

Ecological Approach to Nutrient Management for Soil Health

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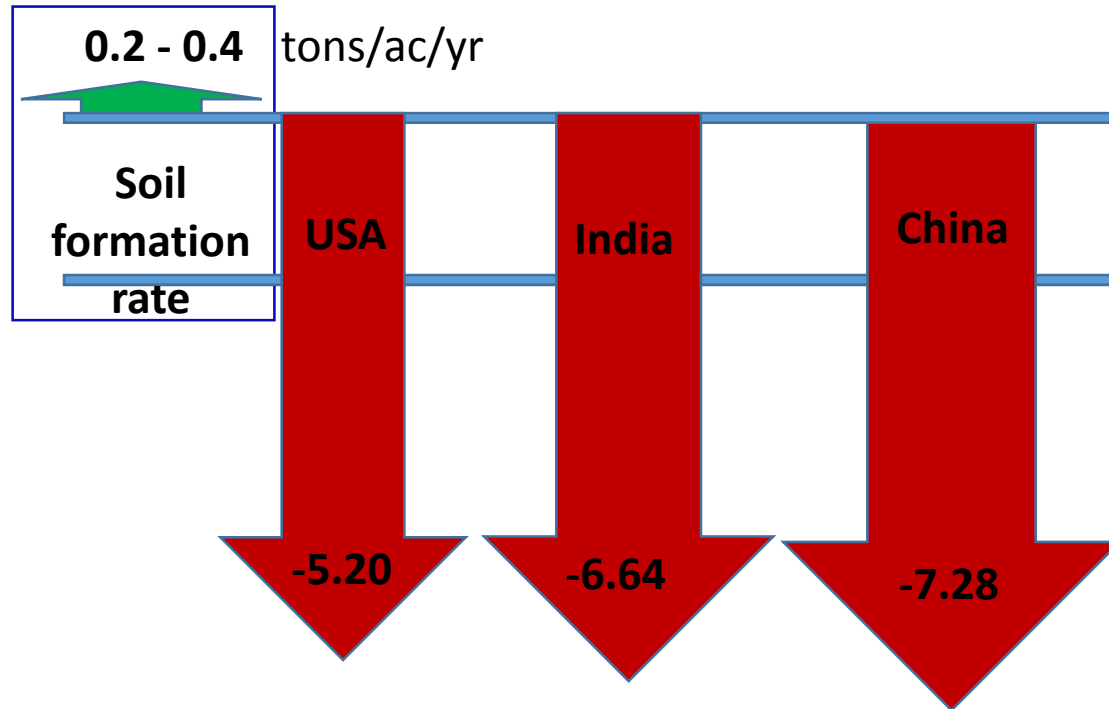
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Outline: Ecological Approach to Nutrient Management

- **Soil Loss from erosion**
- **History of N and P management**
- **Understanding nitrogen dynamics**
- **Soil phosphorus complexity**
- **Current dominant nutrient management model**
- **Efficient nutrient management model**
- **Ecological Approach to nutrient management**

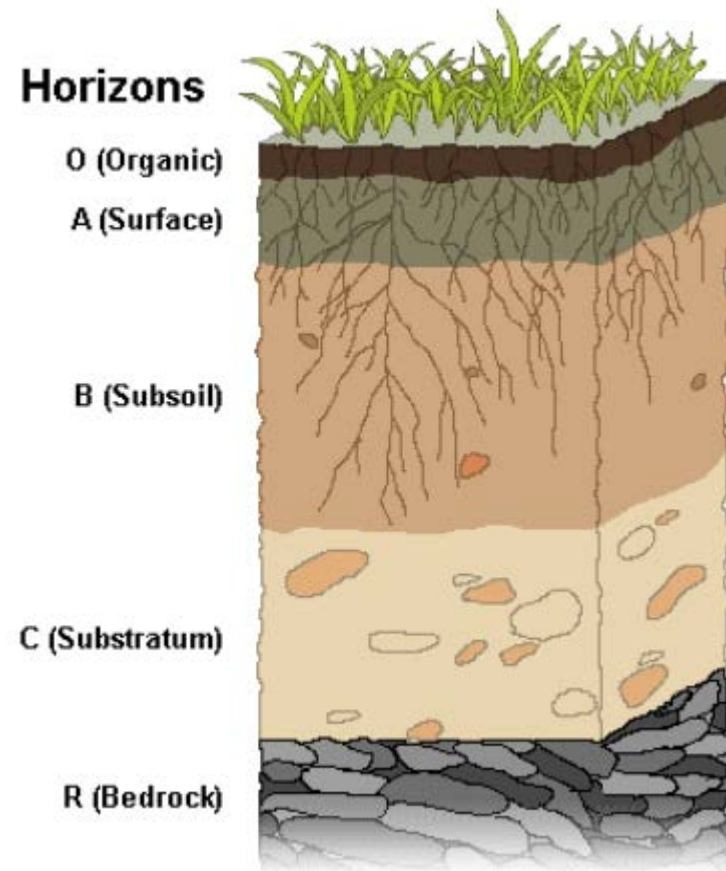
Soil Loss from Water and Wind Erosion



In some regions, erosion has been measured at over 100 t/ac in a single storm event

That means a layer of soil that took over 350 years to form was destroyed in a single day

Save Our Top Soil



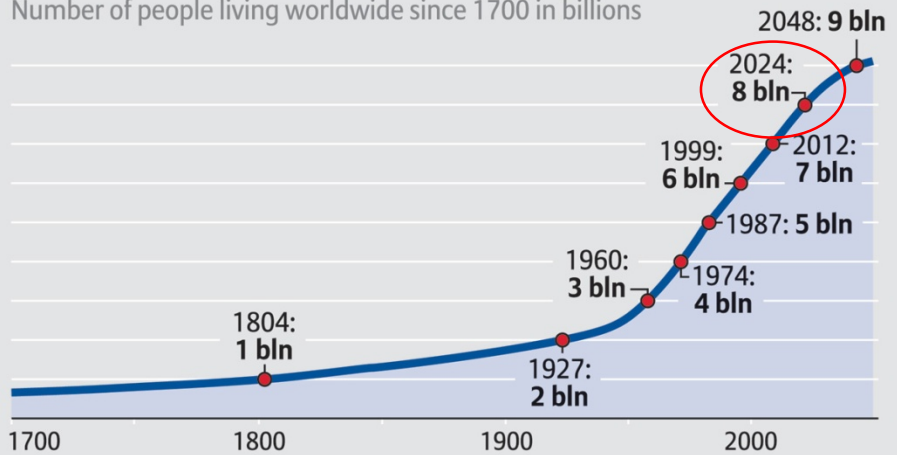
5 tons x 100 years = 500 tons/ac/year



POPULATION OF THE EARTH

Allianz

Number of people living worldwide since 1700 in billions



Source: United Nations World Population Prospects, Deutsche Stiftung Weltbevölkerung
For further information please visit: www.knowledge.allianz.com

Nitrogen and Phosphorus

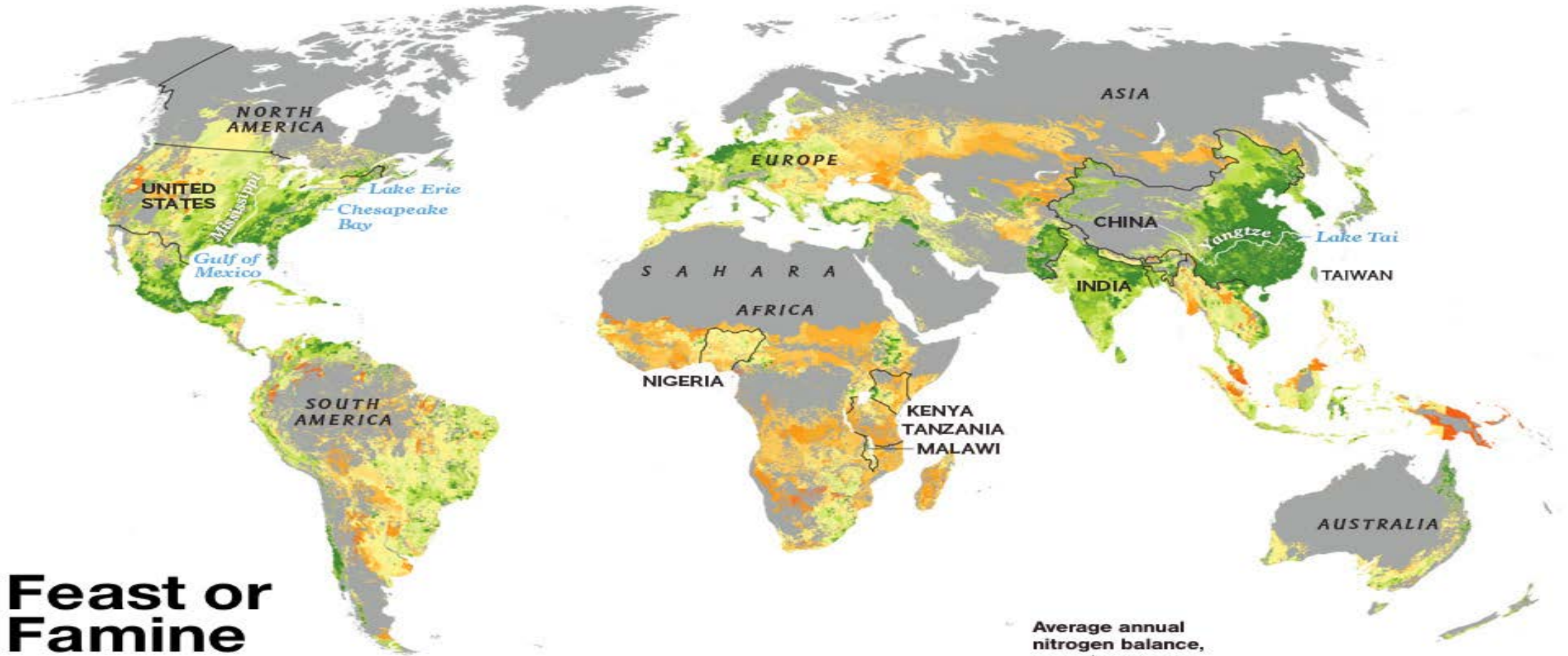
- N and P are the two most limiting nutrients for biological production
- N and P are extensively applied nutrients for crop production
- Almost all nutrient related pollution is due to N & P



