Integrated Crop – Livestock Systems in Humid–Subtropical and Warm–Temperate Environments

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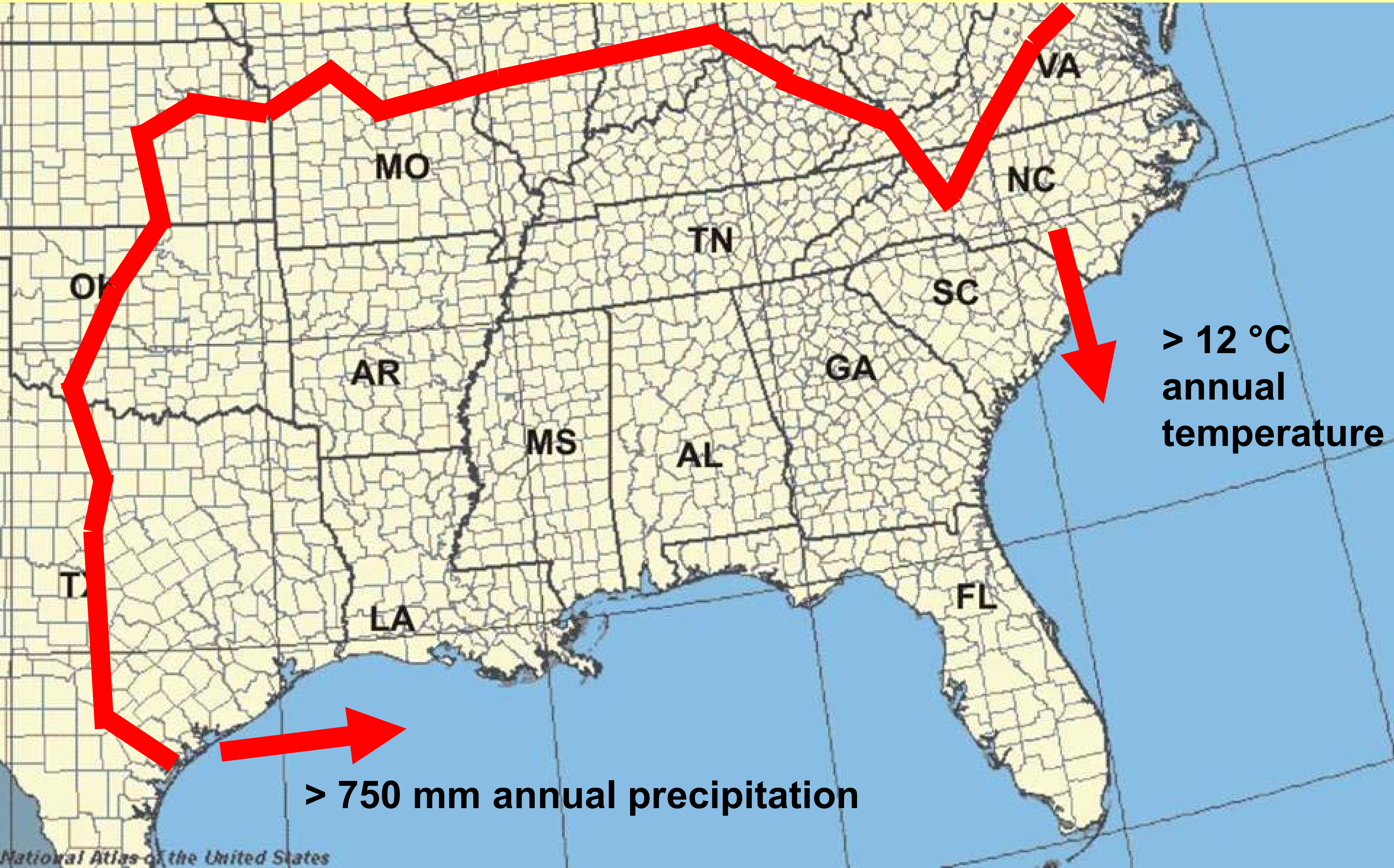
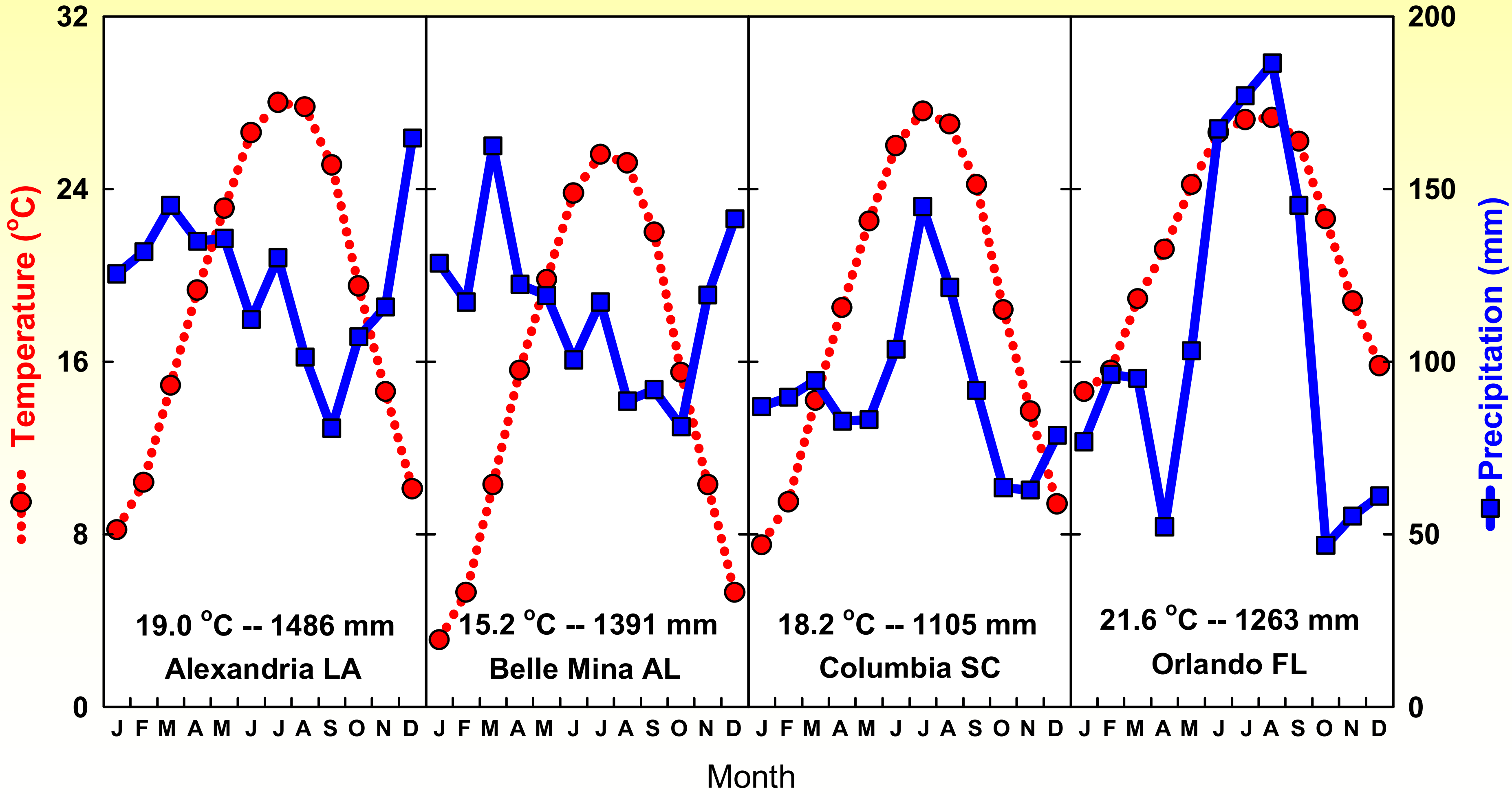
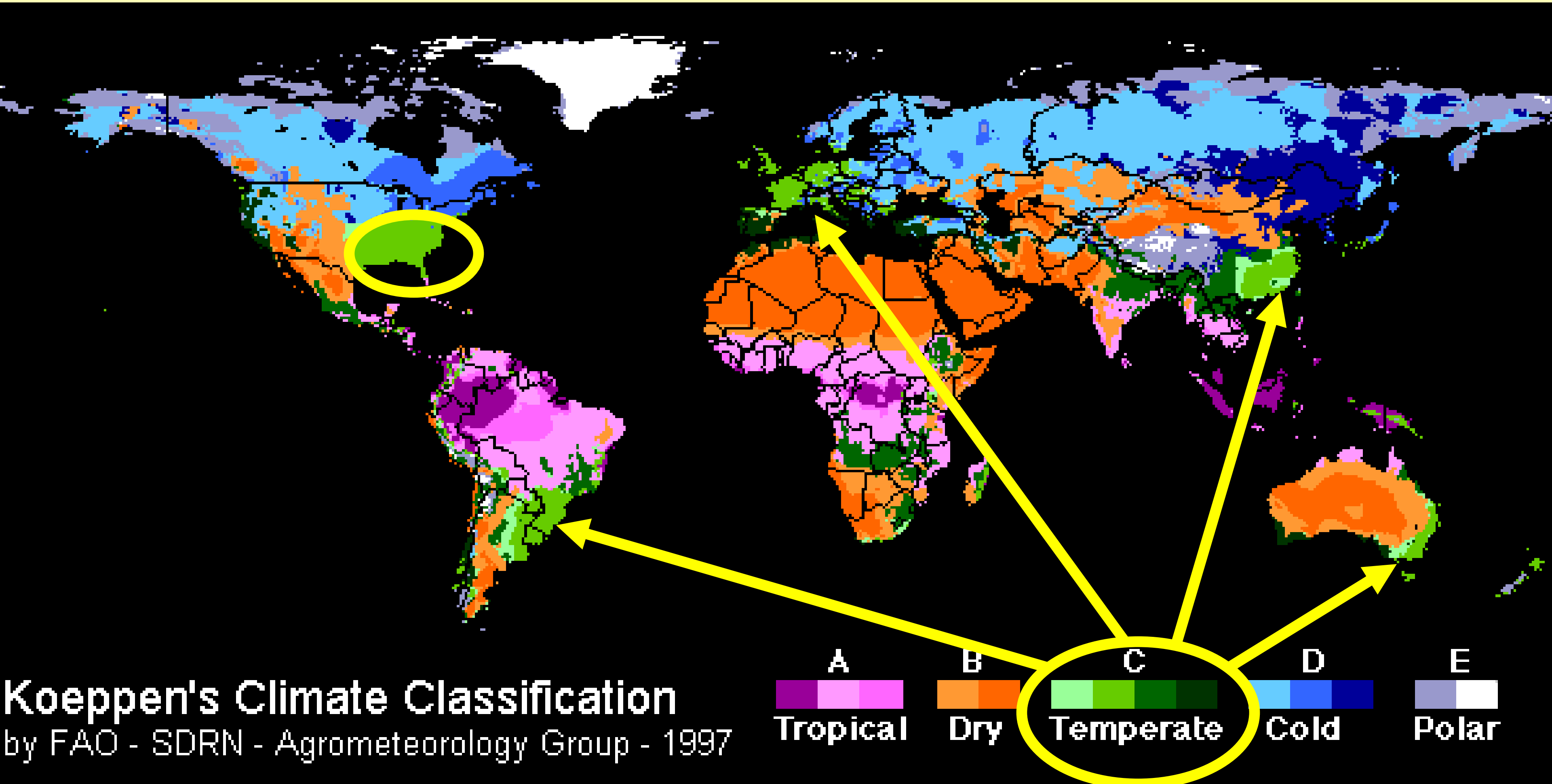
Warm and Humid Region in the USA



