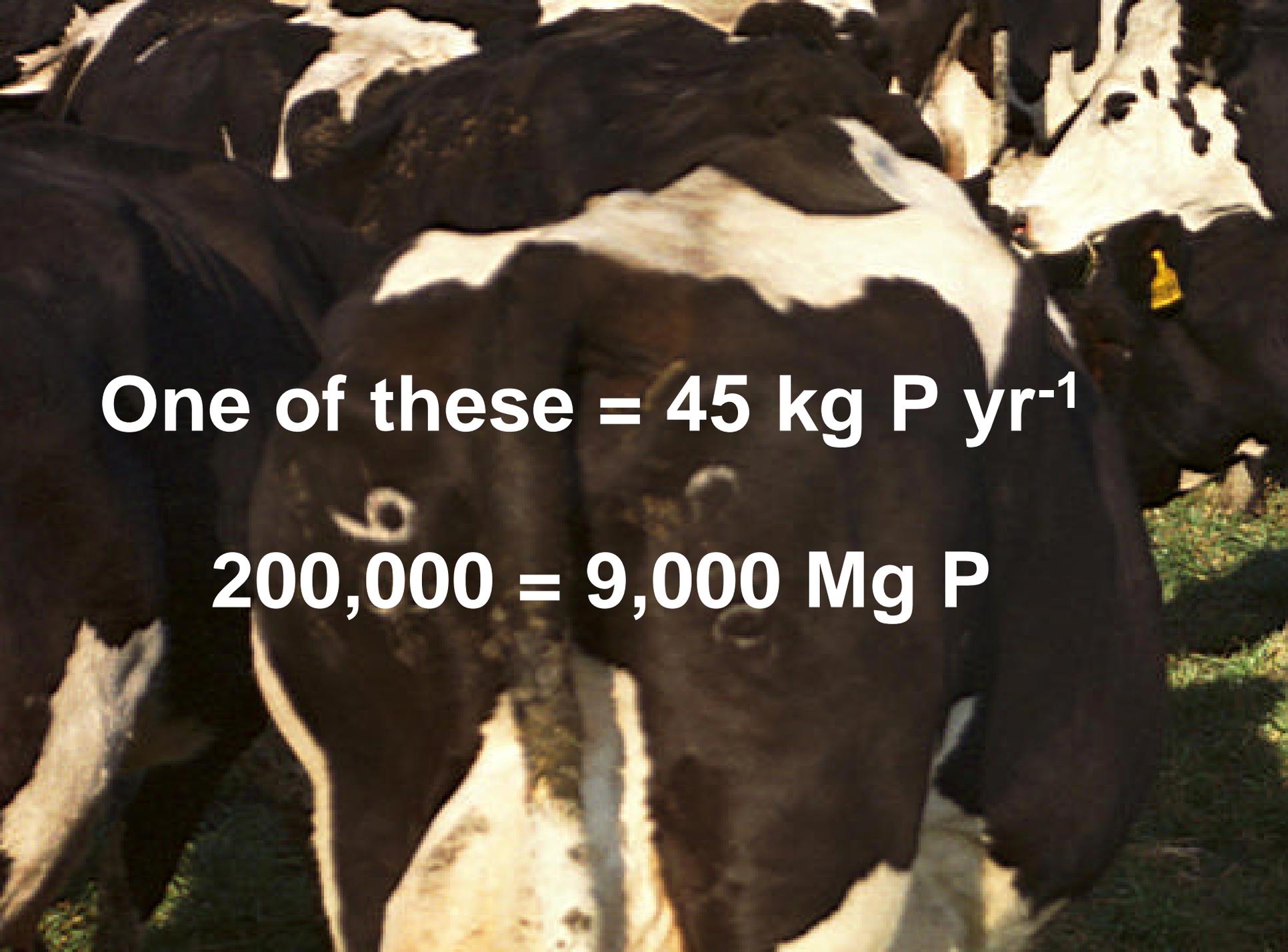


Hype or Hope: How much does phytoremediation of phosphorus-overloaded soils really accomplish?