Nitrogen fertilizer plays a tremendous role in Human civilization

- Nitrogen is the engine of modern Agriculture
- Without N fertilizer about half of us would not be here (Smil, 2011)
- However, if we don't watch out, N fertilizer could destroy our planet

Global N Balance



Feast or Famine

Nearly half the people on the planet wouldn't be alive if not for the abundant food made possible by nitrogen fertilizer. Yet its benefits have not reached everyone. In sub-Saharan Africa, where 239 million people go hungry in a year, crops fail as soil is stripped of nutrients, and farmers can't afford to buy fertilizer. Elsewhere overuse pollutes waterways and releases greenhouse gases.

JEROME N. COOKSON AND LAWSON PARKER, NGM STAFF
SOURCE: PAUL C. WEST, INSTITUTE ON THE ENVIRONMENT, UNIVERSITY OF MINNESOTA

Average annual nitrogen balance, pounds per acre



Zero means the crop used exactly the amount of nitrogen applied. The ideal range varies due to local conditions.

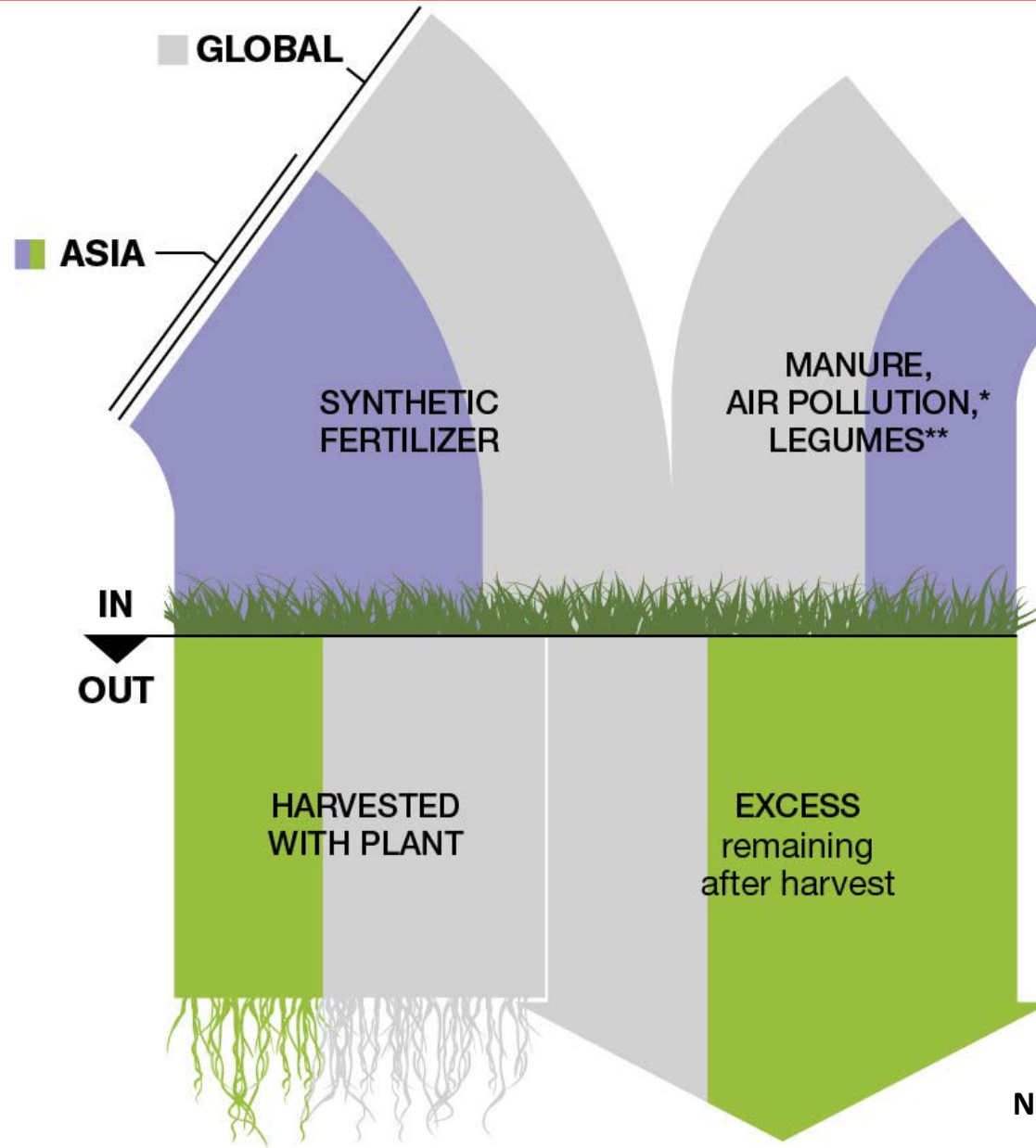
Surging Nitrate in China Waters

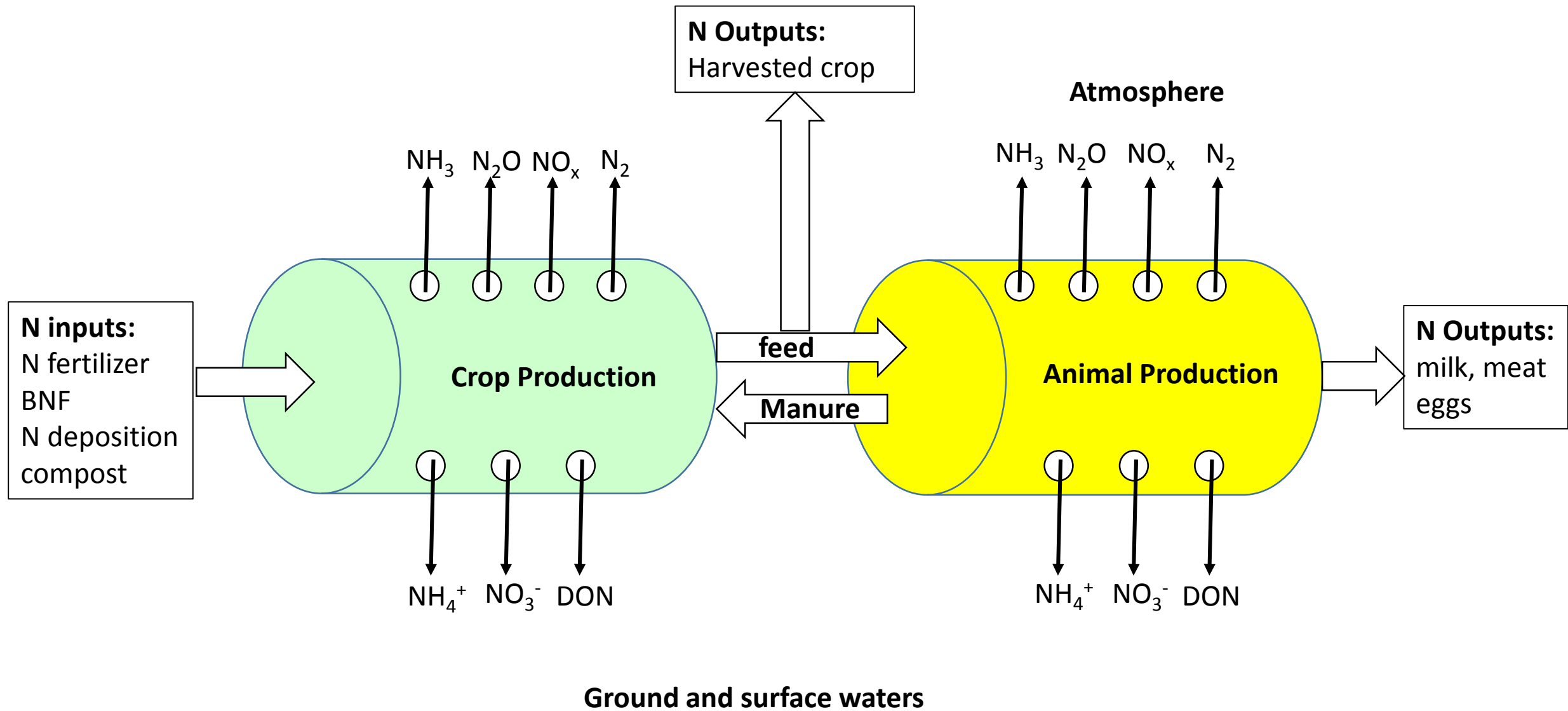


Rising nitrate levels provide perfect conditions for algal blooms.

