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Proceedings of the

2015 Crop Pest Management Shortcourse &

Minnesota Crop Production Retailers Association Trade Show

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Productive Agriculture, Conservation and Water Quality: Opportunities and Challenges

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Crop Pest Management Short Course
Dec.9, 2015, Minneapolis, MN

University of Minnesota Extension

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What do we know?

- Unlike N, P rock is a finite resource that will become more expensive to extract
- Implementing CPs must be precise & targeted
- There are no “cure-all” CPs and there are tradeoffs
- CP adoption has occurred mainly as a result of voluntary measures

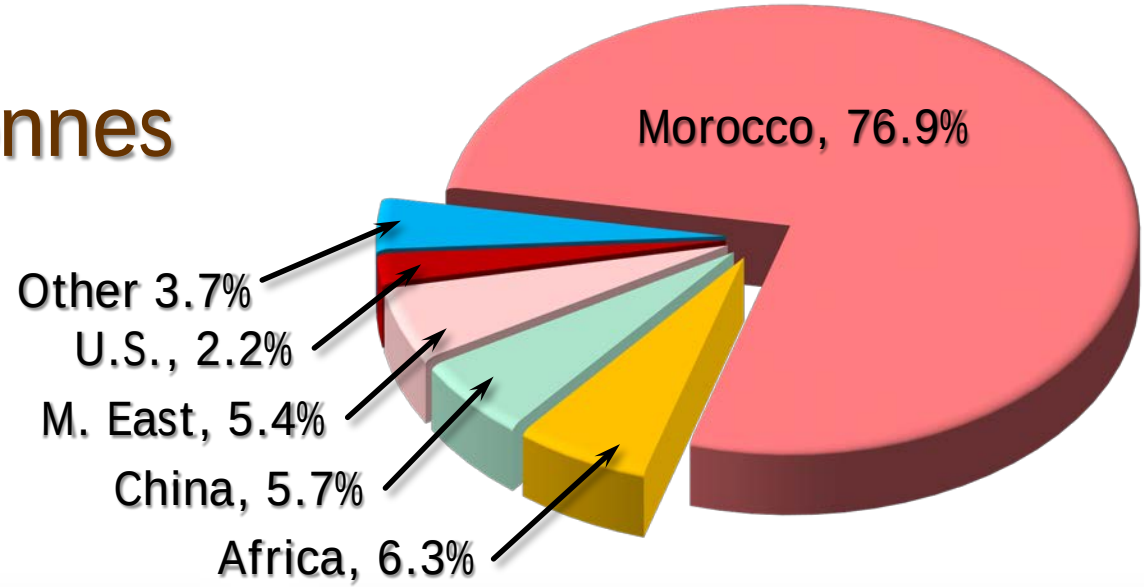
Where do we go from here?

- Need to set realistic goals
  - Or risk failure
  - After low-hanging CPs, it becomes more costly
- Phased-in approach
- System legacies can mask CP benefits
- Outreach & education at field to farm to watershed scales

P is a finite resource

65,000 million tonnes

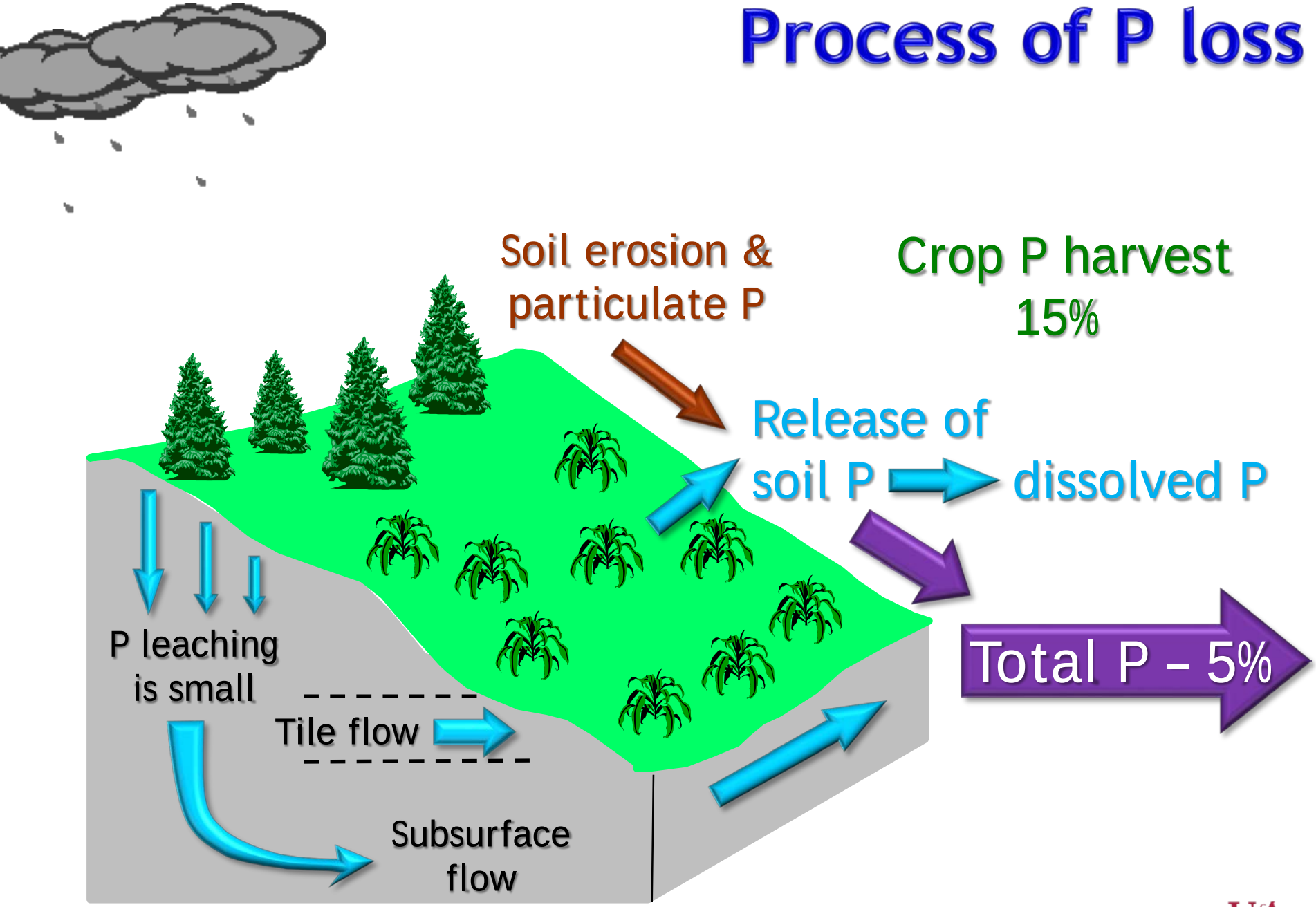
USGS, 2010



P is a finite resource

- Productive agriculture requires P inputs
- P also increases freshwater productivity
- Global issue

