Drainage for the Long-Haul: What Have we Learned?

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Naturally poorly-drained soils present many challenges for crop production.


Subsurface “tile” drainage is a common water management practice for crop production throughout the Midwest.
Often seasonal in function.

https://www.agry.purdue.edu/drainage/

SEPAC Drainage Research

Home
Yields
Water Quality
Layout & Design
Publications

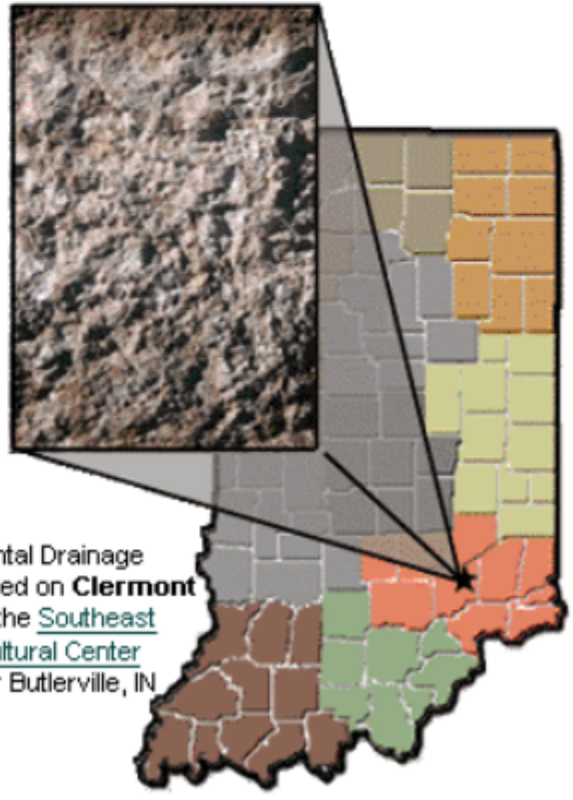
Related Links

Agricultural Drainage
Water Quality Field Station

Experimental Drainage Plots

The Experimental Drainage Field at the Southeast Purdue Agricultural Center (SEPAC) was initiated in 1983 by researchers in Purdue's Departments of Agronomy and Agricultural & Biological Engineering.

The original goal of the project was to evaluate the effectiveness of modern subsurface drainage practices on both soil drainage and crop yield, on a soil that was traditionally not subsurface- ("tile-") drained. Additional goals were added with time and included study of nitrate and pesticide leaching into drain water as well as impacts of drainage and agronomic management practices on soil quality.



The Experimental Drainage Plots are located on **Clermont Silt Loam** at the Southeast Purdue Agricultural Center (SEPAC), near Butlerville, IN.

Goals of SEPAC studies

On the poorly structured, low organic matter, naturally poorly-drained, Clermont silt loam soil, to:

- Improve drainage
- Improve soil physical properties
  - Reduce crusting and erosion
  - Increase infiltration and permeability
- Improve crop growth and yield

When drainage makes the "headlines," what are they?

- Drainage improves timeliness of field work
- Drainage improves crop yields
- Drainage improves cover crop growth
- Drainage enables other conservation practices to work better, to improve soils
- Closer drain spacings lose more water and nitrate in tile drainflow
- Cover crops reduce nitrate losses from tiles
- Drainage is a long-term investment

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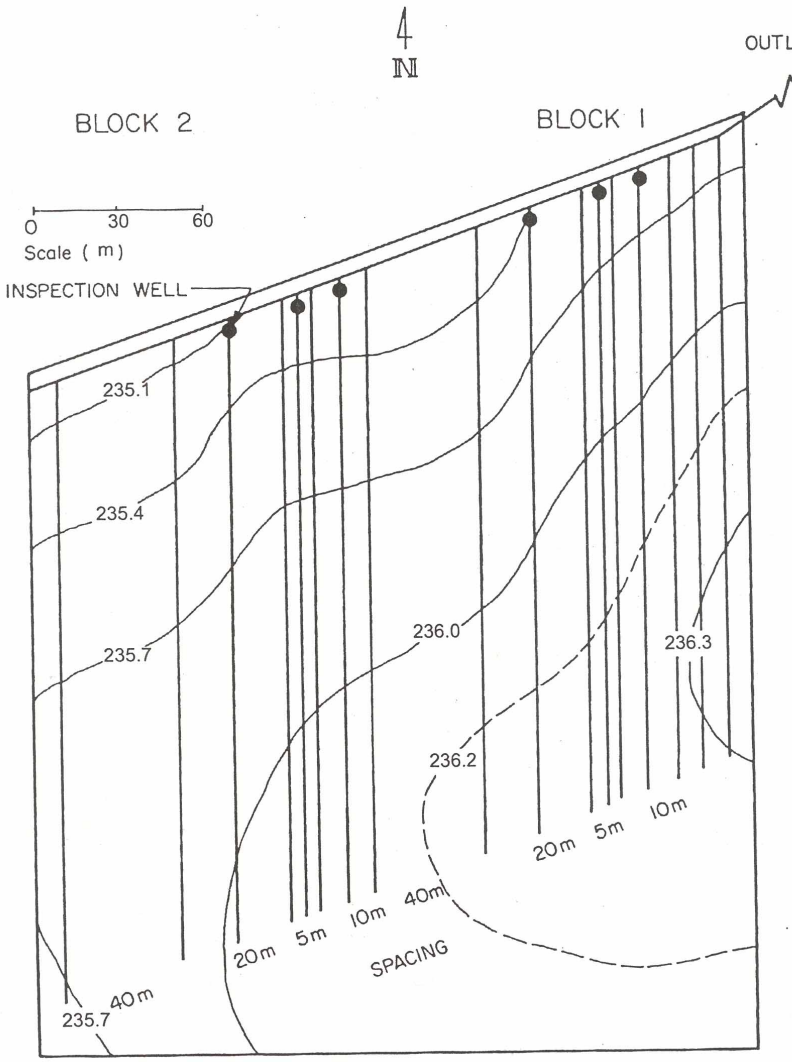
SEPAC drainage research site

- Drainage installed at four spacings to research spacing effect on yield.
- 5m, 10m, 20m, 40 m
- (16 ft, 33 ft, 66 ft, 132 ft)
- 2.5-3 ft depth
- 4-inch plastic drain tube, no sock or filter



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#1

“Headlines”

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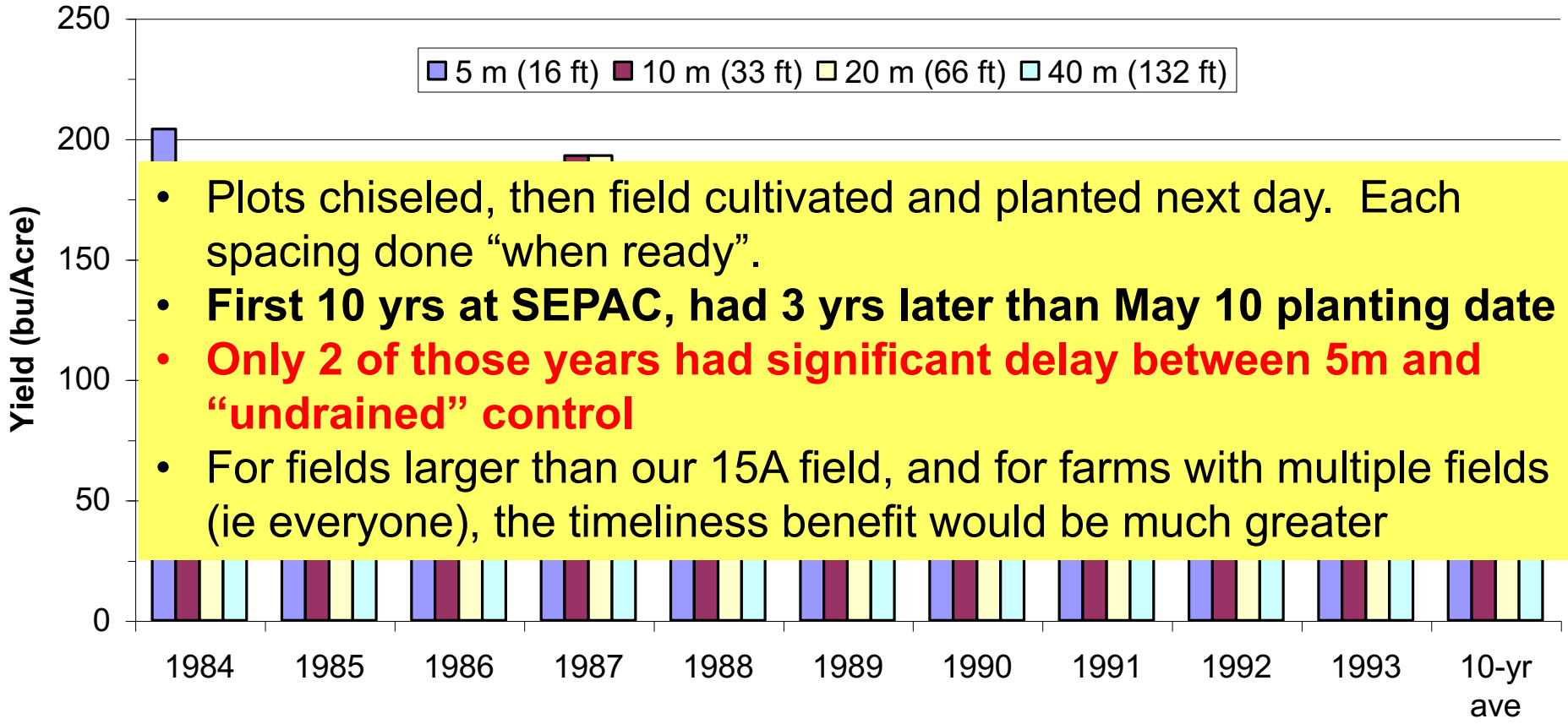
Timeliness of planting at SEPAC during first 10 years; 5m vs. 40m ("undrained")



