Using Green Manure Crops for Nitrogen Management

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Crimson clover in
Missouri in early May


Self reseeding crimson clover
In Missouri in October


Hairy vetch in early April
in Louisiana


Crimson clover in
Alabama in early Mar

Contributors to this presentation

Jac Varco, Mississippi State Univ.
Charles Burmester, Auburn Univ.
Charles Mitchell, Auburn Univ.
Gene Stevens, Univ. of Missouri
Glen Harris, Univ. of Georgia
Rick Mascagni, LSU AgCenter
Robert Hutchinson, LSU AgCenter
M.G. Wagger, N.C. State
Seth Dabney, USDA
Eddie Millhollon, LSU AgCenter
W. L. Hargrove, Univ. of Georgia

Three-part presentation

1. Introduction

2. Legume crops and potential N - Establish the expectations for biomass production and N contribution.

3. Crop yield responses to legumes.

photo courtesy of Gene Stevens, Univ. of Missouri

Questions from farmers and county agents last fall

Which legume should I plant?

How much N will I get from the cover crop and when will it be available?

What is the procedure for measuring the N content in the legume?

Will I still have to apply some fertilizer N?

Cotton planted in hairy vetch residue

Cotton planted in Austrian winter pea residue

Summary of presentation

Winter legumes' biomass contain from 100 to 150 lb N/acre in early spring.

Up to 80 % of this N can be available for the following summer crop.

Based on past research, the best overall legume is hairy vetch followed by several of the clover species and by winter peas.

Cotton planted in hairy vetch residue

Cotton planted in Austrian winter pea residue

Summary of presentation

Legumes should be chosen for early growth, total N and tolerance to cold.

The largest impediment to <u>effective</u> use of winter cover crops for N is the conflict with maximum N fixation time (early spring) and planting of the following summer crop.

Cotton planted in hairy vetch residue

Cotton planted in Austrian winter pea residue

Legume crops

- Vetches (hairy, common, big flower)
- Winter peas (Austrian, Caly, Roughpea, Singletary)
- Clovers - Crimson, Berseem, Arrowleaf, Bur, Sub, Red, White, many others)
- Medics – Barrel medic, annual lucerne
- Lupines – White, blue and yellow

Why plant legume crops?

- Relative cost of other N sources
  - Inorganic fertilizers
  - Organic (poultry litter, gin trash, composts)
- Soil organic matter increase
- Soil quality improvement
- Winter ground cover for BMPs
- Intangibles (improved soil tilth & biology

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Why not plant legume crops?

- Relative cost of other N sources
- Uncertainty of production
- Time management – fall planting; possible delay with spring planting preparation and planting itself.
- The unknowns – Depletion of soil water; increase nematode numbers? diseases?; termination timing and cost.

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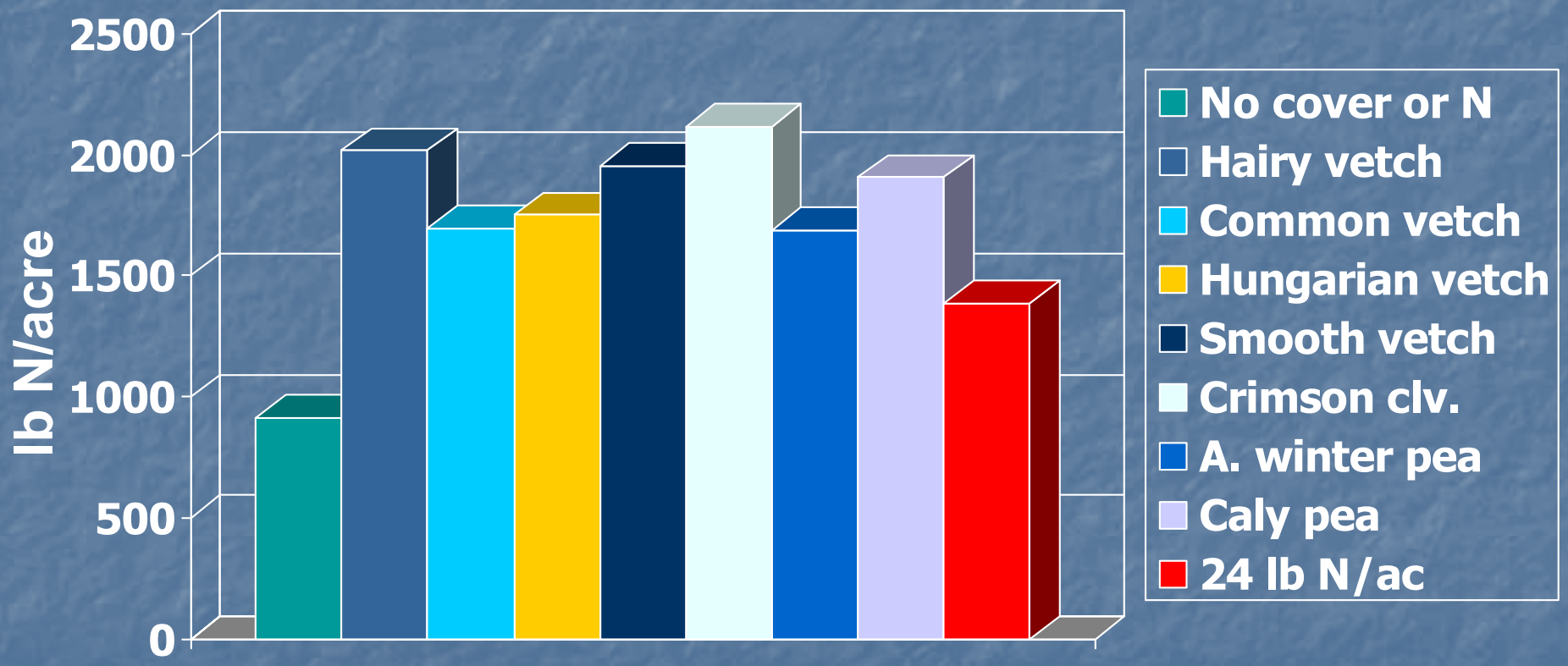
A little history of crop responses to specific legumes

Cotton yield following legume crops, LSU AgCenter Northeast Research Station, 22 years, 1929-51.