Process of P loss



Soil P immobilization – 80%

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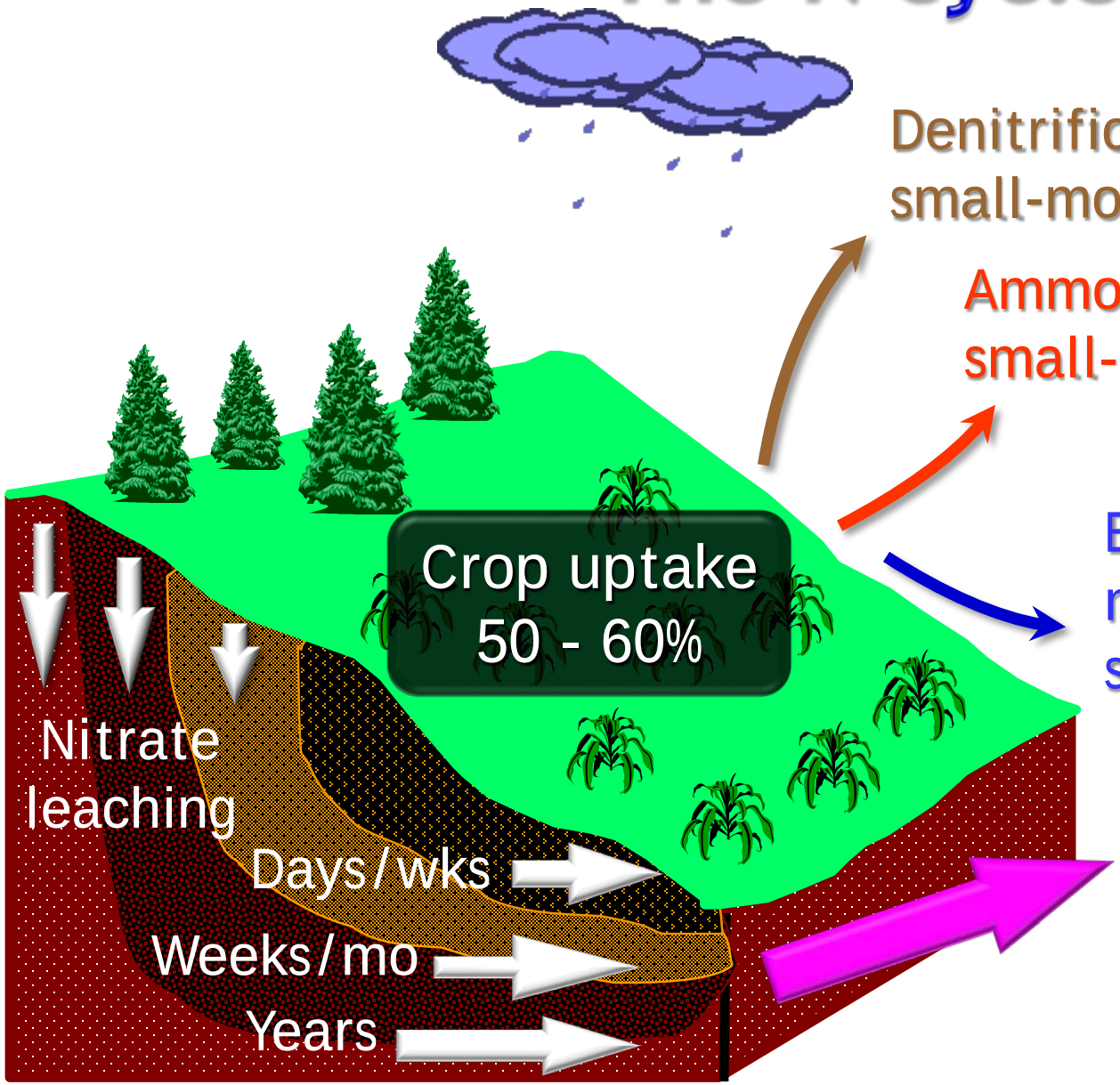
The N cycle - *is leaky*



Denitrification loss:
small-moderate 10-20%

Ammonia loss:
small-moderate 5-20%

Eroded organic &
mineral N:
small losses 1-5%

Leaching loss:
large 10–40%

Soil N immobilization 5–10%

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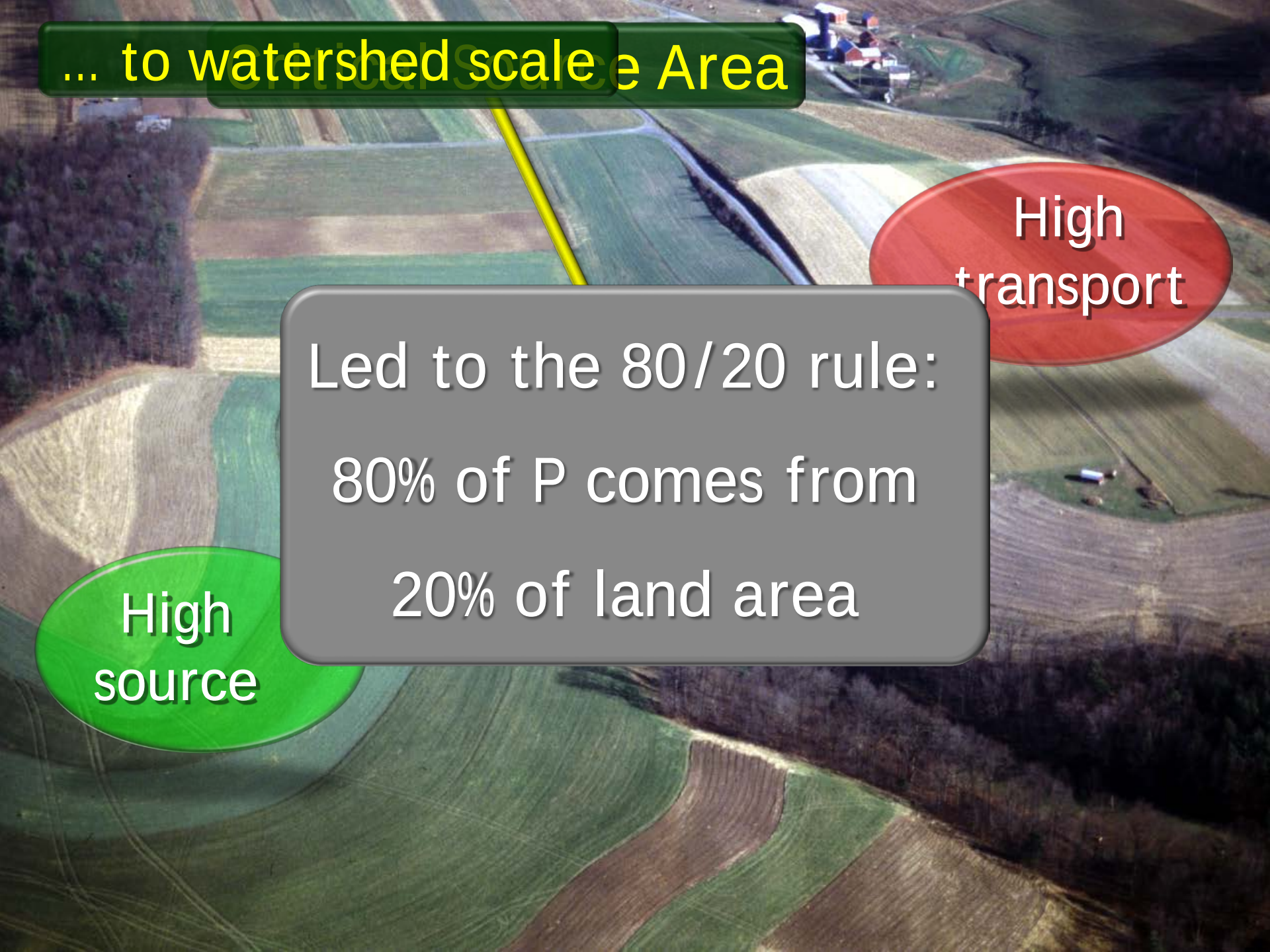
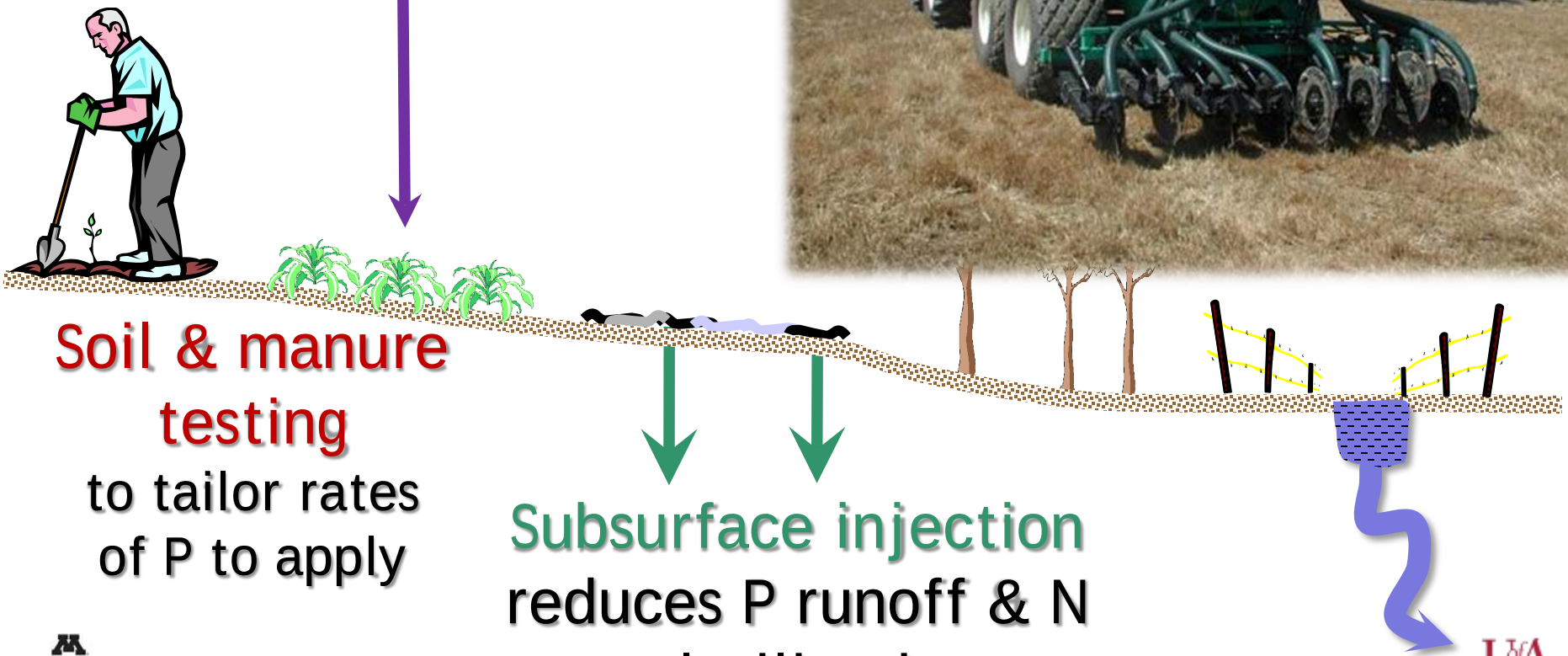

