Management Practices to Minimize Nitrate Leaching

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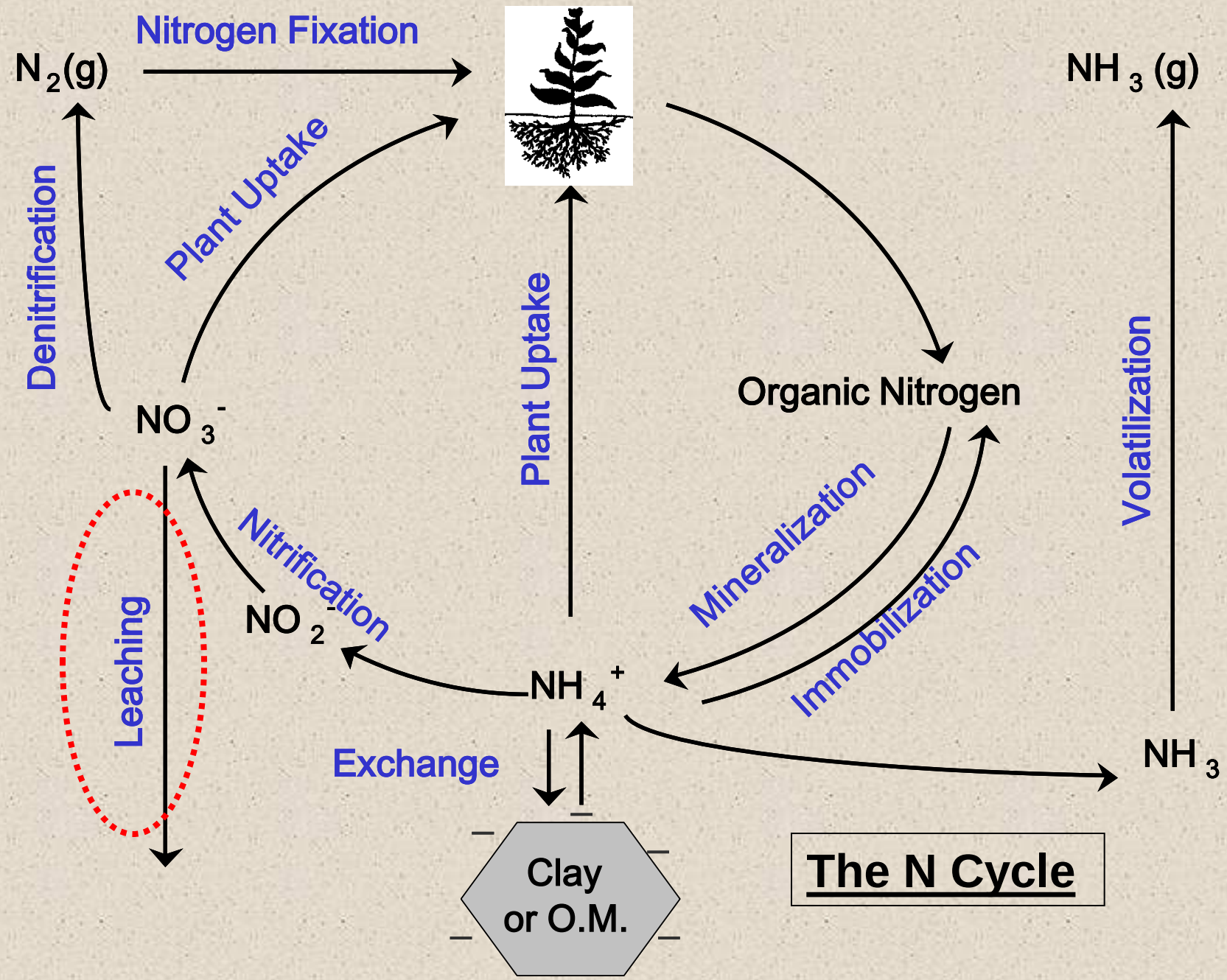
MONTANA STATE UNIVERSITY EXTENSION

Today's Goals

Discuss:

- soil factors that increase nitrate leaching potential
- crop management practices to minimize leaching
- fertilizer management to minimize leaching


Nitrogen Fixation
$N_2(g)$
$NH_3(g)$
Denitrification
Plant Uptake
Plant Uptake
Organic Nitrogen
Volatilization
NO_3^-
Nitrification
Mineralization
Immobilization
Leaching
NO_2^-
NH_4^+
Exchange
NH_3
Clay
or O.M.
The N Cycle

Soil factors that increase leaching

- Soils with large pores
- Soils with cracks or vertical channels that connect surface to below root zone
- Shallow soils