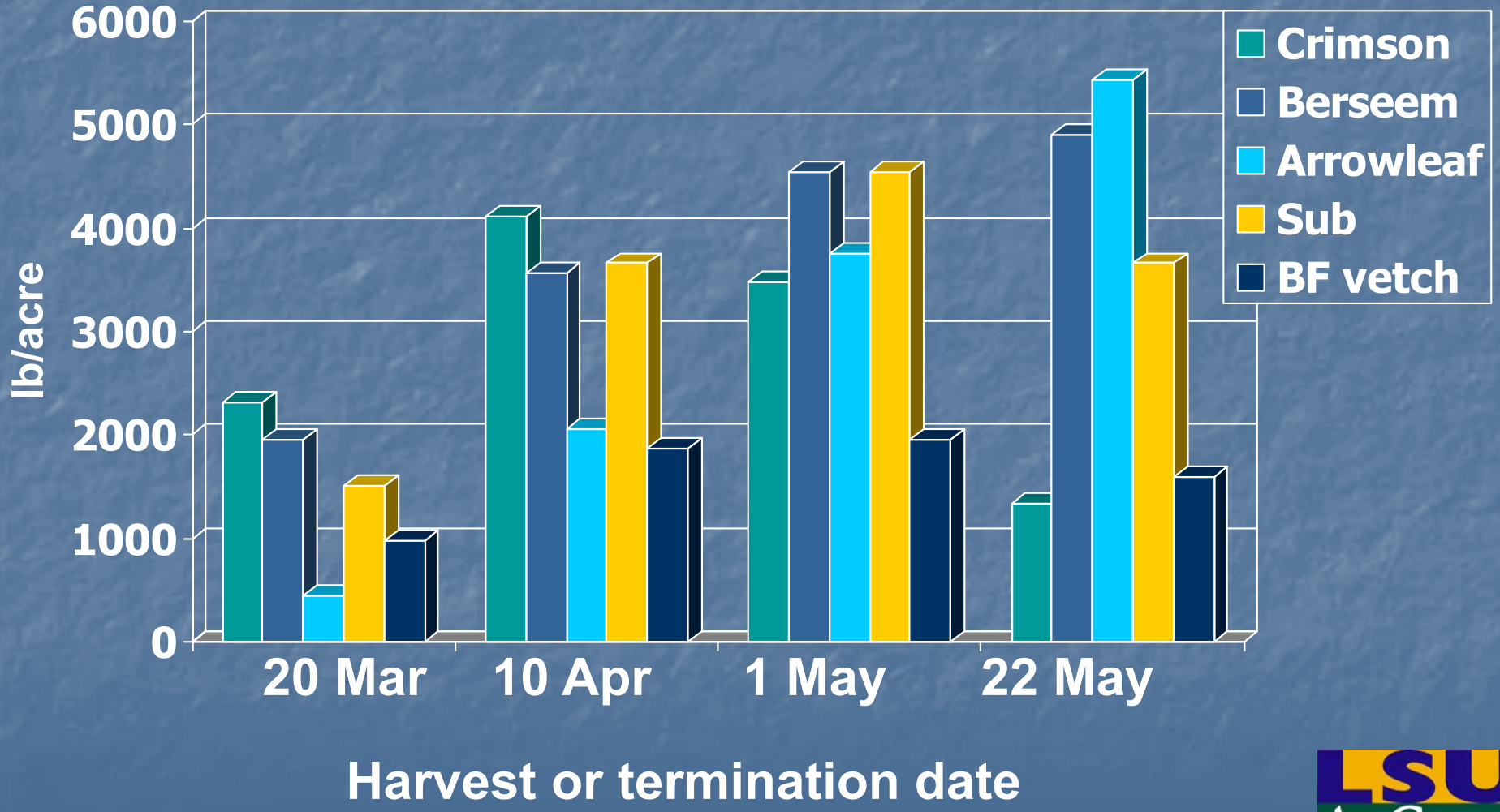
Data from C.B. Haddon from 36 species evaluated

1. Expectations for biomass and available legume N ?

Specific legumes

Results will differ for locations due to specific varieties, weather, and harvest timing.

Cover crop biomass yield with time of harvest (termination) in Louisiana.



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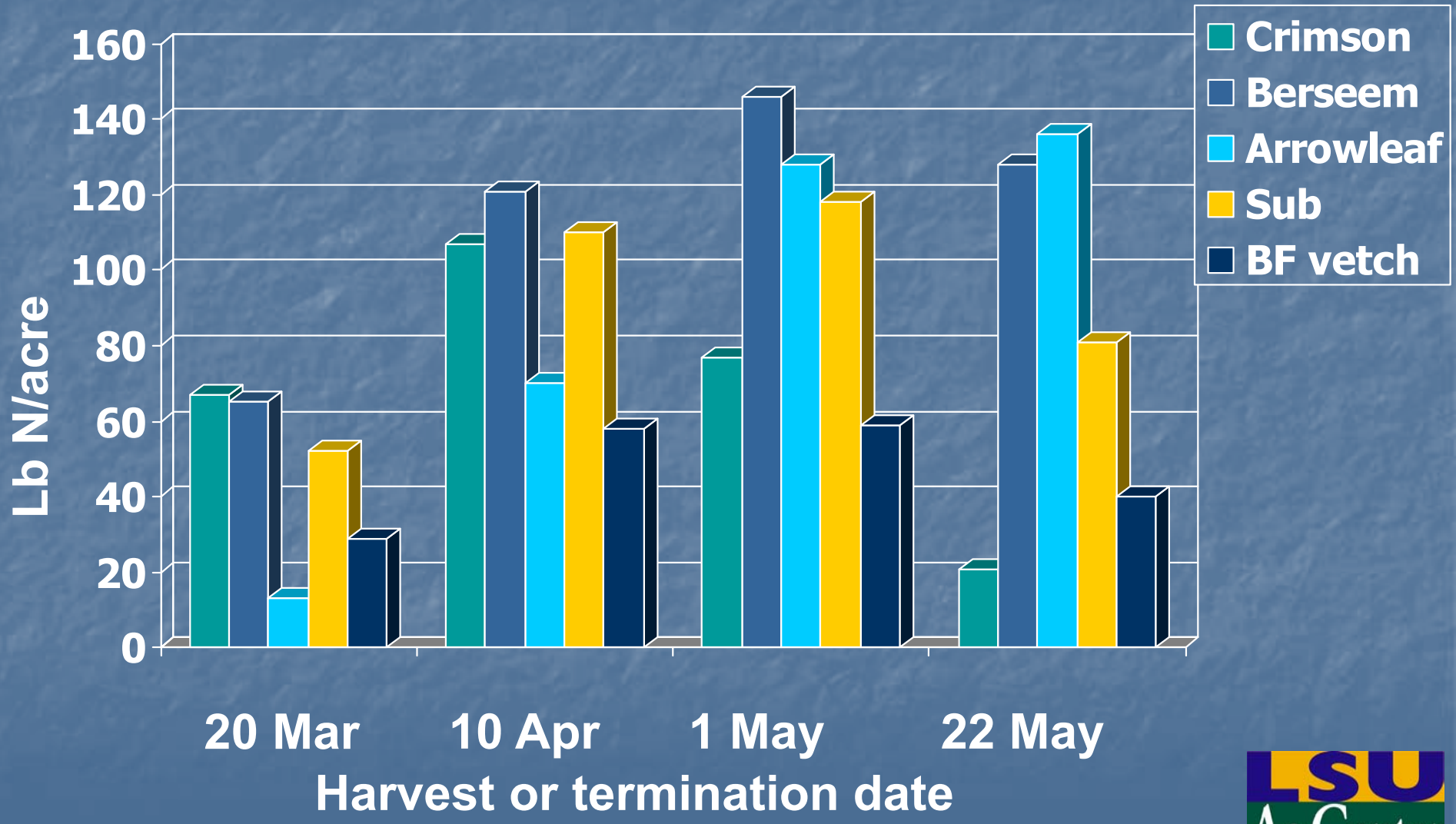
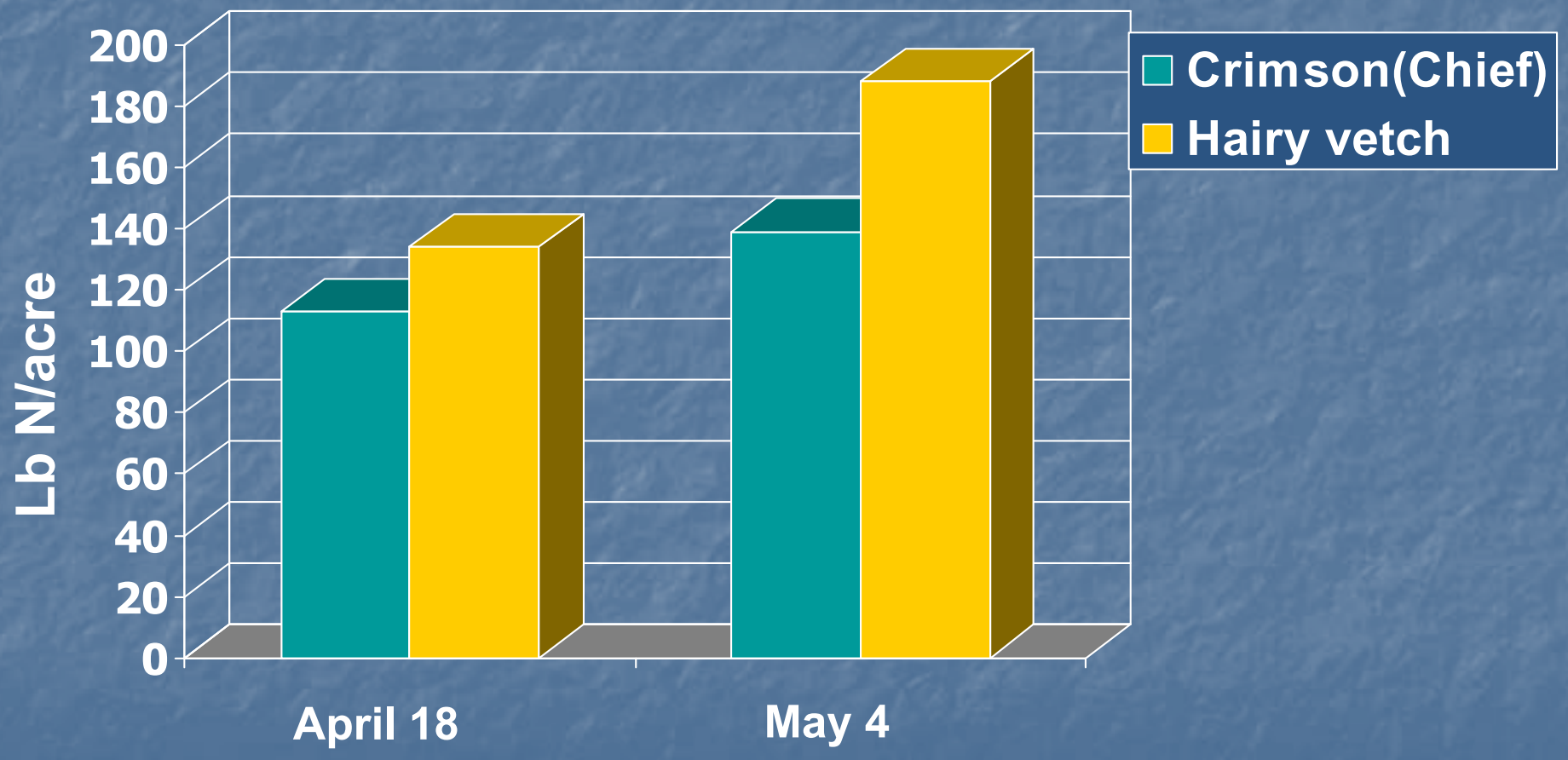
Nitrogen content of legume crops with time of harvest in Louisiana.