**Jim Muir & Yoana Newman
Texas A & M University**

North-central Texas Dairies

- **CAFO ? farms**
- **200,000 cows in Erath County alone**
- **Manure P exceeds sequestration capacity**

A photograph of a herd of black and white cows in a field. The cows are the central focus, with their bodies and heads visible. The background shows a grassy field under bright sunlight. The text is overlaid on the image in white, bold font.

One of these = 45 kg P yr⁻¹

200,000 = 9,000 Mg P



Soils in the region low in P

**Concentration = distribution
problem**

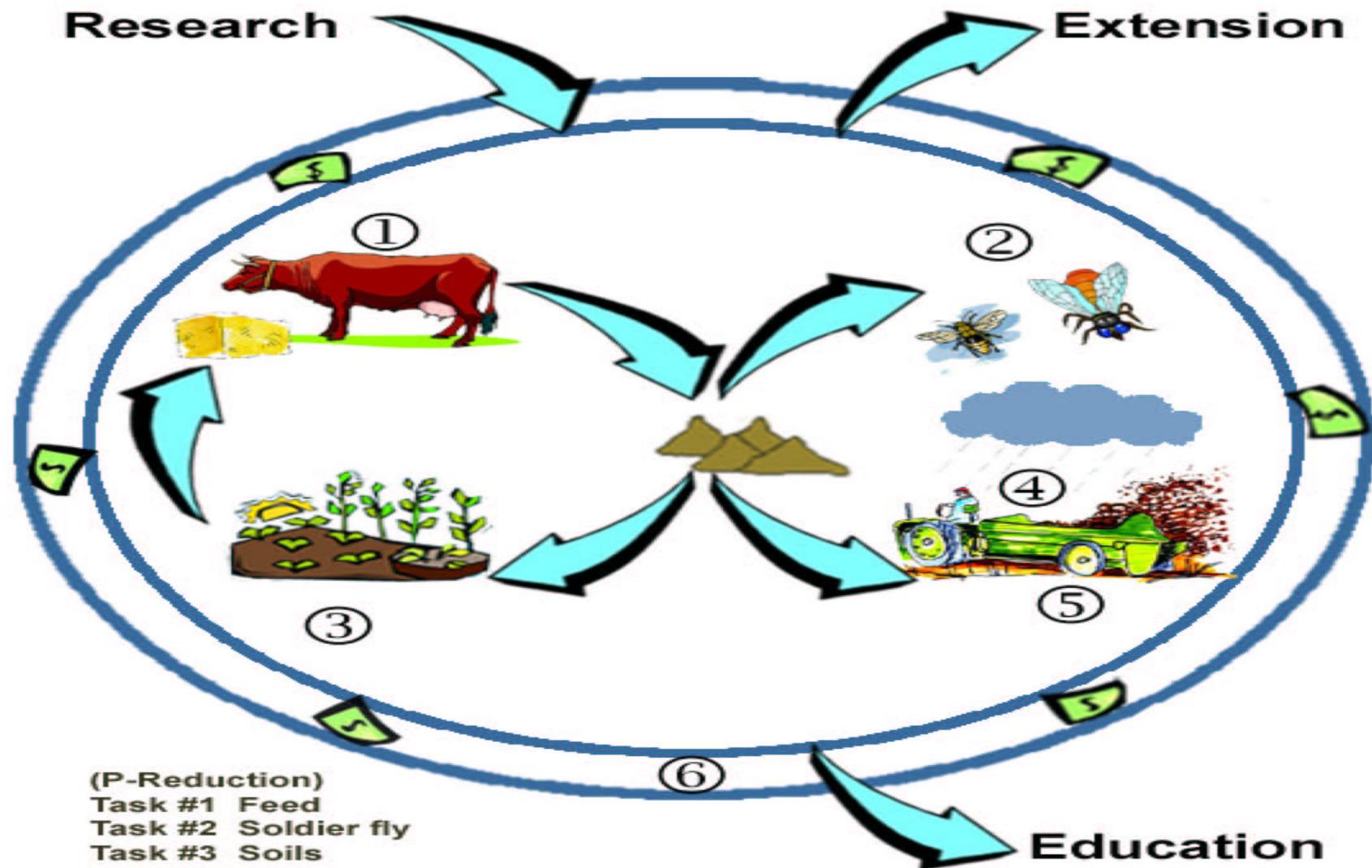
Transportation costs = \$\$

NIWQP Grant

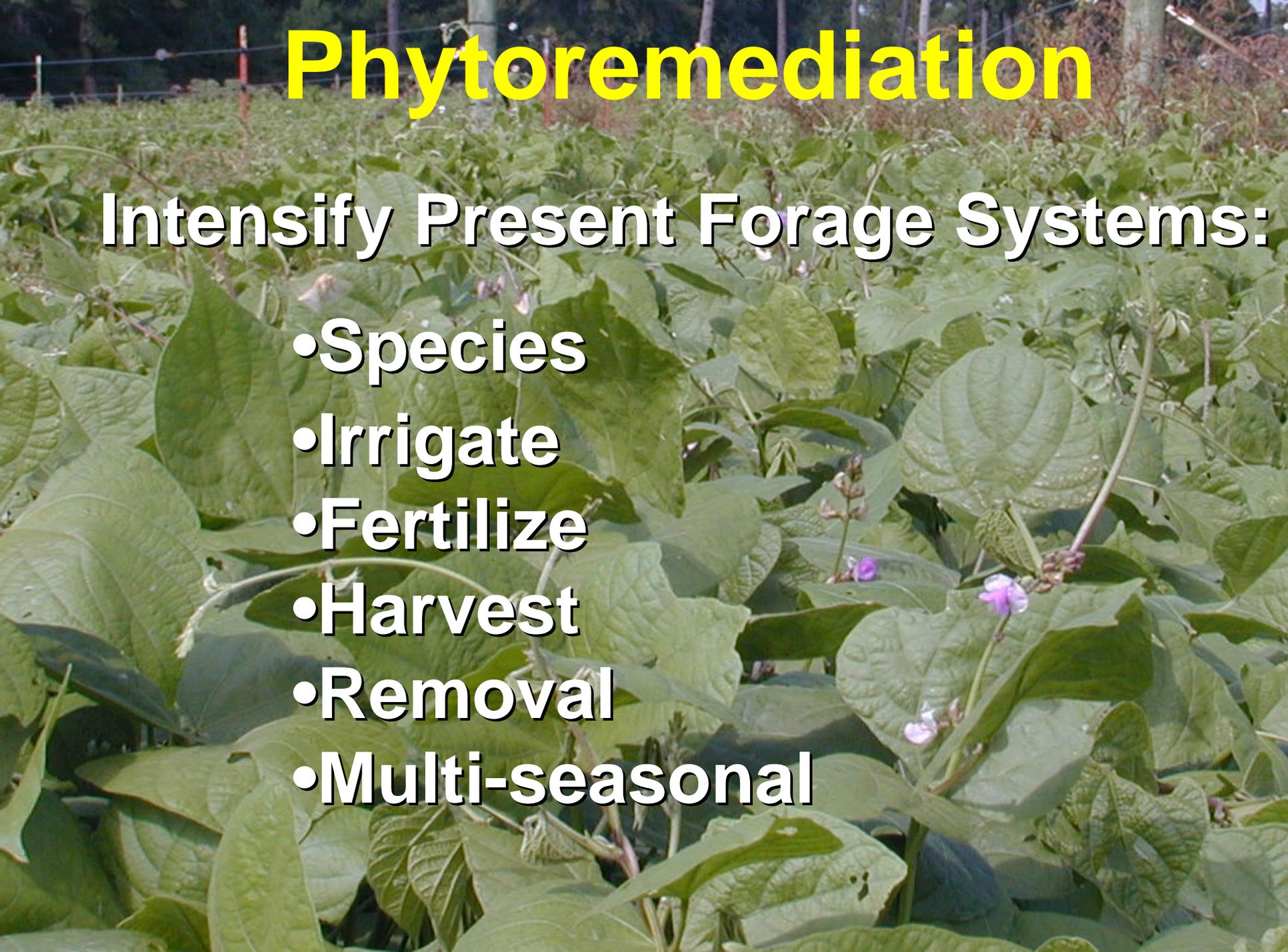
- Multi-disciplinary
 - Dairymen
 - Animal science
 - Plant science
 - Soil science
 - Ag engineer
 - Ag economist
- Multi-institutional
 - Dairies
 - Texas Agricultural Experiment Station
 - Texas Cooperative Extension
 - Tarleton State University

Goals:

- Precisely define P picture within Dairies
- Tighten P cycles by developing BMP
- Research/Extension/Education



Phytoremediation

A photograph of a lush green field of plants, likely a forage crop, with several small purple flowers visible. The plants are dense and healthy, growing in a field setting. The background shows a fence and some trees, suggesting a rural or agricultural environment.