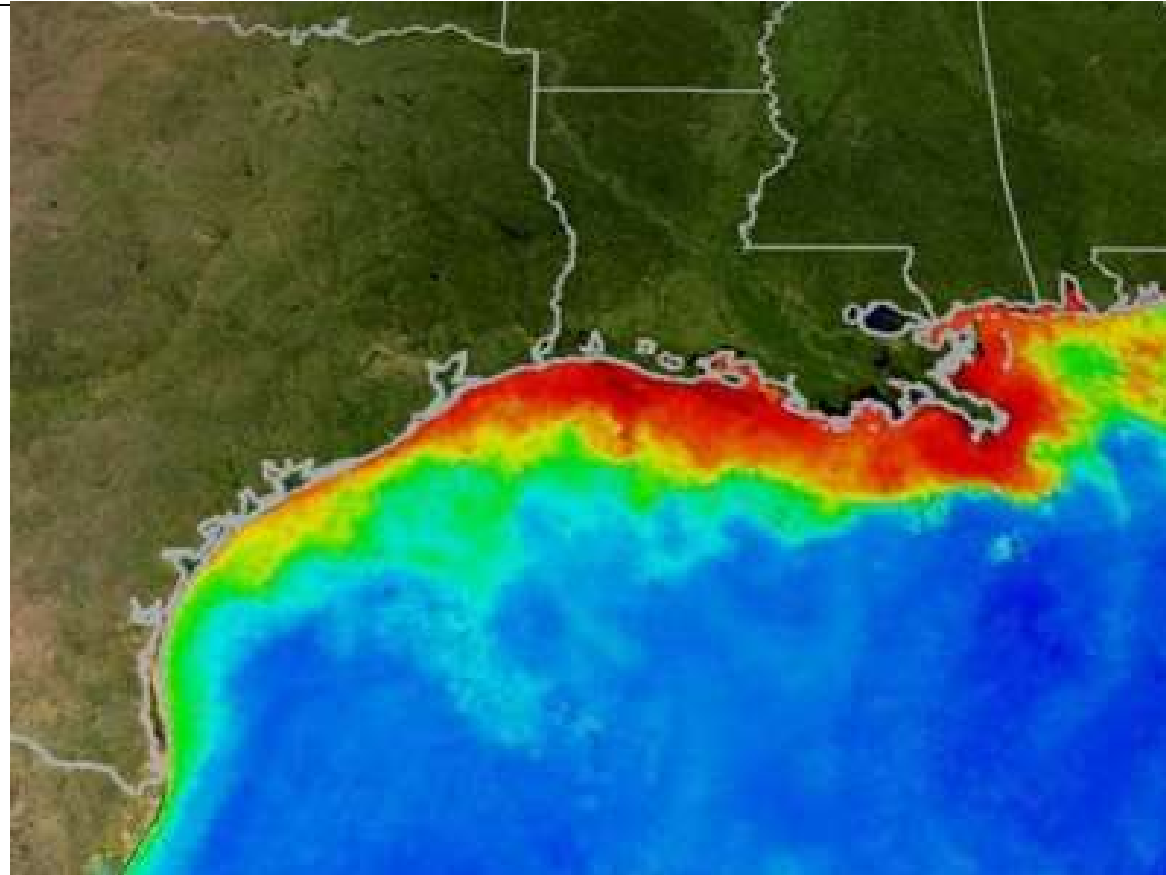
Imaginechina/Corbis

The Flow of Nitrogen

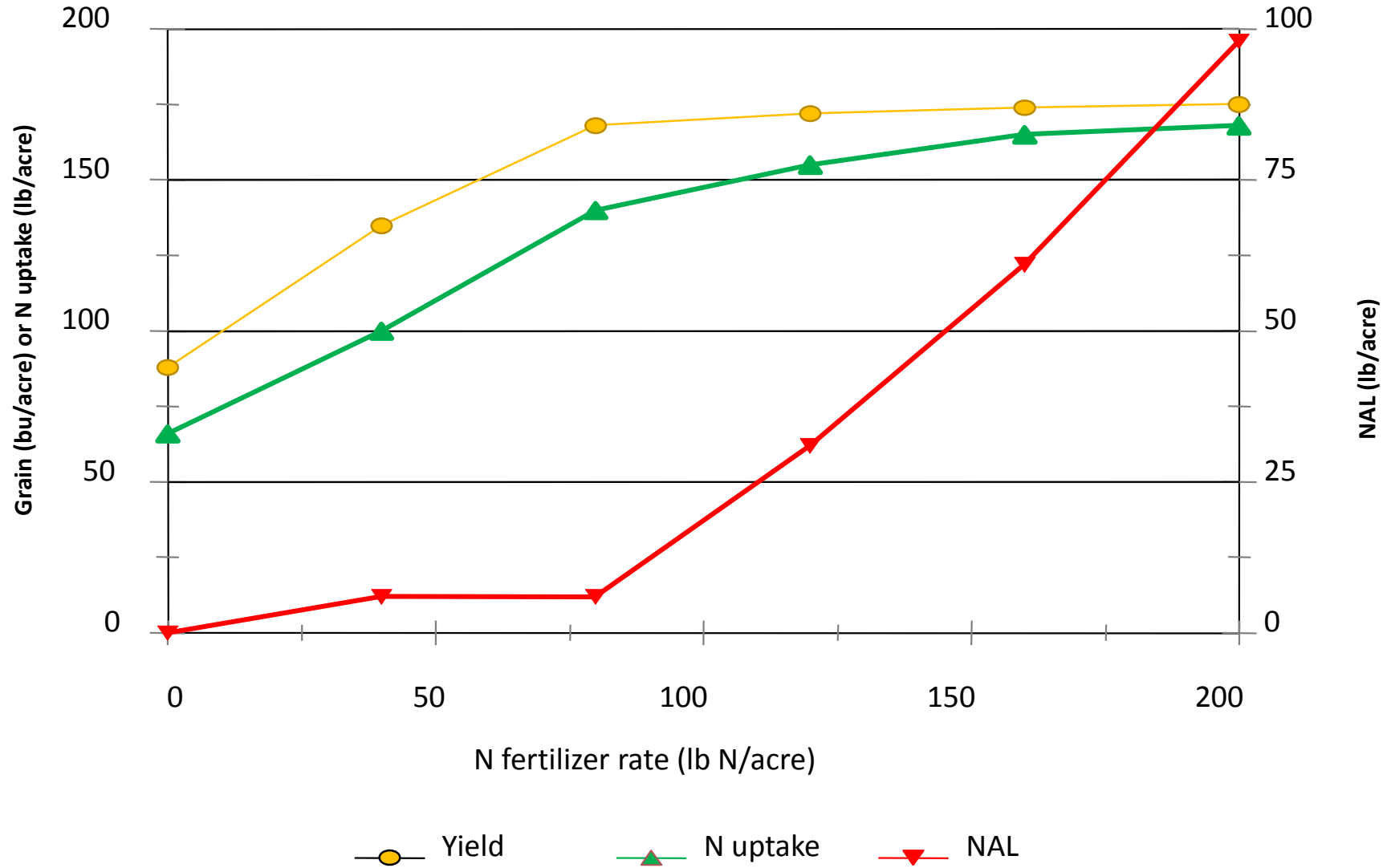




Eutrophication at Gulf Coast Water

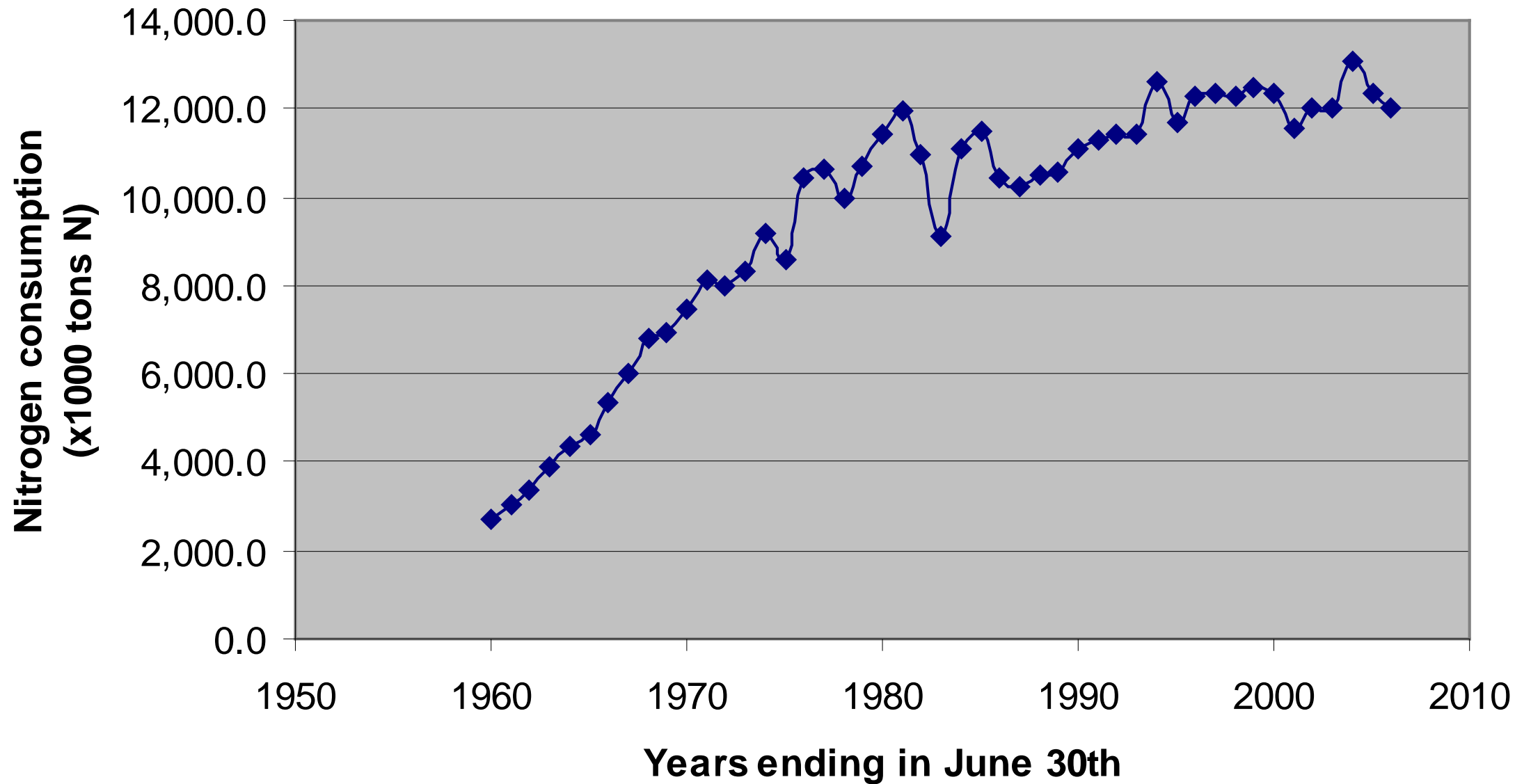


The map shows concentrations of phytoplankton, the algal blooms that contribute to dead zones, in Gulf Coast waters.



Effect of N fertilizer rate applications on yield and N uptake by irrigated corn (Adapted from Bock and Hergert, 1991). Potential N available to leach (NAL) assuming major pathway for losses is leaching. The NAL was estimated as $NAL = N \text{ applied} - N \text{ uptake}$.

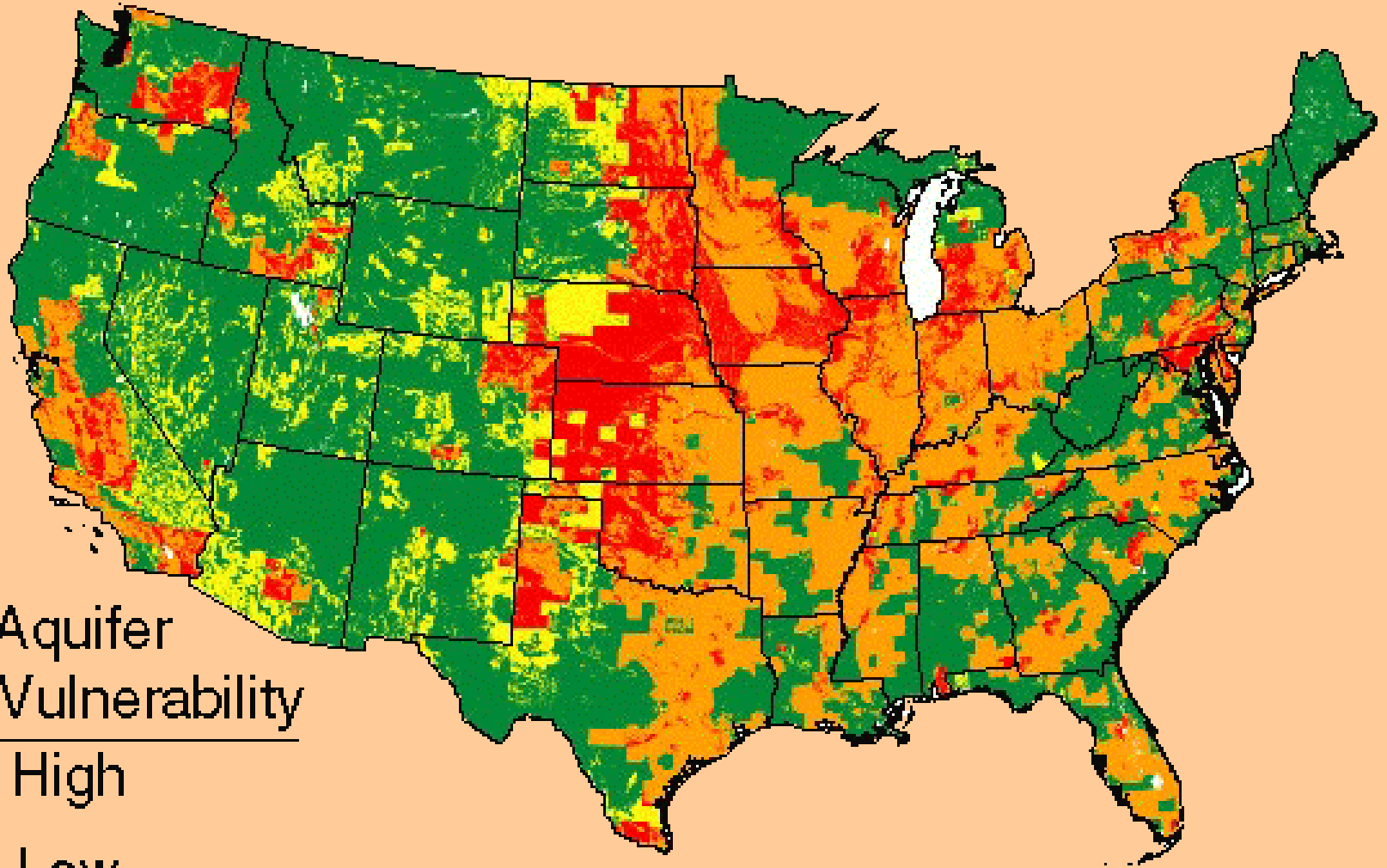
U.S. consumption of Nitrogen



Increasing risk of ground-water contamination



	<u>Nitrogen Input</u>	<u>Aquifer Vulnerability</u>
■	High	High
■	High	Low
■	Low	High
■	Low	Low