Nitrogen content of legume crops at two harvest dates in North Carolina.



Data from M.G. Wagger, N.C. State

Above ground biomass yield and N content of legume cover crops in LA, 5 yr. avg., 1986-90.

	Biomass	N content
	---- lb/ ac ----	
Hairy vetch	3402	121
Crimson clv. (Chief)	5535	150
Bigflower vetch	3238	97
Austrian winter pea	2902	86
Roughpea (Caley)	3364	130
Berseem clv.	4624	119

Data from Seth Dabney, formerly LSU AgCenter, now USDA

Above ground biomass yield and N content of legume cover crops in LA, 5 yr. avg., 1986-90.

Arrowleaf clv. 'Amclo'	4746	135
Subterranean clv.	3844	118
Bur clv. 'Serena'	5119	150
Lupin 'Tifblue 78'	5342	143
Barrel medic 'Paraggio'	4254	124
Common vetch	3549	105

' Cahaba White'

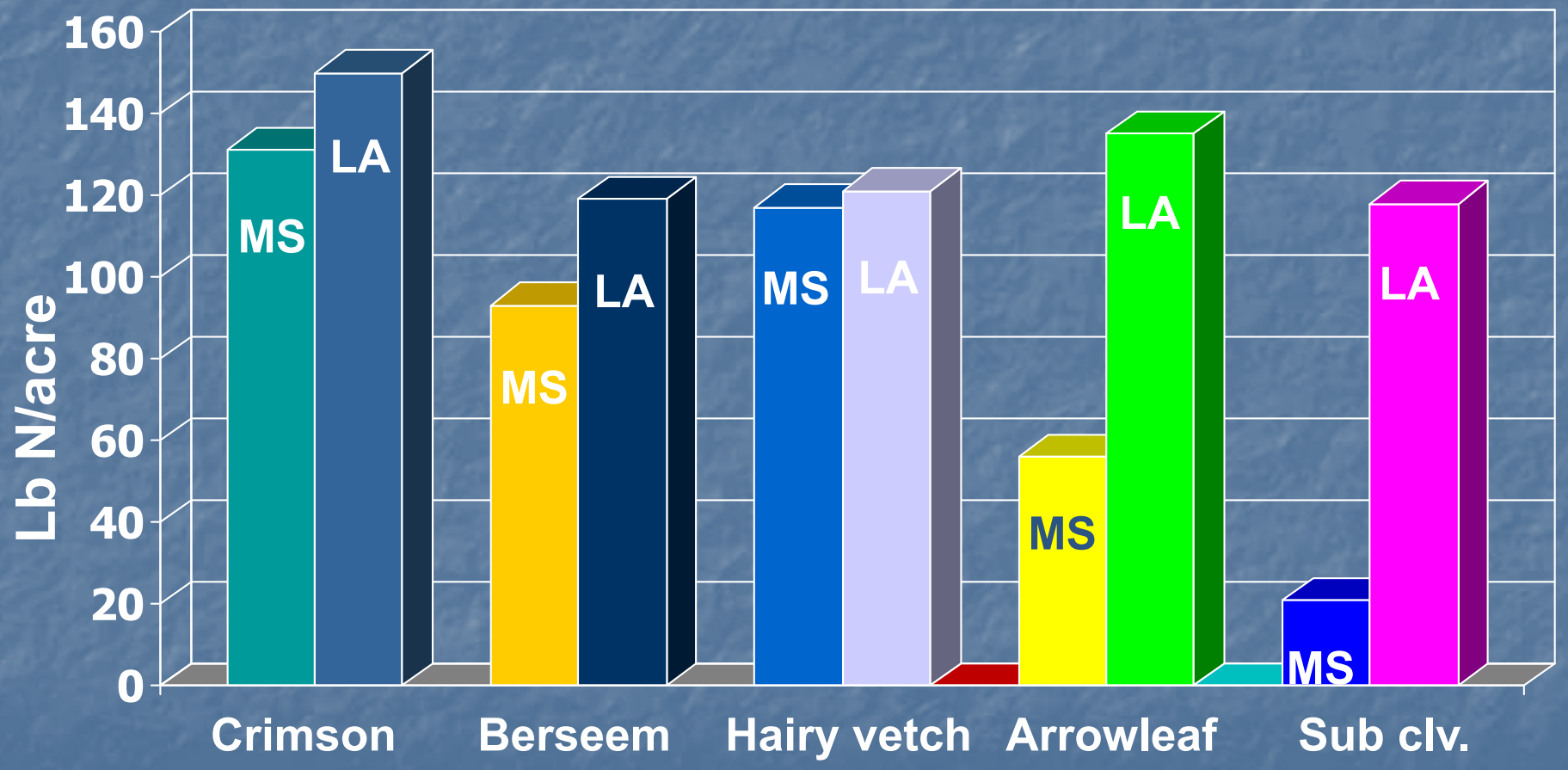
Data from Seth Dabney, formerly LSU AgCenter, now USDA

Above ground biomass yield and N content of legume cover crops in Mississippi, 4 yr. avg.

	Biomass	N content
	------- lb/ac -------	
Hairy vetch	4130	117
Crimson clv. 'Chief'	6060	131
Bigflower vetch	3480	88
Austrian winter pea	3050	81
Berseem clv. 'Bigbee'	4820	93
Arrowleaf clv. 'Amclo'	2980	56
Subterranean clv. 'Mt. Barker'	1230	21

Data from Jac Varco, Mississippi State

Nitrogen content of legume crops in Louisiana and Mississippi research



Data from Jac Varco, Mississippi State and Seth Dabey, USDA

Above ground biomass yield and N content of legume cover crops in Alabama, 2 yr. avg.