… to watershed scale
Critical Source Area
High transport
Led to the 80/20 rule:
80% of P comes from
20% of land area
High source

Source BMPs

Appropriate rate, method timing, & placement of P can increase crop uptake & decrease runoff loss



Soil & manure testing to tailor rates of P to apply

Subsurface injection reduces P runoff & N volatilization

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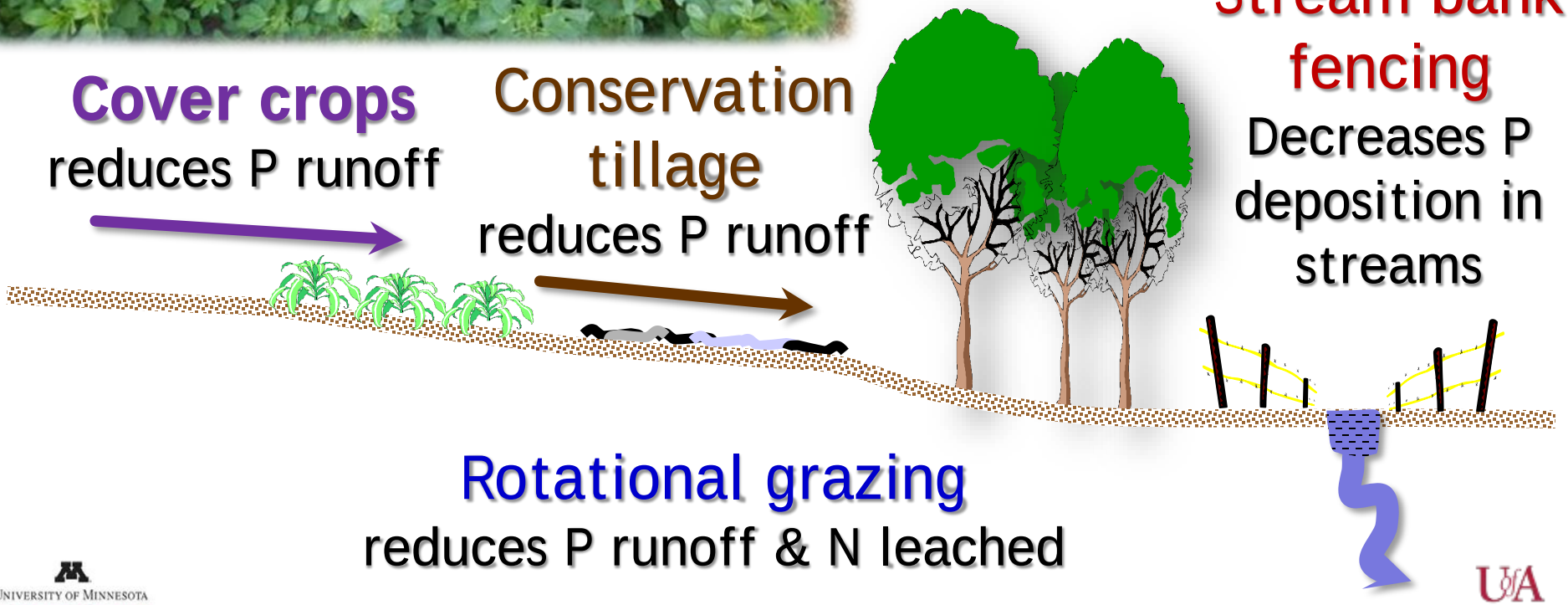
Transport BMPs

Riparian buffers
trap particulate nutrients

Stream bank fencing
Decreases P deposition in streams

Cover crops
reduces P runoff

Conservation tillage
reduces P runoff



Rotational grazing
reduces P runoff & N leached

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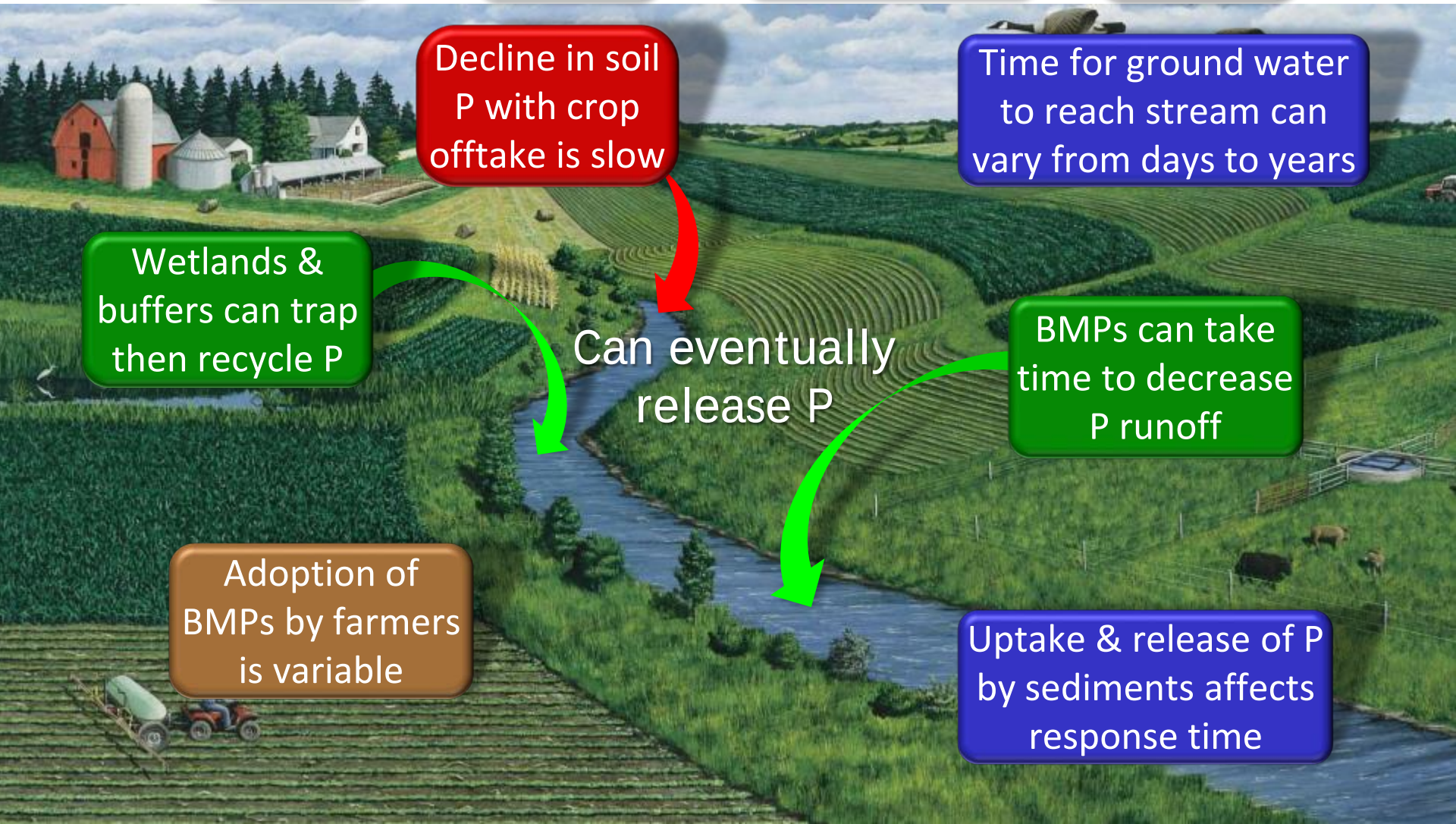
System legacy drivers