Intensify Present Forage Systems:

- Species
- Irrigate
- Fertilize
- Harvest
- Removal
- Multi-seasonal

Winter Legumes Overseeded on Tifton 85

■ Legume	Total	Coastal % Loss
	-----kg/ha-----	
Control		(6100)
Hairy Vetch	4800	80
Crimson CI	2400	47
Rose CI	1800	71
Arrowleaf CI	800	64
Burr Medic	0	0

Thesis:

- **Phytoremediation benefits do not always reflect at the landscape level.**
- **Phosphorus removal via plant removal does not necessarily translate into lower laboratory soil P analyses as interpreted by regulatory agencies.**

Phytoremediation Disconnect

Scientist: Plant P removal = lower total P in soil

Dairyman: Plant P removal = lower soil P analysis

Regulator: Plant P removal = lower plant-available P

Environment: Plant P removal = decrease P runoff

Are Scientists misleading industry & agencies?

Phytoremediation:

? lower soluble P

? lower soil P analyses

? reduce P runoff

Intensifying Forage Systems

- **Intensifying = greater herbage production = greater P recycled**
- **Hay, silage or green-chop!!**
- **Irrigation: increases DM yields 3 to 10 times!!**
- **Multi-seasonal: increases DM yields up to 3X**
- **Ideal soil fertility = maximum yields**
- **Choose species**

A photograph of a herd of black and white cows in a field. The cows are the background for the text. One cow in the foreground has a white patch on its back with the number '6' written on it. The text is overlaid on the image in yellow and white.

LAR (Land Area Requirement)