Climatic Characteristics in the Southeastern USA



Similar Climatic Zones Around the World



Sustainable Agricultural Systems

1. **Specialization,** based on considerations of:
   - Climate
   - Socioeconomics
   - Infrastructure
   - Markets

Specialized agricultural system

Chicago Board of Trade

Leading to a focus typically on the most profitable system possible without high regard to other factors

Or most traditional system that fits climate/infrastructure domain of region without high regard to other factors

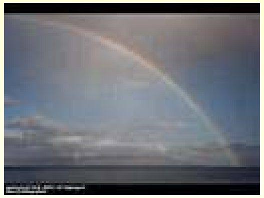
Sustainable Agricultural Systems

2. <u>Integration</u>, **based on considerations of:**
   - **Climate**
   - **Socioeconomics**
   - **Infrastructure**
   - **Markets**
   - **Natural capital**
   - **Environmental impacts**

Integrated agricultural system





Leading to diverse agricultural enterprises to balance production and economic gains with minimal negative influence on the environment.

Typically, systems that rely on natural capital rather than purchased capital to maximize resource efficiency.

Agriculture in the Southeastern USA

The 11-state region has the following characteristics compared with totals for the USA:

- **15% of the total land area**
- **26% of farms**
- **12% of farmland**
- **38% of woodland on farms**
- **14% of cropland**
- **4% of pasture or rangeland**

- **75% of broiler chicken inventory**
- **26% of layer chicken inventory**
- **21% of hog inventory**
- **16% of cattle inventory**
- **3% of sheep inventory**

- **68% of peanut** (2.7 Mg ha^{-1})
- **49% of cotton** (0.7 Mg ha^{-1})
- **15% of cut forage** (4.9 Mg ha^{-1})
- **11% of wheat** (4.2 Mg ha^{-1})
- **11% of soybean** (2.0 Mg ha^{-1})
- **5% of corn** (6.3 Mg ha^{-1})

Data from Census of Agric. (2002) Nat. Agric. Stat. Serv., USDA
(SE region included AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA)

Why Integrate Two Dominantly Conventional Systems?

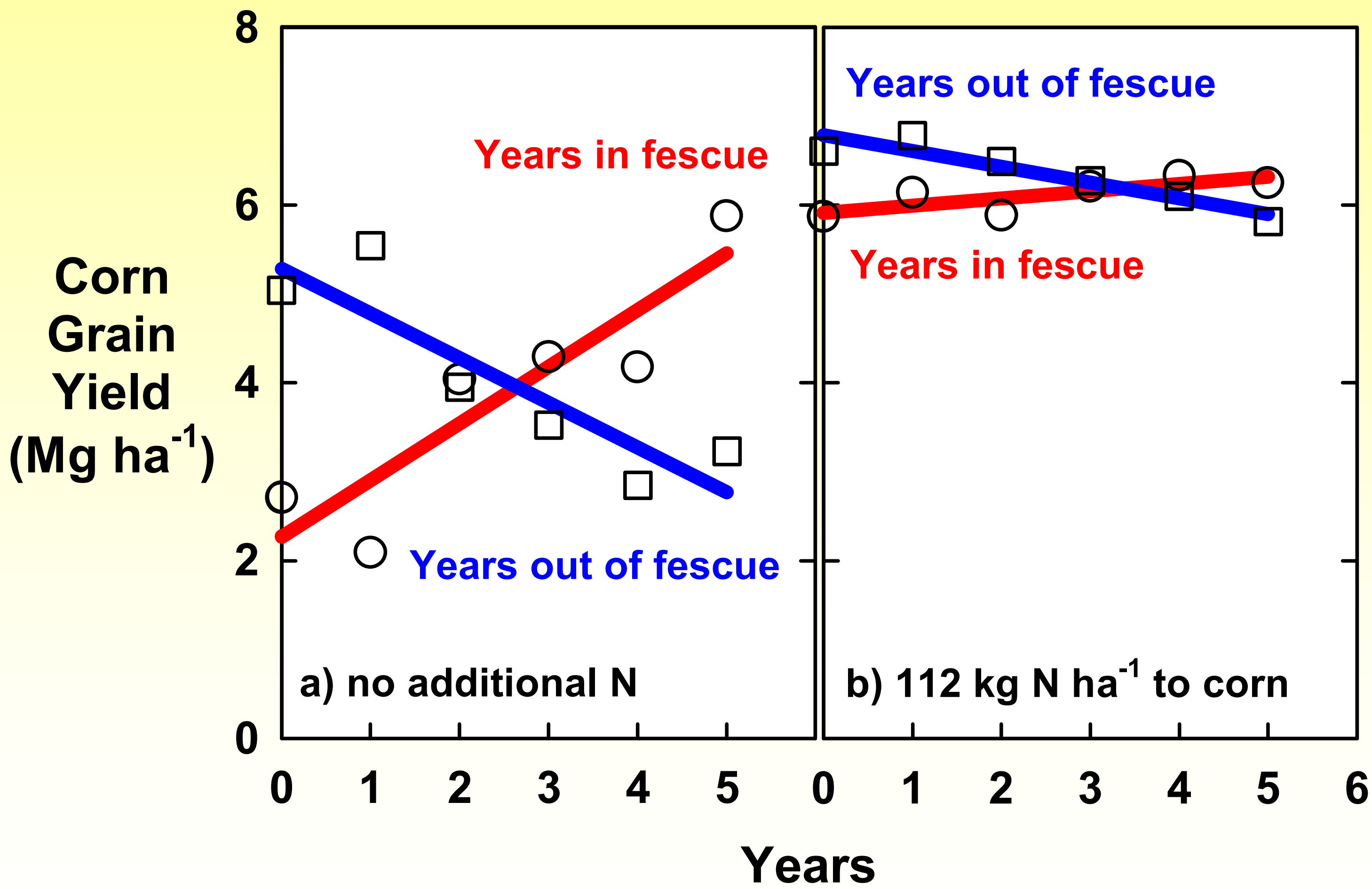
Production

- ✓ Farms operating on marginal profit
- ✓ Economic vulnerability with specialized production
- ✓ High cost of fuel and nutrients
- ✓ Pests become greater with monocultures
- ✓ Yield decline could be overcome with rotation