Water and Soil

Plant available water holding capacity for various soil textures	
Soil Texture	Inches Water per Inch Soil
Sand, fine sand	0.06
Loamy sand	0.08
Sandy loam	0.12
Loam, silt loam silt, sandy clay, silty clay, clay	0.17
Sandy clay loam, clay loam, silty clay loam	0.18

1 ft

Over 2 ft

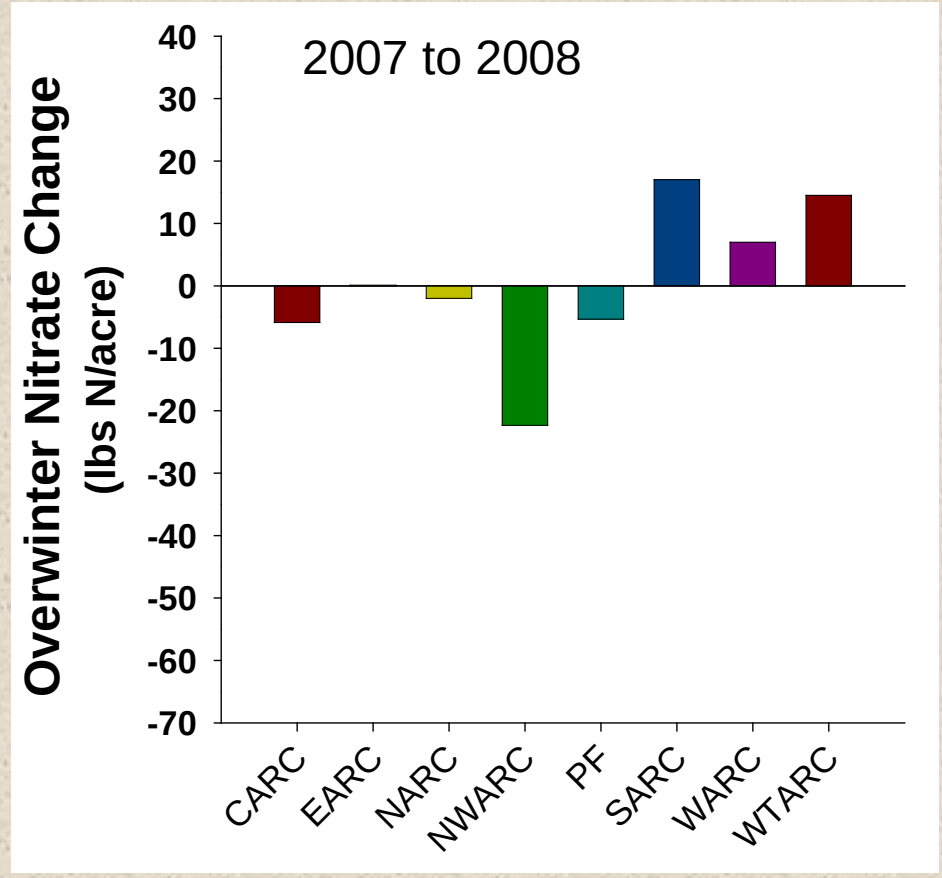
(0.12 x 12) + (0.18 x 24) = 5.8 inches water to refill soil to 3 ft depth

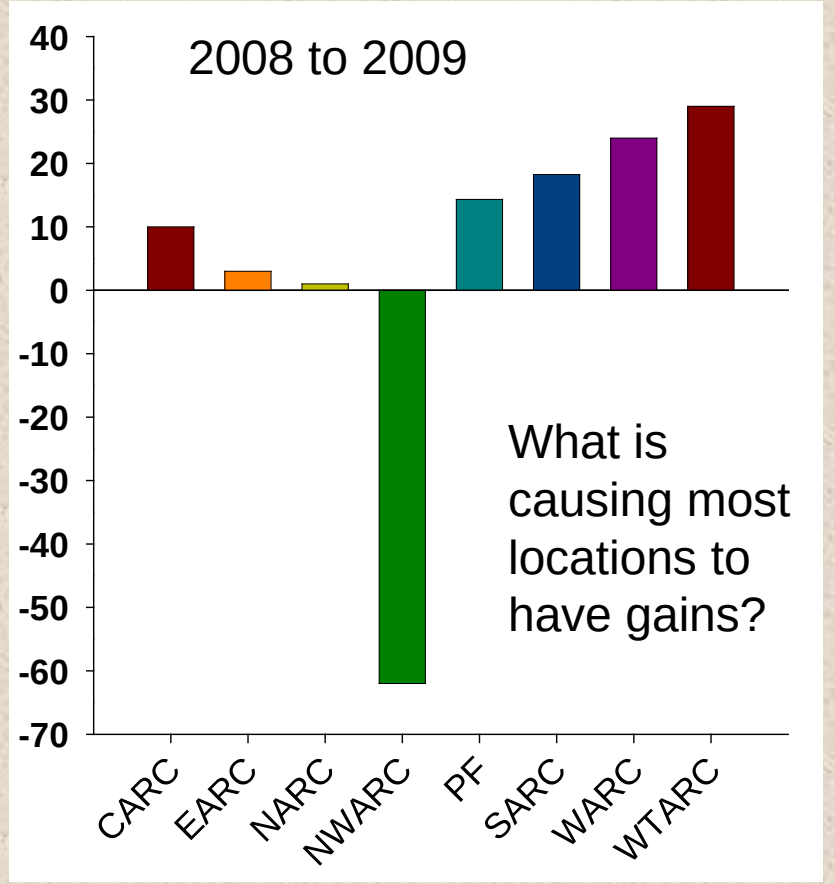
More precipitation or irrigation could leach nitrate