- Plots chiseled, then field cultivated and planted next day. Each spacing done "when ready".
- **First 10 yrs at SEPAC, had 3 yrs later than May 10 planting date**
- **Only 2 of those years had significant delay between 5m and "undrained" control**
- For fields larger than our 15A field, and for farms with multiple fields (ie everyone), the timeliness benefit would be much greater

My21	Ap22	Ap30	Ap28	My02	**My18**	**My29**	My01	My05	My10
+11	+2	+0	+2	+3	**+15**	+3	+2	+3	+1

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See https://www.agry.purdue.edu/drainage

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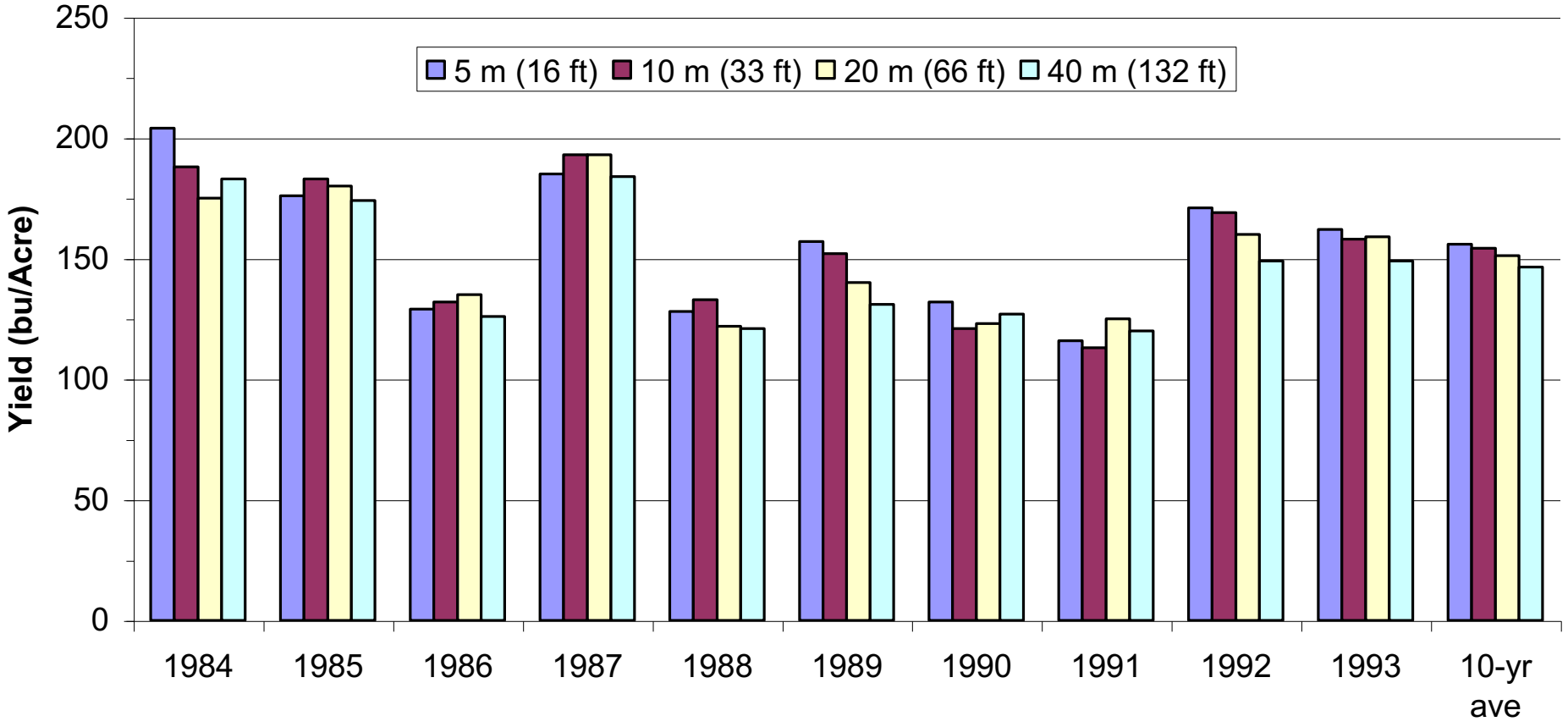
Effects vary year by year -- Continuous Corn Yield at SEPAC over first 10 years



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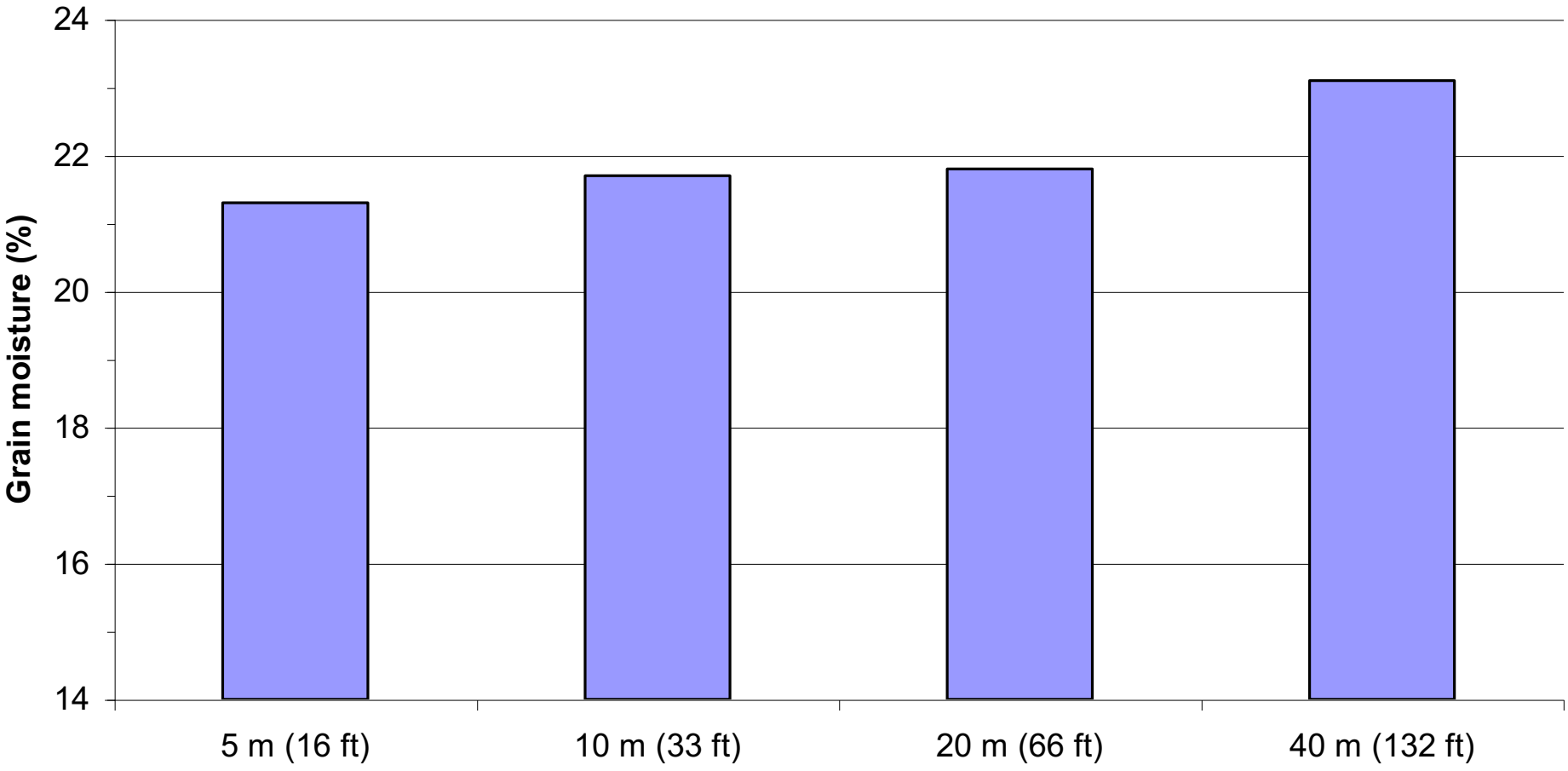
SEPAC 10-yr continuous corn grain moisture averages