Environment

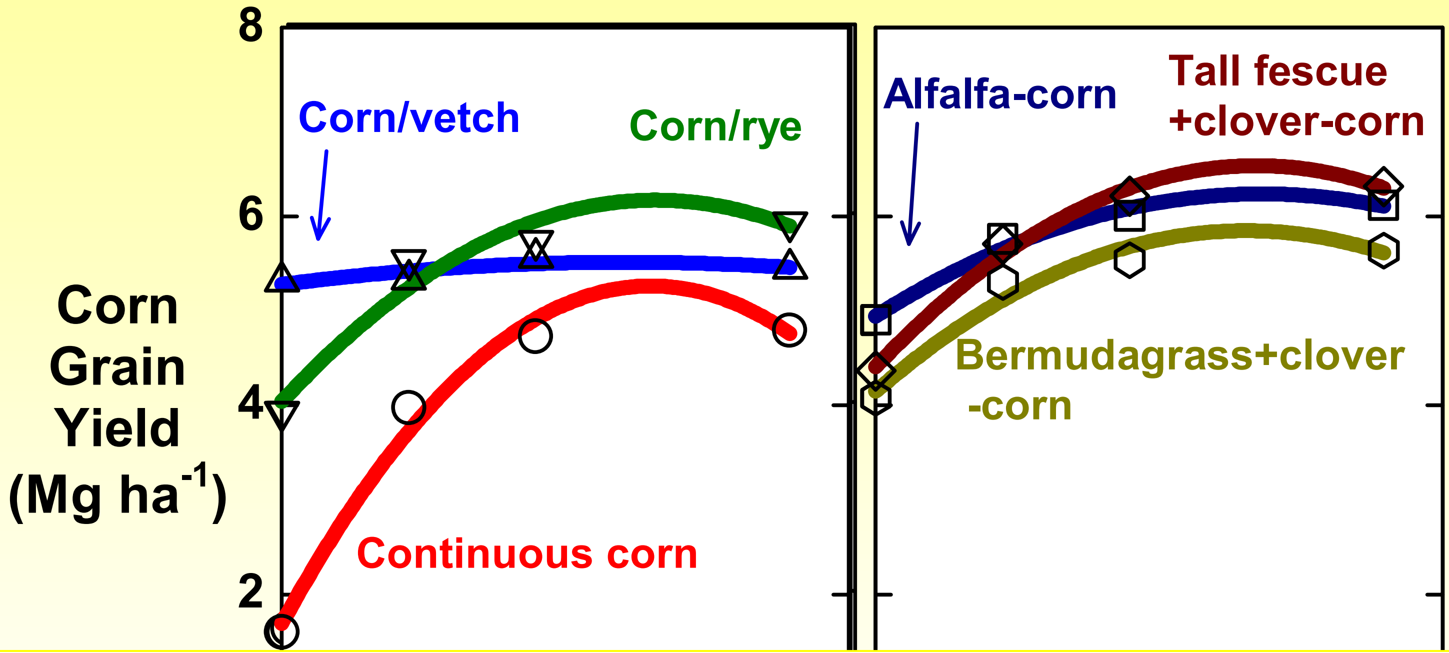
- ✓ Nutrient recycling could be improved in both systems
- ✓ Conservation of soil and water possible with sod-based management systems

Rotational Effect of Pasture on Nitrogen Requirement of Corn



Data from Giddens et al. (1971) Agron. J. 63: 451-454.

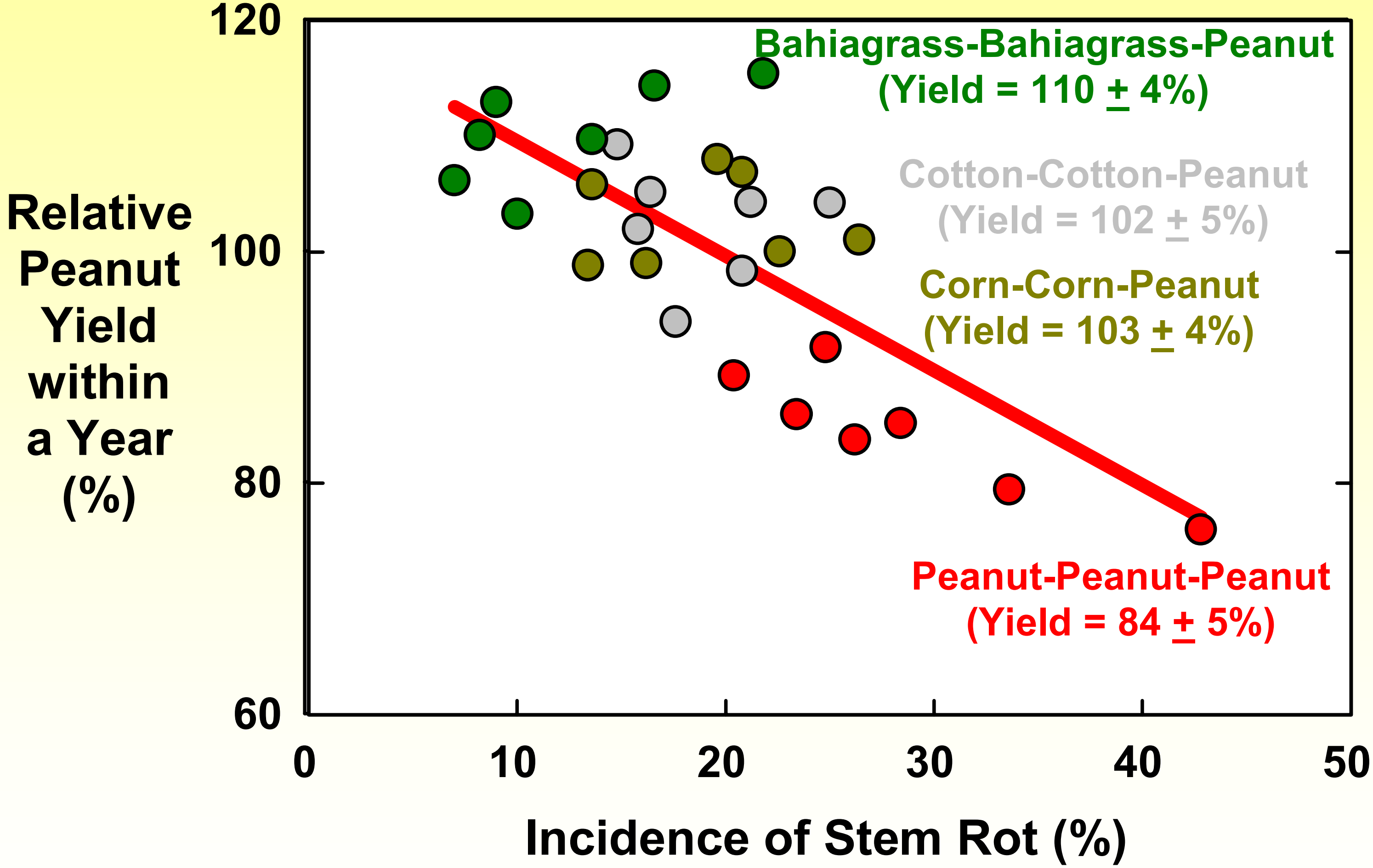
Rotational Effect of Pasture on Corn Production



Compared with continuous corn	Rye	Vetch	Alfalfa	Bermuda	Fescue
Nitrogen savings (kg ha^{-1})	7	120	17	13	7
Rotation effect (% yield increase)	17	1	17	10	23