Manage irrigation

- Irrigate to meet crops needs but not exceed soil's ability to hold water
- Sprinkler systems allow better control than furrow or flood

Regional changes in soil nitrate from November to April in top 2 feet of soil





Research Station

Jones unpubl data.

Averaged over 4 previous crops at each research station.

Crop management factors to decrease N leaching

- Know your soil and yield potential for proper N management
- Recrop rather than fallow
- Reduce tillage
- Diversify to include perennial and/or deep rooted crops
- Consider legumes since don't need to fertilize w/ N
- Space crops for optimal yields to optimize resource use; ex. SW in 6" rows and 30 plants/ft^2 – Fertilizer Fact # 37
- Use variable rate technology
- Carefully manage irrigation

Long-term Effect of Cropping System on Soil Fertility

- 1983 to 2004 near Culbertson, MT
- Comparing tillage and crop
- Small-plot field trial
- Soil samples:
  - Collected in October 2004, 4-6 weeks after fall tillage
  - Taken to 8 inch depth

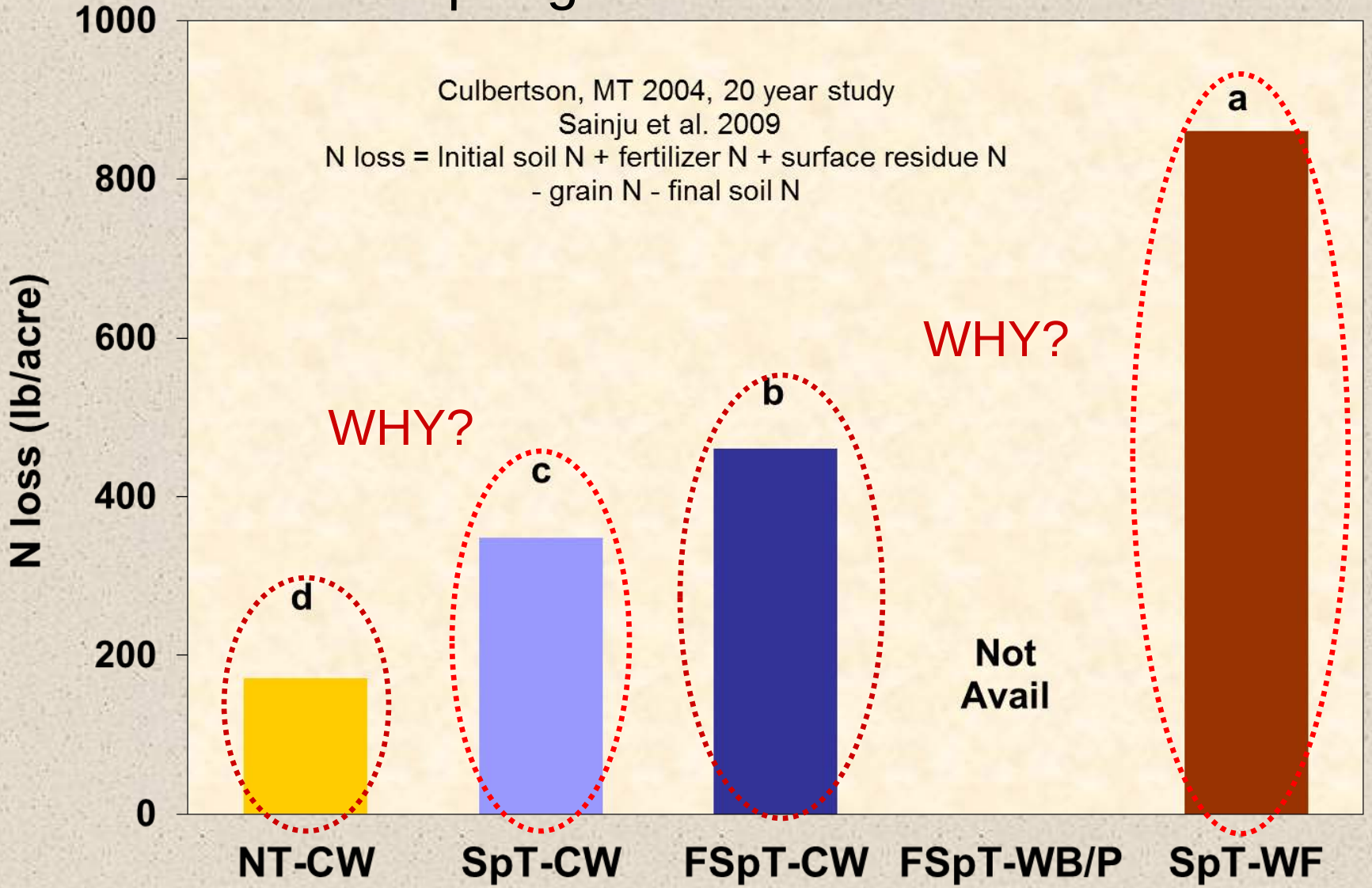
Tillage and Crop Combinations

- NT-CW : No Till-Continuous Spring Wheat
- SpT-CW: Spring Till-Continuous Sp. Wheat
- FSpT-CW:
  Fall & Spring Till – Continuous Sp. Wheat
- FSpT-WB/P: Fall & Spring Till –
  Wheat/Barley (17 years), Wheat/Pea (4 years)
- SpT-WF: Spring Till – Sp. Wheat/Fallow

All residue was left on the field

Estimated N loss

Spring 1983 to Fall 2004

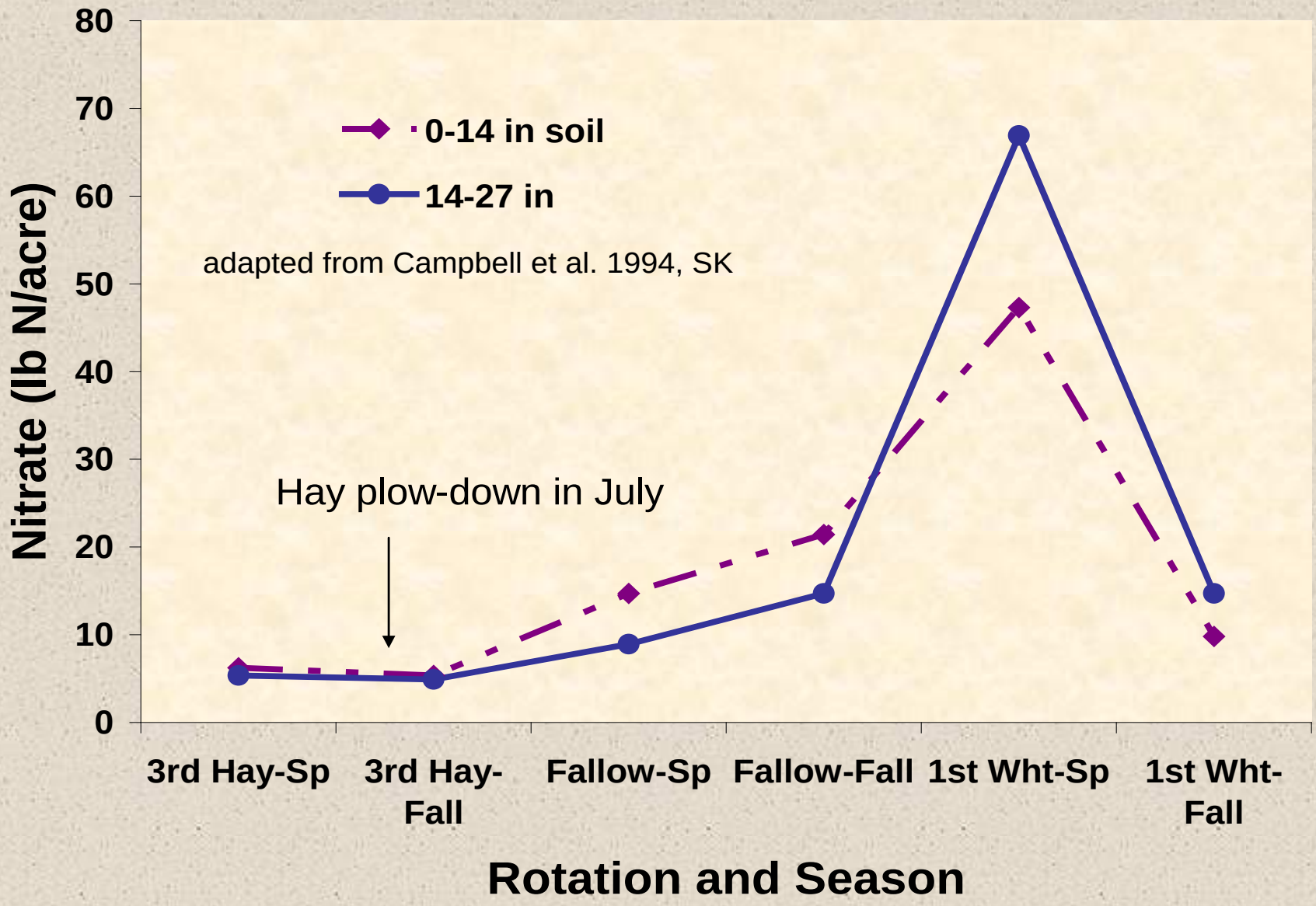


Economics?