Soil processes

BMP response

Hydro-chemical response

System response



Conservation tradeoffs

Conservation tradeoffs

- Cover crops
  - There are many cover crops available
  - Can dec
  - Manage ortant
  - Decayin runoff
  - In-field adapt

Mikey Taylor, Helena, AR

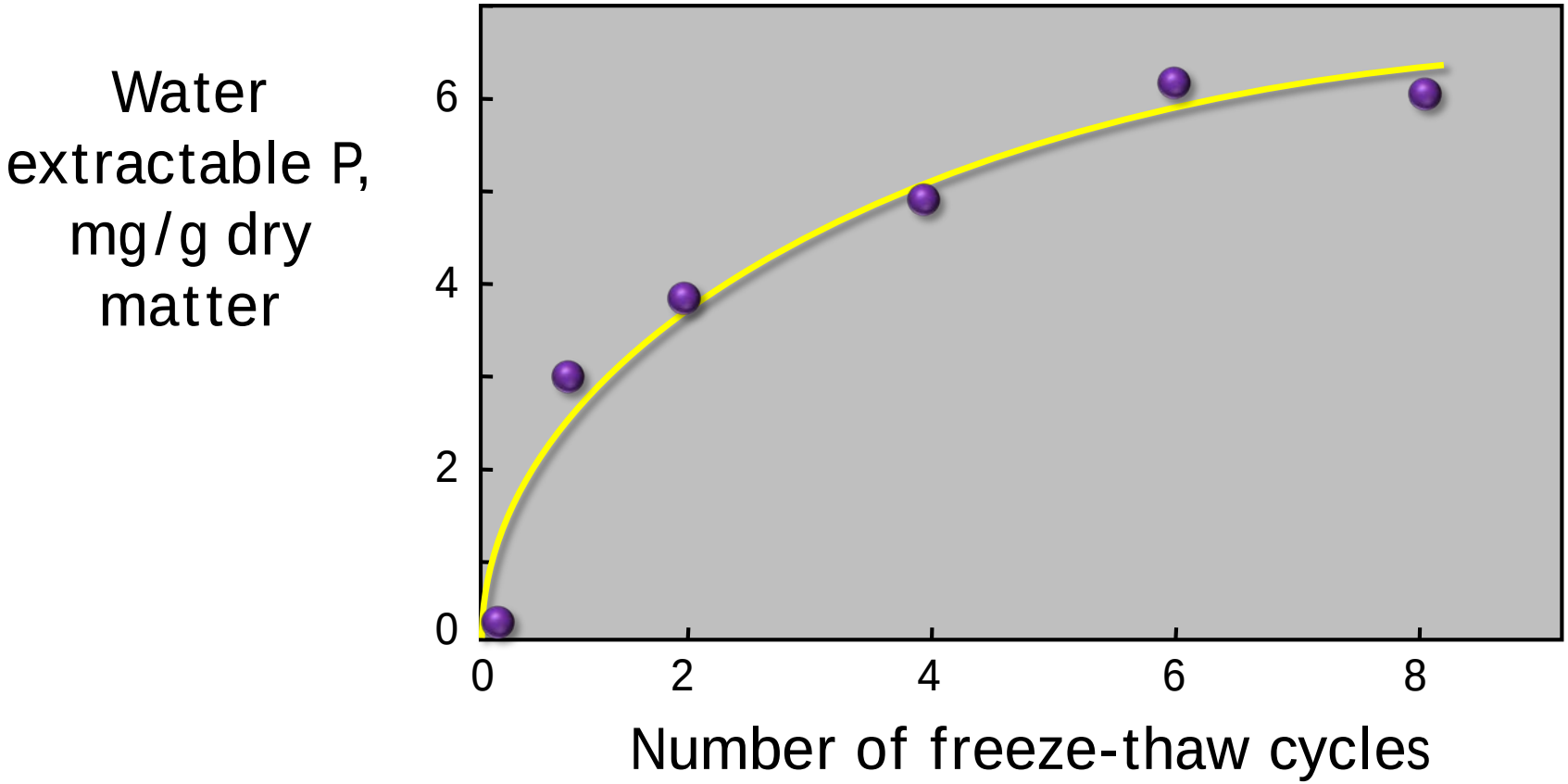
Cover crop decreases P runoff from peanuts

	No cover crop	Wheat cover crop
Runoff, inches	4.81	1.00
Erosion, tons/ac/yr	7.9	1.0
Dissolved P, lbs/ac/yr	0.13	0.04
Total P, lbs/ac/yr	5.26	0.82