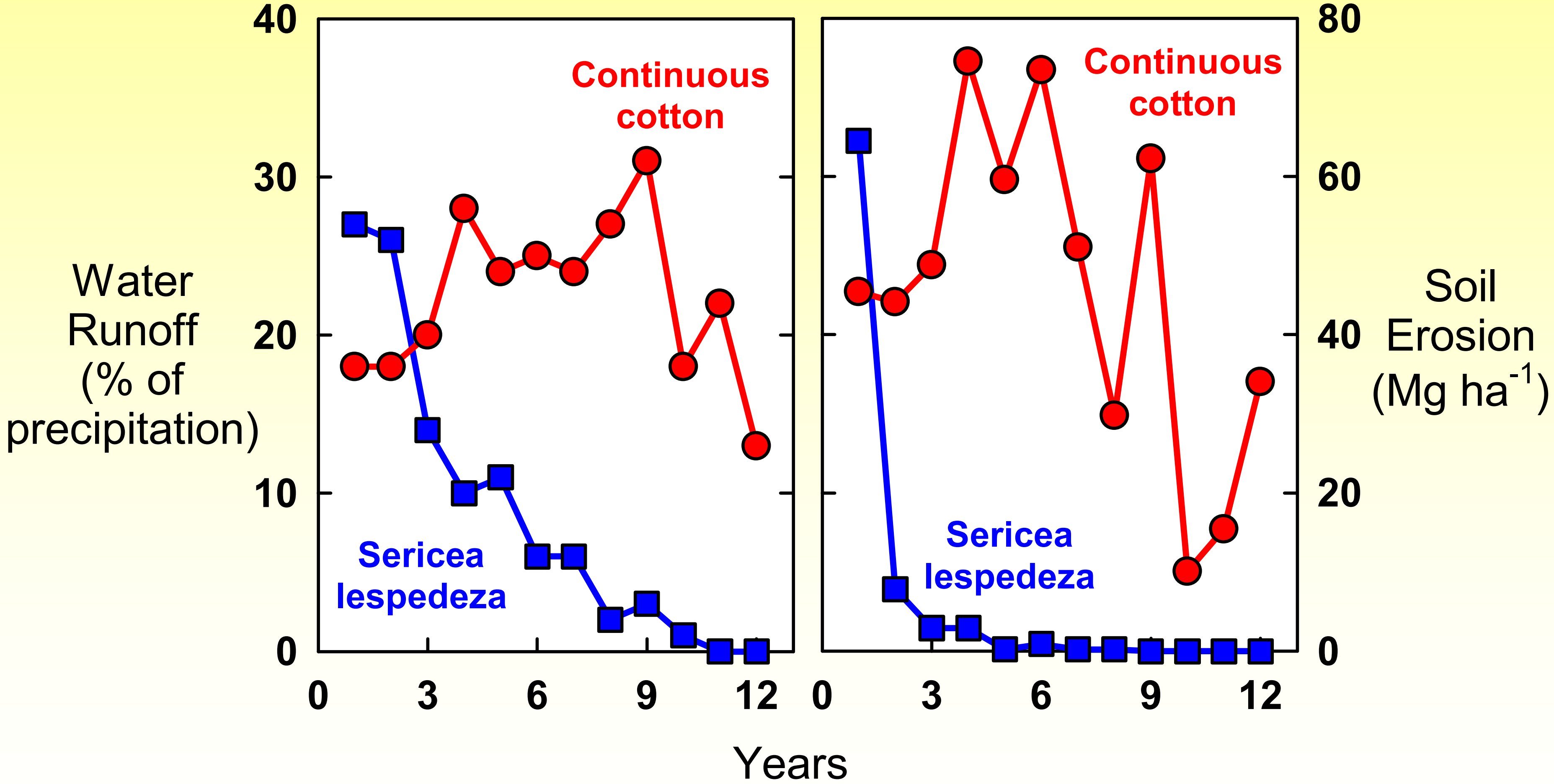
Data from Adams et al. (1970) Agron. J. 62: 655-659.

Rotational Effect of Pasture on Disease Incidence



From Brenneman et al. (2003) Proc. Sod-Based Crop. Syst. Conf., Quincy FL, p. 59-65.

Rotational Effect of Pasture on Soil Erosion and Water Runoff



Data from Barnett (1965) J. Soil Water Conserv. 20: 212-215.

Scenarios Being Investigated

1. Multi-state project to sustain peanut and cotton yields by incorporating cattle into a sod-based rotation

Year 1	Year 2	Year 3	Year 4
			
Bahiagrass hay	Grazed bahiagrass	Peanut	Cotton

Sod Rotation

USDA UNITED STATES DEPARTMENT OF AGRICULTURE

College of Agriculture AUBURN UNIVERSITY

UNIVERSITY OF FLORIDA Institute of Food and Agricultural Sciences

The University of Georgia

Scenario

1. Multi-state project to sustain peanut and cotton yields by incorporating cattle into a sod-based rotation

Years Following Bahiagrass	Peanut Yield (kg ha^{-1})	Yield Increase (%)
>4 – (P-P-P-P)	3450	--
3 – (B-P-P-P)	3405	-1
2 – (B-B-P-P)	4054	18
1 – (B-B-B-P)	5096	48

Study conducted in Georgia by John Baldwin
B, Bahiagrass
P, Peanut

From Wright et al. (2003) Proc. Sod-Based Crop. Syst. Conf., Quincy FL, p. 34-45.

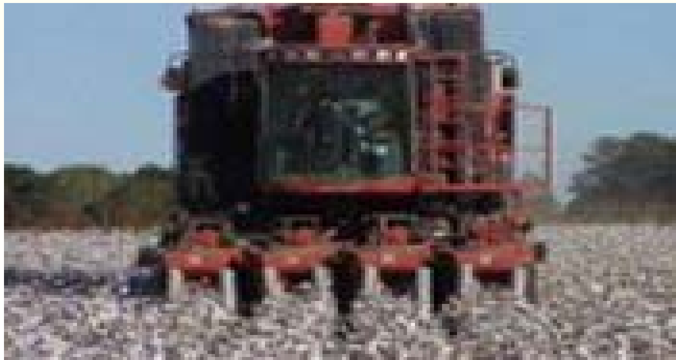
Scenario

1. Multi-state project to sustain peanut and cotton yields by incorporating cattle into a sod-based rotation

Crop Rotation	Total Cotton Biomass (kg ha^{-1})	Nitrogen Concentration (g kg^{-1})	Nitrogen Uptake (kg ha^{-1})
B-B-P-C	13.0	17.6	226
C-P-C-C	8.4	17.3	144
LSD $_{(p=0.05)}$	2.3	NS	41