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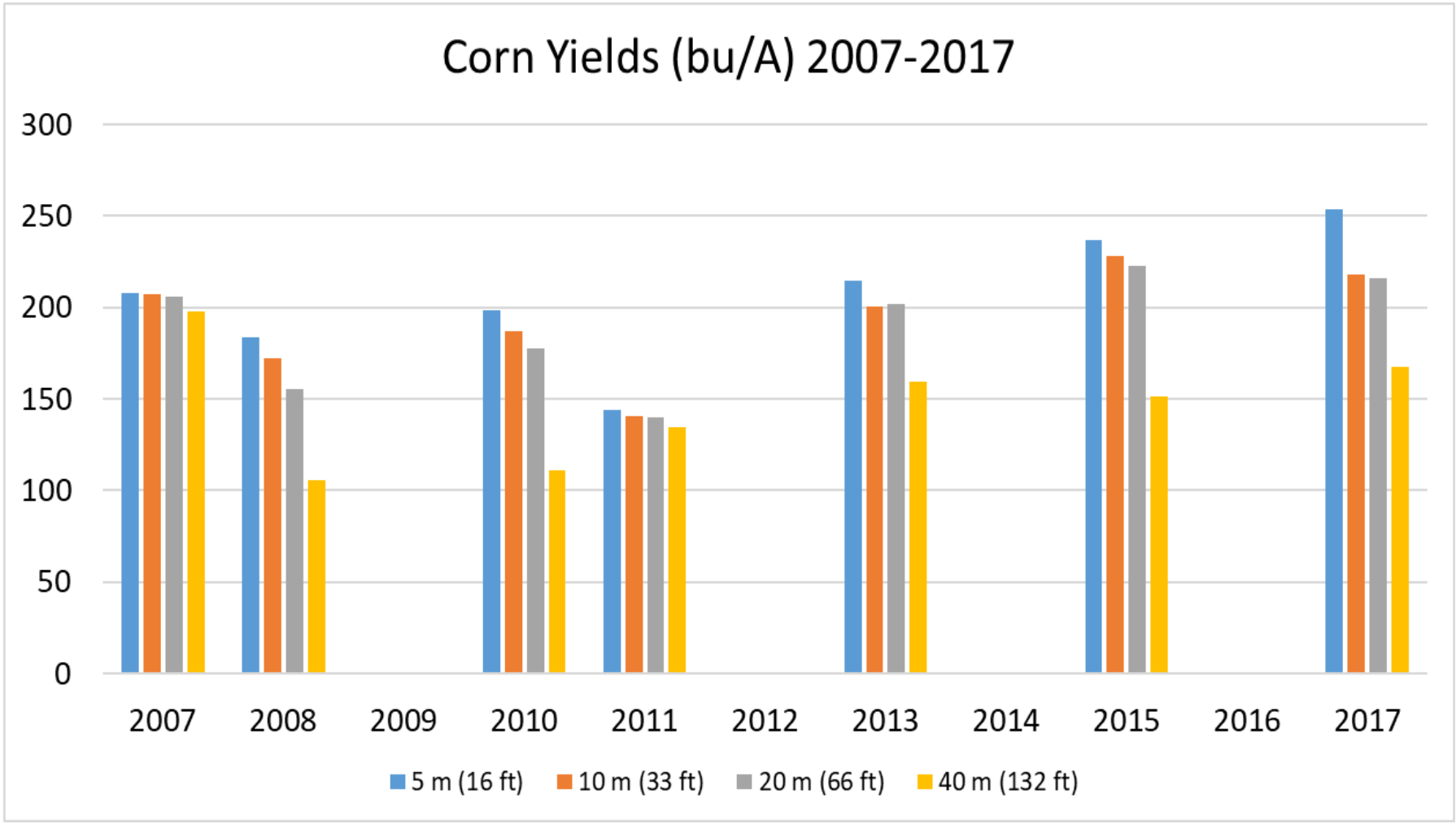
SEPAC Drainage Spacing Corn Yields (bu/A)



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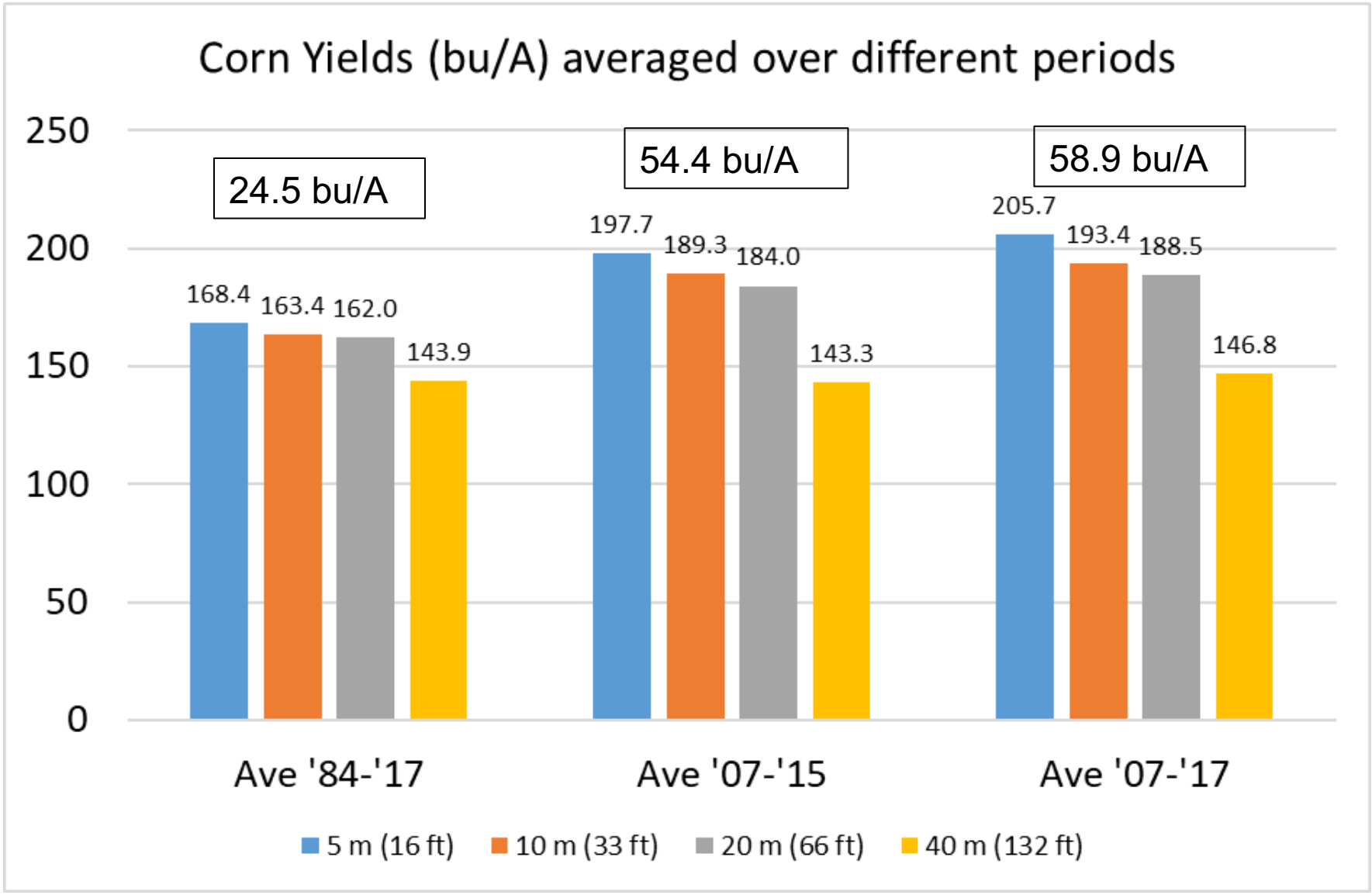
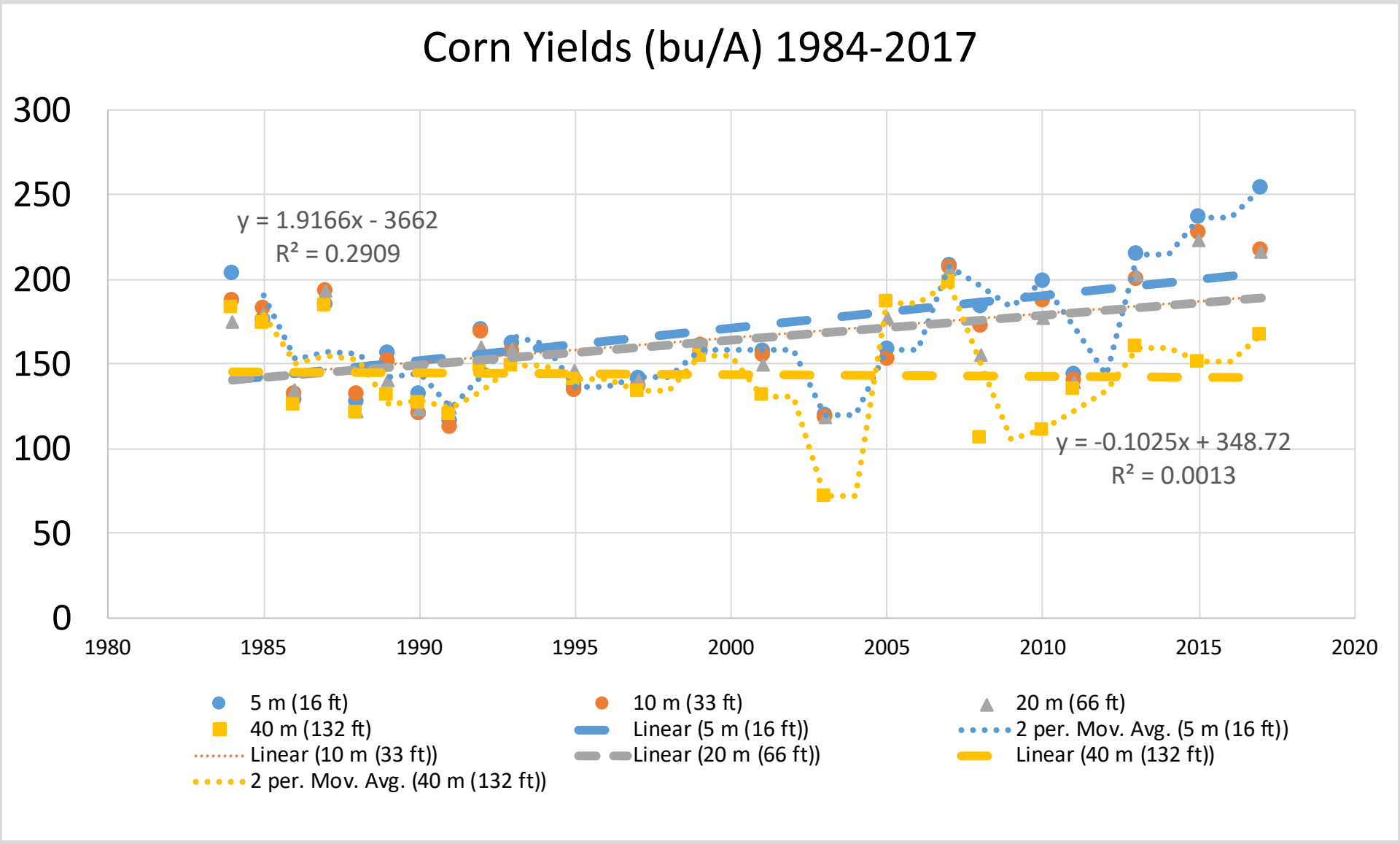
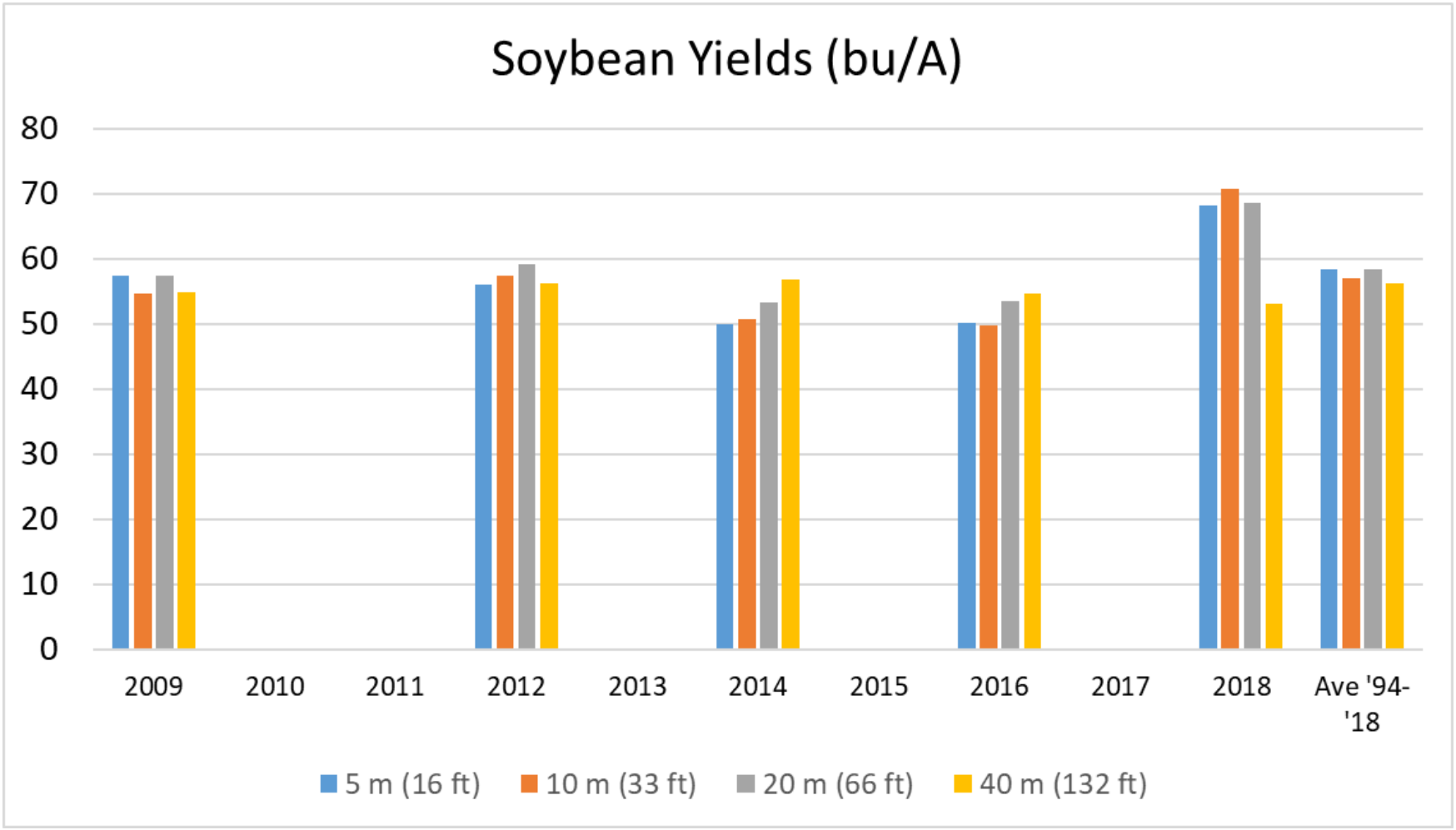


