Nutrient Management in the Bay Watershed

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Nutrient Management Basics

- There are 18 essential nutrients for plant growth
- Two are a concern for water quality
  - Nitrogen (N)
  - Phosphorus (P)
- Nutrient use efficiency is generally the percentage of nutrient applied that makes it into the crop

Nutrient Management Basics

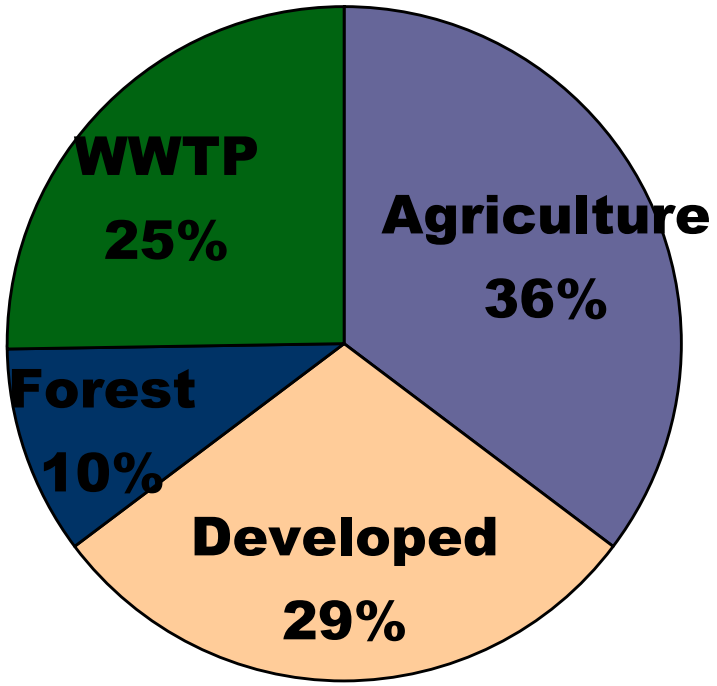
- A nutrient management plan guides application of nutrients to maximize crop production, minimize losses, and maintain or improve soil quality.
  - Form, timing, placement, and amount
  - Basically balances nutrient application with crop need
- How do we determine crop need?
  - For phosphorus soil test is used to guide rate decisions
  - For nitrogen no reliable soil test exists so a yield goal is typically used (e.g. 150 bu/acre = 150 lbs-N/acre)
- A comprehensive plan includes conservation measures to reduce losses

Nutrient Management Basics

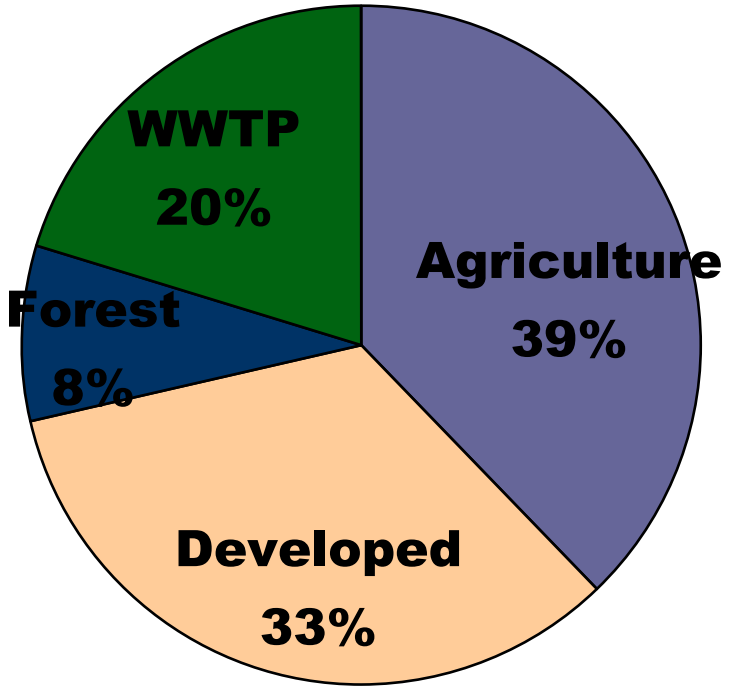
- Sometimes nutrient inefficiencies can be economically efficient
- Climate and environmental conditions far outweigh management in determining net nutrient use efficiency
- Environmentally significant nutrient losses are rarely economically significant
- There will be nutrients lost to the environment (limit of technology) with any farming operation
- N and P can be lost to the environment from fertilizer as easily if not easier than from manure
  - However, manure can be more difficult to handle and plan for because it has very low and highly variable nutrient content

