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

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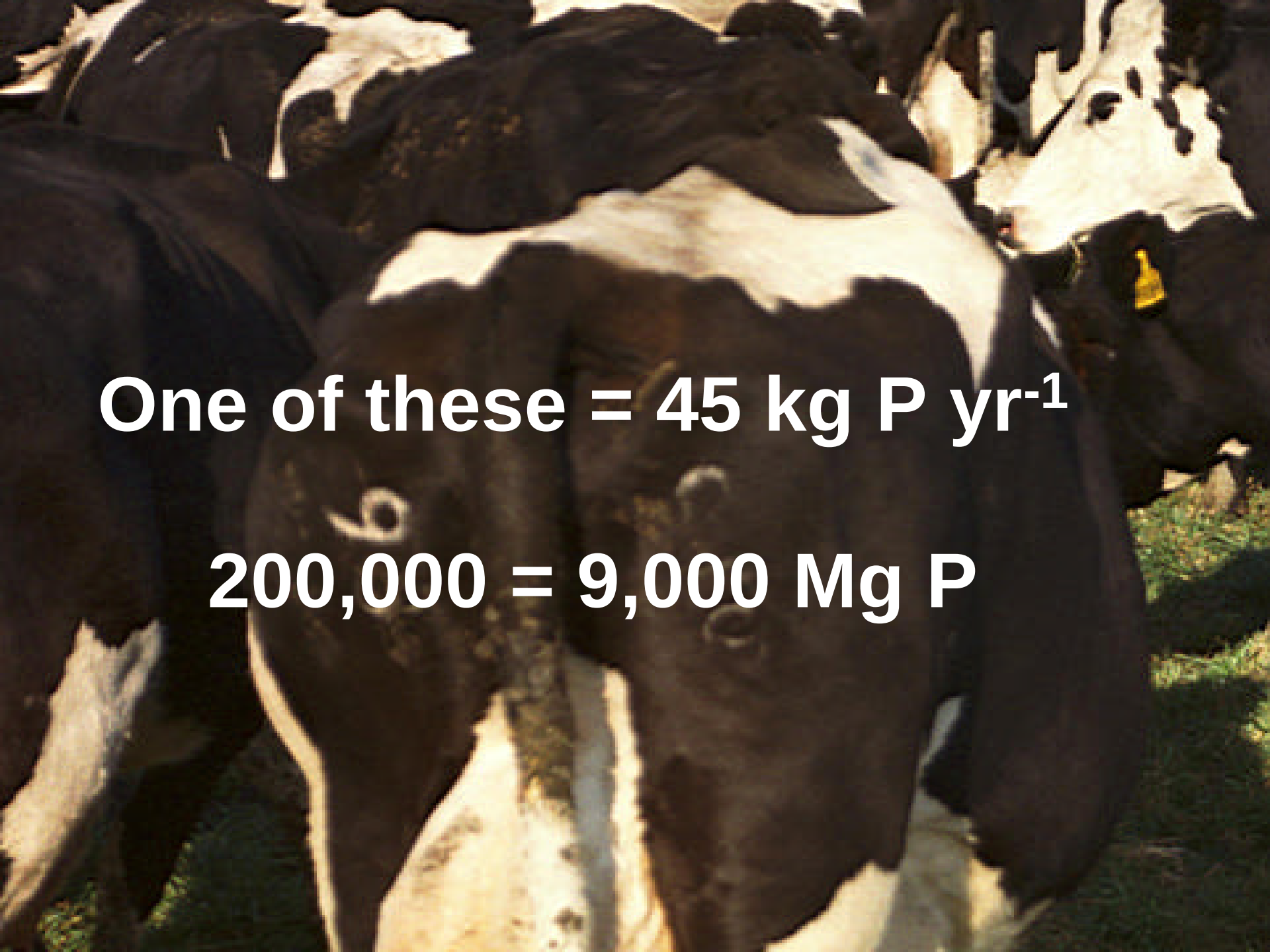
North-central Texas Dairies