Adding legume-perennial grass to the rotation

- 33 years of 6-yr rotation in SK on heavy clay soil
- Alfalfa/bromegrass hay-hay-hay-fallow-wheat-wheat
- No fertilization
- Soil sampled in 1991 at end of May and early Sept after harvest

Perennial forage reduces nitrate leaching compared to fallow-wheat



Inclusion of legumes

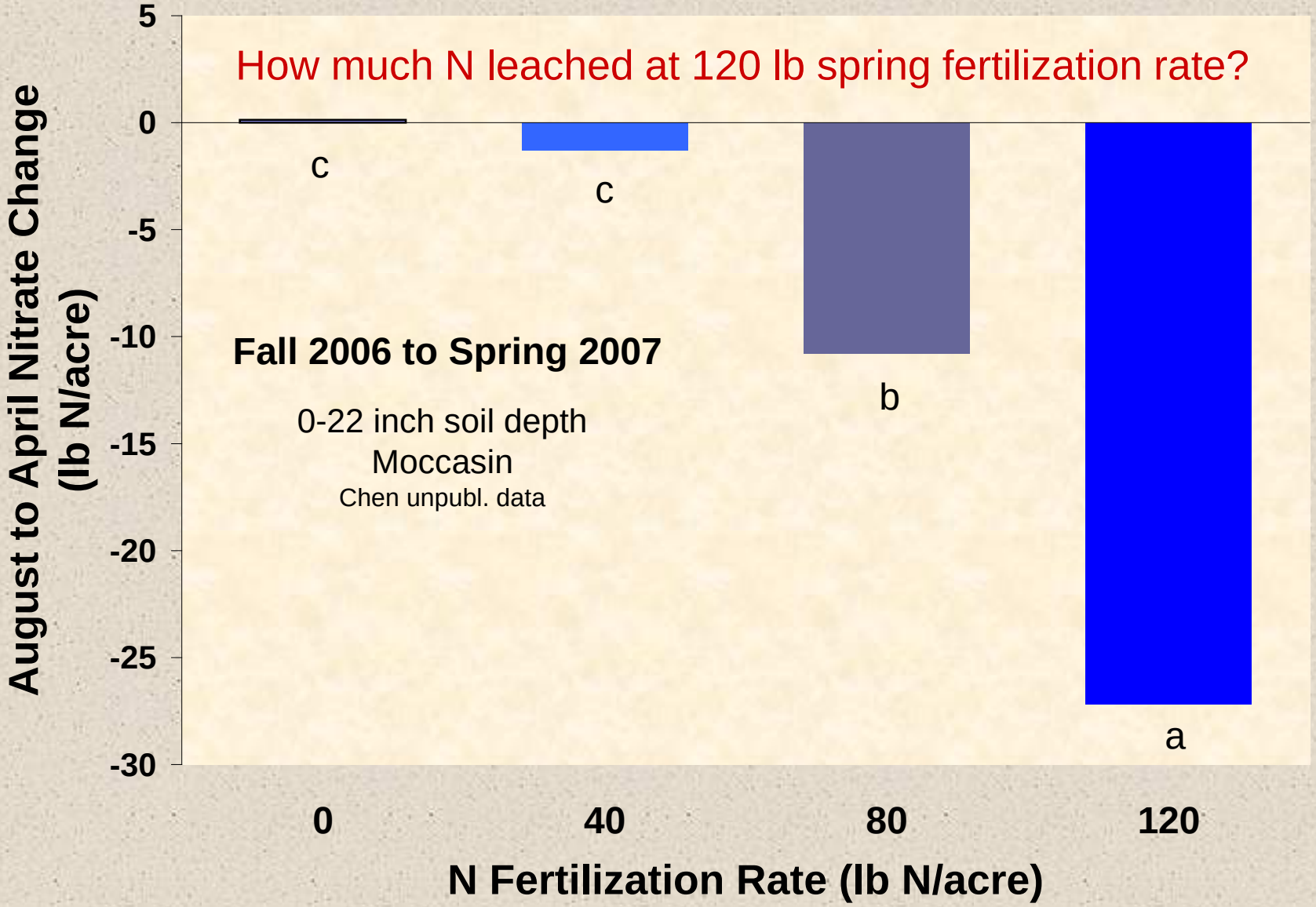
- Legumes are excellent N scavengers – will use much of what is in soil before ‘fix’ N
- Since legumes don’t need N fertilizer, this leaves less nitrate in soil, especially in dry year when crops don’t remove much
- Legume residues are similar to ‘slow release N fertilizers’ which can lower N fertilizer needs in long run
- Interrupt disease and insect cycles = fewer pest problems