Modeled Nutrient Losses

Sources of Nitrogen from Maryland



Sources of Phosphorus From Maryland



How the Bay Model Works

- Riparian Forest Buffers and Wetland Restoration - Agriculture:
- Coastal Plain Low
- Coastal Plain Diss
- Coastal Plain Upla
- Piedmont Crystalli
- Blue Ridge
- Mesozoic Lowland
- Piedmont Carbona
- Valley and Ridge
- Valley and Ridge
- Appalachian Plate
- Riparian Grass Bu
- Coastal Plain Low
- Coastal Plain Diss
- Coastal Plain Upla
- Piedmont Crystalli
- Blue Ridge
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- Piedmont Carbonate
- Valley and Ridge
- Valley and Ridge
- Appalachian Plate
- Cereal Cover Crop
- Early-Planting - U
- Late-Planting - Up
- Cereal Cover Crop
- Early-Planting - U
- Late-Planting - Up
- Commodity Cerea

Conventional-Till:

- Early-Planting - Up to 7 days prior to published first frost date
- Late-Planting - Up to 7 after published first frost date
- Commodity Cereal Cover Crops / Small Grain Enhancement on

- Conservation Plans - Agriculture1(Solely structural practices such as
- Conservation-Tillage1
- Land Retirement - Agriculture

Export Coefficient Model

versus

Process Based Model

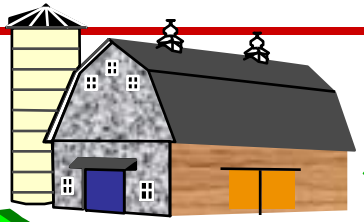
There is tremendous debate over the accuracy of all these models

Underlying Issue

…understanding, and quantifying, the nutrient balance on a farm, and at larger scales such as watersheds, represents the first step in strategic nutrient management planning. This is the highest level of planning for any operation and focuses on the development of long-term goals and the broader strategies needed to achieve these goals. (Sims et al. 2008)

We are importing nitrogen and phosphorus in grain to the Chesapeake Bay Watershed