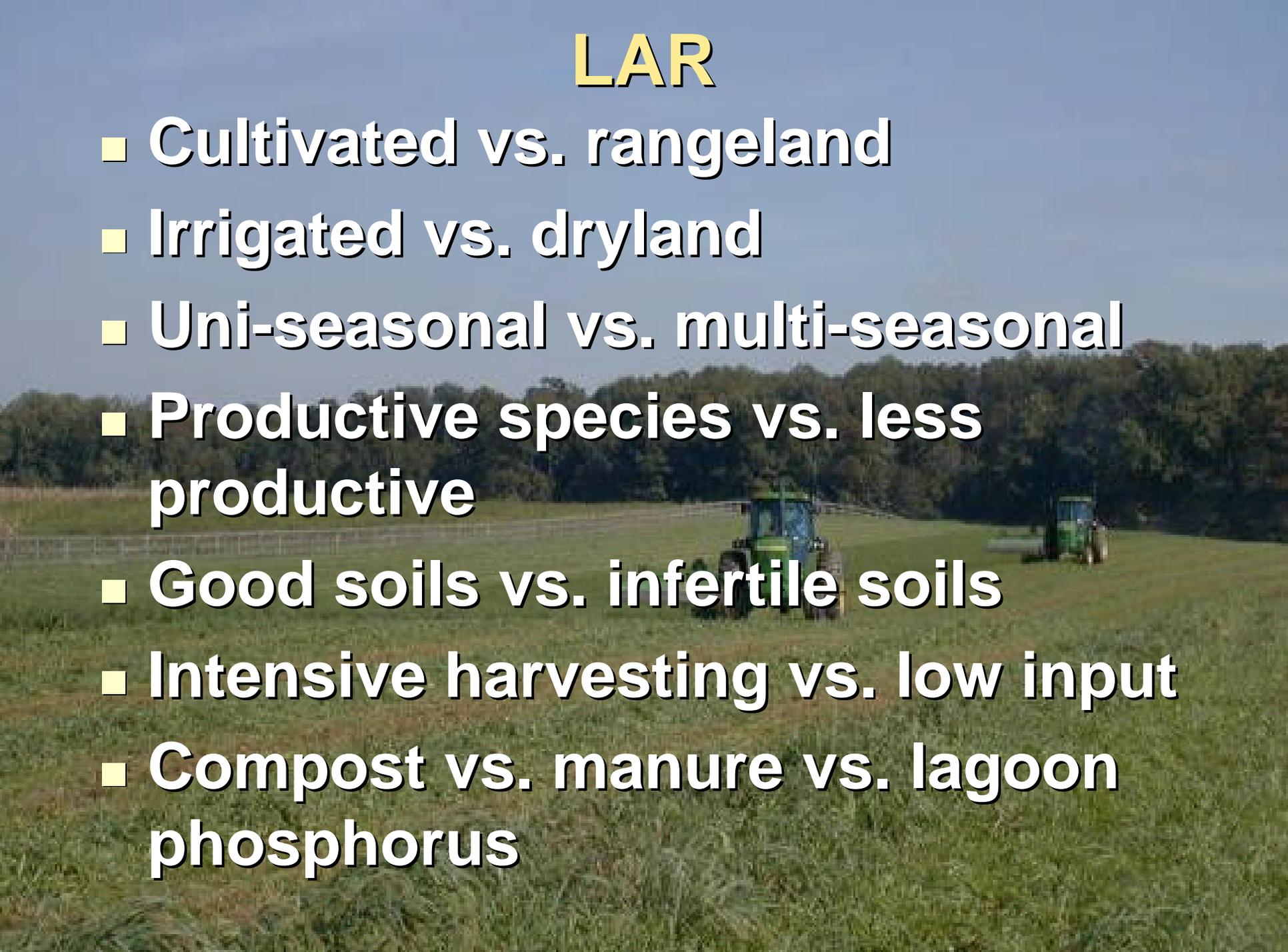
One of these = 45 kg P yr⁻¹

? ha will recycle 45 kg P yr⁻¹ ?

LAR

- **Basis for permitting CAFO animal numbers**
- **Is this applicable to warmer climates?**
- **How does rainfall affect LAR?**
- **We can reduce by intensifying forage systems**

LAR

- Cultivated vs. rangeland
 - Irrigated vs. dryland
 - Uni-seasonal vs. multi-seasonal
 - Productive species vs. less productive
 - Good soils vs. infertile soils
 - Intensive harvesting vs. low input
 - Compost vs. manure vs. lagoon phosphorus
- 
- A photograph of a green tractor pulling a harrow in a field, with another tractor visible in the distance. The background shows a line of trees under a clear sky.

A photograph of a brown cow with a white blaze on its face, standing in a field. The cow is facing left. The background shows a fence and trees. The text is overlaid on the cow's body.