SEPAC Drain Spacing



SEPAC Drainage Spacing Soybean Yields (bu/A)



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What about surface drainage?

- Good surface drainage on this field. Slightly more slope than many Clermont fields, according to local farmers.
- Thus, the importance of subsurface drainage is not as dramatic as on more typical fields.
- Notice the impact of tiles vs. none, on another part of same field with less ideal surface drainage……..


Untiled planted 3 times, and drowned out all 3 times
(the year after experiment ended!)

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May 13, 2016

Tiled

~3100 lbs biomass/A

Untiled

~700 lbs biomass/A

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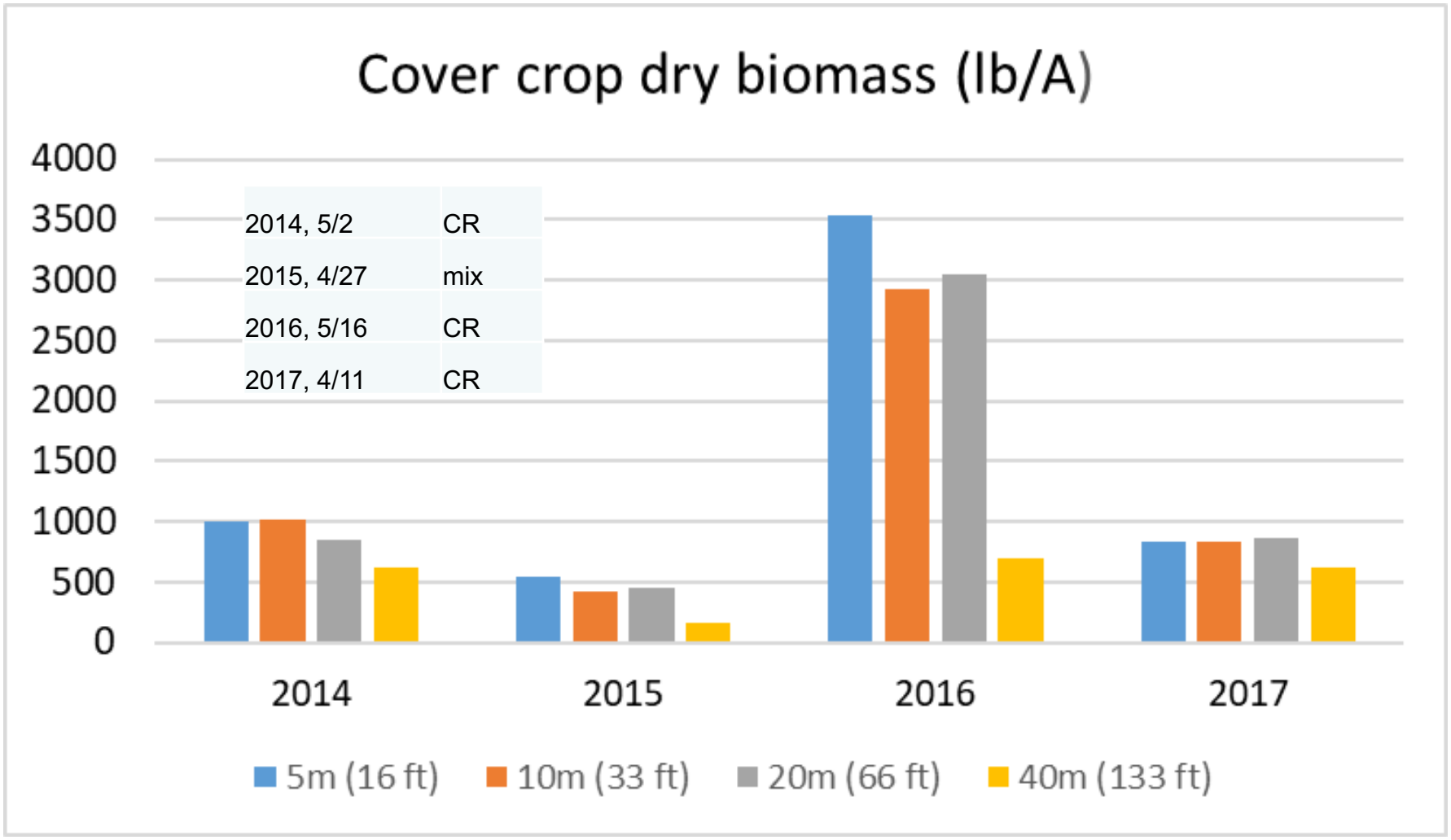
SEPAC Drainage Spacing Site