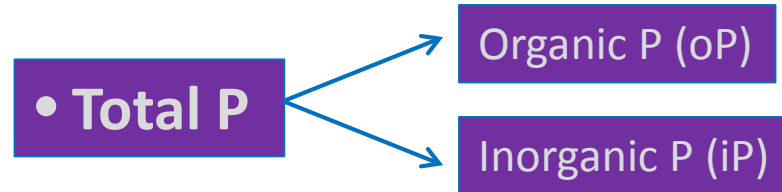




Phosphorus Cycle

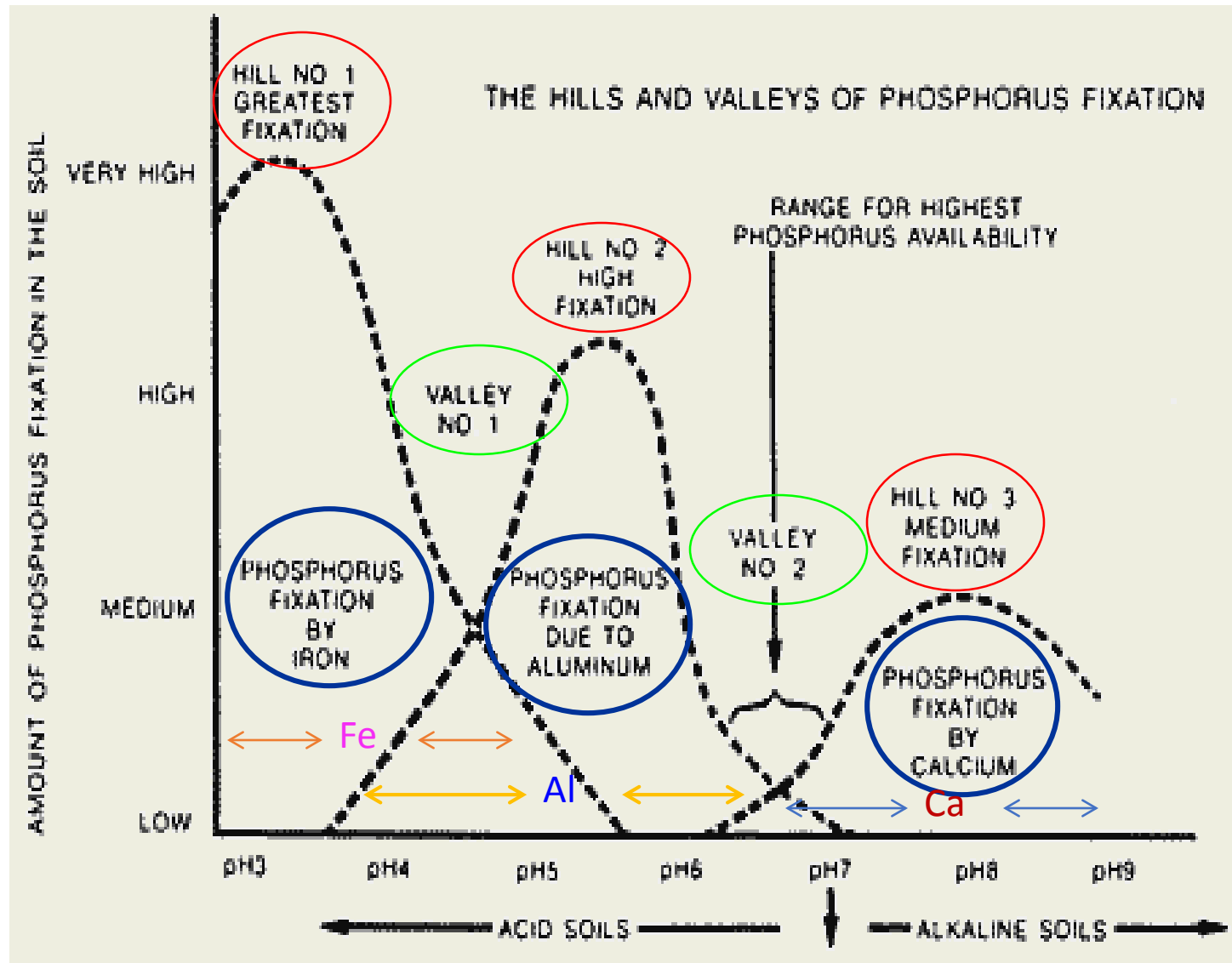
- Phosphorus released from the weathering of rocks such as rock phosphate
- All living organisms need phosphorus for DNA, ATP, lipids etc.

Forms of P in Soil



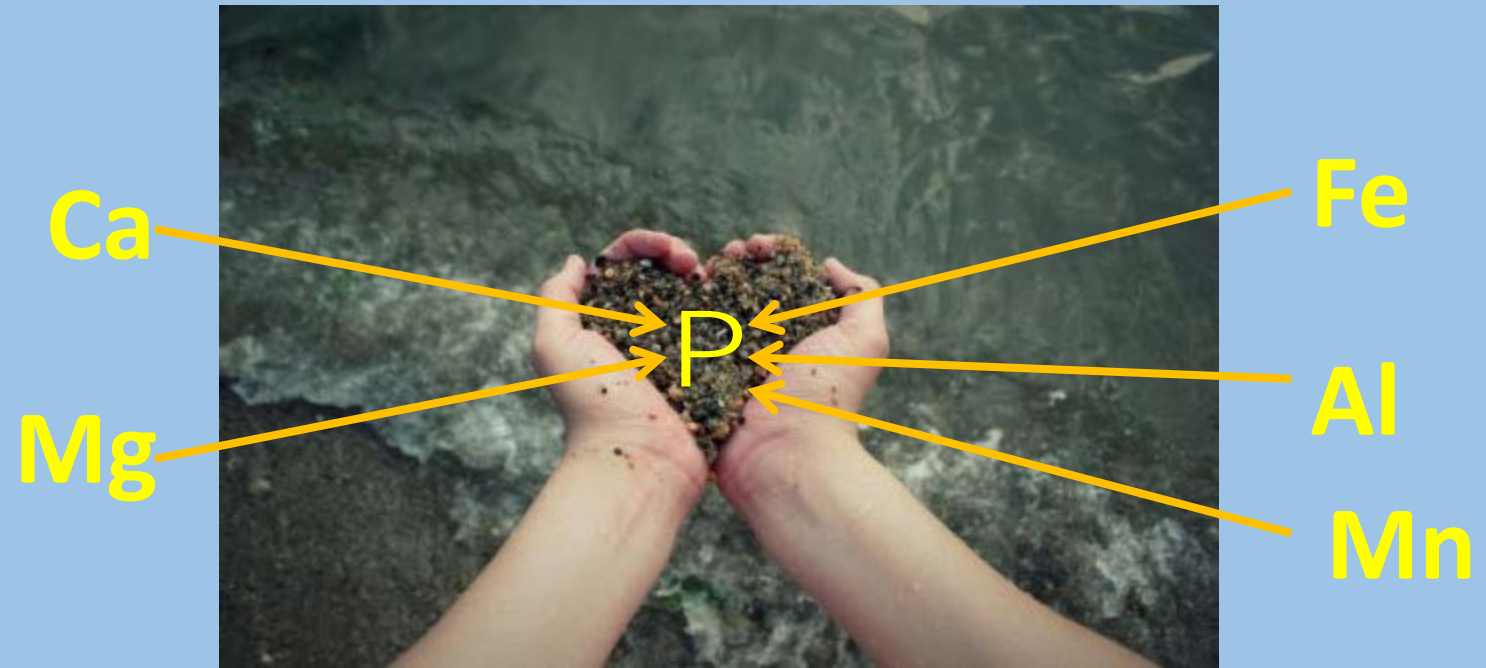
- Total dissolved P: primary iP and some dissolved oP
- Particulate P: attached to the sediment
- Bioavailable P: algal available P

P Fixation and Availability



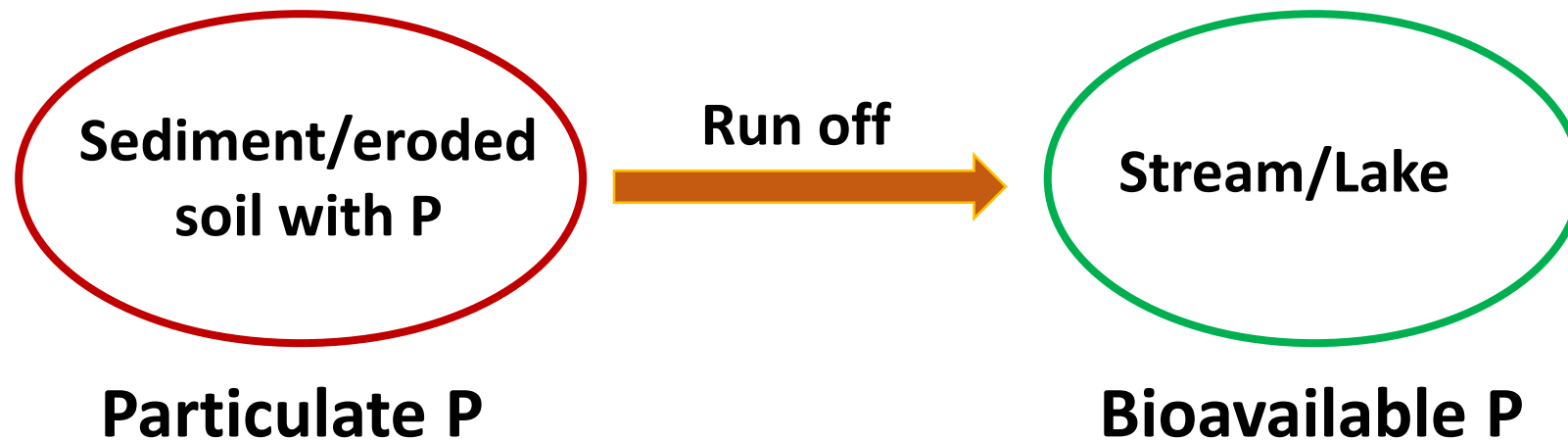
Miss America 2016 Betty Cantrell





In soil, P is Miss America, everyone loves P

Unavailable P becomes Available





Phosphorus and Eutrophication

- **P is also most often the limiting nutrient in freshwater Systems**
- **Lake water concentrations >0.02 ppm generally accelerate eutrophication**