	Biomass	N content
	------- lb/ac -------	
Hairy vetch	3440	133
Crimson clv. 'Tibbee'	3900	91
Common vetch 'Cahaba white'	3480	105
Common vetch 'AU Early Cover'	3050	139

Data from Charles Mitchell, Auburn

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Winter survival of legume cover crops in Louisiana across 5 years

	Total trials	No. lost
Hairy vetch	17	0
Crimson clv. 'Tibbee'	17	0
Bigflower vetch	13	0
Austrian winter pea	13	0
Berseem clv.	13	0
Rough (Caley) pea	13	0
Subterranean clv.	17	0

Data from Seth Dabney, formerly LSU AgCenter, now USDA

Winter survival of legume cover crops in Louisiana across 5 years

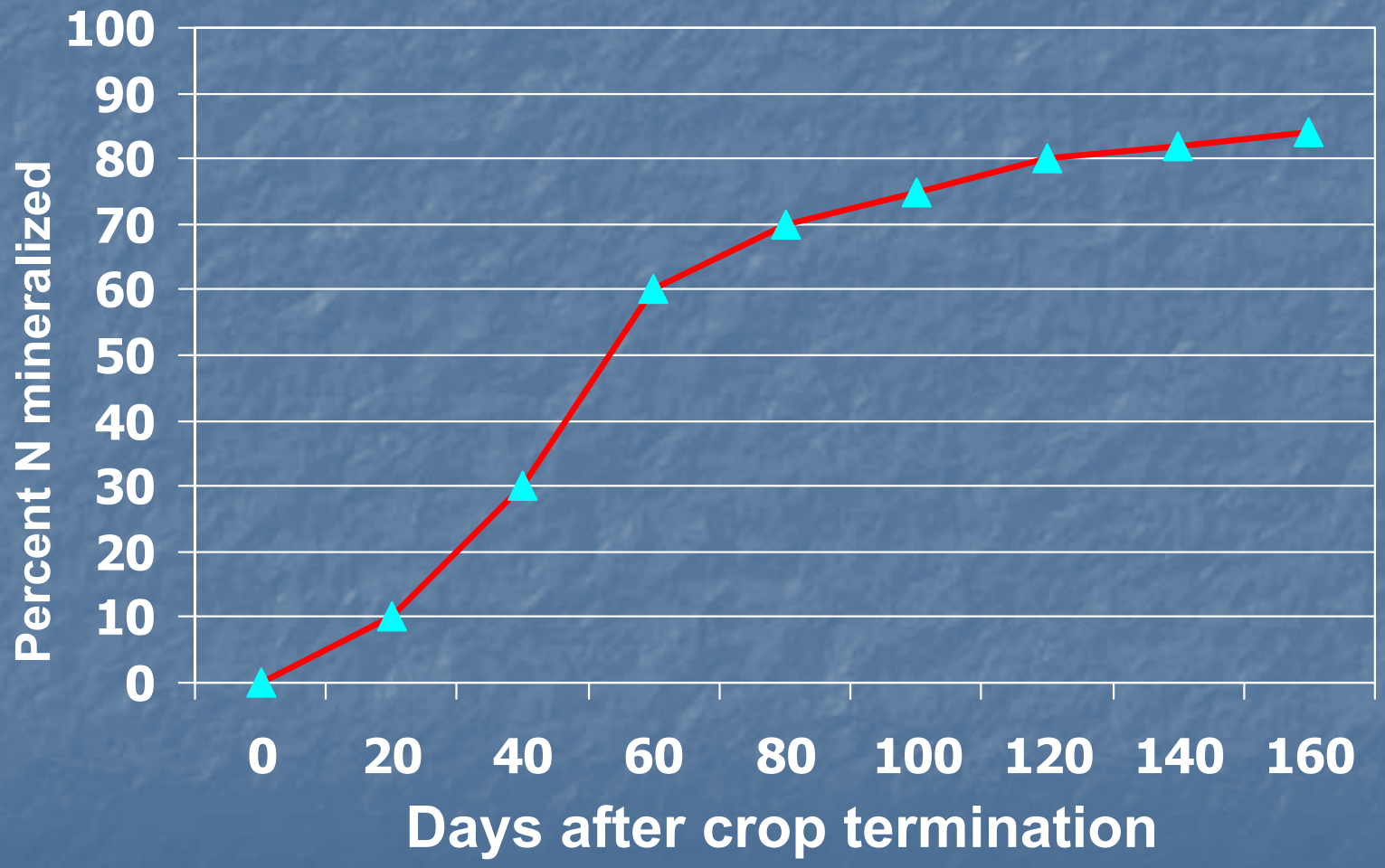
	Total trials	No. lost
Arrowleaf clv. 'Amclo'	14	2
Ball clv. 'Segrest'	9	5
Barrel medic 'Paraggio'	5	3
Common vetch	10	1
' Cahaba White'		
Lupin 'Tifblue 78'	9	7
Sour clv.	8	6
Bur clv. 'Serena'	5	2
Red clv. 'Chesapeak'	*9*	*4*

Data from Seth Dabney, formerly LSU AgCenter, now USDA

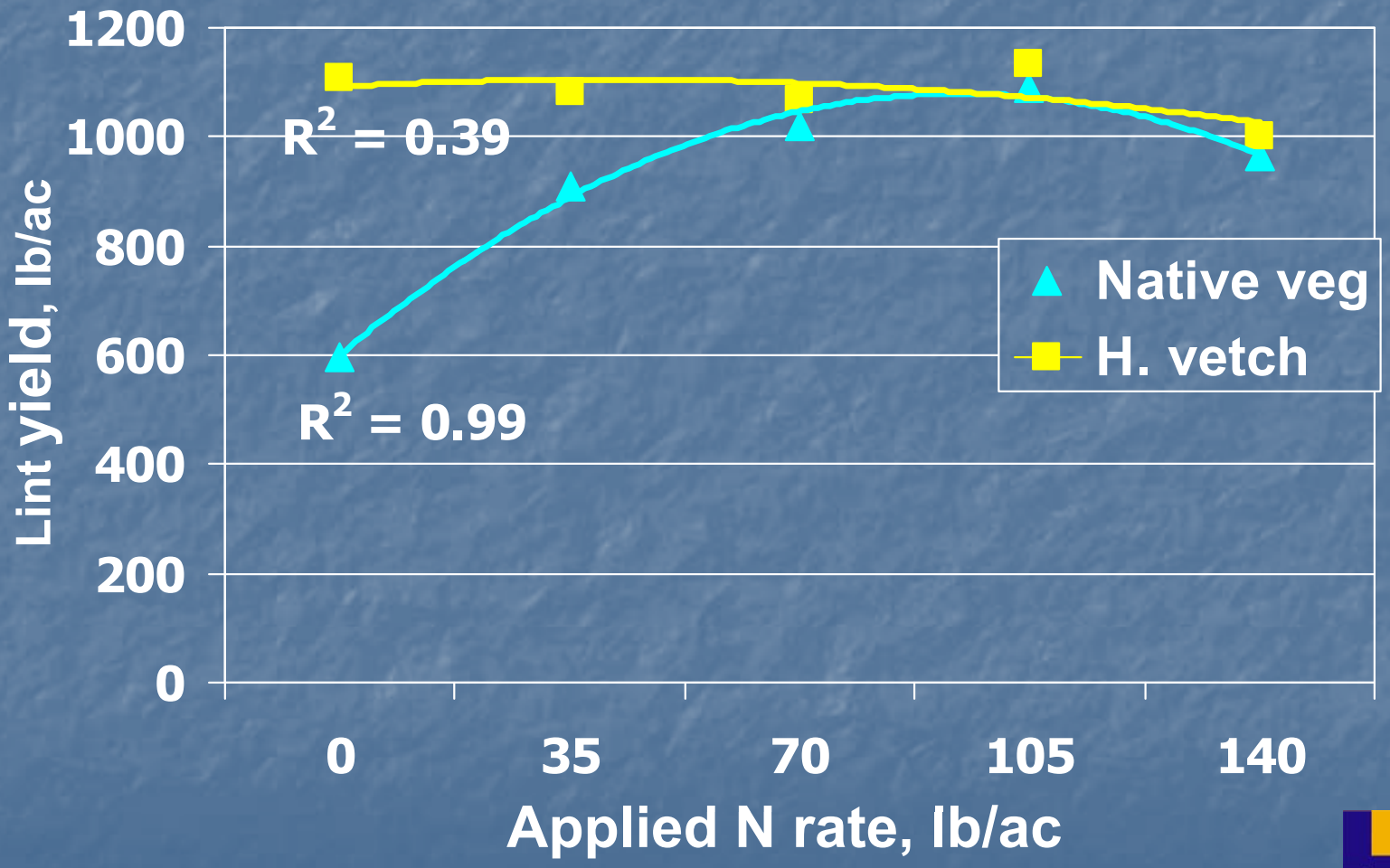
3. Yield responses following legume cover crops?