Traditional Ag P Cycle



1/4

Crop

Soil

Local

Animals

3/4

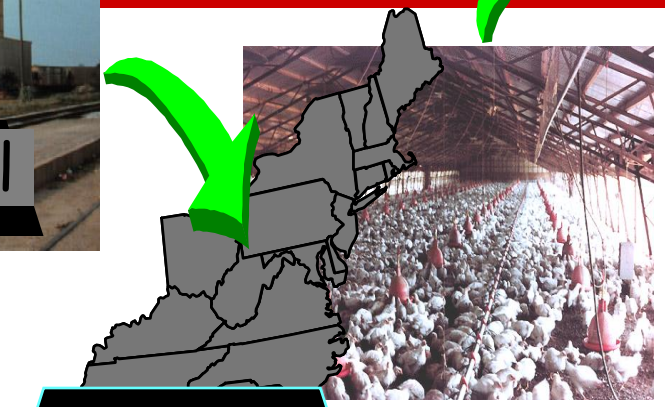
Ag P Cycle Has Become Fragmented

Crops

Soil

Feed mill

Global



Animals

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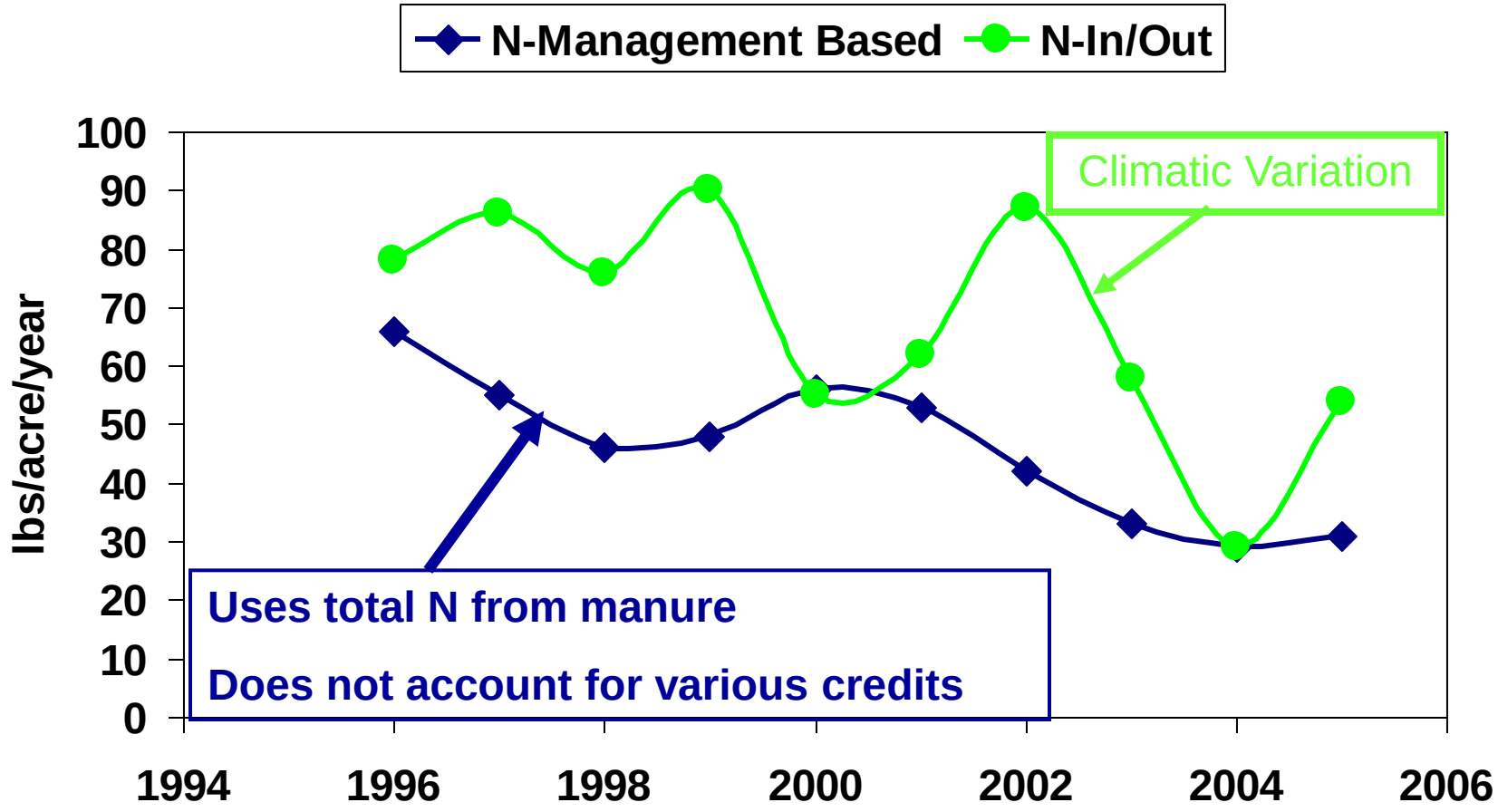
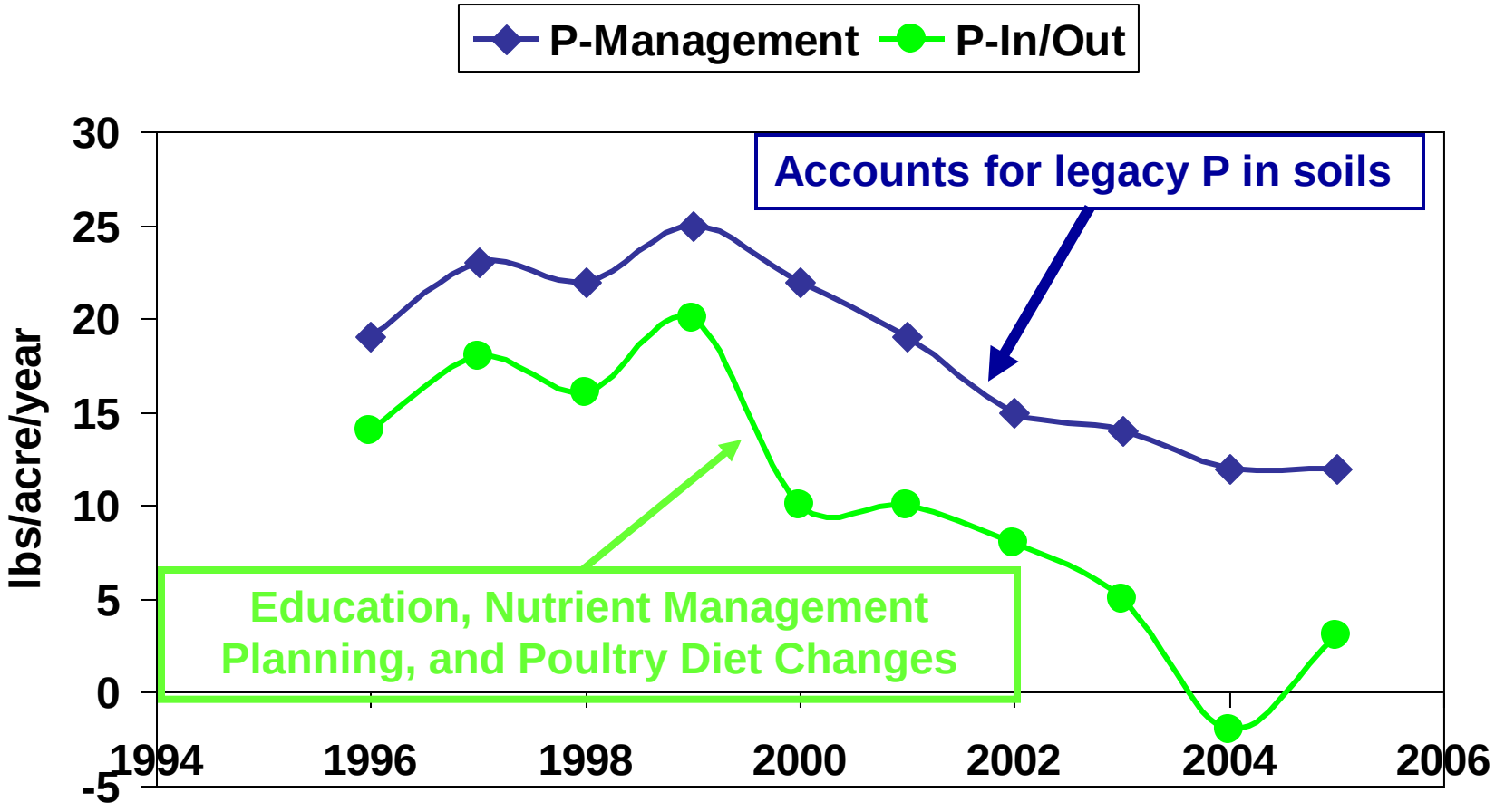
Delaware N Balance