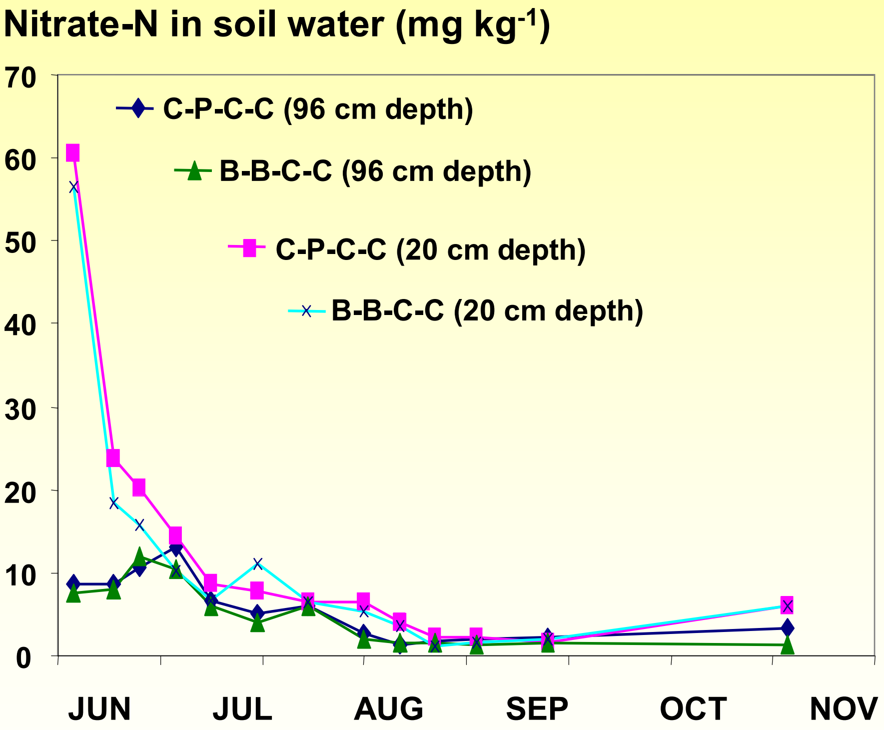
B, Bahia
P, Peanut
C, Cotton

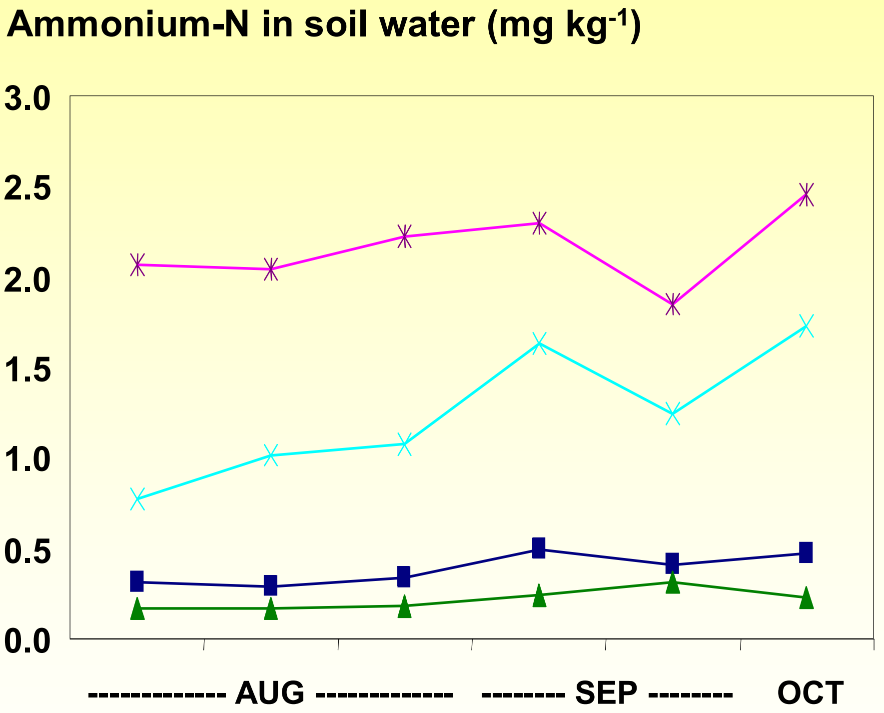
Data from Quincy FL in 2003 (D.L. Wright)



Scenario

1. Multi-state project to sustain peanut and cotton yields by incorporating cattle into a sod-based rotation





Soil water sampling at Quincy FL in 2003

No major change in soil nutrients between rotation sequences

Scenarios Being Investigated

2. Stocker cattle on winter cover crop in the Coastal Plain

Cotton–peanut rotation with or without grazing of rye cover crop at Sunbelt Ag Expo in Moultrie GA

Cotton–peanut rotation with grazing of rye cover crop at Headland AL

Scenario

2. Stocker cattle on winter cover crop – Moultrie GA

Cotton-peanut rotation initiated in 2001
Treatments:

- Tillage – conventional
  — conservation
- Cover crop – unharvested
  —grazed by stockers

Yield component	Ungrazed	Grazed
Cotton lint (kg ha^{-1})	1178	1260
Peanut (kg ha^{-1})	4144	4200
Cattle gain (kg ha^{-1})	--	167
Value of gain ($ ha^{-1})	--	304

------- Tillage -------	
Conv.	Conserv.
1152	1280
3954	4370

From Hill et al. (2004) UGA/CPES Res./Ext. Pub. No. 6, p. 40-45.

Scenario

2. Stocker cattle on winter cover crop – Moultrie GA

Soil property	Ungrazed		Grazed
Bulk density (Mg m^{-3})			
Under conventional tillage	1.71		1.71
Under conservation tillage	1.72		1.75
Hydraulic conductivity (cm h^{-1})			
Under conventional tillage	4.4	>	3.4
Under conservation tillage	2.4	<	3.0

From Hill et al. (2004) UGA/CPES Res./Ext. Pub. No. 6, p. 40-45.

Scenario

2. Stocker cattle on winter cover crop – Headland AL

Potential surface soil compaction by cattle grazing winter cover crops can be successfully alleviated with non-inversion deep tillage combined with conservation planting of cotton or peanut:

System	Cotton Yield ($Mg\ ha^{-1}$)	------- Peanut ------- Yield ($Mg\ ha^{-1}$)	Net Return ($\$\ ha^{-1}$)
Chisel + disk	3.78	4.30	371
NT only	2.85	3.00	41
NT + subsoil	3.77	4.50	462
Variety trials		4.11	121

From Siri-Prieto et al. (2005) and Gamble et al. (2005) Proc. South. Conserv. Tillage Syst. Conf., Florence SC, p. 160-164.