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


One of these = 45 kg P yr-1
200,000 = 9,000 Mg P

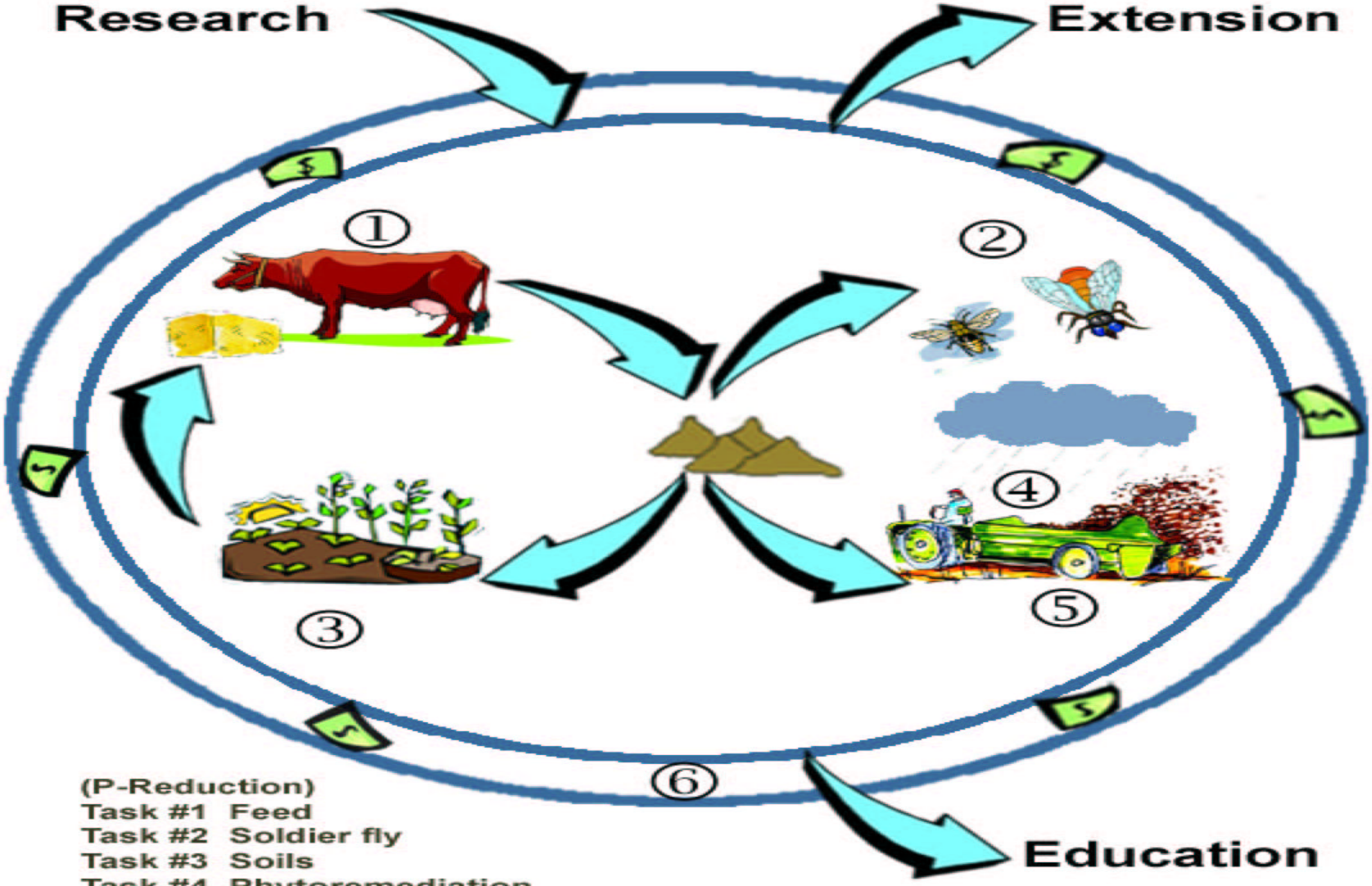

Soils in the region low in P
Concentration = distribution problem
Transportation costs = $$

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



(P-Reduction)
Task #1 Feed
Task #2 Soldier fly
Task #3 Soils
Task #4 Phytoremediation
Task #5 Buffer Strips
Task #6 Economics