Beware of herbicides with high persistence

N fertilizer management factors to decrease N leaching

- Soil test so don’t over-apply
- Apply in spring or slow release fertilizer in fall
- Time application as close to peak N uptake as possible
- Top dress between tillering and flowering in moist years

Overwinter N loss is greater when more is available to lose



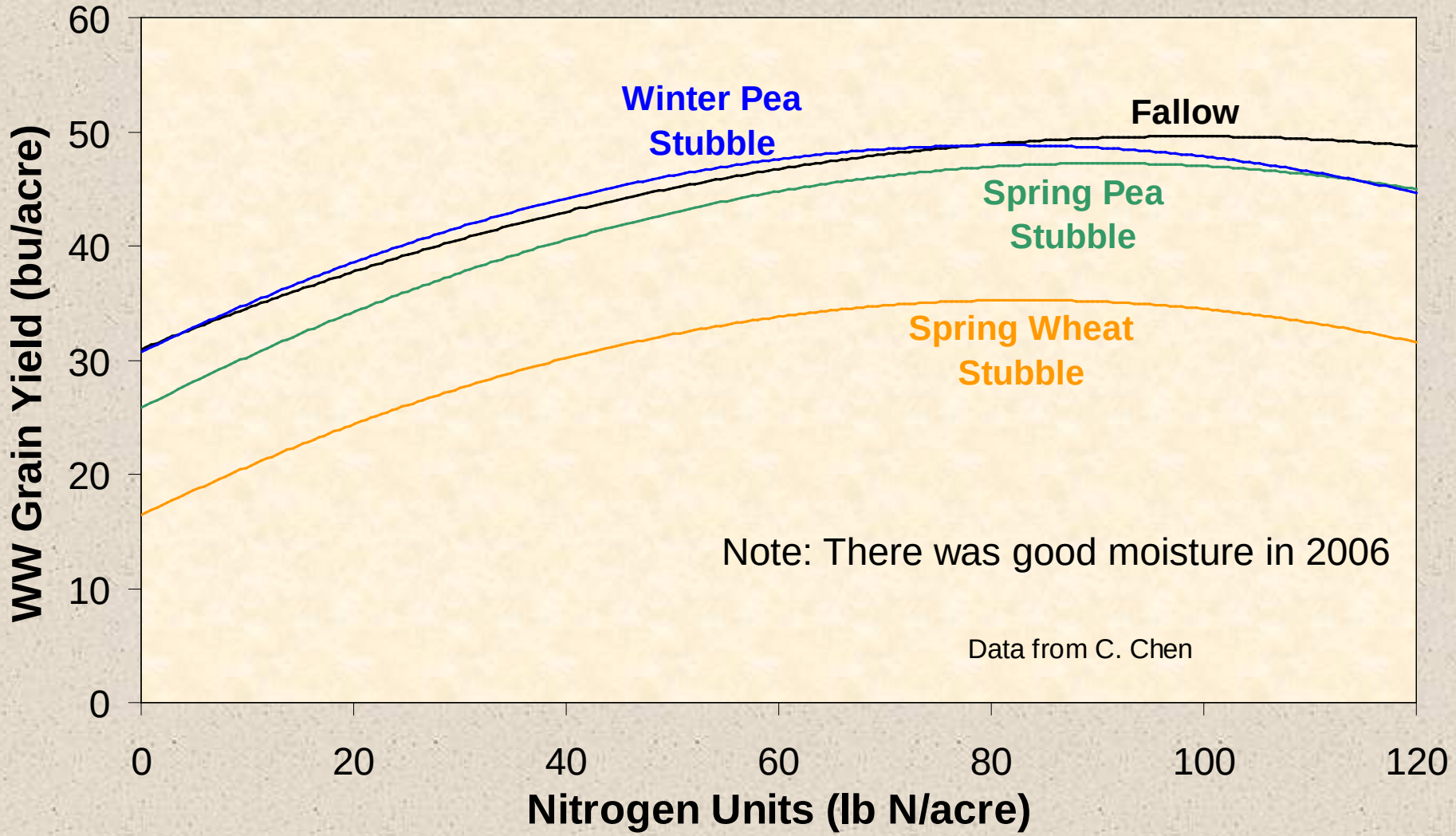
How should I determine my fertilizer N rates?

- Soil Test
  - When??
- Spring is best
  - Why??