Scenarios Being Investigated

3. Pasture / crop rotation in the Piedmont – Watkinsville GA

Winter cover crops

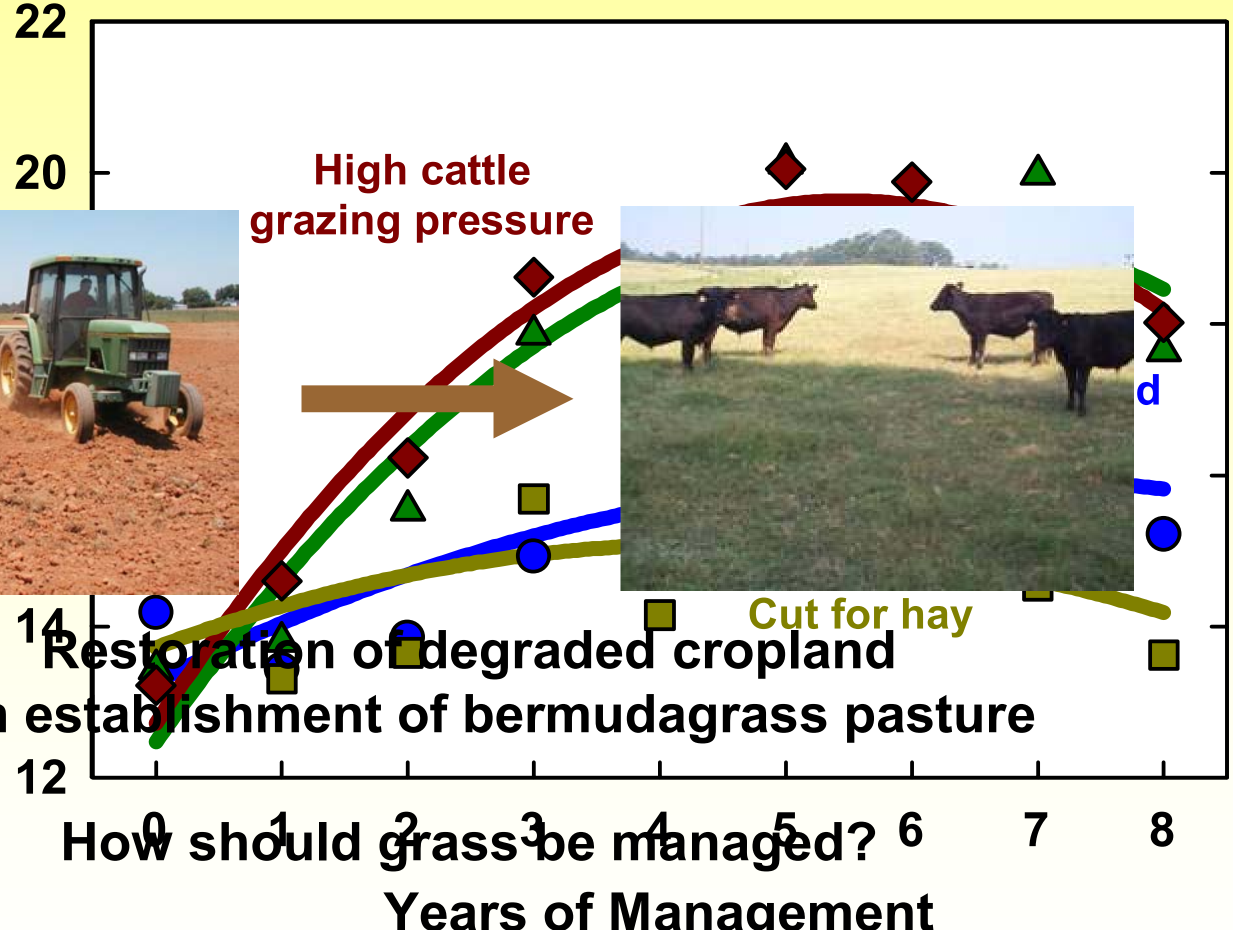
Summer cover crops

Conservation tillage

Effects of cropping following long-term pasture

Scenario

3. Pasture / crop rotation in the Piedmont – Watkinsville GA



Restoration of degraded cropland with establishment of bermudagrass pasture

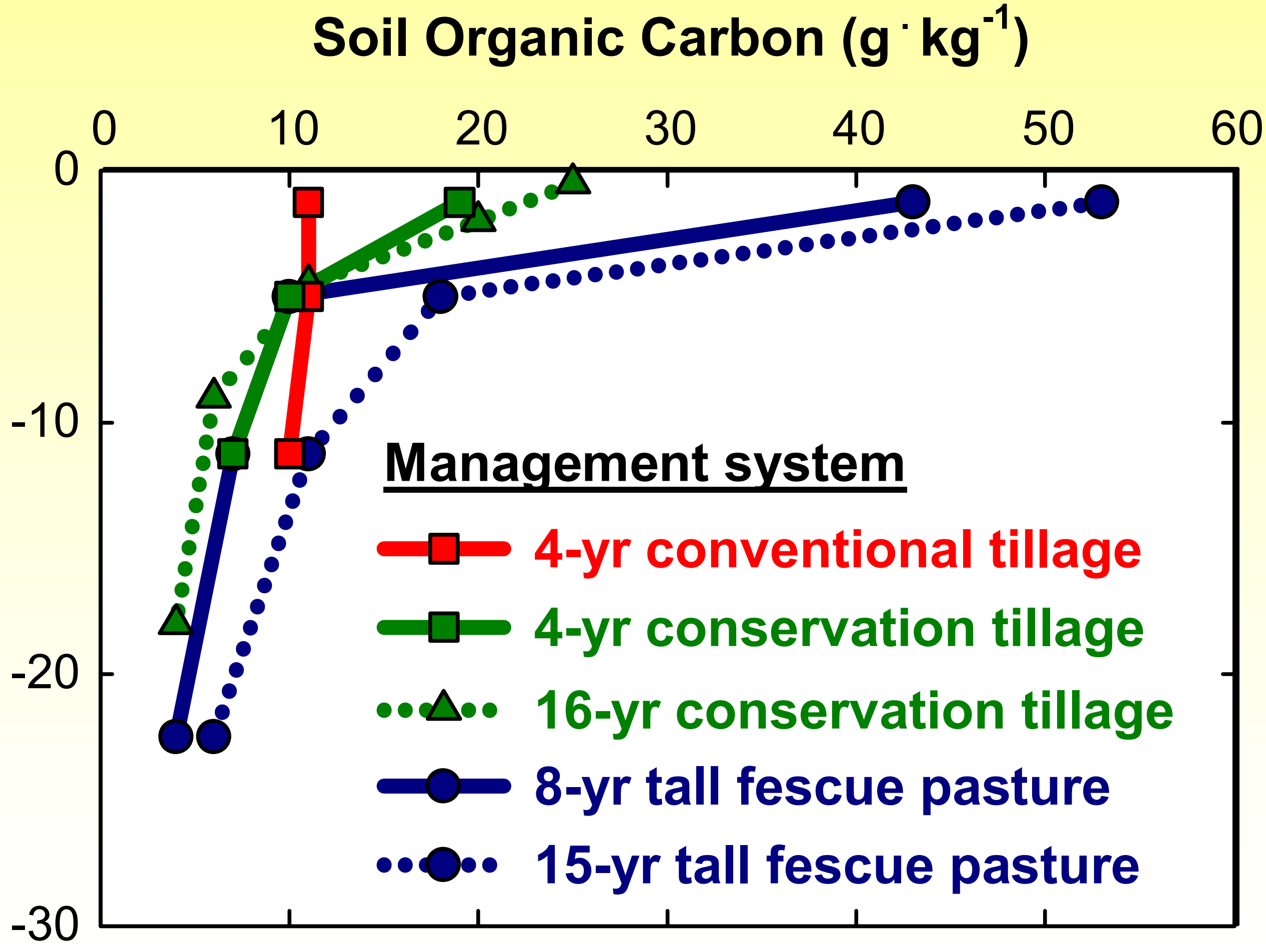
How should grass be managed?

Following long-term cropping, both soil organic C and economic return could be improved with cattle grazing of bermudagrass.