Are responses related to: N, crop residue, other nutrients, other factors?

Nitrogen release curve for legume residue



Cotton lint yield response to N rate and cover crop on silt loam, 5 yr. avg.



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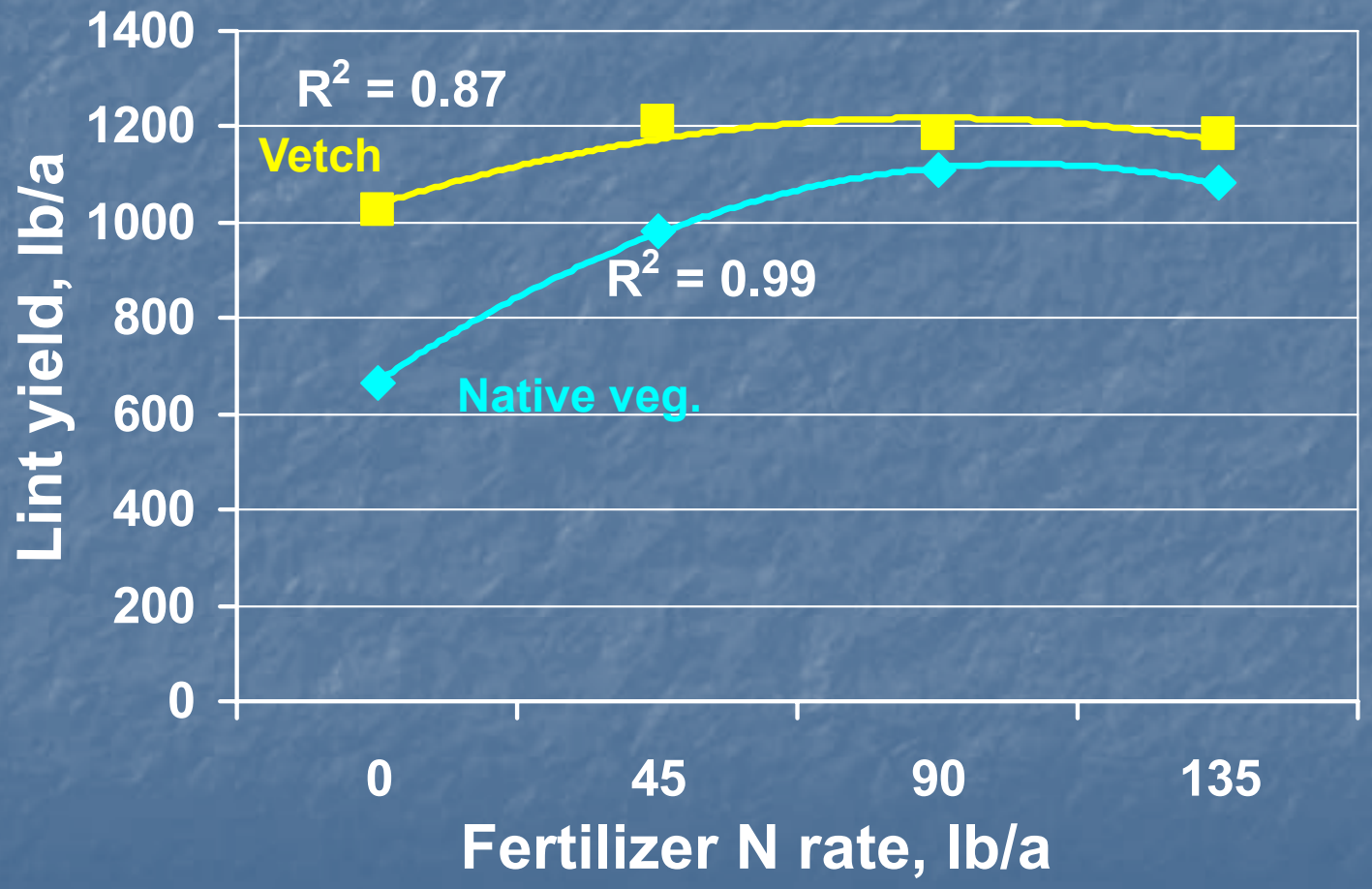
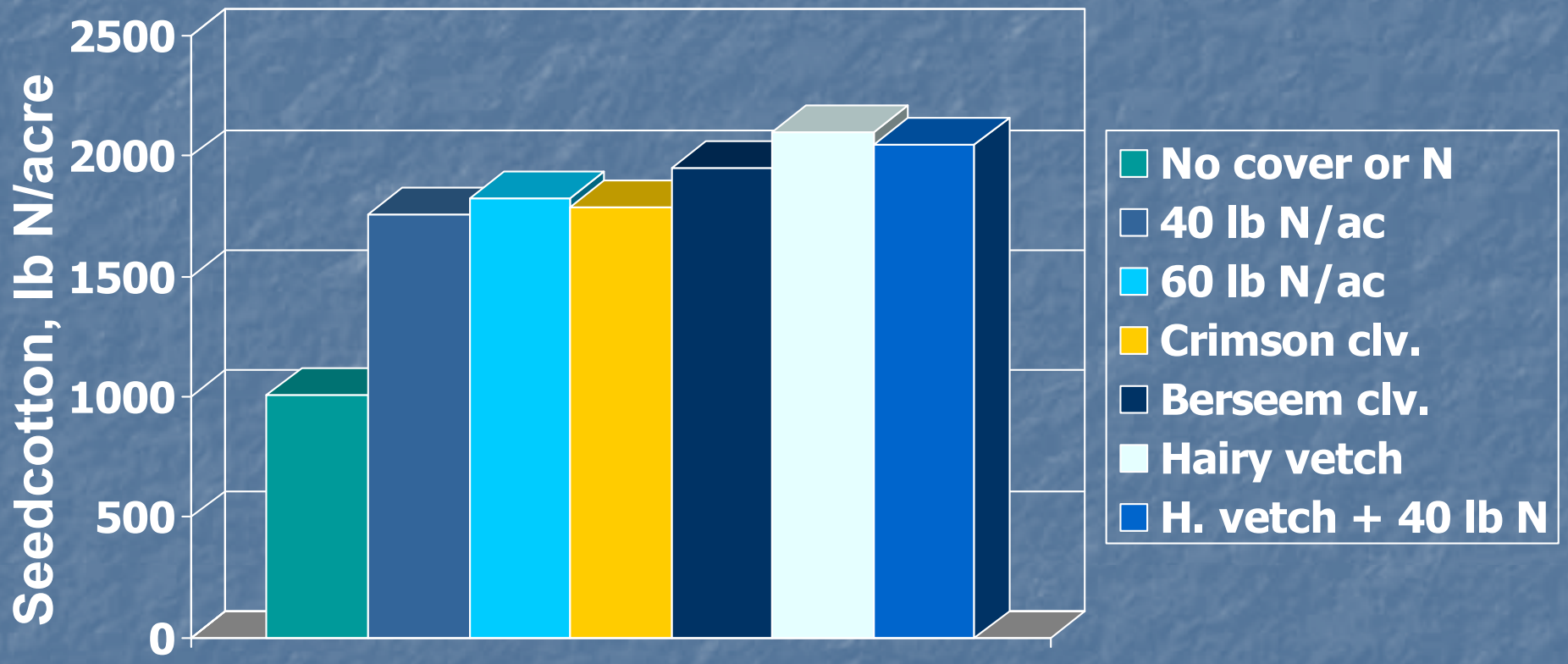
Cotton lint yield response to N rate and cover crop on Sharkey clay, 2-yr avg.