Sharpley, 1991: Ft. Cobb, OK watersheds

Freezing releases biomass P

Repeated freezing & thawing of ryegrass, which is then extracted with water



Bechmann et al., 2005

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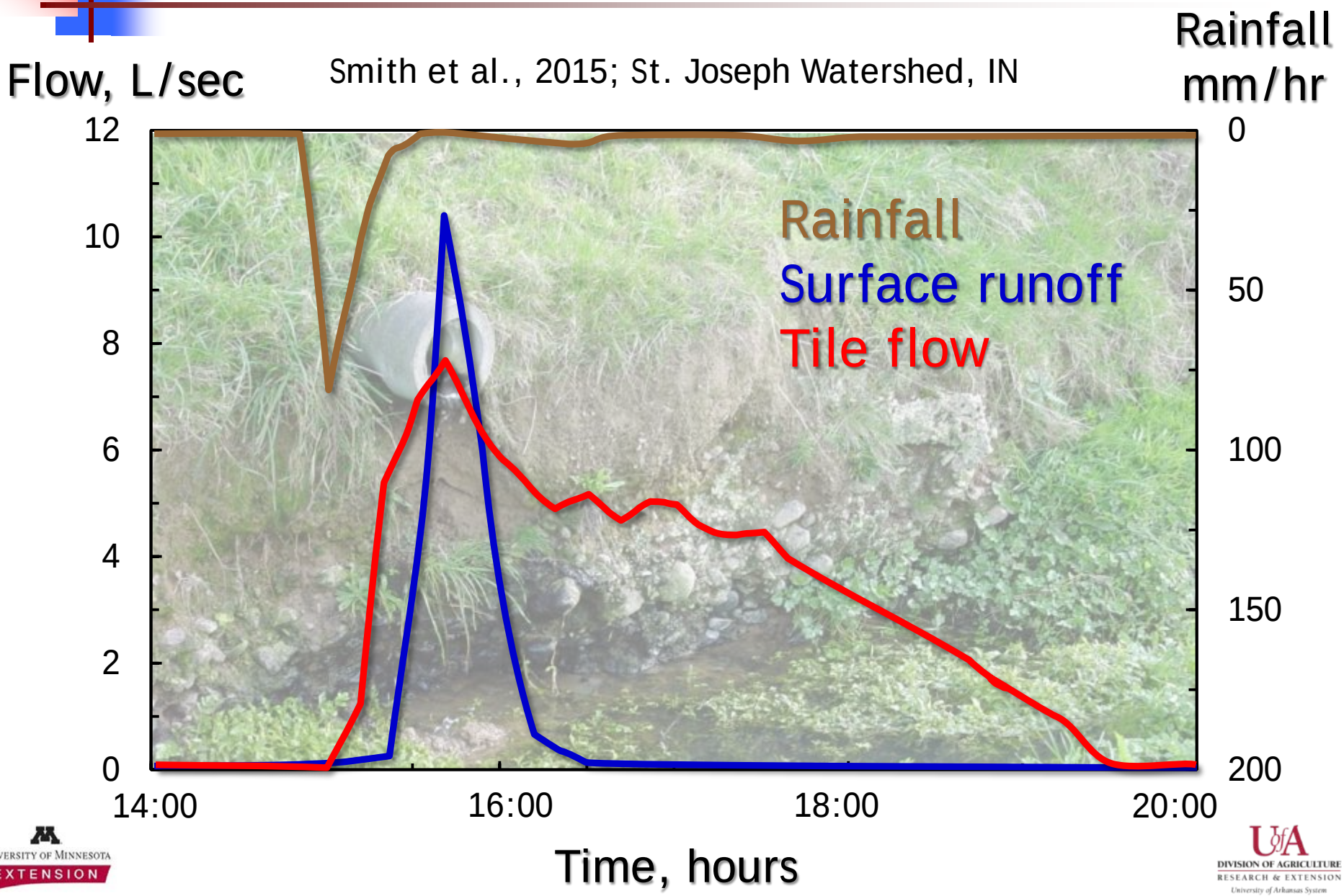
Conservation tradeoffs

- Tile drainage increases
  - Soil productivity
  - Critical source areas
  - Increase connectivity to streams
  - By-passes a large mass of reactive soil

Rainfall, runoff & tile flow



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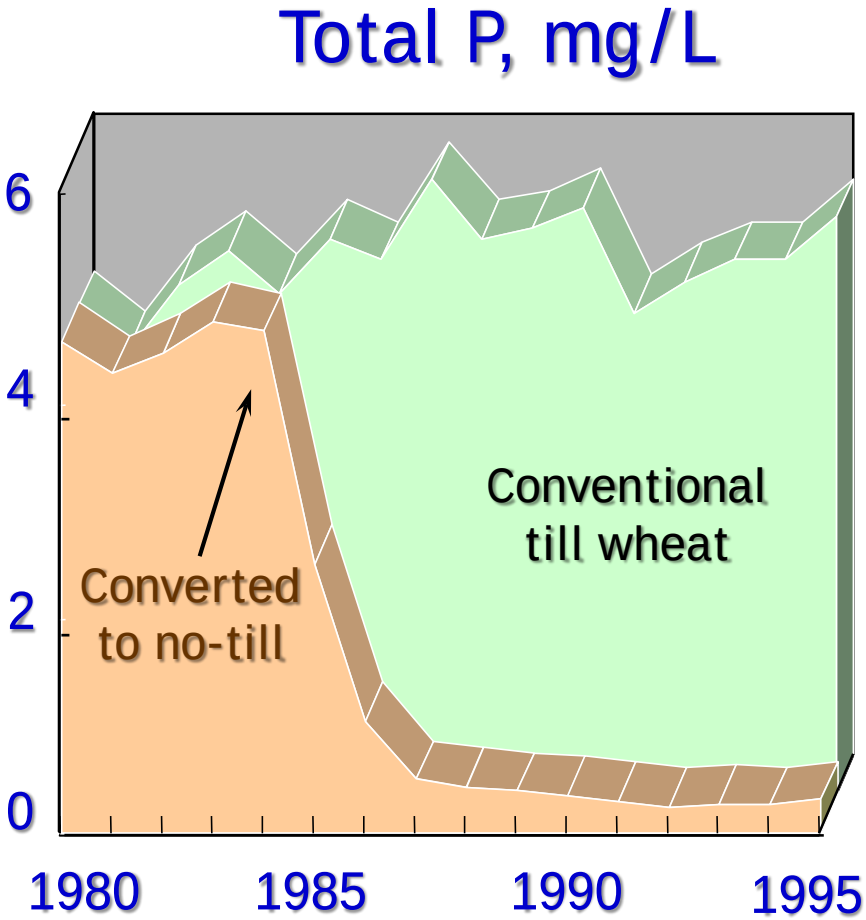
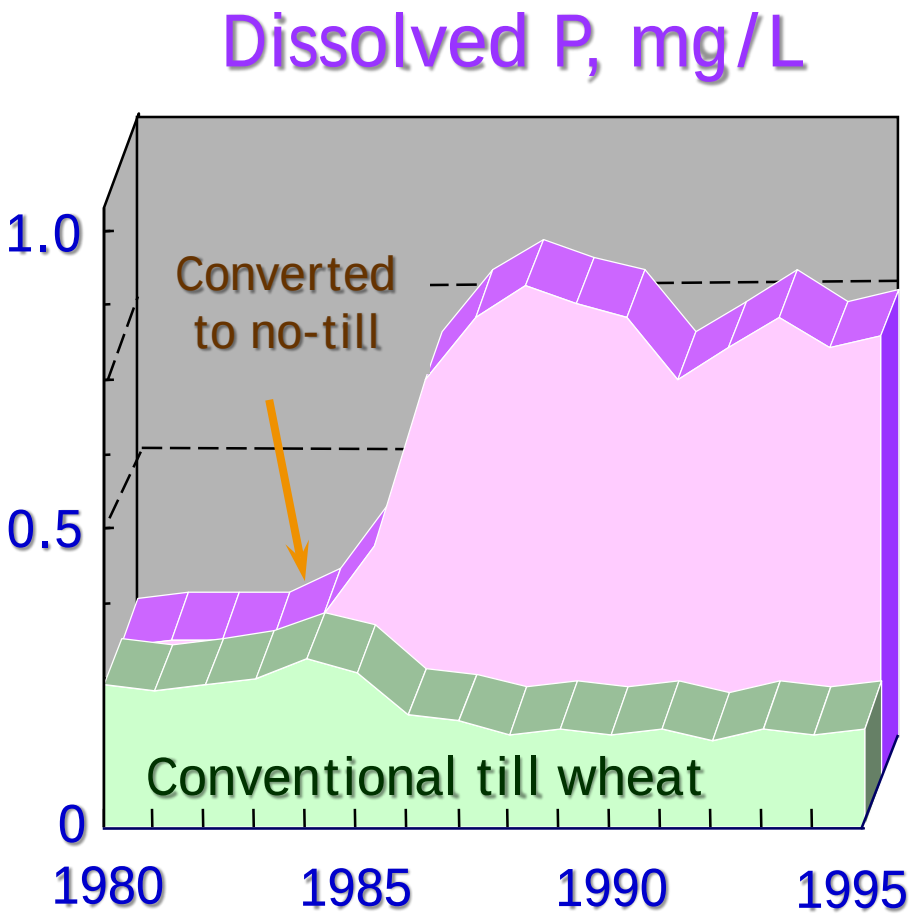
Conservation tradeoffs

- No-till management
  - Enhances macropore development
  - Increases soil organic matter