Phytoremediation

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 Cl	**2400**	**47**
Rose Cl	**1800**	**71**
Arrowleaf Cl	**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

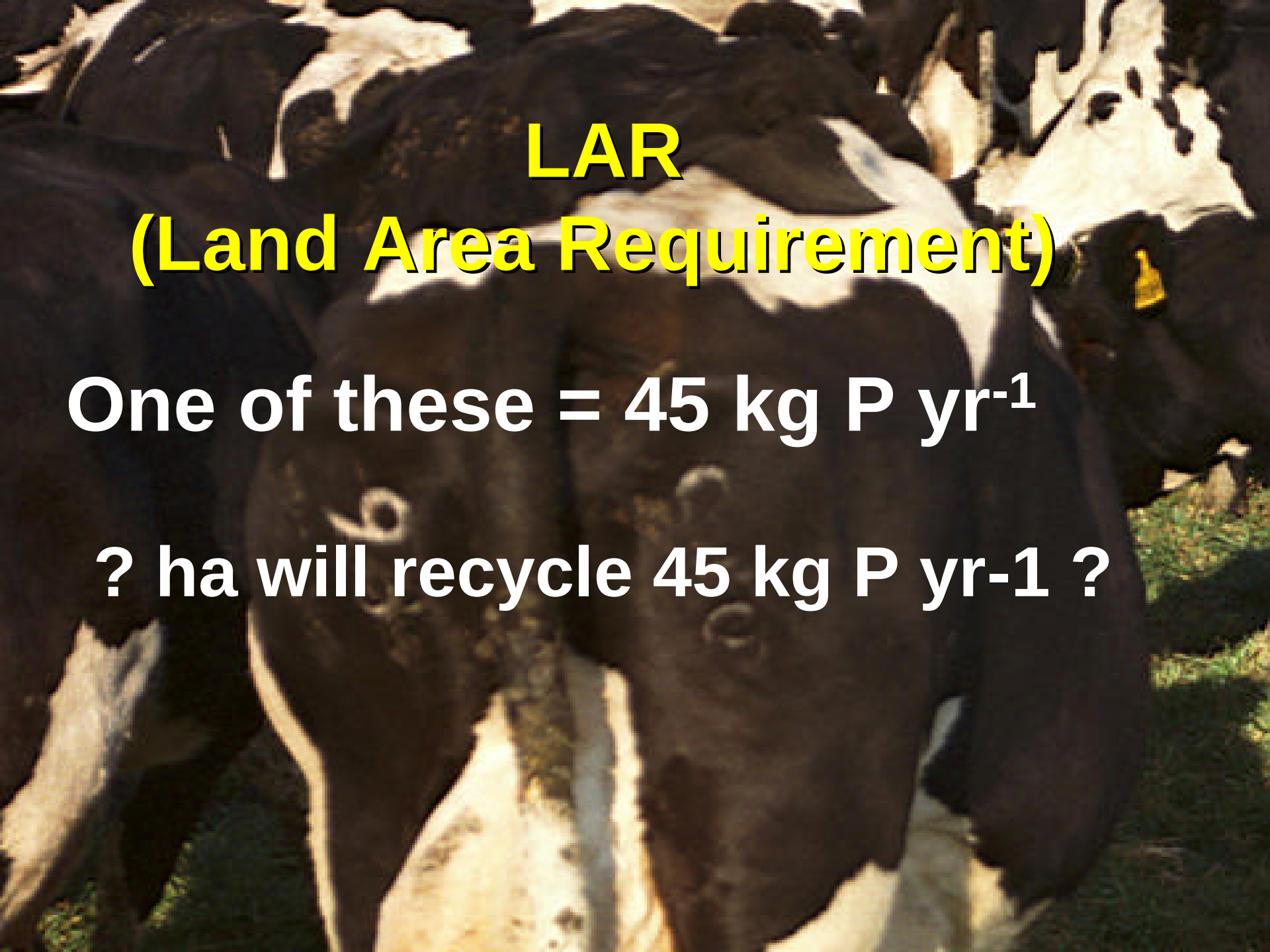
Are Scientists misleading industry & agencies?