Source: NASA

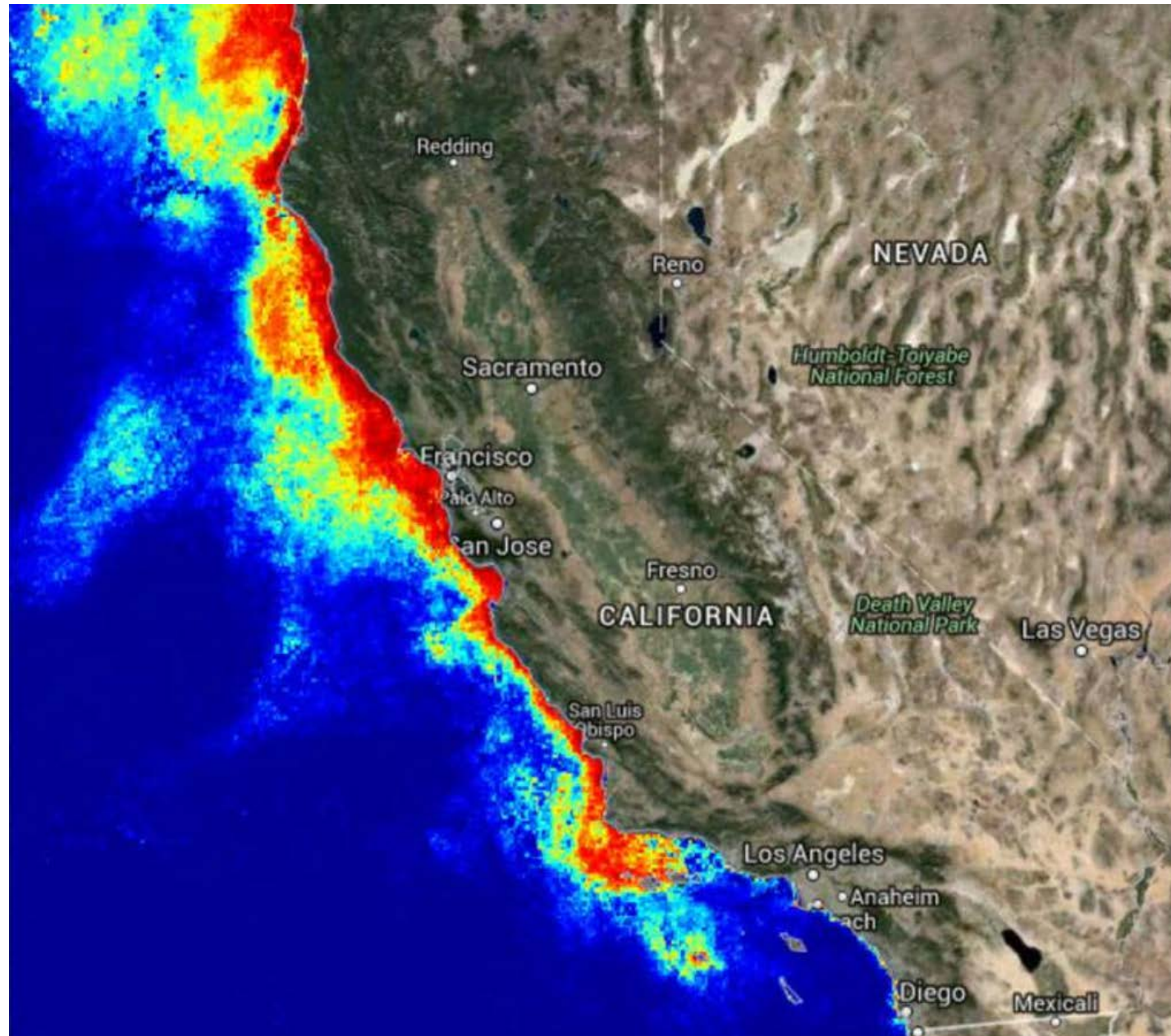
Lake Erie Becomes Eerie





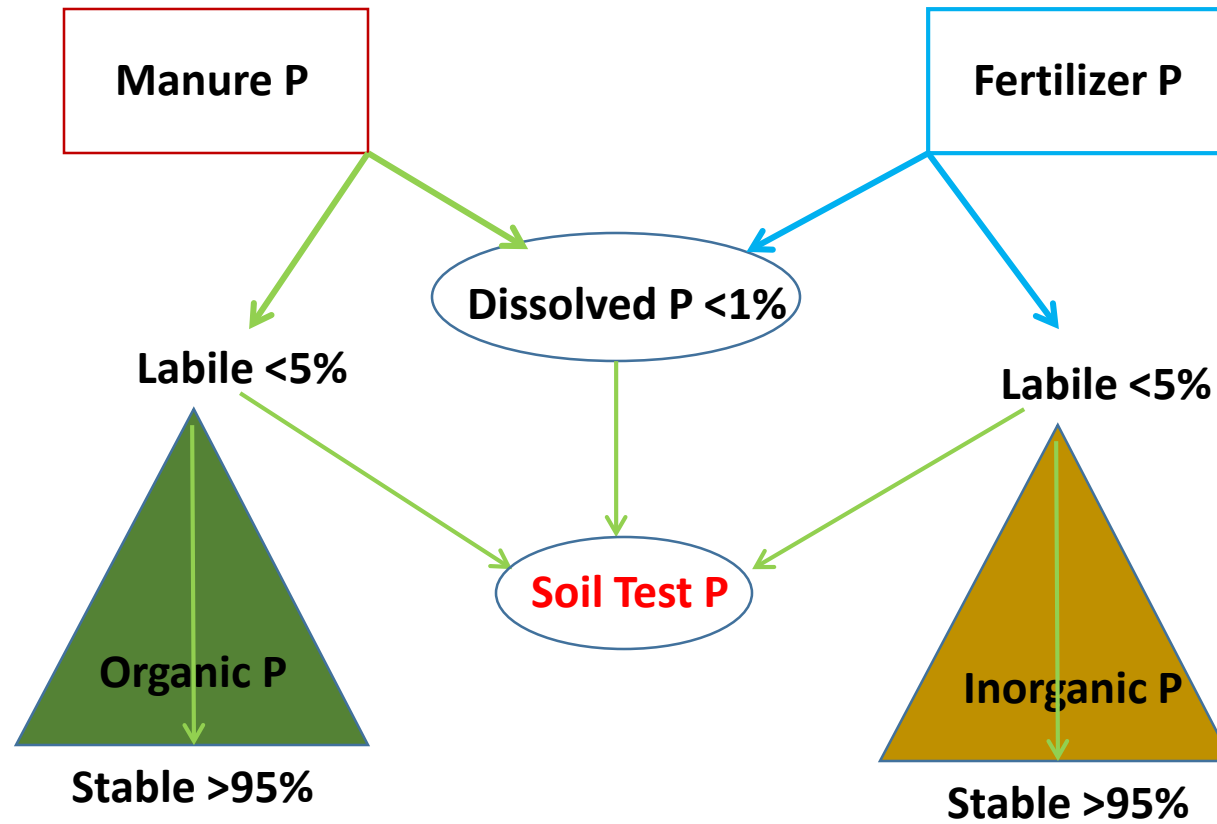
P flux to coastal oceans has nearly triple in the last 50 years, largely as a result of P applications to agricultural lands (Horwath et al. 1995)