Result if soil test too early: Fertilizing more or less than needed ($$)

Effect of previous crop and N on 2006 winter wheat grain yield (NT)

Moccasin, MT



Increasing N Fertilizer Use Efficiency

Enhanced Efficiency Fertilizers

Two major types:

- slow release (ex: polymer coated or aldehyde bonded)
- inhibitors (ex: alter soil processes)

Should you consider using them?

- Yes: on warm season, irrigated crops
- Maybe: on cool season, dryland crops

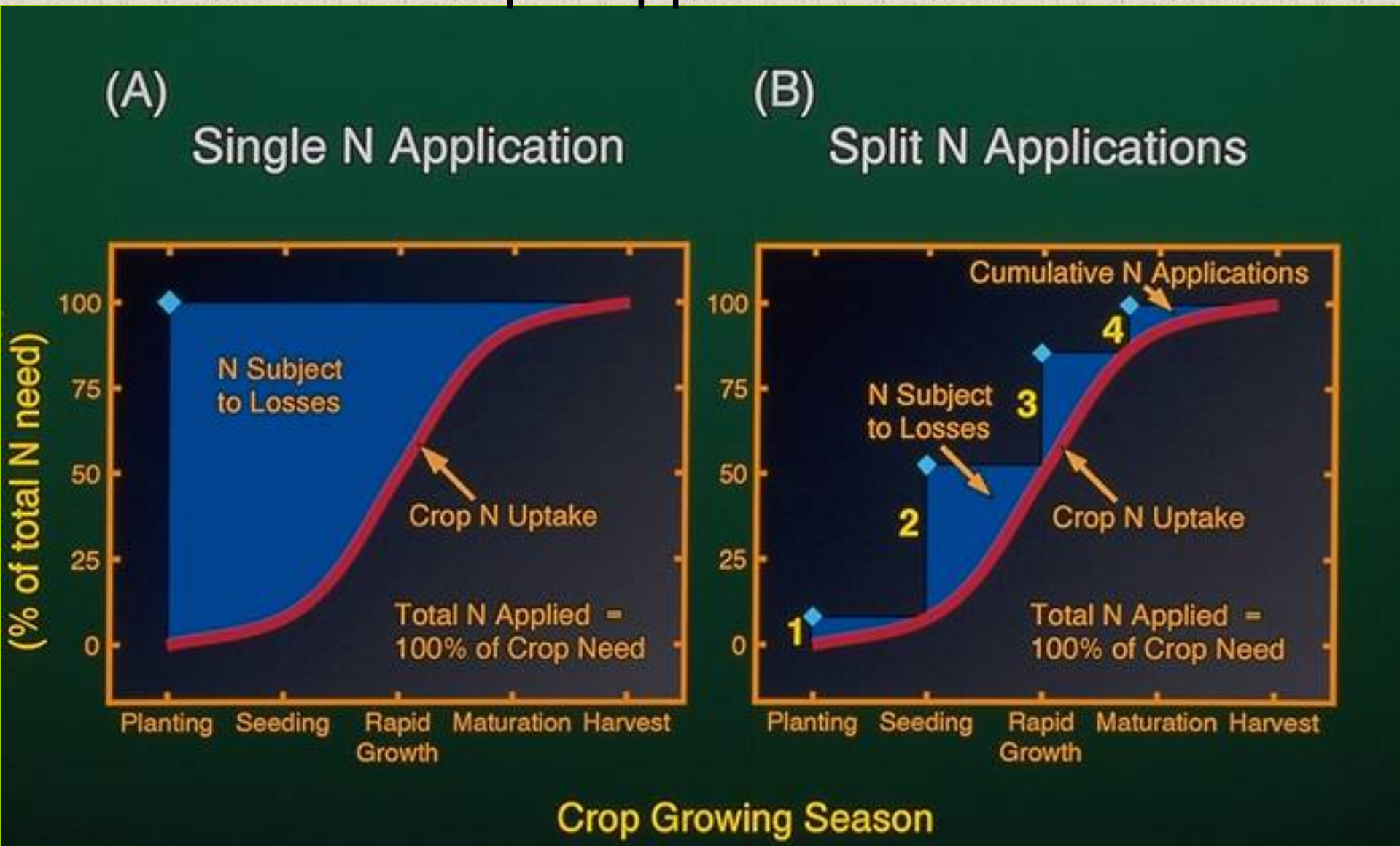
Downside-N release often occurs too late to match N uptake

Upside-can apply ~2 – 4x as much slow release product as conventional urea directly with the seed