Conservation tillage

No-till reduced erosion from wheat 95%





Sharpley and Smith, 1994 – El Reno, OK

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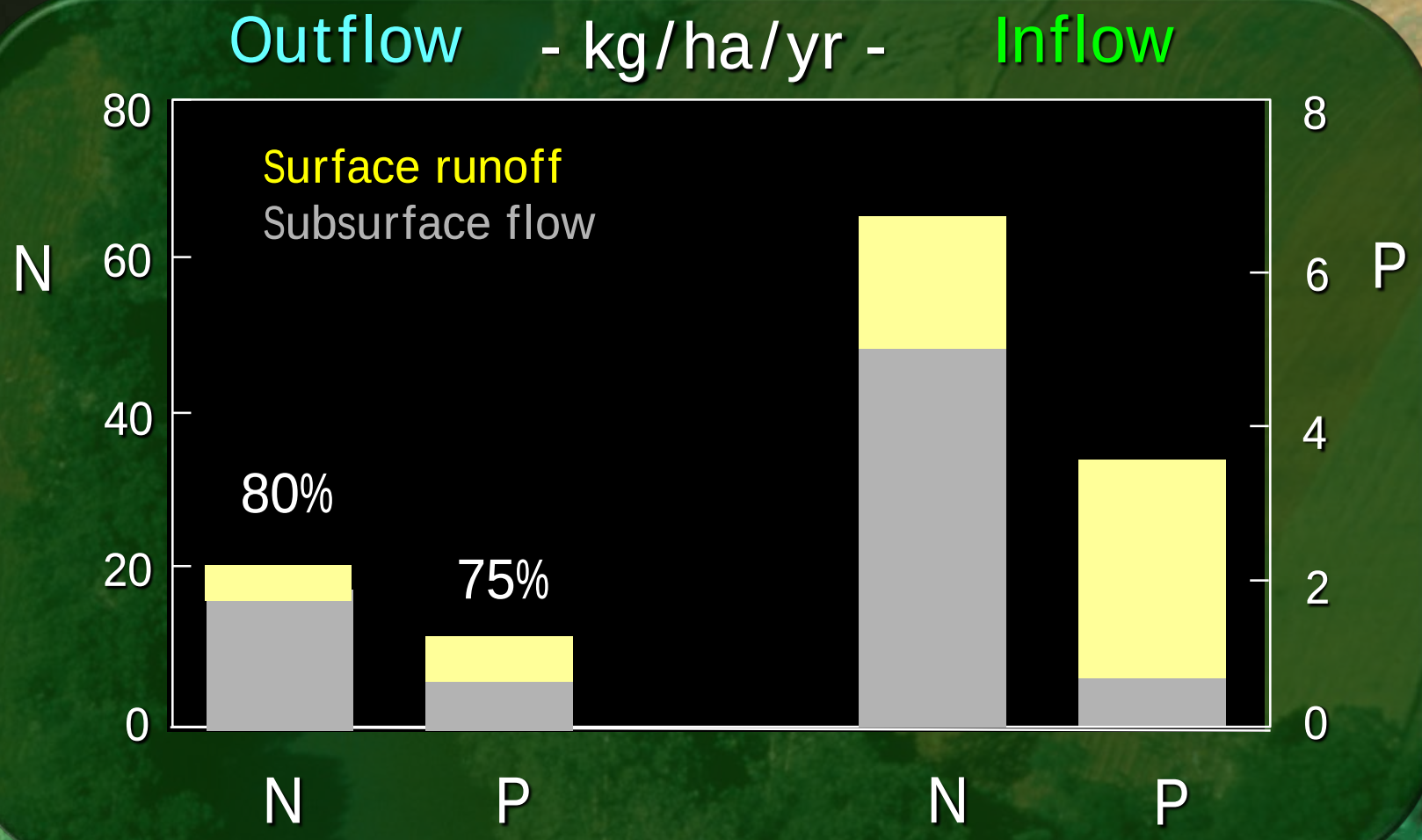
Riparian buffers



Watershed sources

Contribution of pathways, %

	Surface runoff
Discharge	10
Dissolved P	32
Particulate P	9
Total P	11

Sharpley et al., 1976; New Zealand

Buffer impacts are site specific

- They are most effective adjacent to sloping fields
- Less effective adjacent to tile-drained fields
- And where stream bank erosion is main source of sediment

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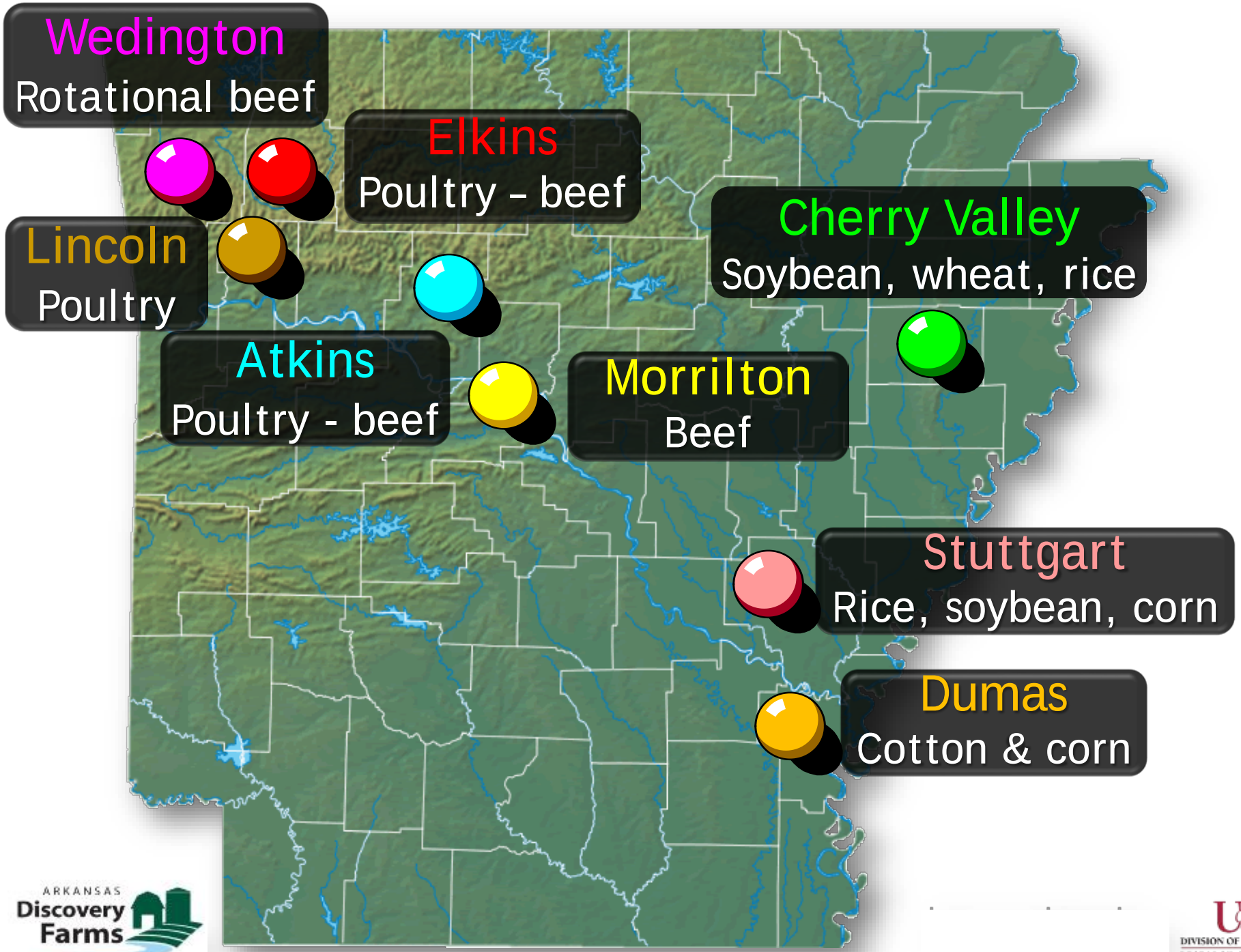
Discovery Farms Program

- Private “real-world” farms: now have 9
- On-farm research & demonstration
- Demonstrate success stories