Delaware P Balance



What we learned from the budgets

- **Nutrient management has had an impact on a statewide basis**
- **Phosphorus surpluses exist at the farm-gate due to soil P accumulation not at the regional level**
  - BMP's should address **site specific** concerns and be targeted using a transport – source tool such as the P index
- **Nitrogen surpluses exist as a result of how we make recommendations**
  - NUE must be priority
  - BMPs such as cover crops do not markedly improve NUE

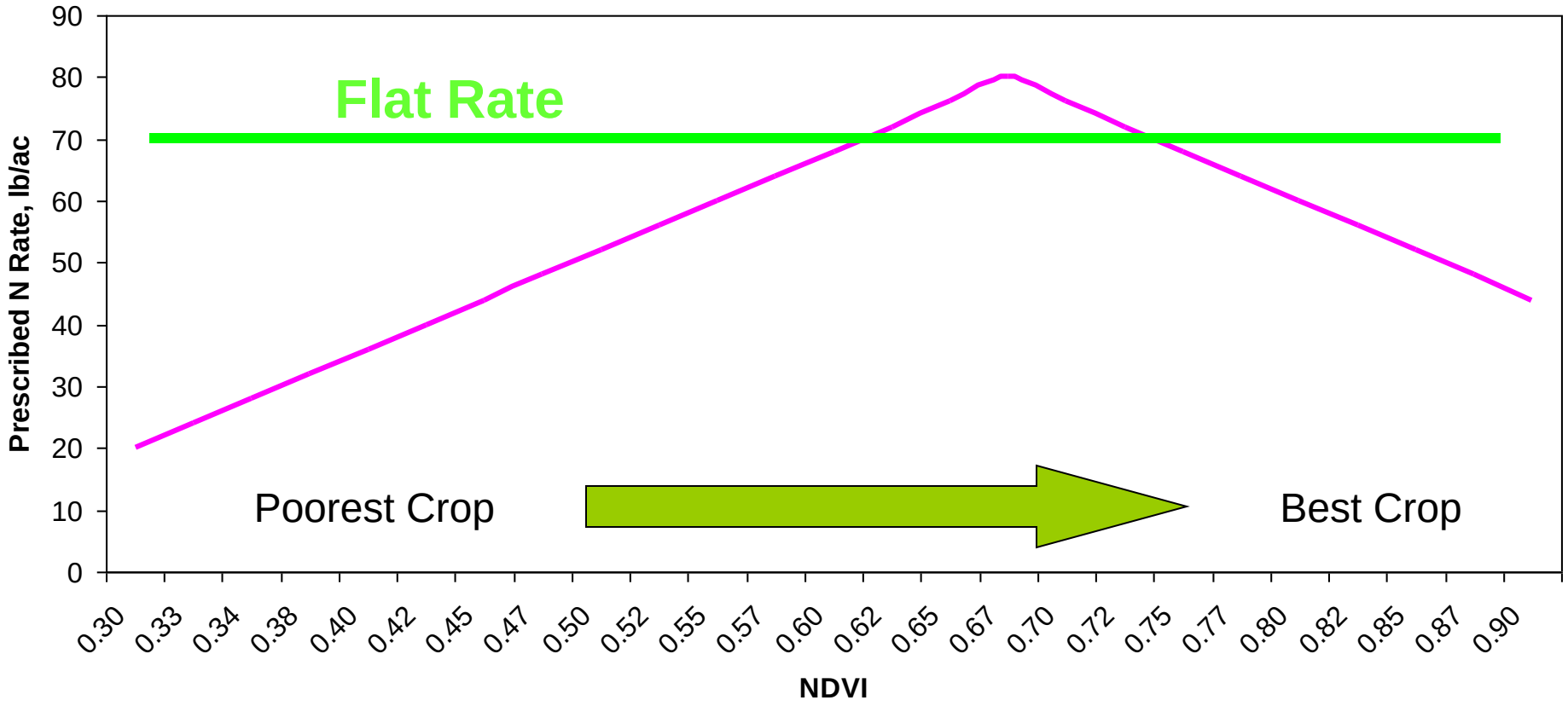
Nitrogen Requirement is Complex

- Nitrogen requirement to achieve maximum yield for cereal grains is determined by **N responsiveness, N availability,** and **potential yield**.
  - All three factors vary spatially and temporally
  - All three factors are independent of each other and independent of time.
- Soil type, climate, and previous management vary in space and time and influence yield potential, N availability, and N responsiveness independently.
- N surpluses exist due to our recommendations and seasonal and spatial variability
- Example: A process based approach emphasizes cover crops – which generally do not address the N surplus

Technology example: *Active* Optical Sensors

- Emit light in the red and near infrared wavelength (60/sec)
- Average reflectance measurements calculated every second
- Calculates simple ratio or NDVI
  - NDVI = (NIR – Red)/(NIR + Red)
- Correlate sensor reading to crop vigor and N need
- Not affected by:
  - Light conditions
  - Atmospheric conditions
  - Variety

Varies N rate according to yield potential and N responsiveness



Thoughts on Phosphorus

- The P surplus – as it is commonly portrayed – is a myth
  - Incinerating poultry litter does not address the issue and is morally questionable
- Proper manure management can help address the N issue – slowly available N source with higher nutrient use efficiency

Closing Remarks

- First we must address underlying issues
  - Regional N surpluses
  - Local P hotspots
- We don’t know everything yet
  - New technologies
  - System approach
- Keep global issues in mind when making local decisions
  - Ultimately global issues related to energy consumption, food demand, and fertilizer supply will surpass local issues of water quality.

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