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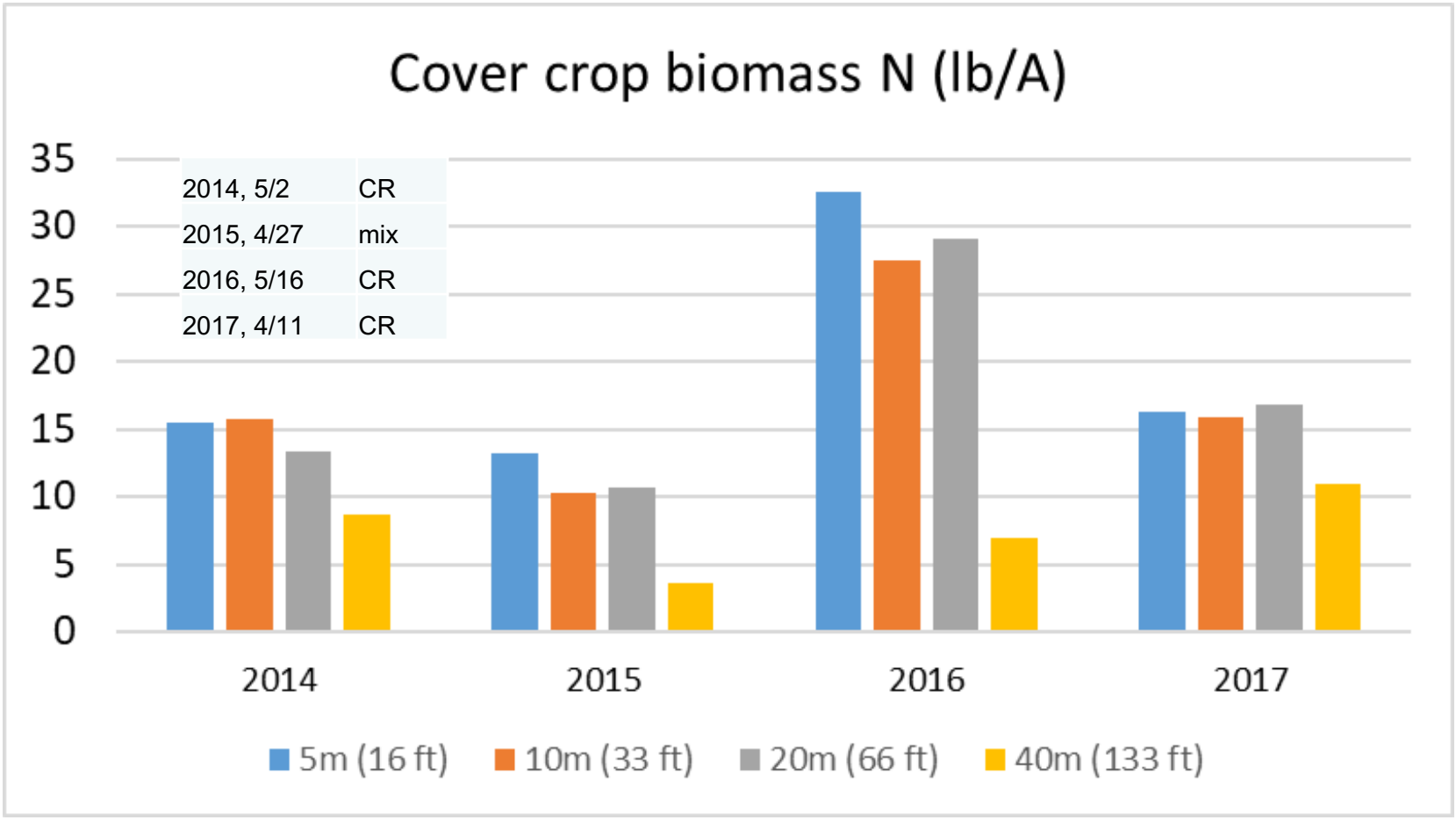

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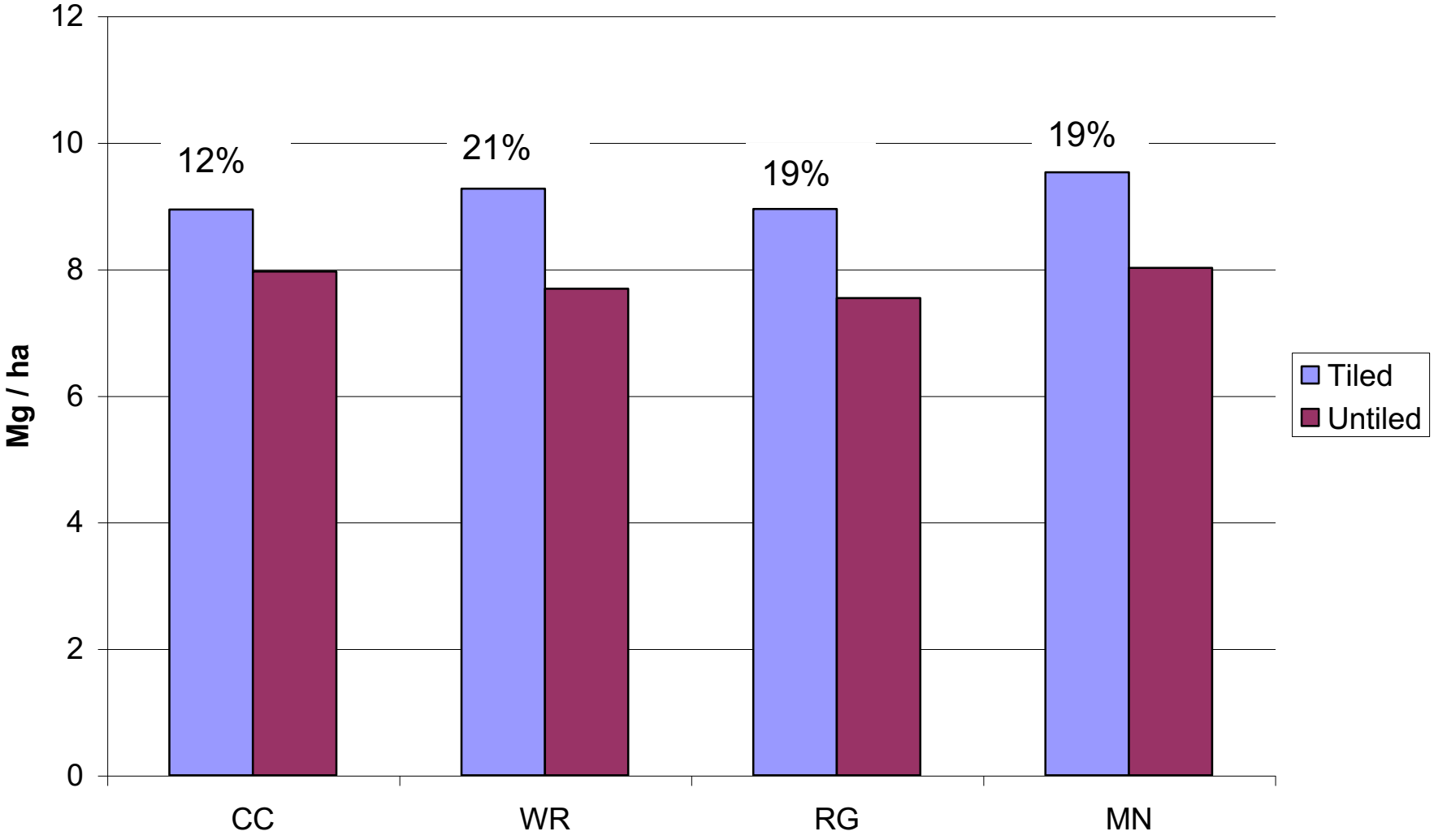
Field Experiments

- Drainage 1
  - Four drain spacings (16, 33, 66, 133 ft)
- Drainage 2
  - Subsurface “tile” drainage vs. none (2 subfields)
  - Chisel vs. no-till
  - 5 agronomic practices
    - CC: (cont.corn) only
    - WR: CC with winter cover of wheat or cereal rye
    - RG: CC with winter cover of annual ryegrass
    - MN: CC with dry manure spring application
    - RO: 3-yr rotation, corn-wheat-orchardgrass/redclover
    - (covers hand-broadcast into standing corn each autumn)

Maize grain yields and % increase for tiling (9-yr ave)



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Earthworms and soil properties

- Earthworm populations were generally higher in:
  - No-till vs. chisel
  - Tiled vs. untiled
  - Covers, rotation, manure vs. control
- Soil physical properties tended to be improved by cover crops and rotation (aggregate stability, infiltration)

Summary- Agronomic plots

- Average continuous corn yields were 16 to 25 bu/A higher in tiled than in untiled subfield, depending on agronomic treatment. (Note—this is a different experiment than the spacing treatments, and was run for 9 years (1985-1993).
- Cover crops, rotation, and manure had equal or greater corn yields than control in tiled subfield, but equal or lower than control in untiled subfield

➢ A good drainage system is a necessary first step to improving crop yields and soil health. Agronomic practices alone are not likely to make up for an inadequate drainage system.

