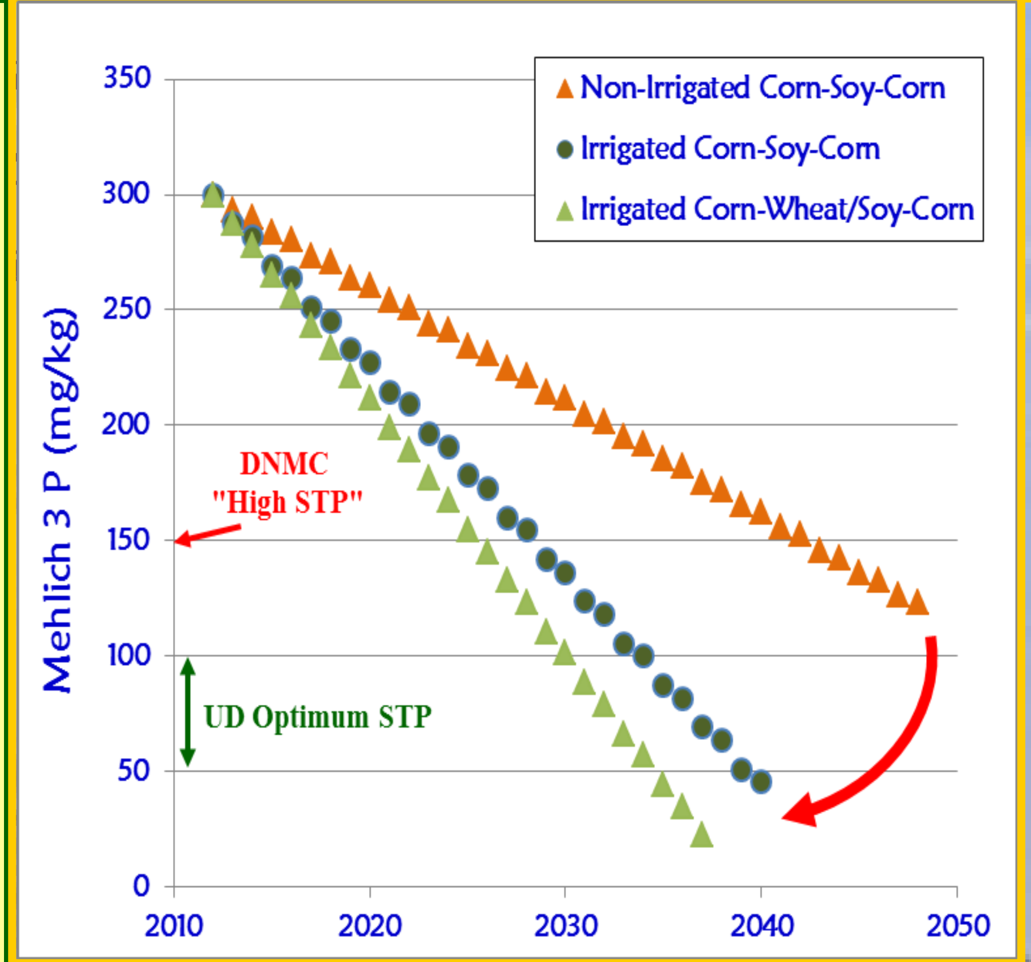


STP Target	Corn/Soy Yield (Mg/ha)	Years
30	10/4	21
30	14/5	15
50	10/4	15
50	14/5	11