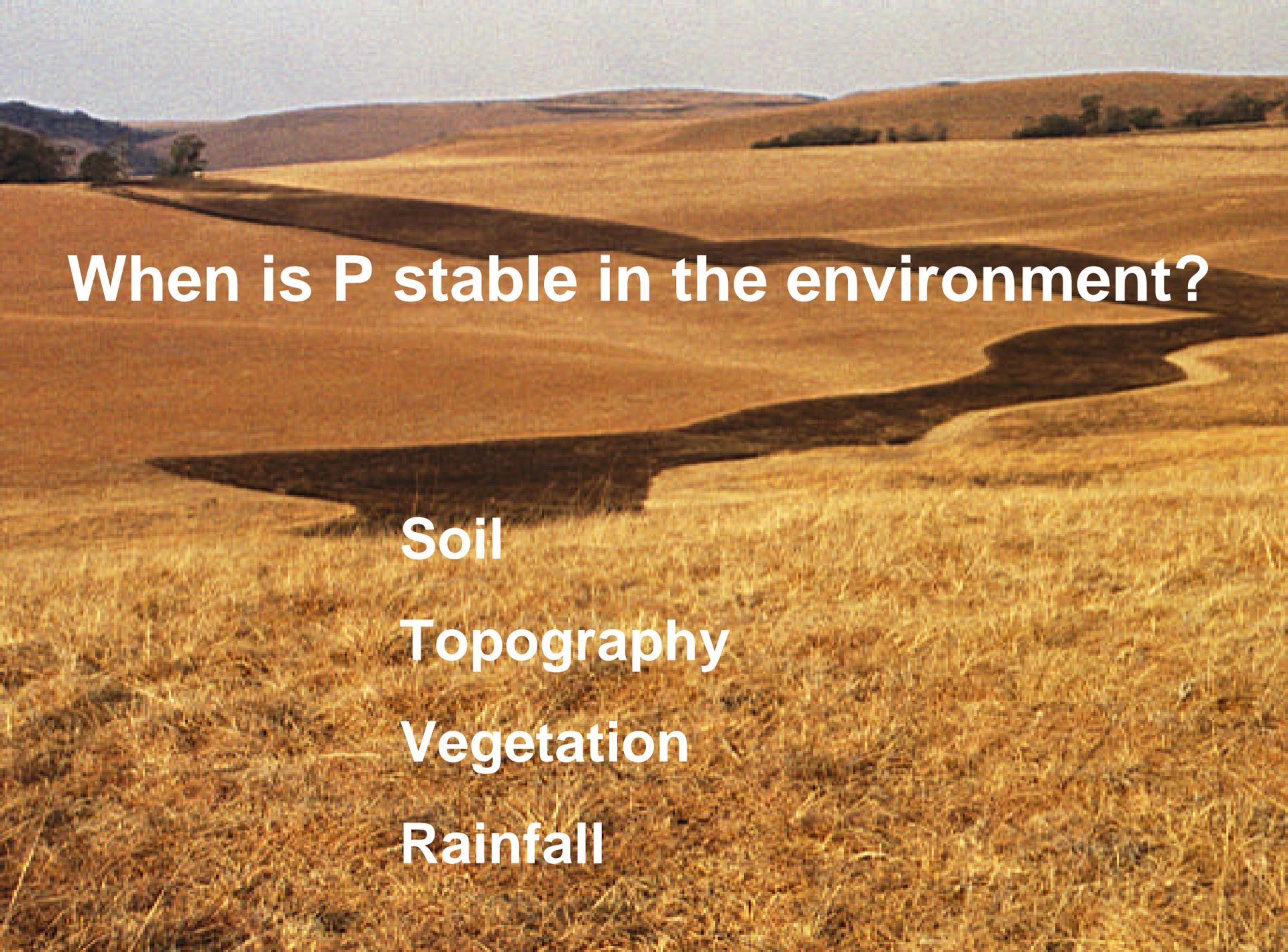
**Not all forage P equally available
Combination of concentration & availability
= excreted P**

Stabilizing soil-P

- If we can keep P from moving = no runoff
- Application method
- Incorporated into soil?
- Soil types
 - Texture: sand vs. clay
 - Deep vs. shallow
 - Slope
 - Organic matter
 - Fertility



Incorporation = less P surface runoff
Tilling = more particle runoff

A landscape of rolling hills with a winding stream, used as a background for a presentation slide. The hills are covered in golden-brown grass, and the stream flows through the center of the frame. The sky is a pale, clear blue.

When is P stable in the environment?

Soil

Topography

Vegetation

Rainfall

Stabilizing soil-P (con't)

- **Vegetation**
 - Tilled (annuals) vs. perennial
 - Bunch vs. tillered (matt)
 - Winter vs. summer growth
 - Grazed/disturbed
- **Doubt as to stability of soil-P fixation**
 - Root exudates cause P release
 - Root uptake allows further soil-P release
 - Mycorrhizae symbiosis increases root reach