Cotton yield following legume crops, LSU AgCenter Red River Research Station, 50 year avg., 1955-2008.



Data from Eddie Millhollon, LSU AgCenter

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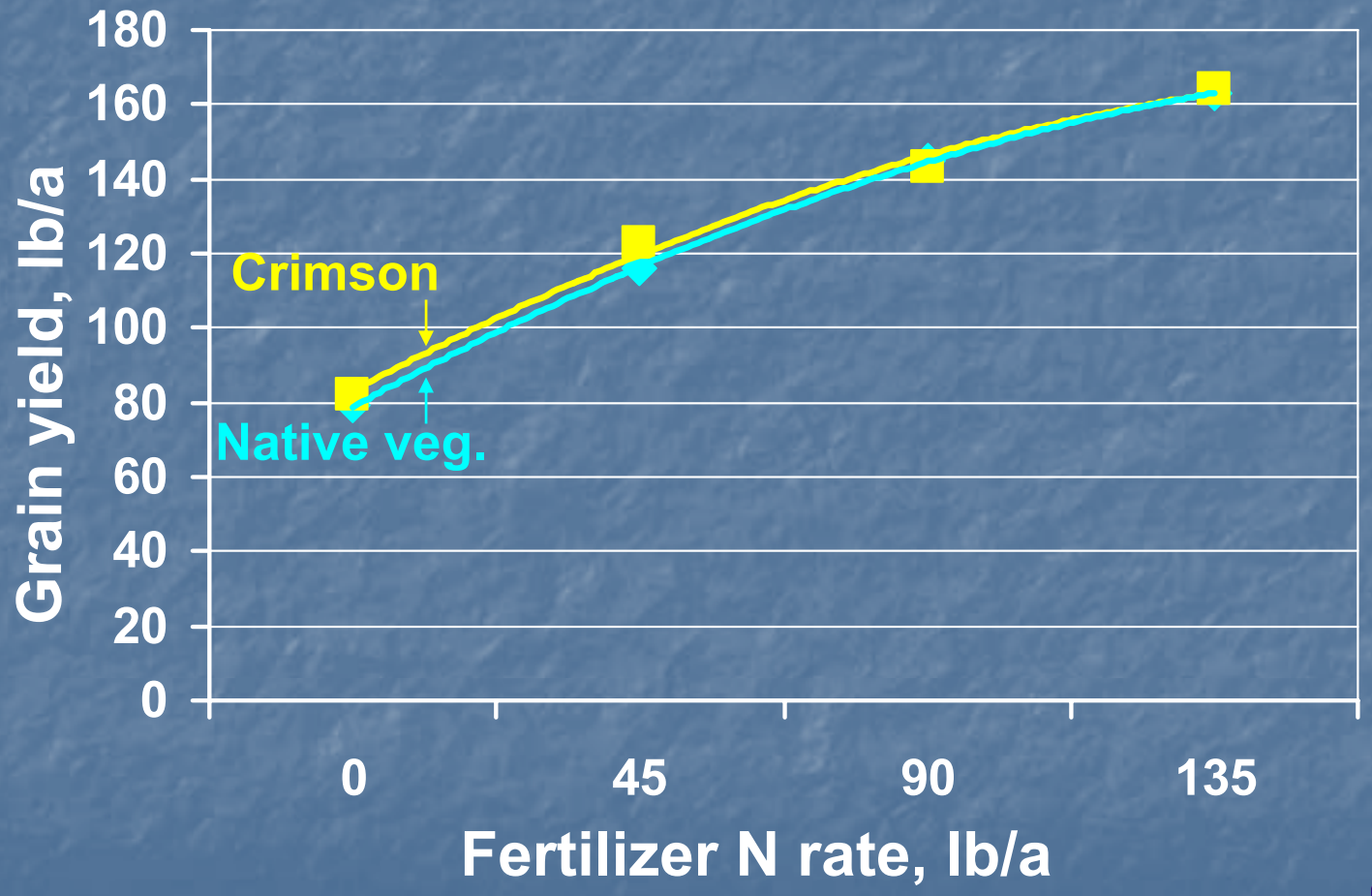
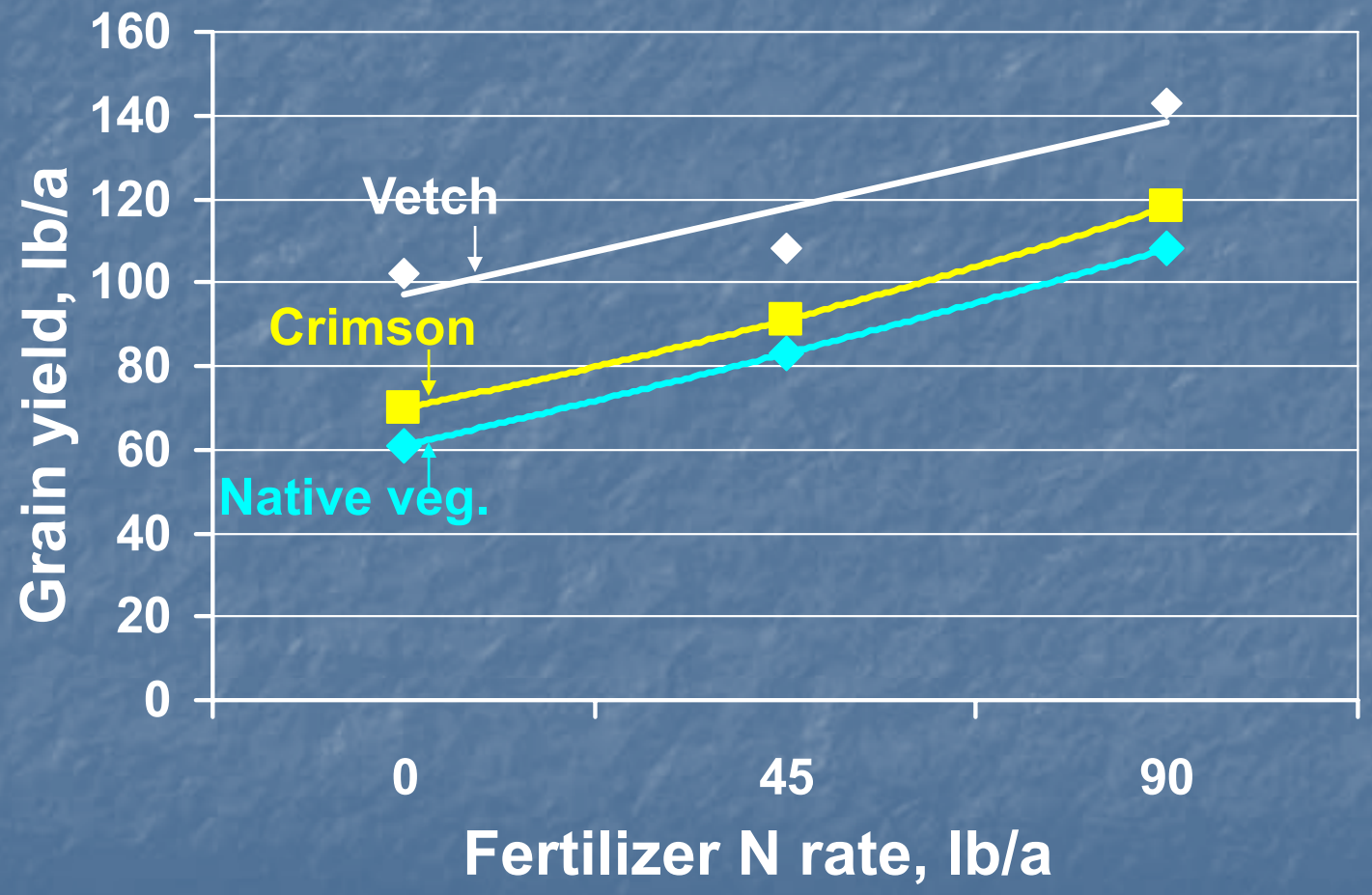
Corn grain yield response to N rate and cover crop on Sharkey clay in Louisiana, 3-yr avg.