EEFs and leaching

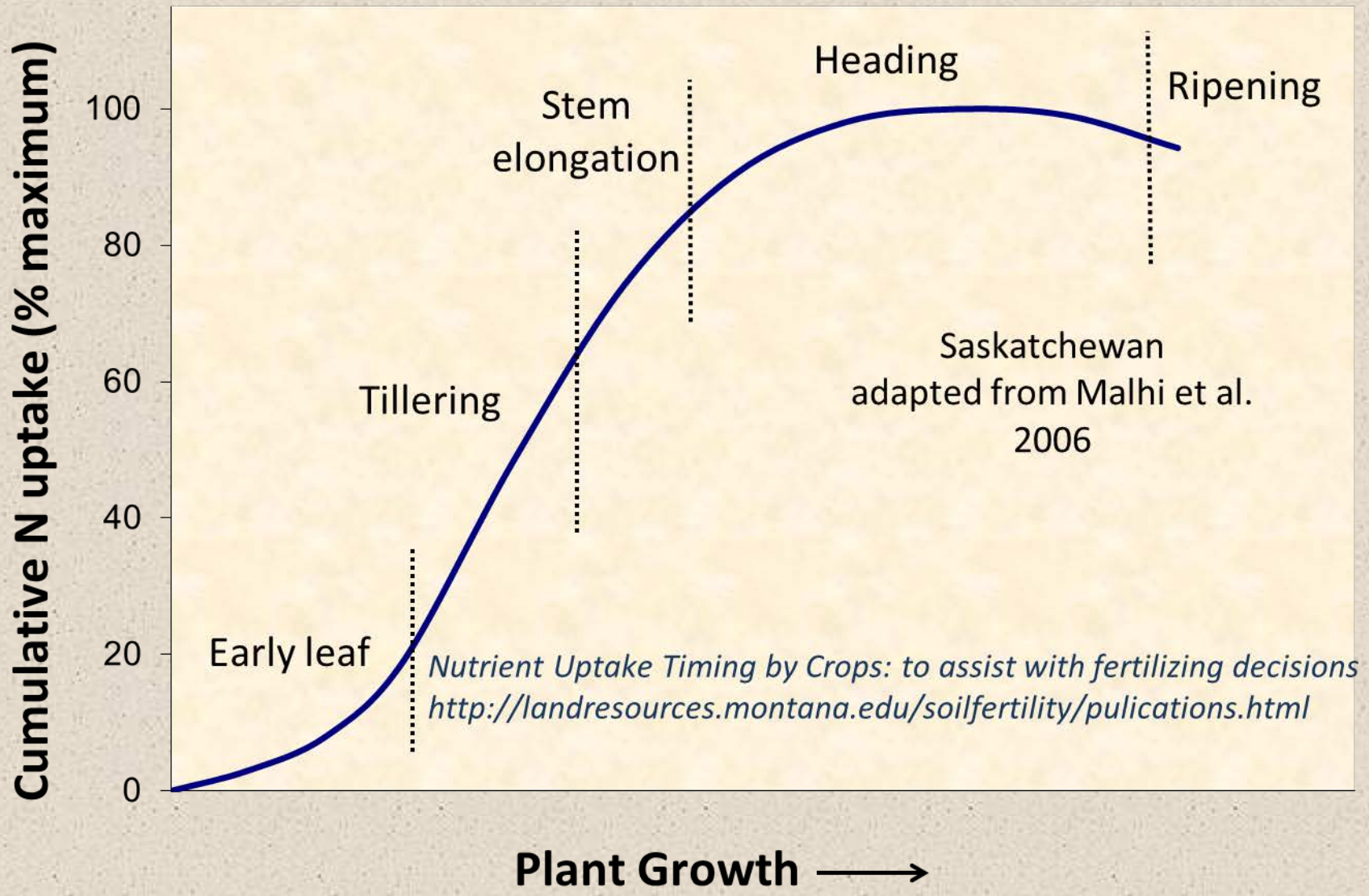
- Nitrogen use efficiency has been found to be 4 to 14% higher with CRU (Controlled Release Urea) than conventional urea. Improvement is likely due in part to reduced leaching.
- Watch for continued development of ‘new and improved’ products
- See *Enhanced Efficiency Fertilizers* (EB0188) for more information
  http://landresources.montana.edu/soilfertility/PDFbyformat/publication%20pdfs/Enhanced_Efficiency_Fert_EB0188.pdf

Reduction of potential N loss through split applications



Modified from HortTechnology. 9(4): 603.

Cumulative N uptake by spring wheat



Summary

Nitrate leaching is affected by both natural and human factors. For example, leaching is increased by:

- Porous and shallow soils
- Higher precipitation
- Annual cropping rather than perennial forage
- Summer fallow

Summary:
Farming practices that reduce nitrate leaching

- Include perennial forage in rotation
- Recrop rather than fallow
- Reduce tillage
- Apply N in spring according to soil test
- Split N application to match plant needs or use EEFs
- Consider applying less N in areas that yield less or have shallower soils

Other Resources

- Soil Fertility information: http://landresources.montana.edu/soilfertility

Questions?