Binford, et al., in preparation, 2011

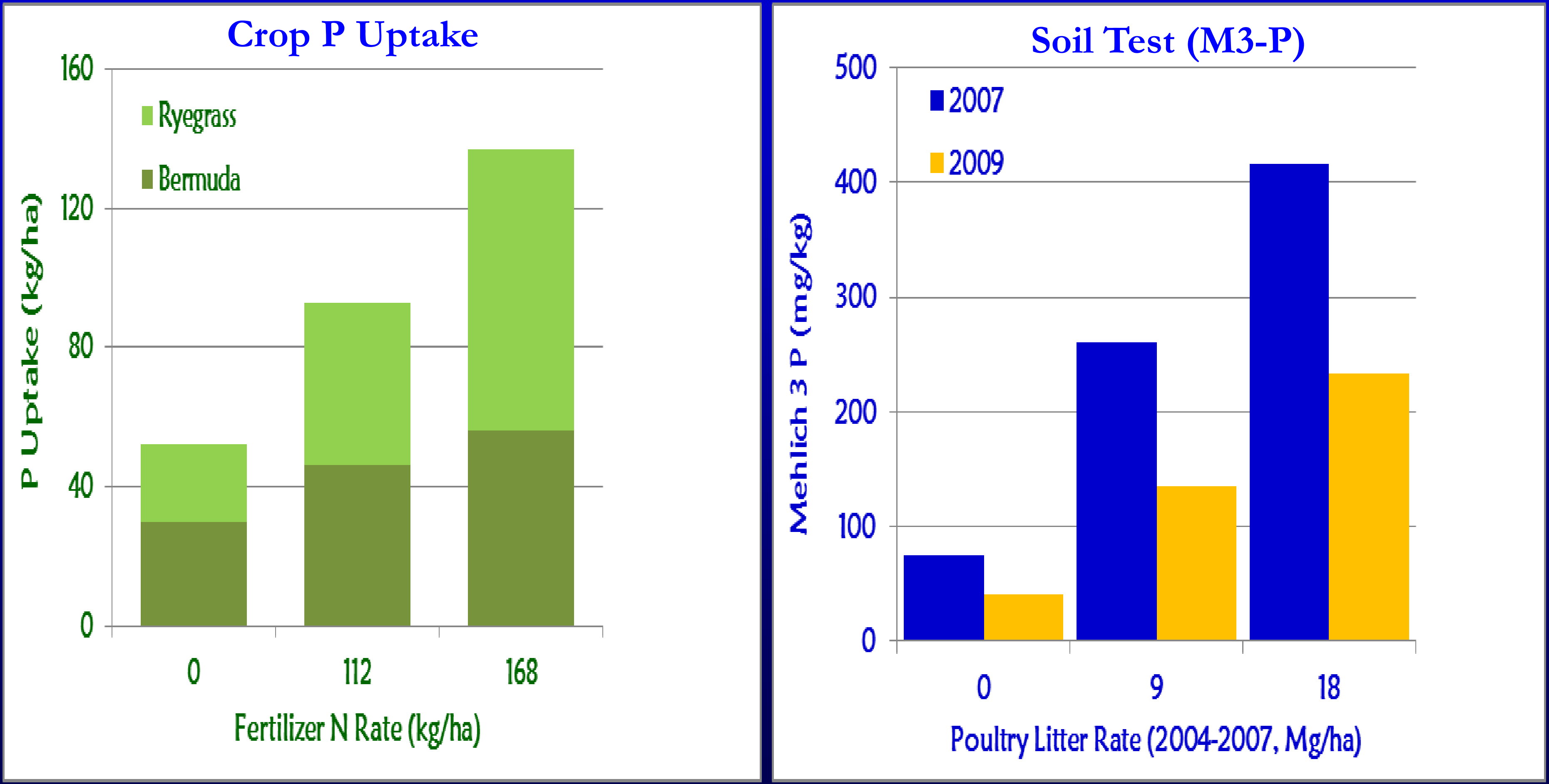




Efficient Irrigated Crop Management Systems

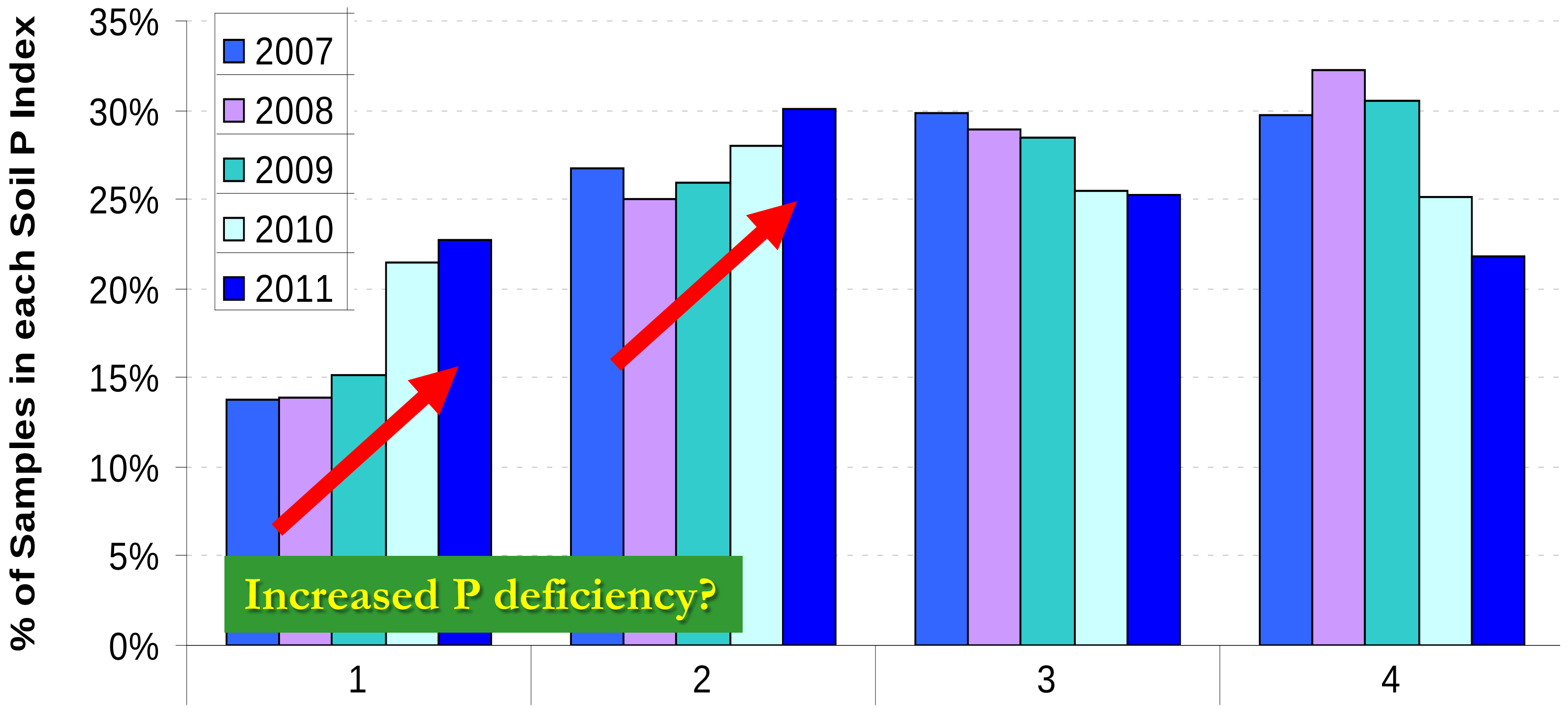
- ✓Stabilize crop yields, increase farm income
- ✓**Increase nutrient uptake (N, P)**
- ✓Intercept and use groundwater nitrate
- ✓Build soil organic matter (sequester carbon?)

Managing Ryegrass-Bermudagrass to Phytoremediate High P Soils



Read (2012)

Environmental Policy Impacting Agricultural Sustainability?



Soil P Index

(4 = >8 mg/l Morgans P for grassland soils and is considered in excess of agronomic optimum and at greater risk of P loss to water)

Trends in soil P status in Ireland between 2007 and 2011 (for soils from commercial farms submitted to Teagasc for analysis).