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



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

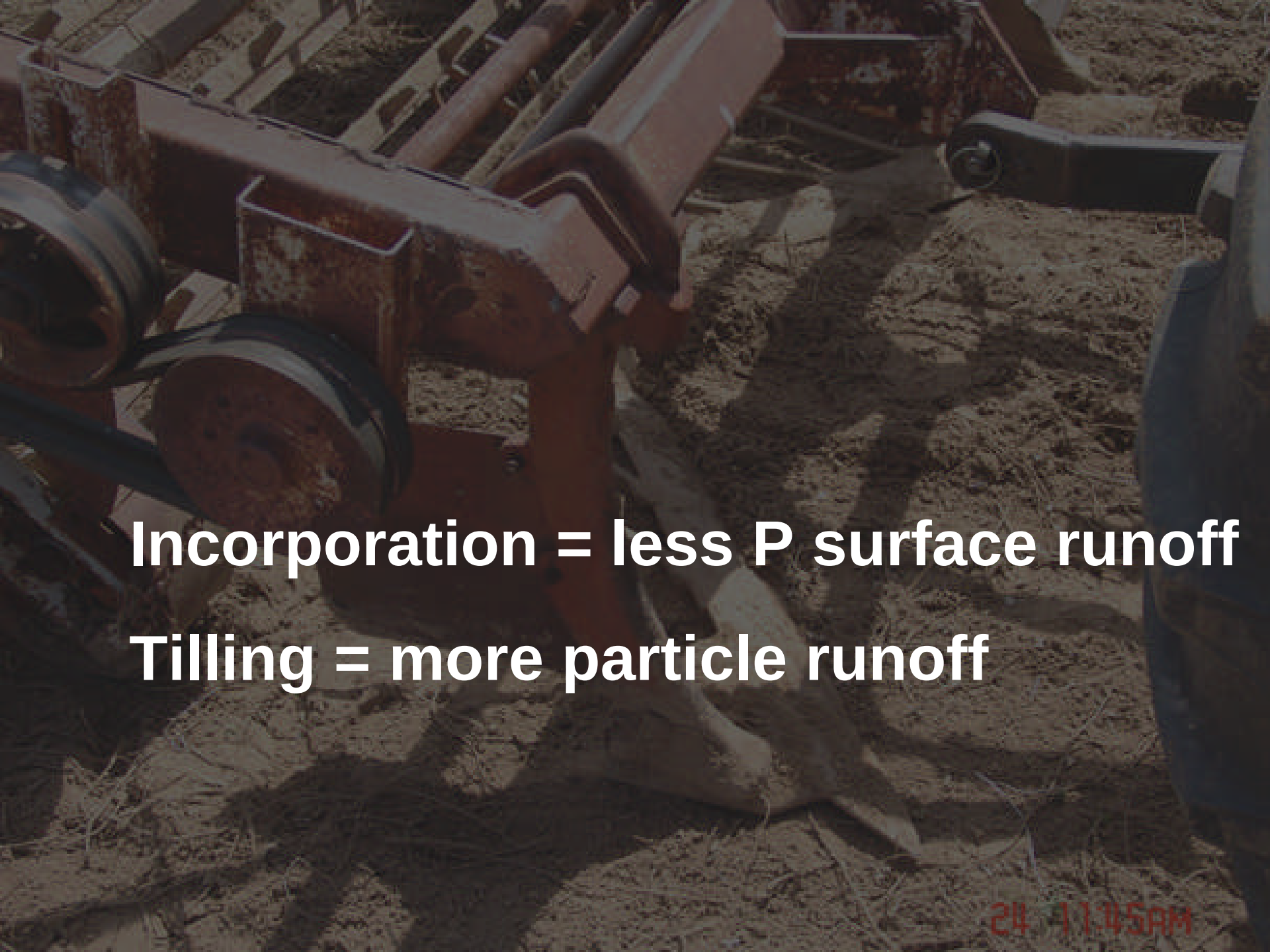
LAR

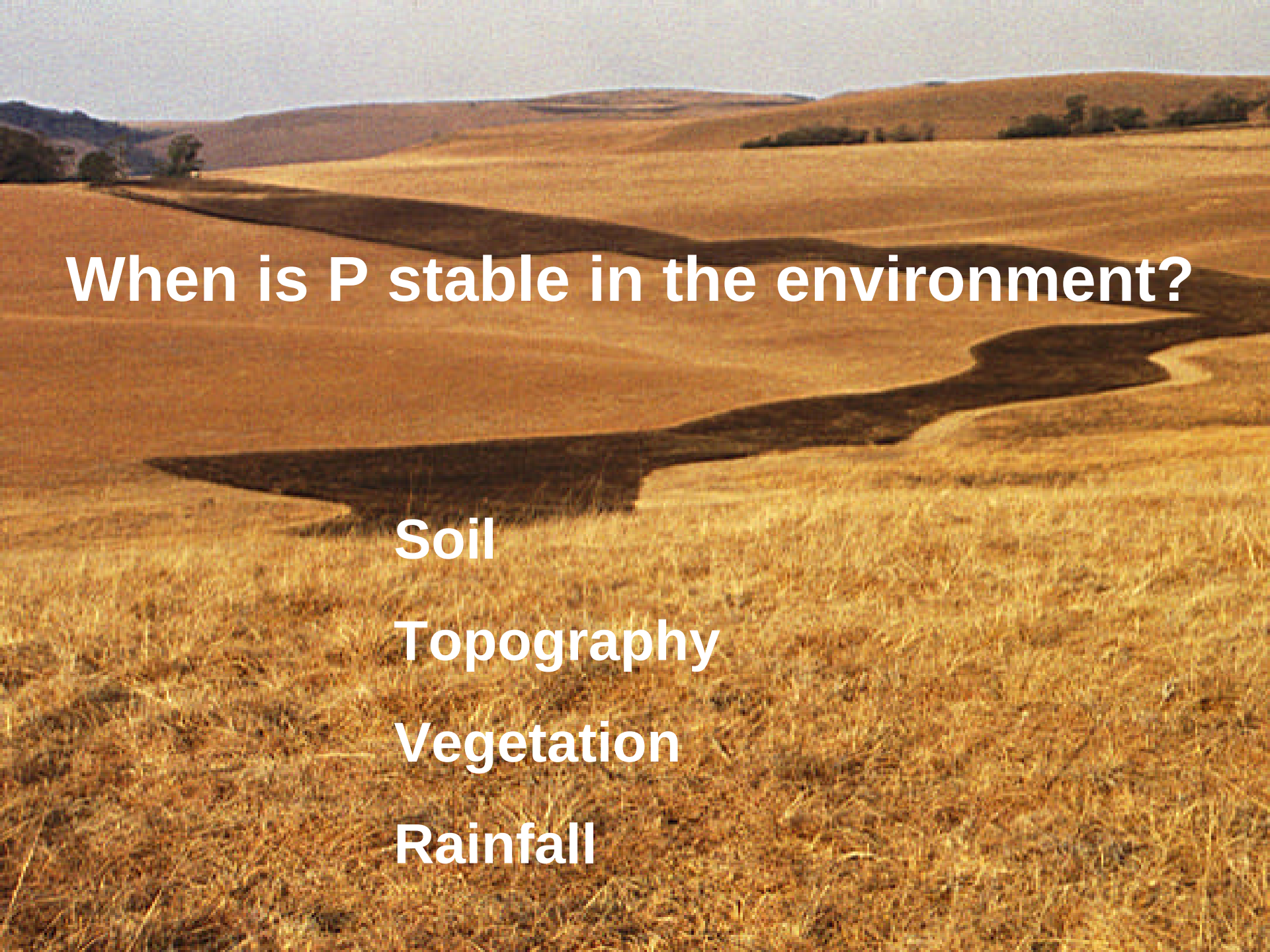
- Cultivated vs. rangeland
- Irrigated vs. dryland
- Uni-seasonal vs. multi-seasonal
- Productive species vs. less productive
- Good soils vs. infertile soils
- Intensive harvesting vs. low input
- Compost vs. manure vs. lagoon phosphorus