ARKANSAS Discovery Farms



ARKANSAS Discovery Farms

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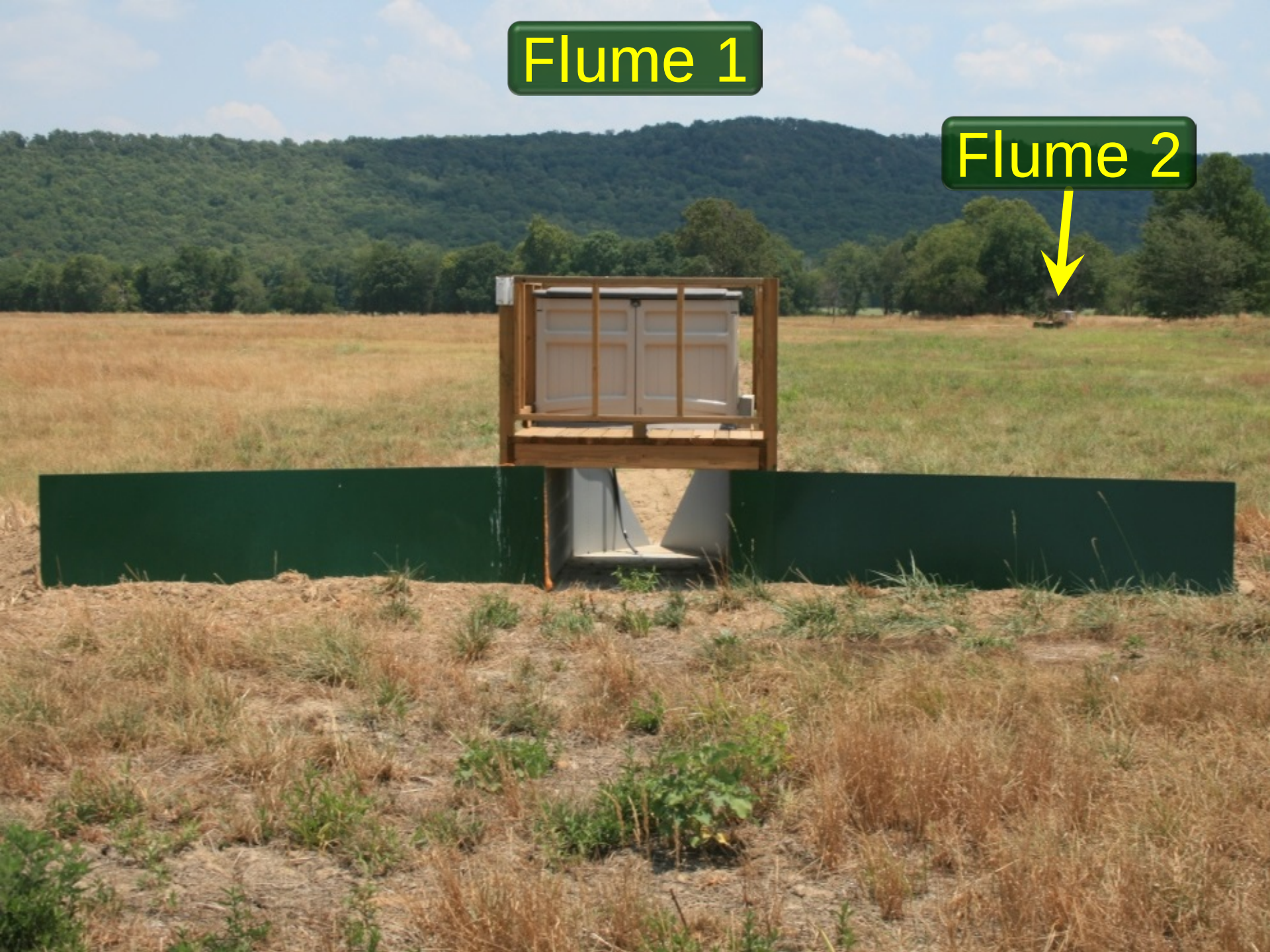

Flume 1
Flume 2

Mean annual totals, kg/ha/year

	Flow	Diss. P	Total P	Total N
Flume 1	693,722	4.5	5.3	20.1
Flume 2	80,542	0.9	1.0	2.1

Most important farmer involvement

.. and farmer
empowerment

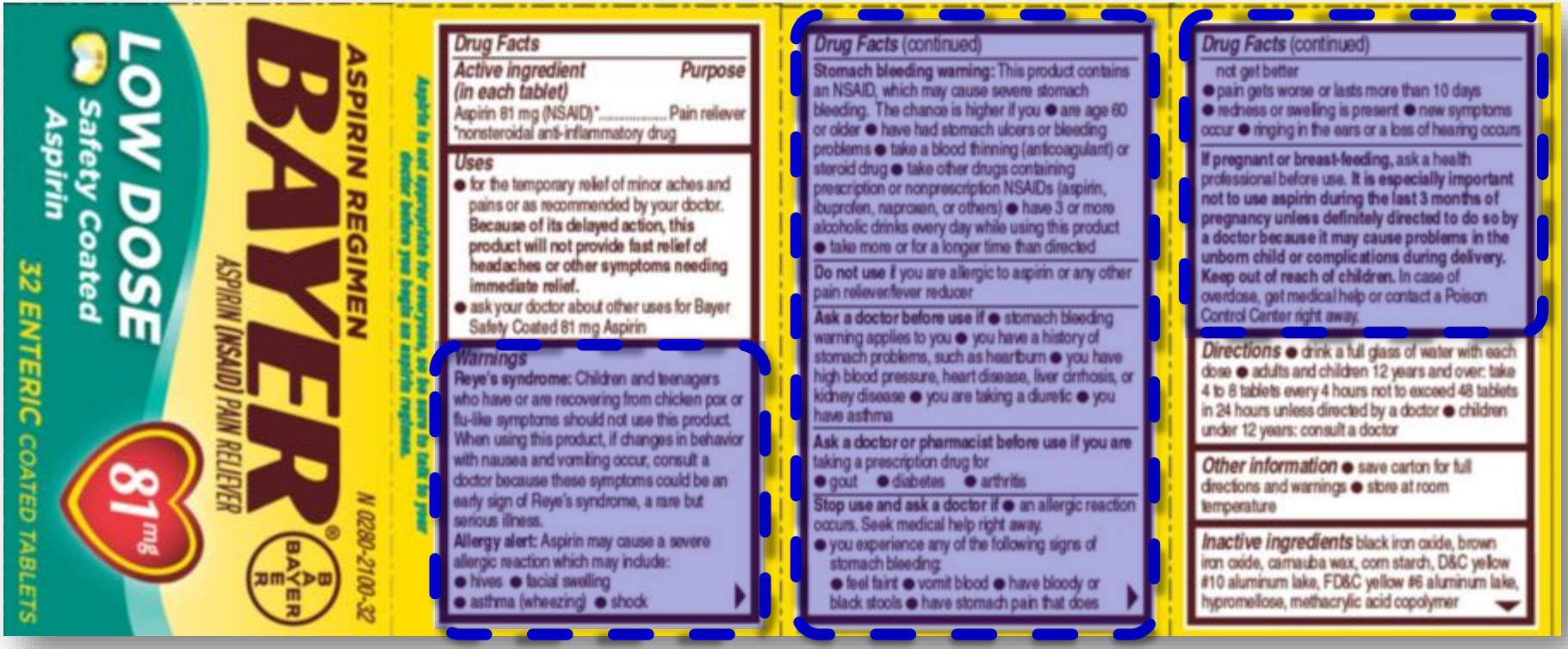
Are we expecting too much from "cure-all" CPs?