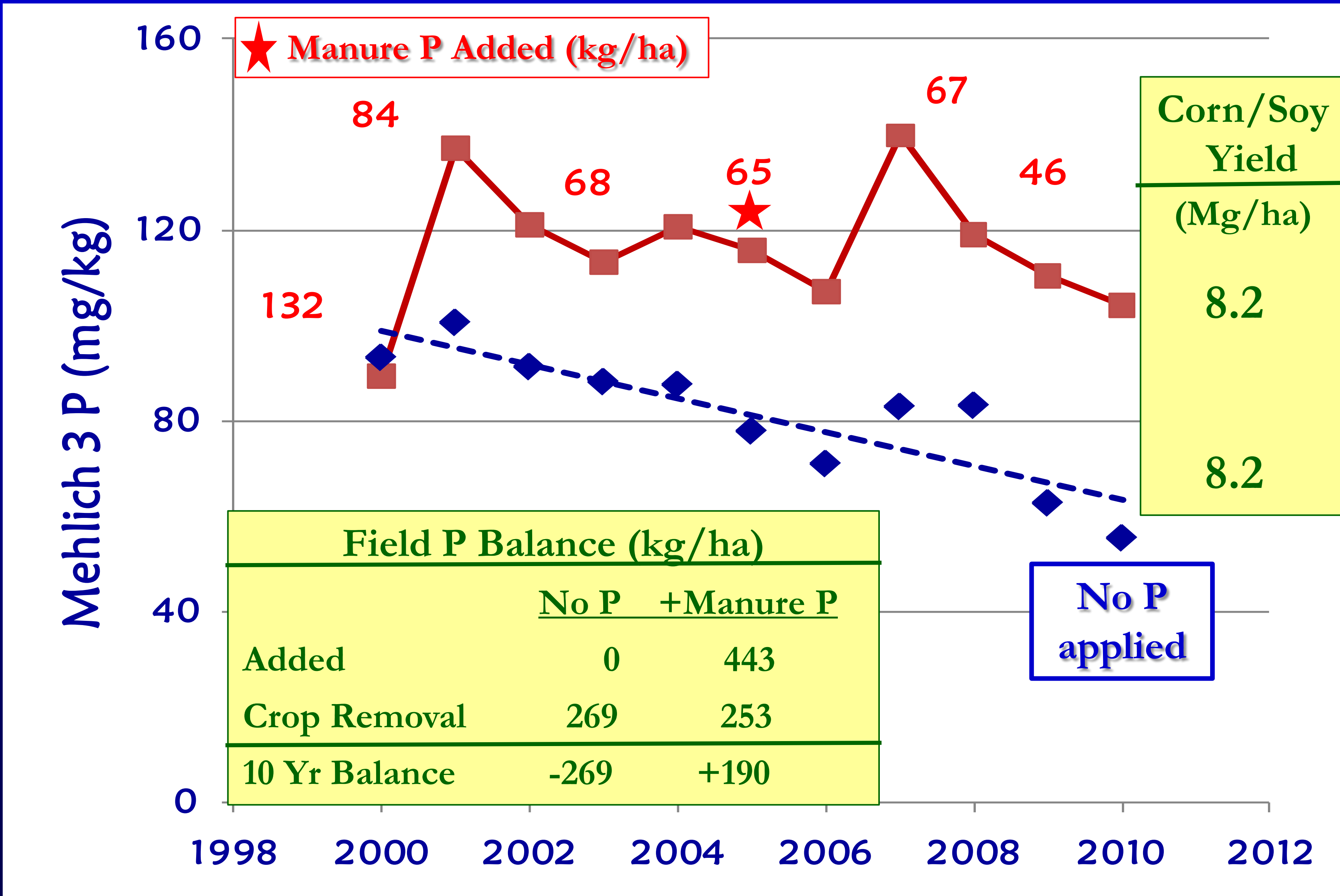
(Murphy et al., 2013)

Management/Remediaton Options for Legacy Phosphorus

Option #2:

Continue with "unavoidable" P applications to cropland (manures, biosolids), manage risks associated with all P sources and P transport to water

UD "Long-Term" STP Depletion Studies



Conclusions

- Legacy P in soils presents a long-term (decades?) risk to water quality and agricultural sustainability, especially for animal-based agriculture
- Science-informed strategies to manage legacy P can – and should - be developed and systematically implemented that sustain (increase?) agricultural profitability and reduce water quality impacts
- SERA-17 will undertake, in 2014, a systematic review – on legacy P management, including potential action items – and encourages your input into our efforts (contact jtsims@udel.edu)!