Implications

- Cover crops, manure application, conservation tillage, and rotation with hay crops can improve soil physical properties and crop yields, on low organic matter, poorly structured soils, when adequate drainage is present.
- **As we talk with the public about soil improvement, we may need to remind them that a good drainage system is a necessary first step to improving soil health and crop production.**


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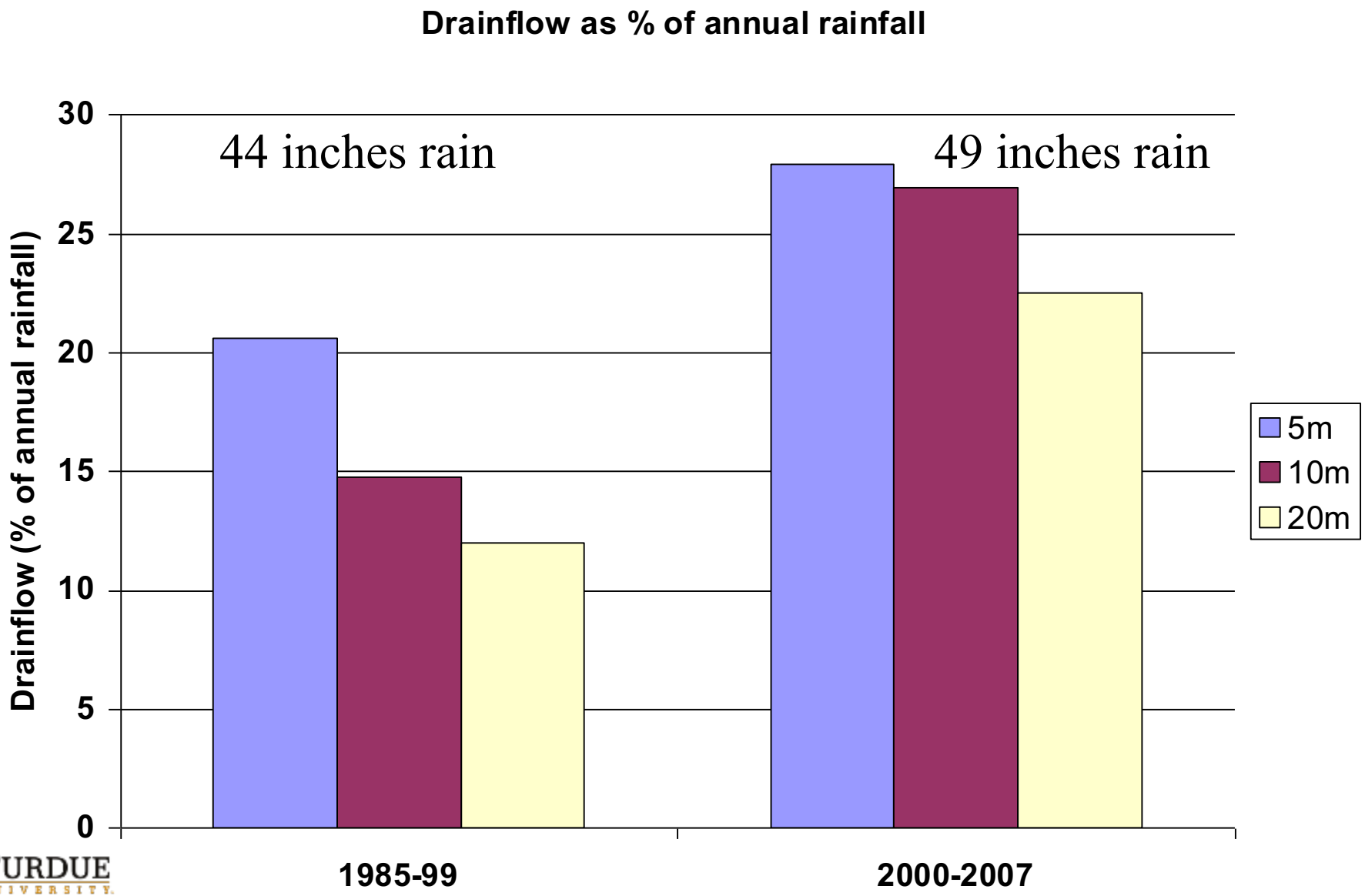
Drainflow greater with narrower drain spacings



SEPAC Drain Spacing

- Concentrations did not vary among spacings, because crop yield differences among 3 spacings (5, 10, 20m) were relatively small (no drain to sample for “undrained” control).
- But since drainage flow (water) differed greatly, total nitrate loss did differ with spacings. More water and nitrate loss with narrower spacing (greater drainage intensity)…….

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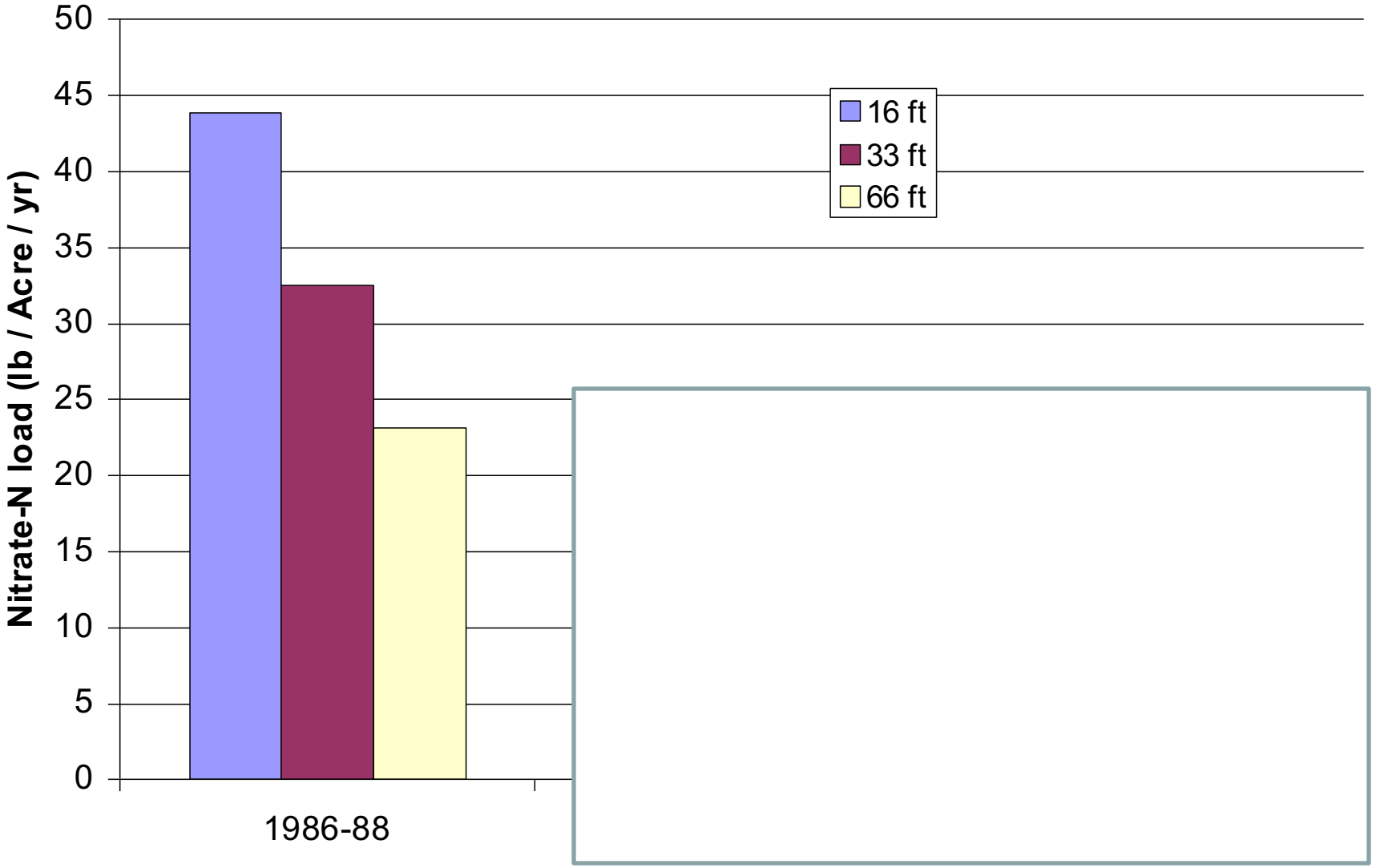
Annual nitrate-N load from 3 drain spacings--SEPAC