Bunch grasses = exposed soil surface =
greater runoff potential



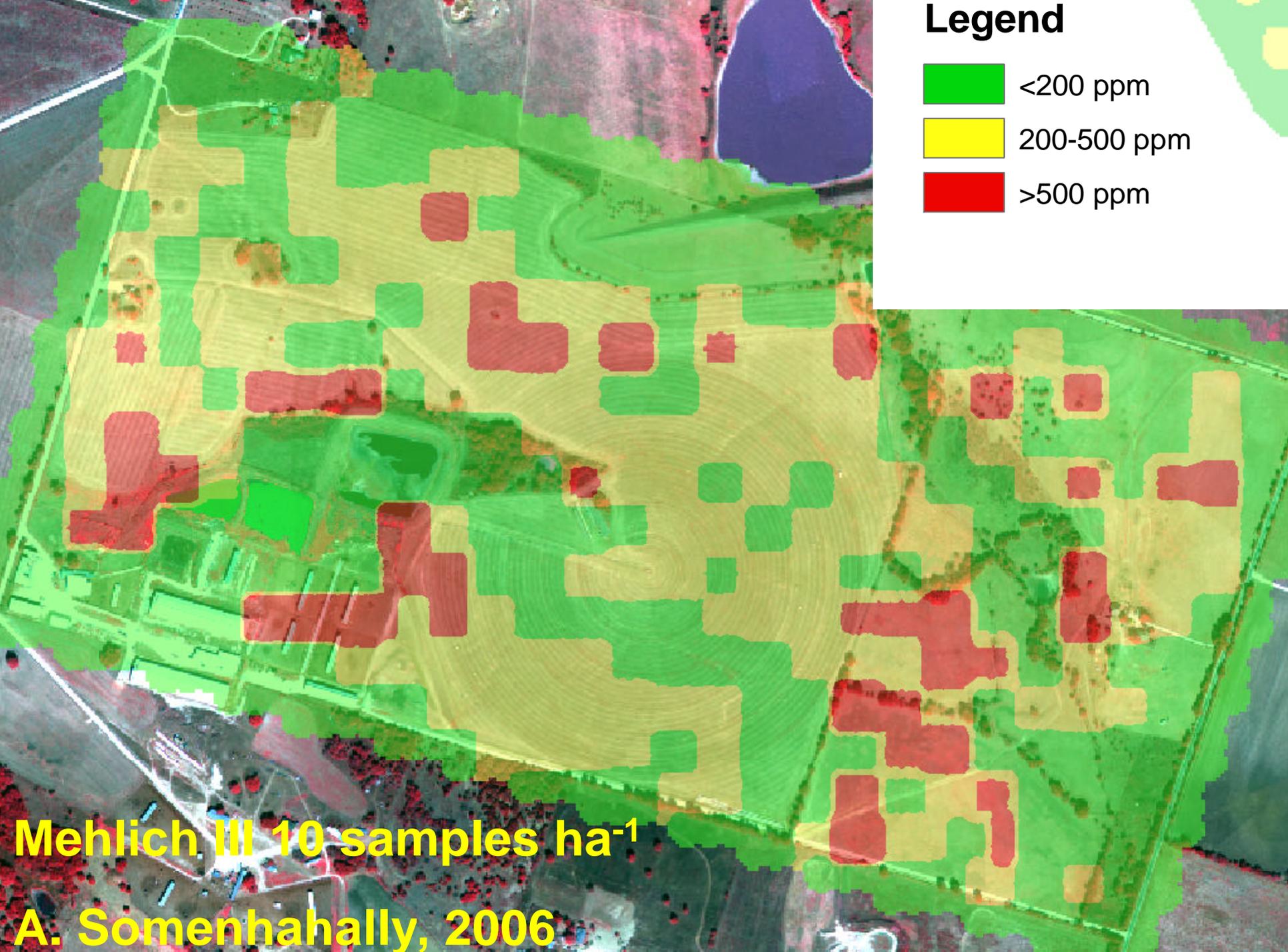
Soil & Vegetation “fix” (hold) P

Soil Tests & Regulatory Agencies

- 200 ppm P maximum (water soluble!!!)
- Nutrient utilization plan (Texas Admin. Code, 1997) if over 200 ppm
- Plant-available P vs. total P

Total P vs. Plant-available P

- Plants Remove water-soluble P only?
- Root rhizosphere changes P availability of soil-fixed P
 - Symbiotic micro-organisms
 - Root (pH) exudates



Legend

- <200 ppm
- 200-500 ppm
- >500 ppm

Mehlich III 10 samples ha⁻¹

A. Somenhally, 2006

Soil Tests (con't)

- **Agricultural soil tests**
 - **water soluble, plant available**
 - **not designed for regulatory agencies**
 - **Melich III most common**
 - **Others = different results**
- **Once water soluble removed by plant, soil replenishes**
- **Root exudates & mycorrhizae change soil-P fixation**
- **Many questions remain before regulatory agencies catch up**

CONCLUSIONS:

- **Phytoremediation has been hyped**
- **Soil P removal ? lower soil tests!!!**
- **Total P vs. Plant-available P vs.
soluble P**
- **Soils & climate = different LAR**