West Coast Algal Bloom



2015 Algal Bloom in CA
Raphael Kudela, UCSC

Soil P Pools





Nutrient Use Efficiency

Generally fertilizer use efficiency

For annual crop: N: 30-70%

P: 5-40%

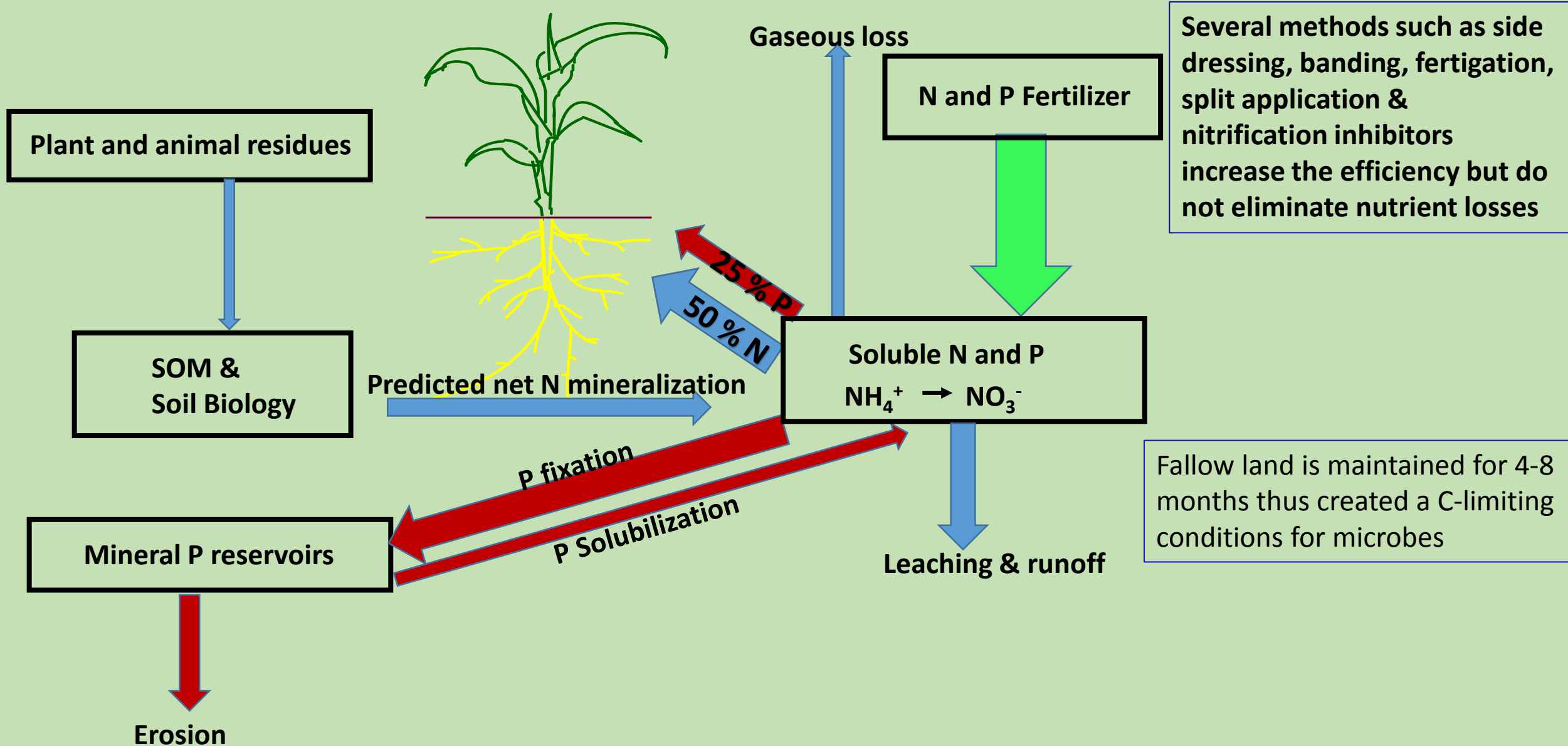
K: 50-80%

Orchards /Pasture N, P & K: 5-40%

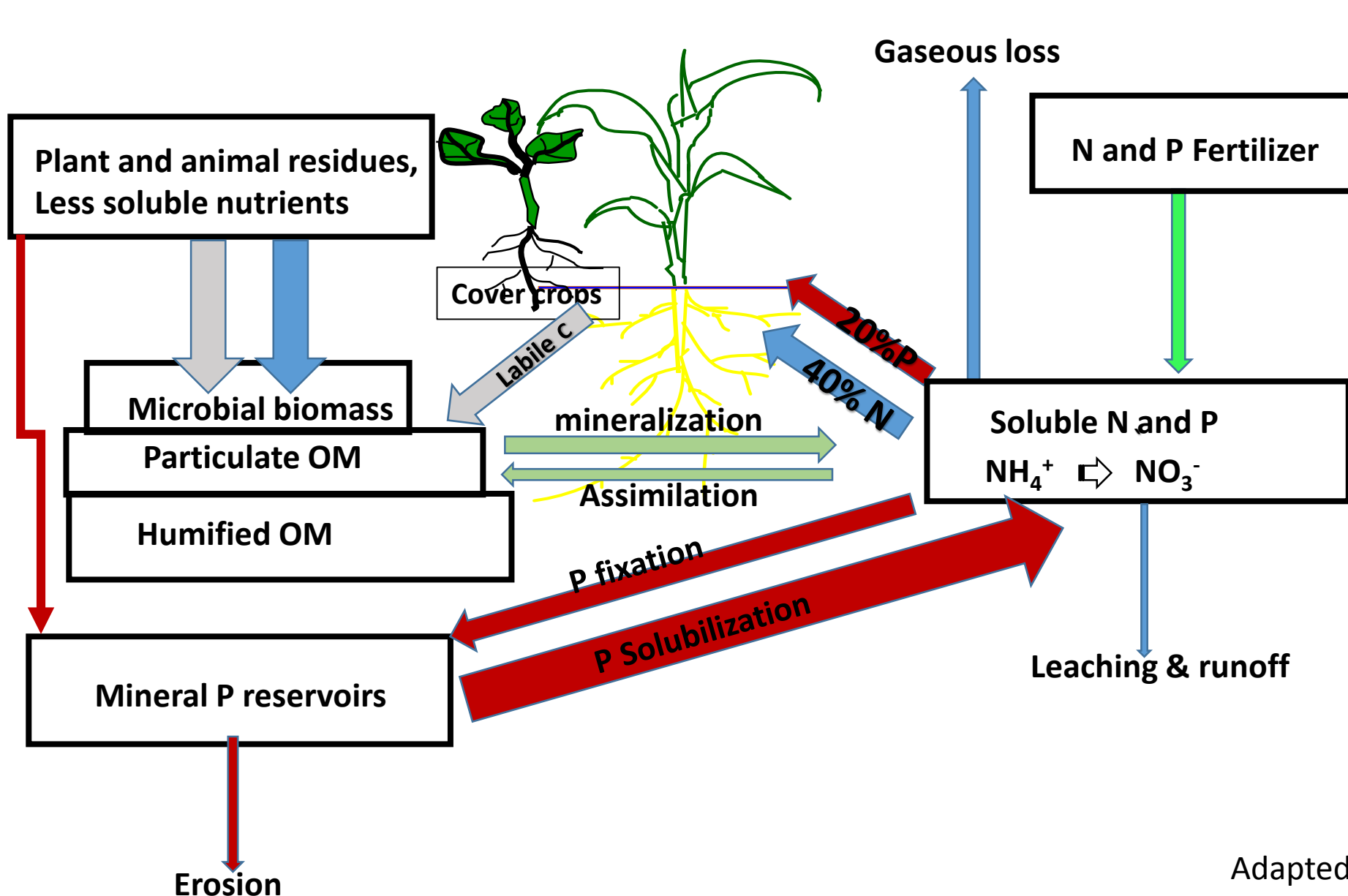
Nitrogen use efficiency for cereal 30-35% (Agron. J. 91:357-363)

In tropical rice fields, as much as 50 to 70 percent Nitrogen can be lost (H. Kronzuccker, UOT, 2

Crop-based Nutrient Management- 4R strategy (Intermediate)



Ecological Approach to Nutrient Management



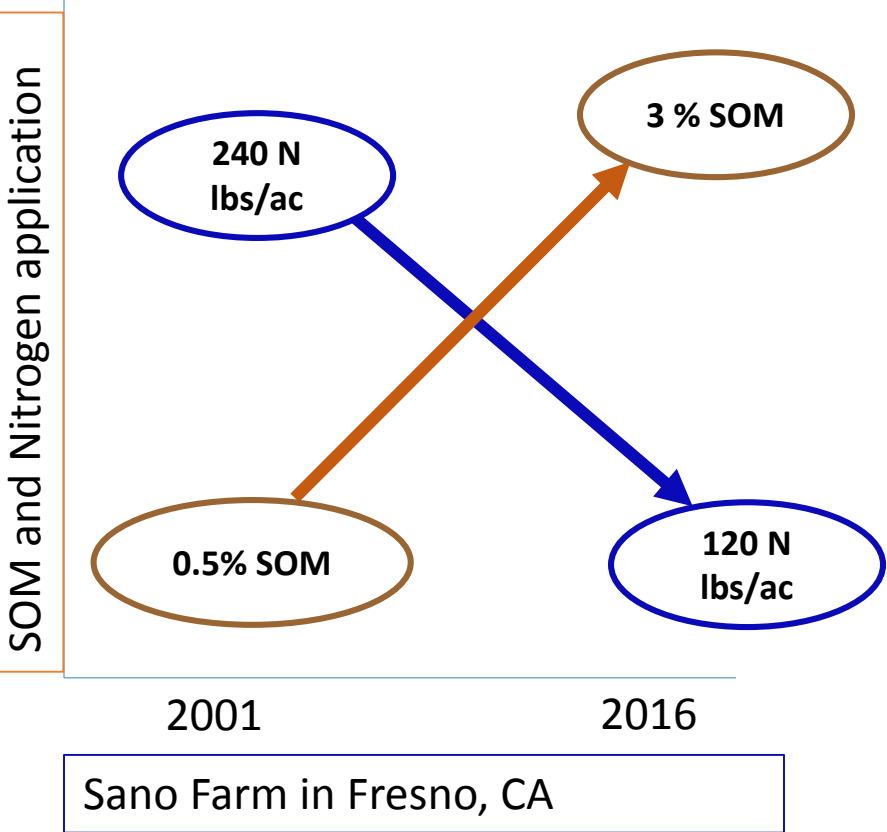
This model is to find how to best achieve yields while minimizing fertilizer use and minimizing harm to the environment