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


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

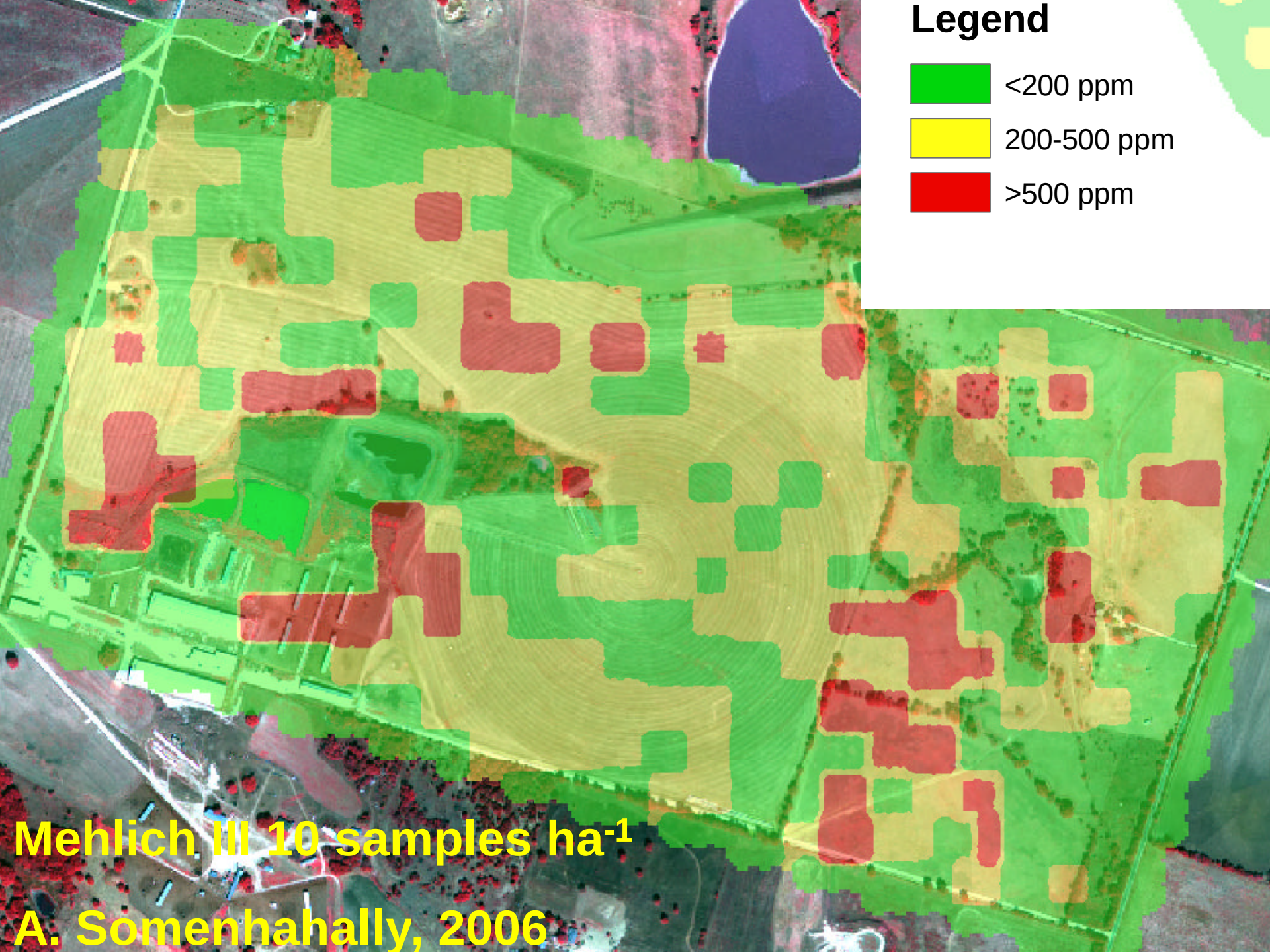
Soil & Vegetation “fix” (hold) P

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. Somenhahally, 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