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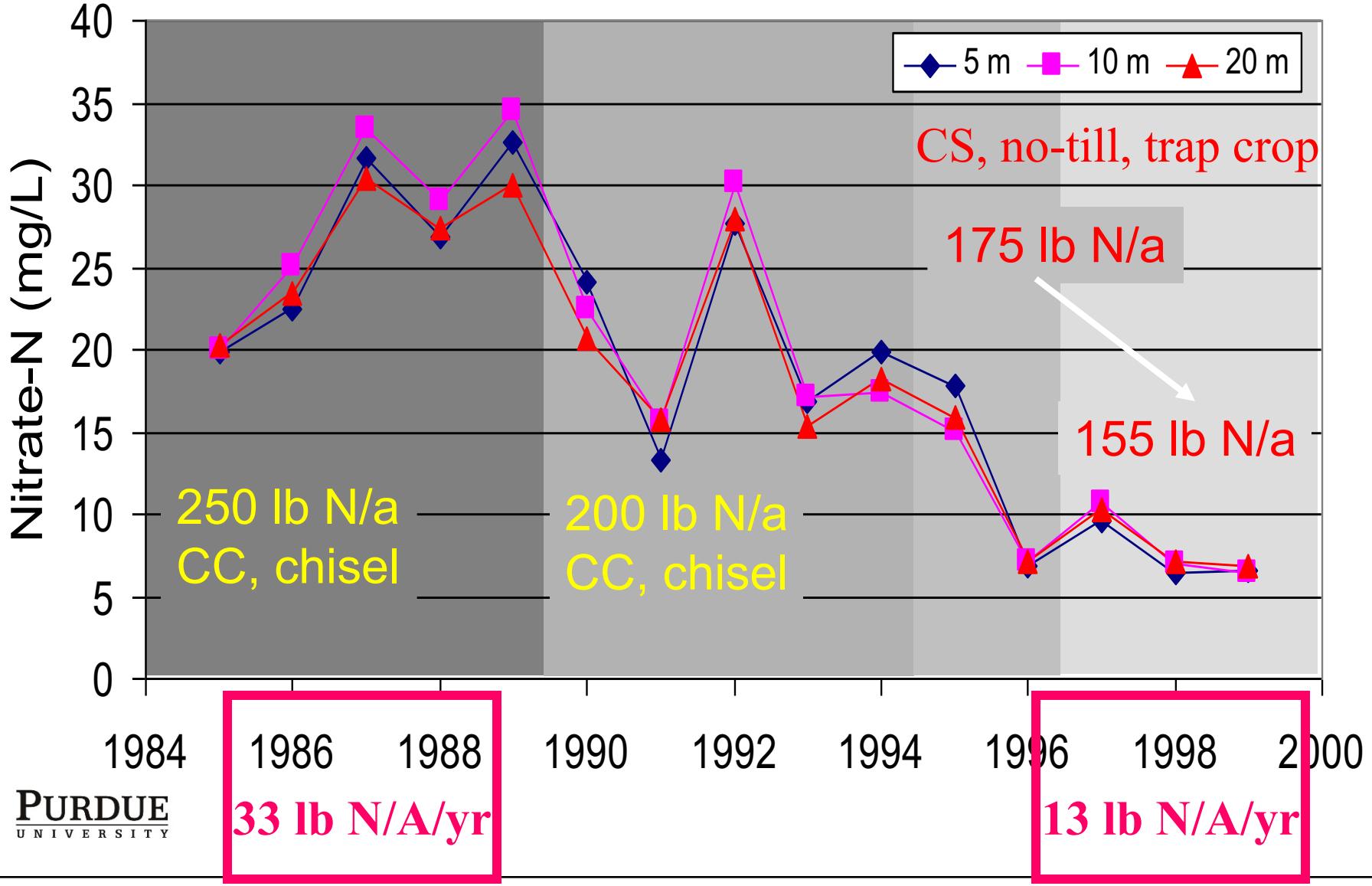
Kladivko

Nitrate-N in Drainage Water - SEPAC



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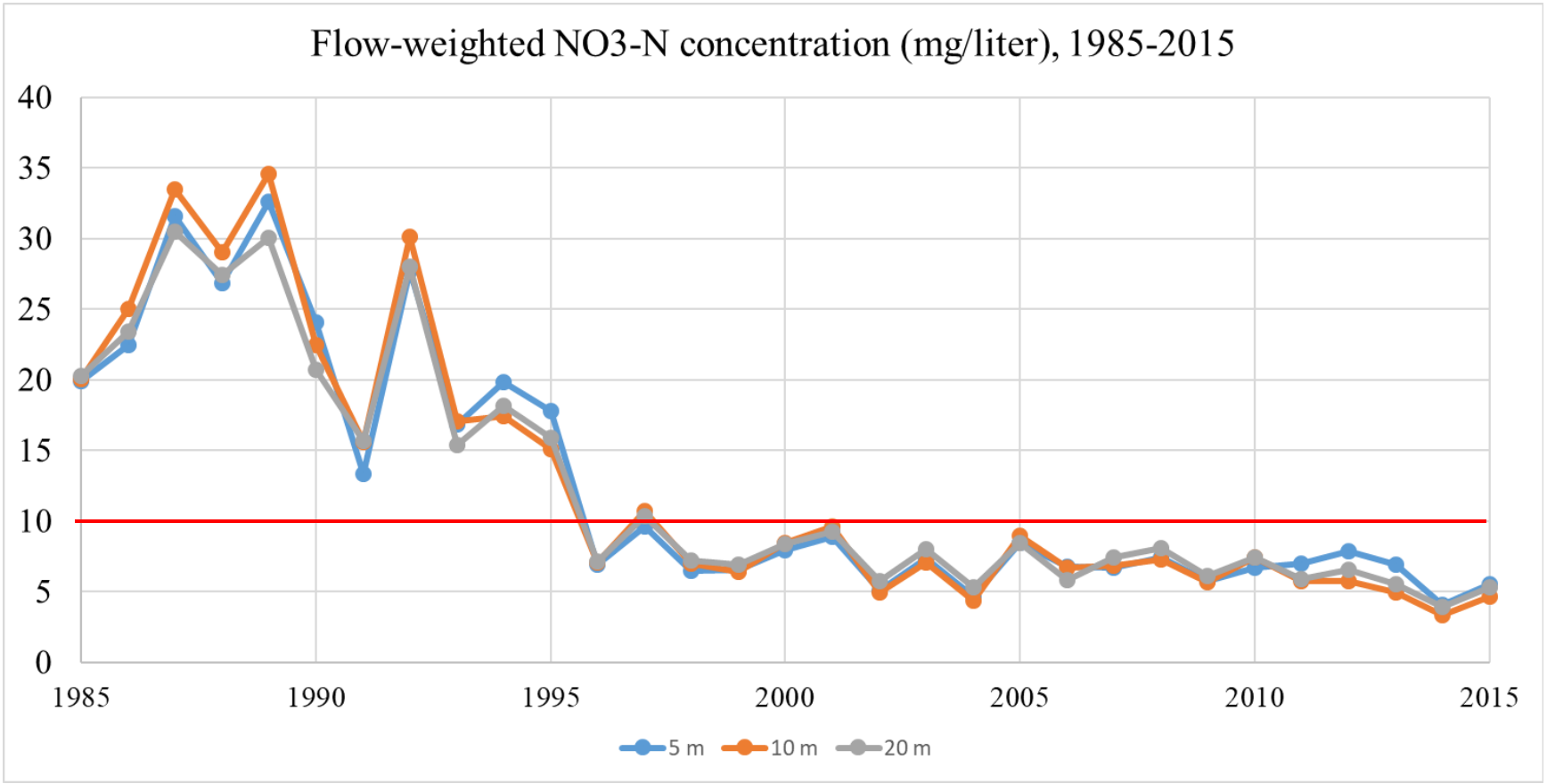
SEPAC Drainage Site