Data from H.J. Mascagni, LSU AgCenter

Corn grain yield response to N rate and cover crop on Sharkey clay in Kentucky, 5-yr avg.



Data from S.J. Ebelhar, Univ. of Kentucky

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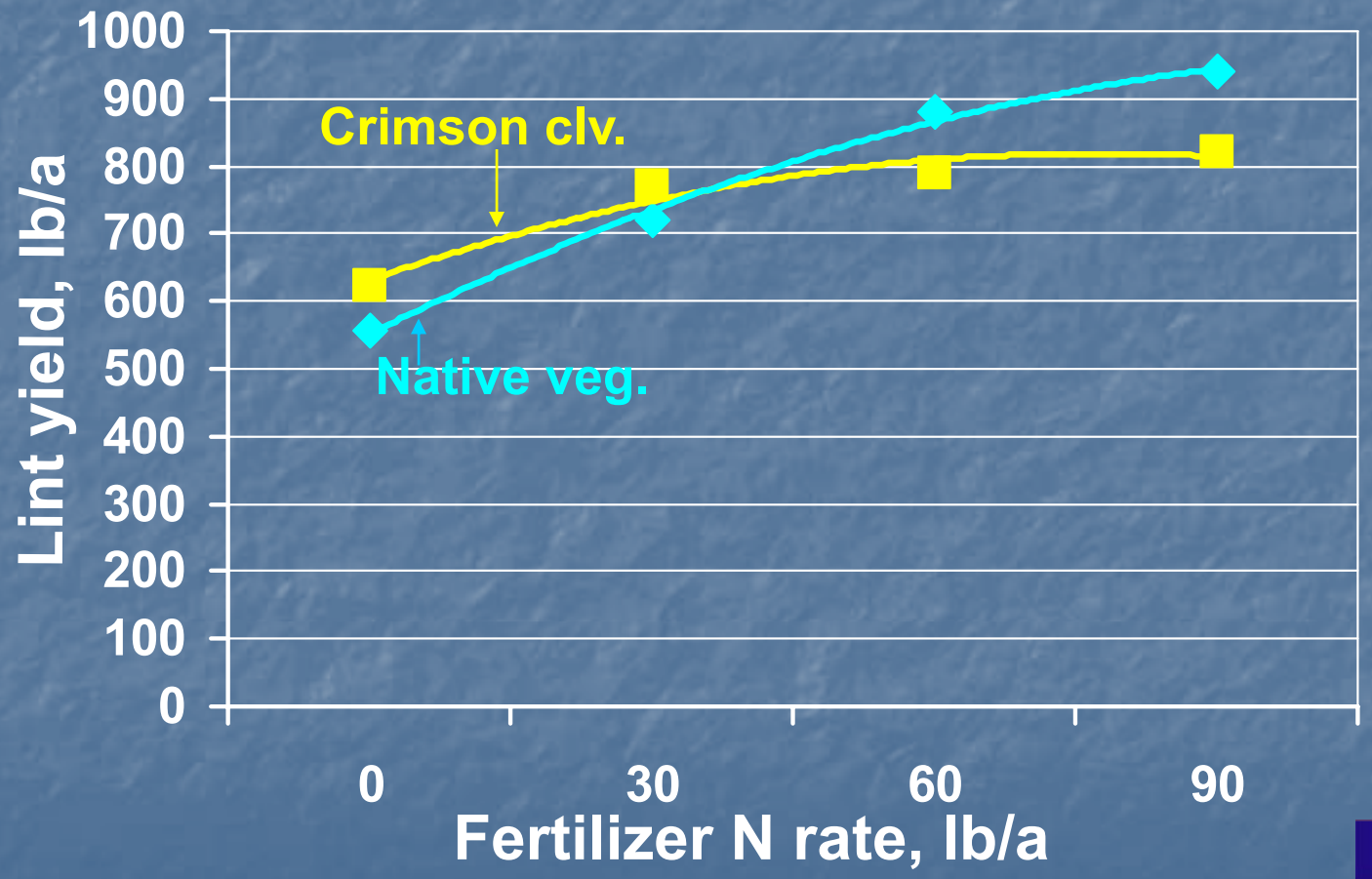
Cotton lint yield response to N rate and cover crop on Tiptonville sandy loam, in Missouri, 4-yr avg.



From Gene Stevens, Univ. of MO

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Cotton lint yield (rainfed) response to tillage and cover crop in Alabama, "Old Rotation" 10-year avg.

Cover crop	Lint yield	Corn yield
None	390c	-------
Crimson clv.	1060b	-------
120 lb N/ac	1170b	-------

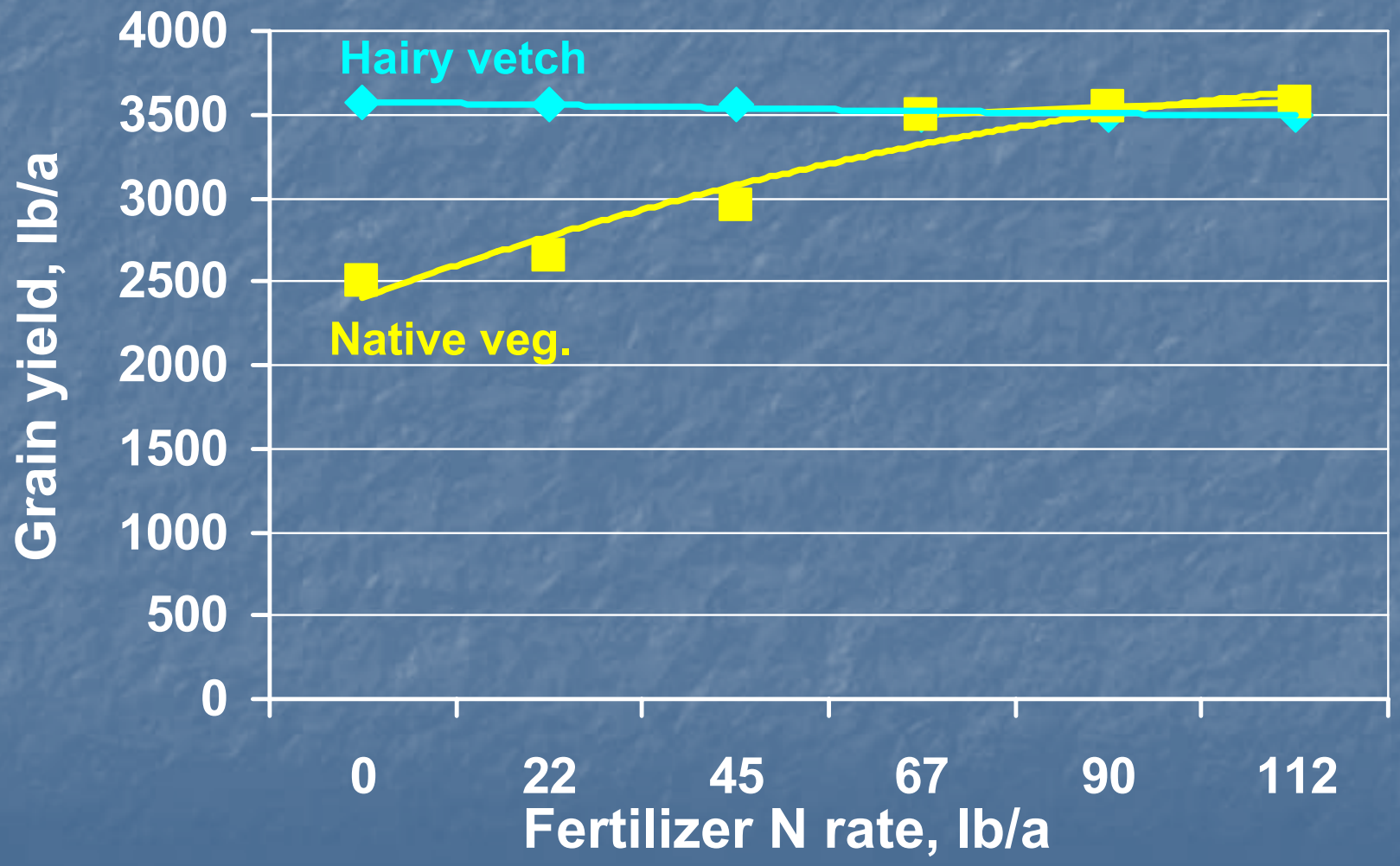
Data from Charles Mitchell, Auburn

Cotton lint yields following legume cover crops in Alabama.