Yields and soil reservoirs are maintained with nutrient inputs that are approx. equal to harvested export

Diversification of inputs such as adding carbon, diverse cropping system, cover crops, slow release N & P

Measure all pools of N & P

Example: Ecological Nutrient Management





These are both Buxton Silt Loams



Ecological approach to nutrient management

Dorn Cox, 2012

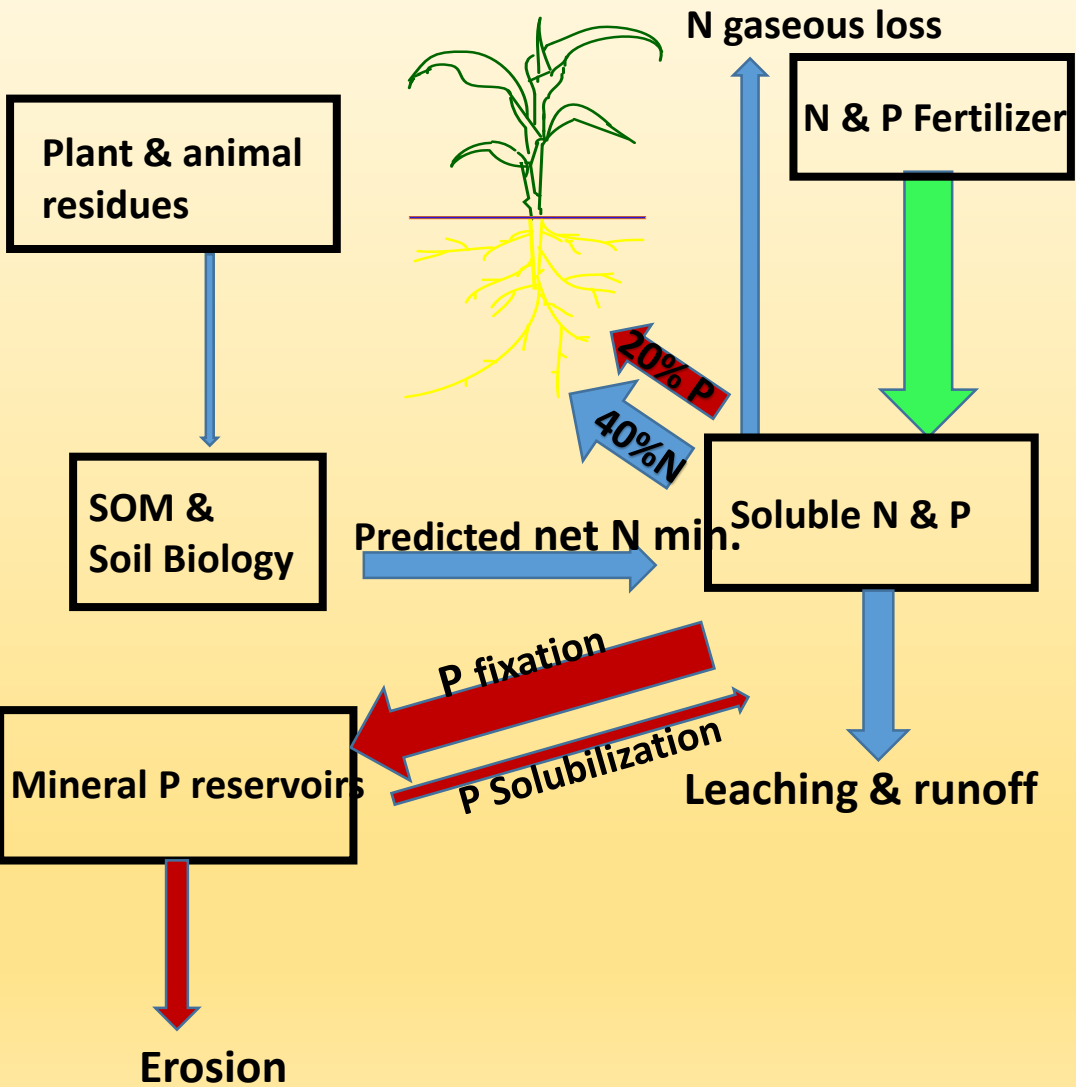


Crop-based nutrient management

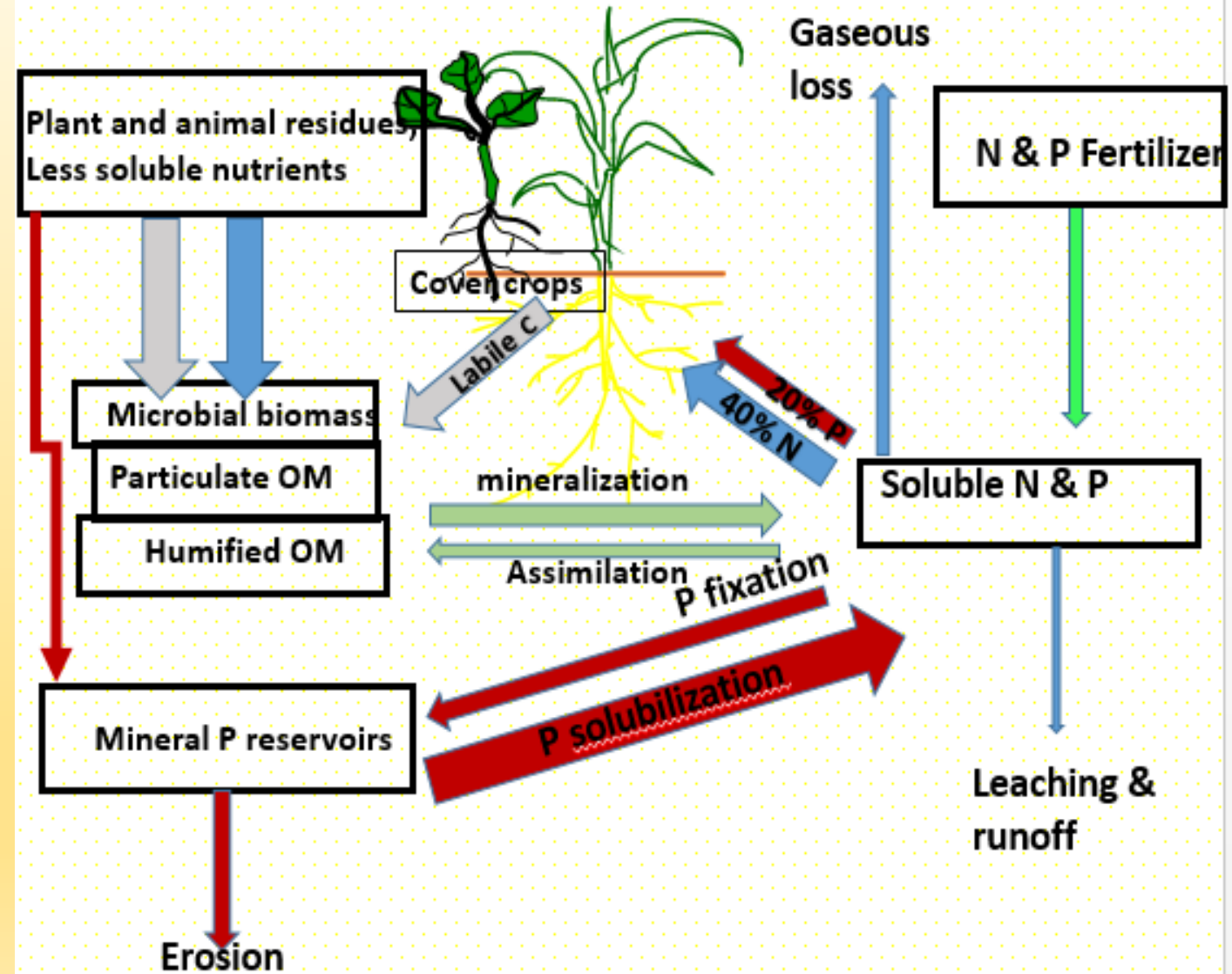
Standard Soil Test says this one is better!

Bianca Moebius-Clune, 2012

Crop-based Nutrient Management



Ecological Approach to Nutrient Management



Soil Health Principles and Ecological Model



- **Living roots: cover crops & soil biology**
- **Minimize disturbance : soil biology-AMF**
- **Maximize soil cover: crop residues**
- **Maximize biodiversity: nutrient cycling & reserve**

Thank You



Any Question?