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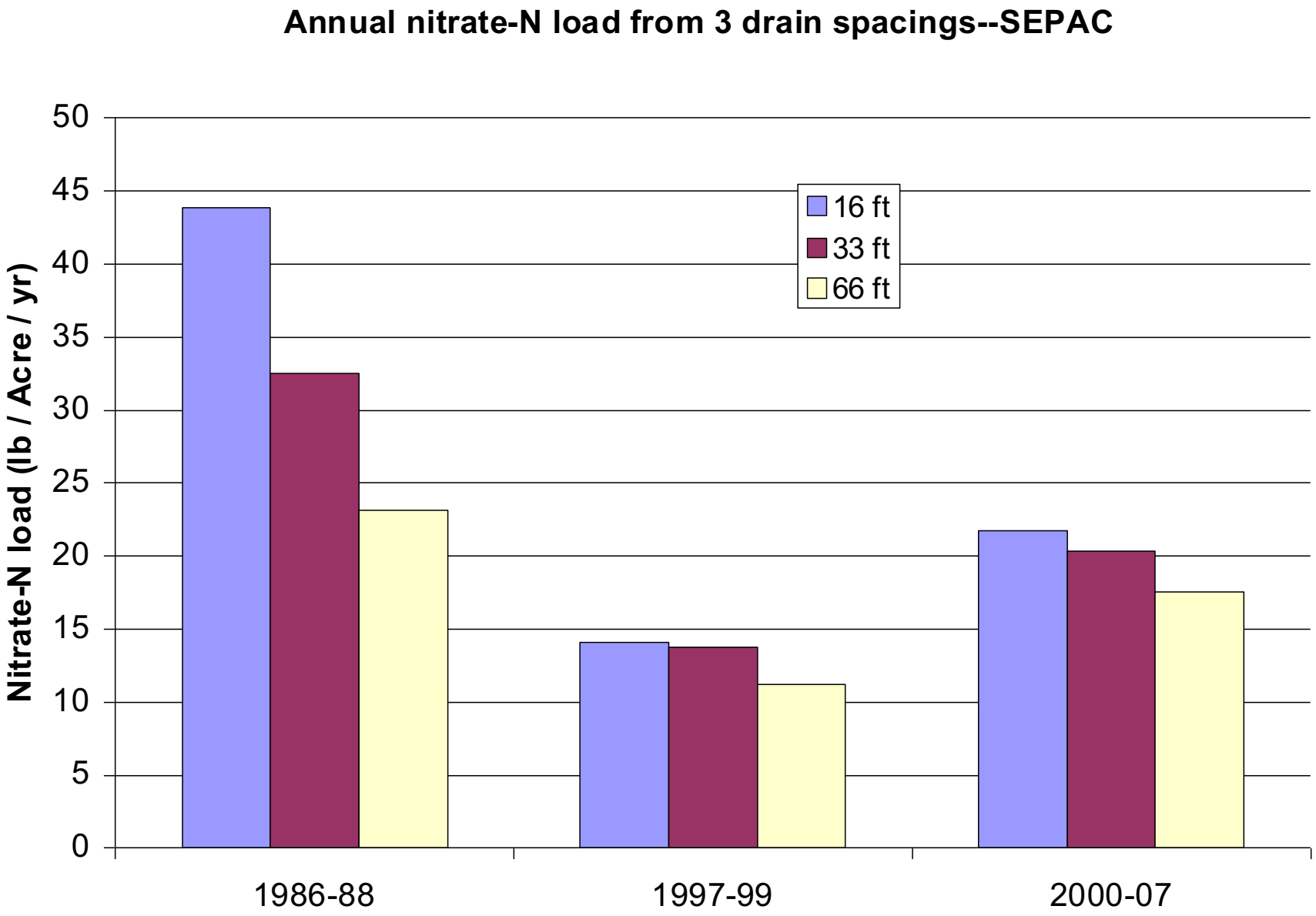
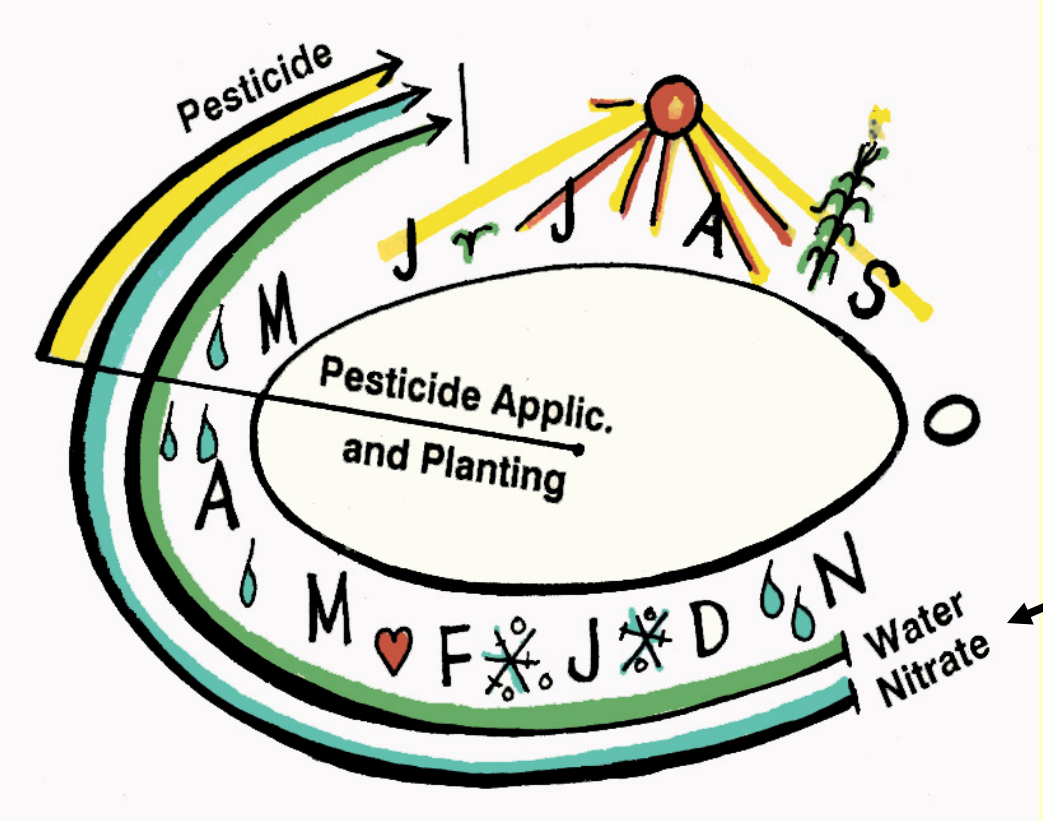

Annual nitrate-N load from 3 drain spacings--SEPAC
Nitrate-N load (lb / Acre / yr)
50
45
40
35
30
25
20
15
10
5
0
16 ft
33 ft
66 ft
1986-88
1997-99
2000-07

Bottom line

- Drain spacing matters
- Rainfall (excess) matters
- N fertilizer rate and form matter
- Cover crops reduce NO3-N concentrations, loads
- Perhaps some development of this soil from drain installation, no-till, or other.

- If we intensify drainage, then we should also intensify management of other aspects of that system, such as cover crops and controlled drainage, to reduce the “leakiness” of the system.

Corn-soybean system normally fallow from Oct – April.



A winter cover crop takes up (or "traps") some of the nitrate that otherwise leaches out during fallow season

Majority of drainflow and N-loads occur in fallow season (at SEPAC)

(64% Nov. – March; 80% Nov. – April)

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Long-term

- Drain flow develops over time, at least for the first several years.
- Yield effects vary from year to year
- Conservation practices take time to improve soil health
- At SEPAC, flows have become “flashier” with time, and we’ve tried to understand this development process. This July we started novel exploration of development of soil structure……..

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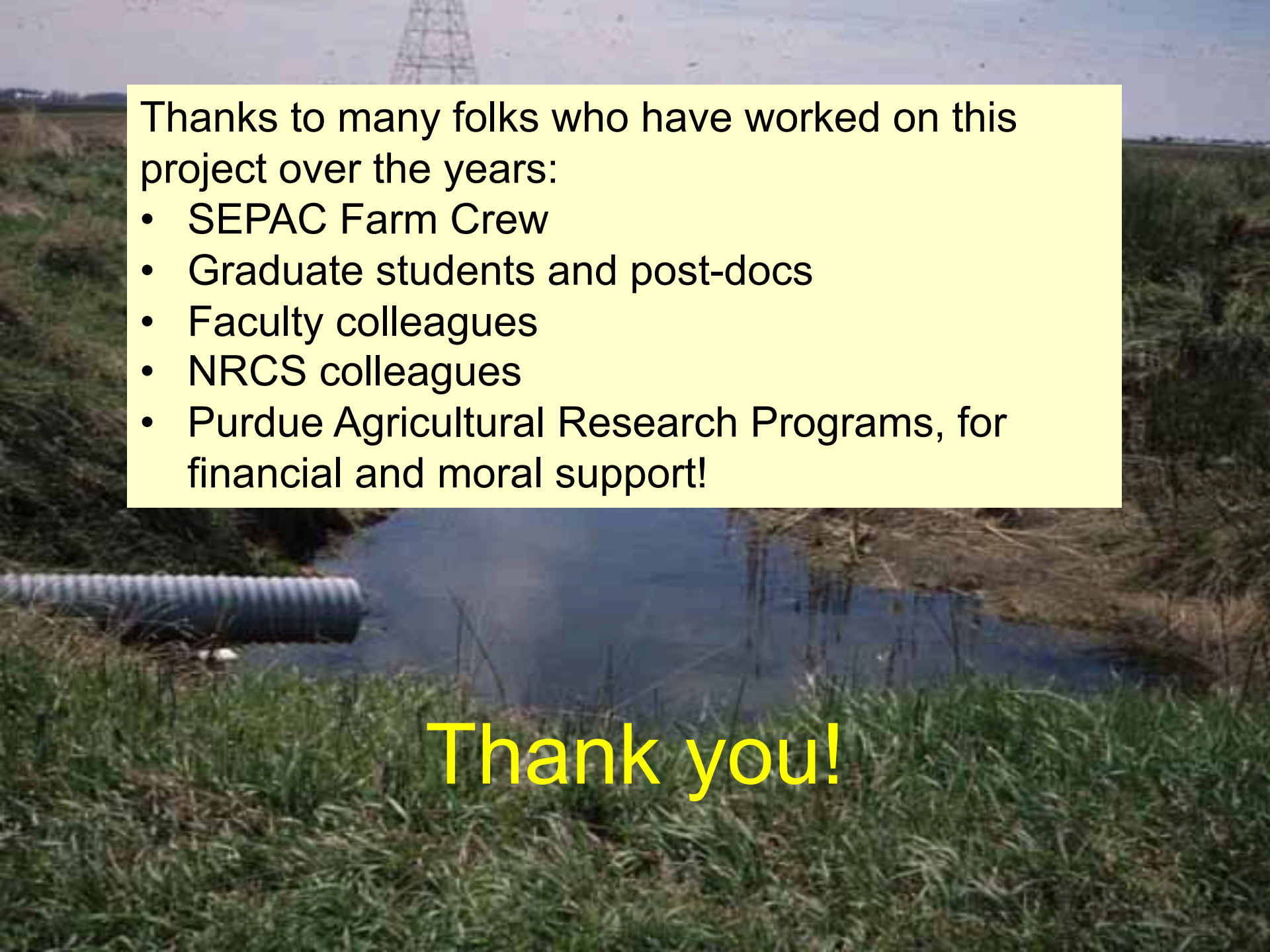

Thanks to many folks who have worked on this project over the years:

- SEPAC Farm Crew
- Graduate students and post-docs
- Faculty colleagues
- NRCS colleagues
- Purdue Agricultural Research Programs, for financial and moral support!

Thank you!

Deciding on spacing

- Drainage Recommendations for Indiana Soils
  - (AY-300) by Don Franzmeier, Bill Hosteter, and Roger Roeske (NRCS).