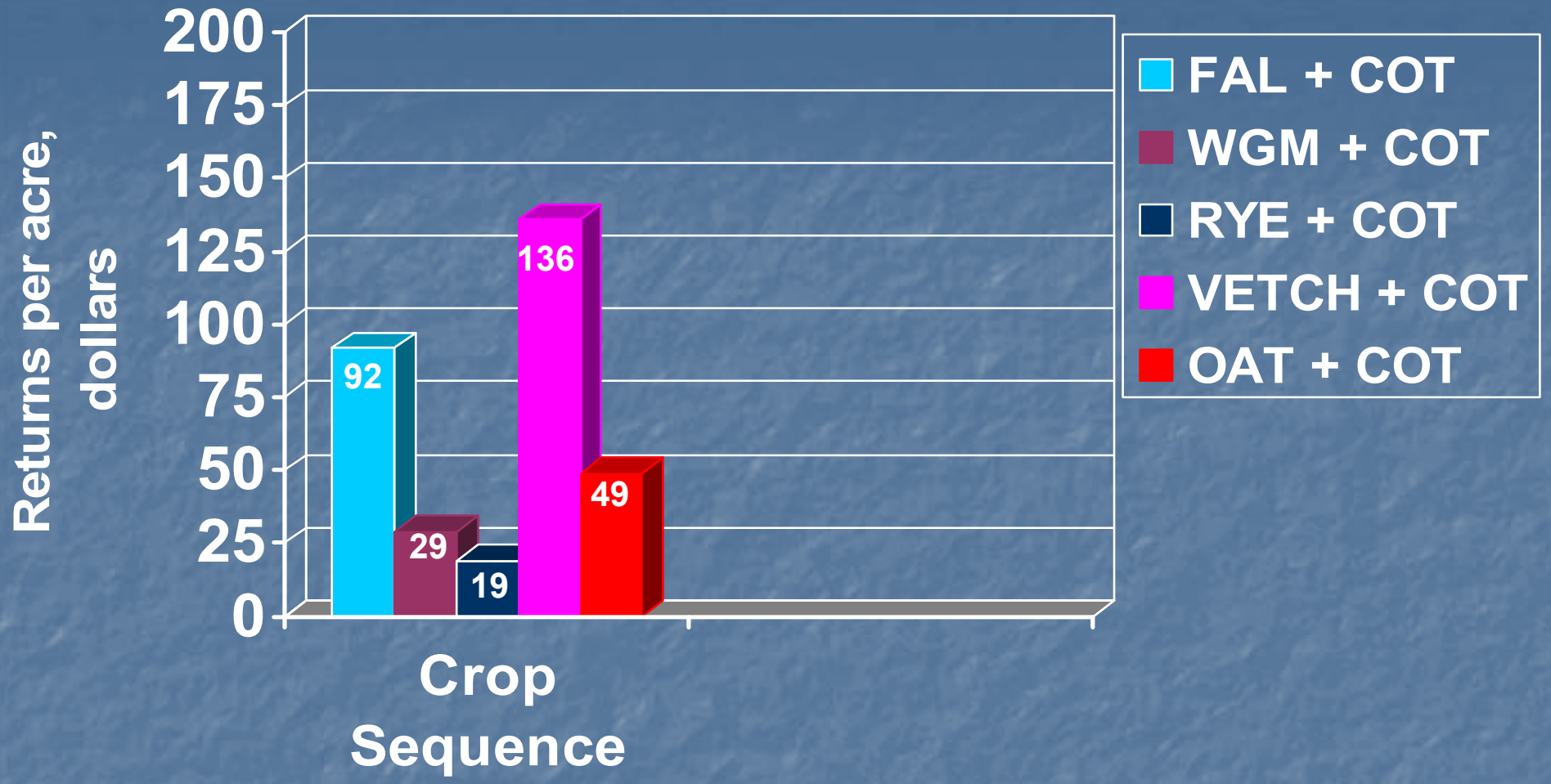
Legume crop	Lint yield
	-- lb/acre --
Hairy vetch	1290
Crimson clv. ‘Tibbee’	1430
100 lb N/ac	1450
No fertilizer N	760

Data from Charles Mitchell, Auburn

Grain sorghum grain yield response to N rate and cover crop on sandy loam in Georgia, 3-yr avg.



Data from W.L. Hargrove, Univ. of Georgia



Annual net returns for winter cover crop and cotton cropping sequences in a BMP study – 2007-2008. *(FAL, winter fallow; WGM, wheat green manure; COT, cotton)*

Economic analysis by Dr. Kenneth Paxton

Wrap up - and general comments

Advantages for hairy vetch as green manure cover crop

- Total Biomass not excessive, but high in N. Residue does not interfere with planting
- N release from residue up to 80% within four months, fastest of all legumes.
- Terminates fairly easily with correct herbicides.
- Most consistent among tested legumes in N supplied. Very cold tolerant.

Disadvantages for hairy vetch as green manure cover crop

- Slow to establish ground cover.
- Susceptible to nematodes when soil temperature above 70 degrees.
- Needs those last two weeks of spring growth for maximum N fixation, so there may be a conflict with planting the summer crop.

Advantages for crimson clover as green manure cover crop

- Rapid and complete winter ground cover. (Total biomass can actually be excessive.)
- Terminates fairly easily with correct herbicides.
- Consistent among tested legumes in N supplied. Very cold tolerant.

Disadvantages for crimson clover as green manure cover crop

- Needs to be planted in September for best results. Conflicts with harvest.
- N release is slower than vetch.
- Yield responses of cotton and corn have not been consistent.

Advantages for winter peas as green manure cover crop

- Good early growth.
- Terminates easily with correct herbicides.
- Very cold tolerant.
- Caly pea (Roughpea) better than Austrian for N fixation.

Disadvantages for winter peas as green manure cover crop

- Ground cover usually not extensive.
- Susceptible to nematodes when soil temperature above 70 degrees.
- Has not consistently produced large amounts of N.

Status of lupin(e)s as green manure cover crop

- Excellent potential for biomass and N fixation but needs genetic improvement.
- Very tolerant to low soil pH.
- Not as cold tolerant as vetch or clovers.
- Very Susceptible to nematodes and root rots.

Cultural practices for legumes

- Plant early to establish stand before cold weather. Sept. for clovers. Oct. for vetch and peas.
- Plant on raised beds for drainage.
- Drilling is best but clovers can be broadcast (after cotton defoliate is applied).
- Inoculate with correct inoculants. Each legume has their own special strains of inoculants.

Cultural practices for legumes

- Plan termination for as late as possible to allow for growth and N fixation in late winter/early spring (especially important with vetches). Two weeks delay will double the biomass and increase N content by 40%.

- Tillage not necessary but will increase N release rate. Benefits of no-till should be considered.

Future for for legumes

- **Use will increase at some point depending mostly on prices for fertilizer N.**
- **Will likely be great funding opportunities for research to improve varieties that are earlier and more effective.**
- **Opportunity for placing a ceiling on fertilizer N prices. Legume N can be produced for less when fertilizer N prices are high.**

Alternatives to winter legumes

- Summer or tropical legumes planted in August after corn or grain sorghum harvest.
- Sun Hemp or soybean -- These have a high N fixation capacity compared with winter legumes.

Crimson clover in Missouri in early May

Hairy vetch in early April in Louisiana