Panacea - a solution or remedy for all ailments

… many still assume that CPs work all the time, in all situations, & don't have any undesirable side-effects

Should treat conservation management like human health

We're all aware of the risks of medications



Get the diagnosis right

- Assess each site comprehensively
- Aim for reduced losses
- Is runoff or leaching the problem?
- Particulate of soluble losses?
- In-field or in-stream nutrient sources
- Anything that gets farmers on the conservation path is positive

Get the treatment right

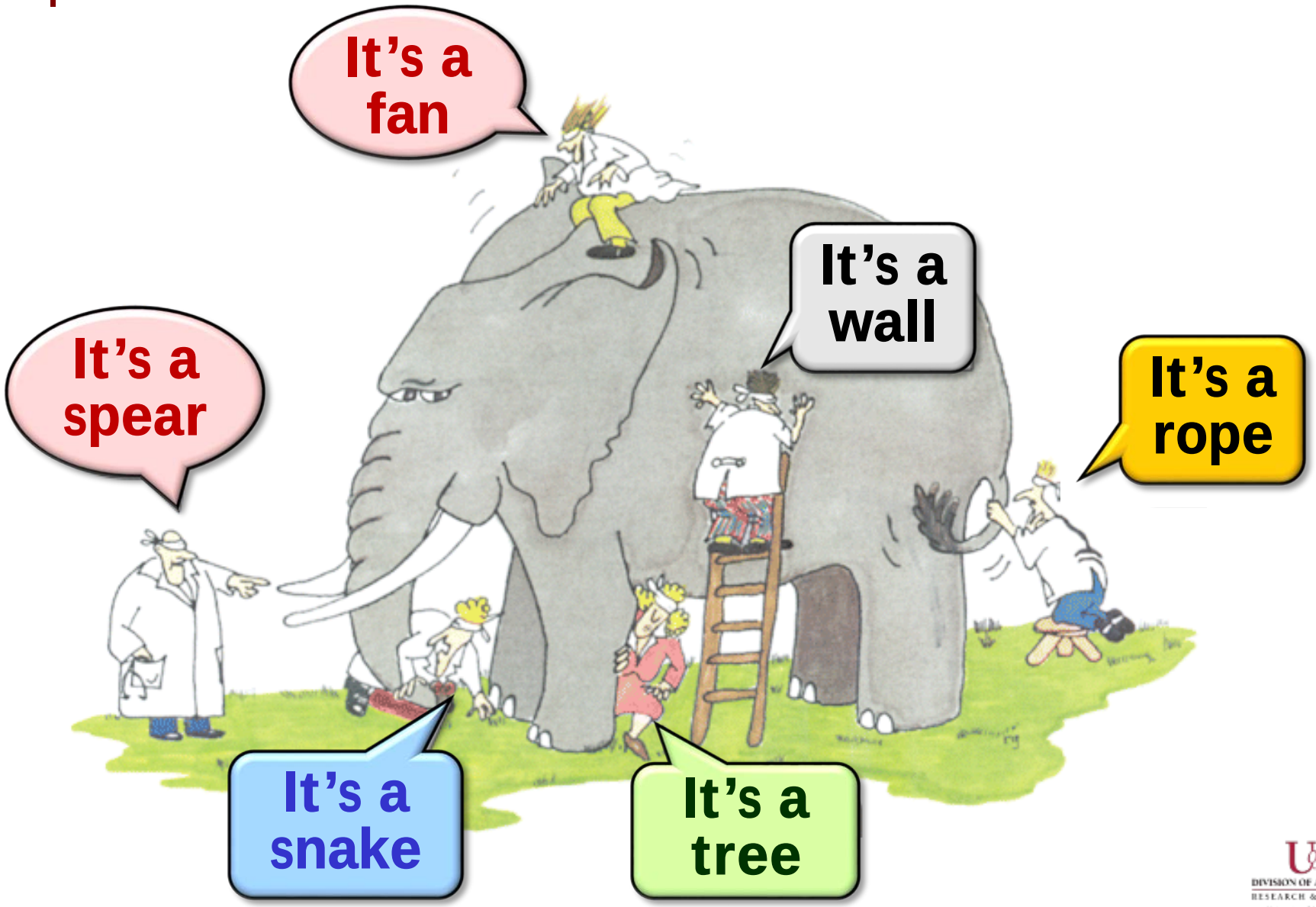
- Make sure the "remedy" works
- Treat with precision
- Consider the benefits & risks
  - No-till & cover crops decrease runoff and erosion
- Look out for problems, then adapt & fine tune
  - No-till can increase surface soil P & leaching
  - Mgt. of cover crop termination is important
  - In-field nutrient mgt. should adapt

Dealing with the elephant

Blue water - green pasture paradox

- Public has grown to expect blue waters & green pastures
- With predicted population growth, 50 - 100% increase in crops yields
  - Will increase pressure to intensify & maximize yields
  - Likely on less suitable lands
  - Economics will remain THE driver

Dealing with the elephant



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Which do you prefer?

Photos courtesy of Colin Neal, Helen Jarvie & Ian Bateman

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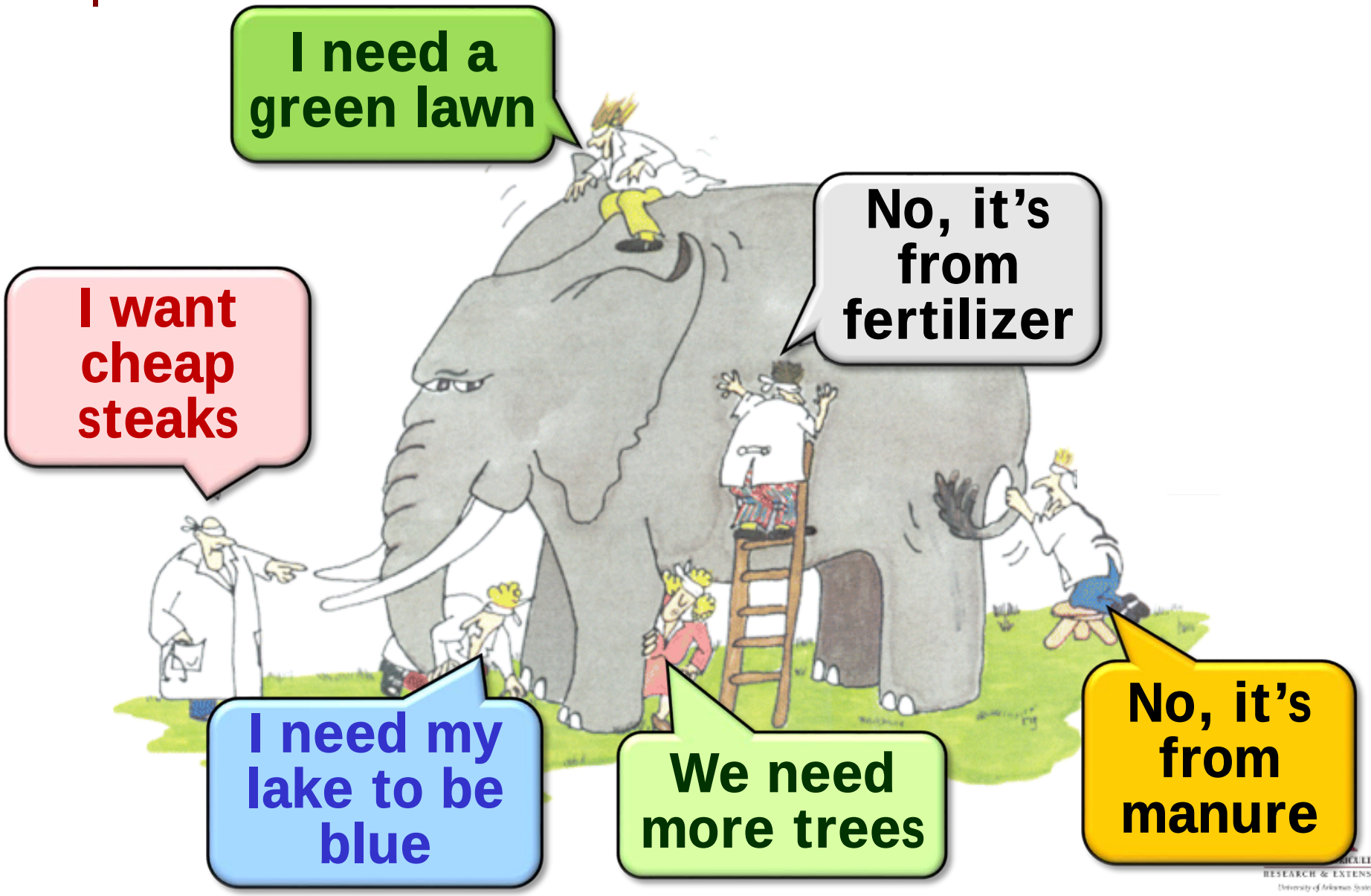
We all view things differently



Questions?