From Franzluebbers et al. (2001) Soil Sci. Soc. Am. J. 65: 834-841 and unpublished data.

Scenario

3. Pasture / crop rotation in the Piedmont – Watkinsville GA



Surface SOC can be improved with conservation tillage cropping and even further increased with perennial pastures.

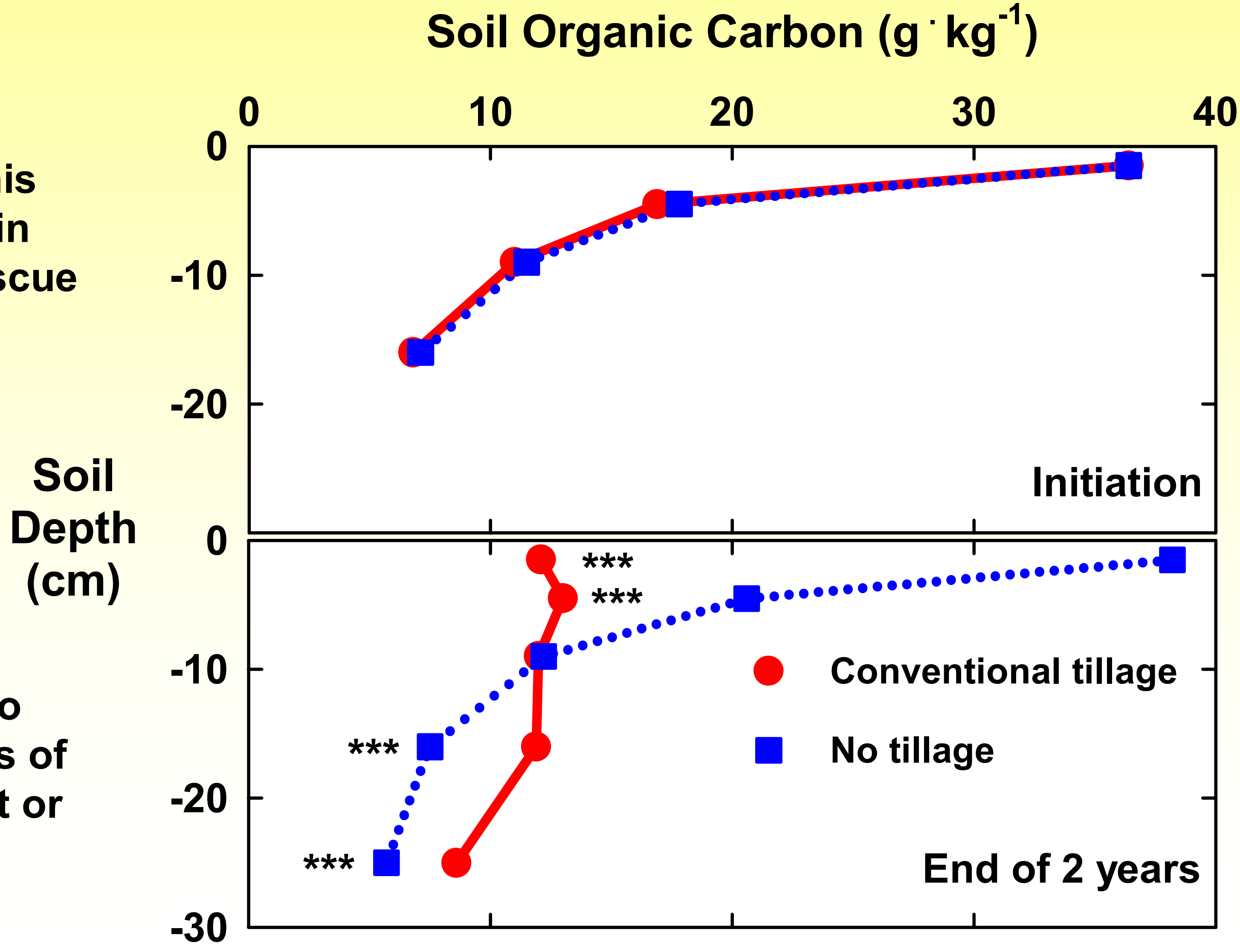
From Schnabel et al. (2001) Potential of US Grazing Lands to Sequester C & Mitigate the GH Effect, p. 291-322.

Scenario

3. Pasture / crop rotation in the Piedmont – Watkinsville GA

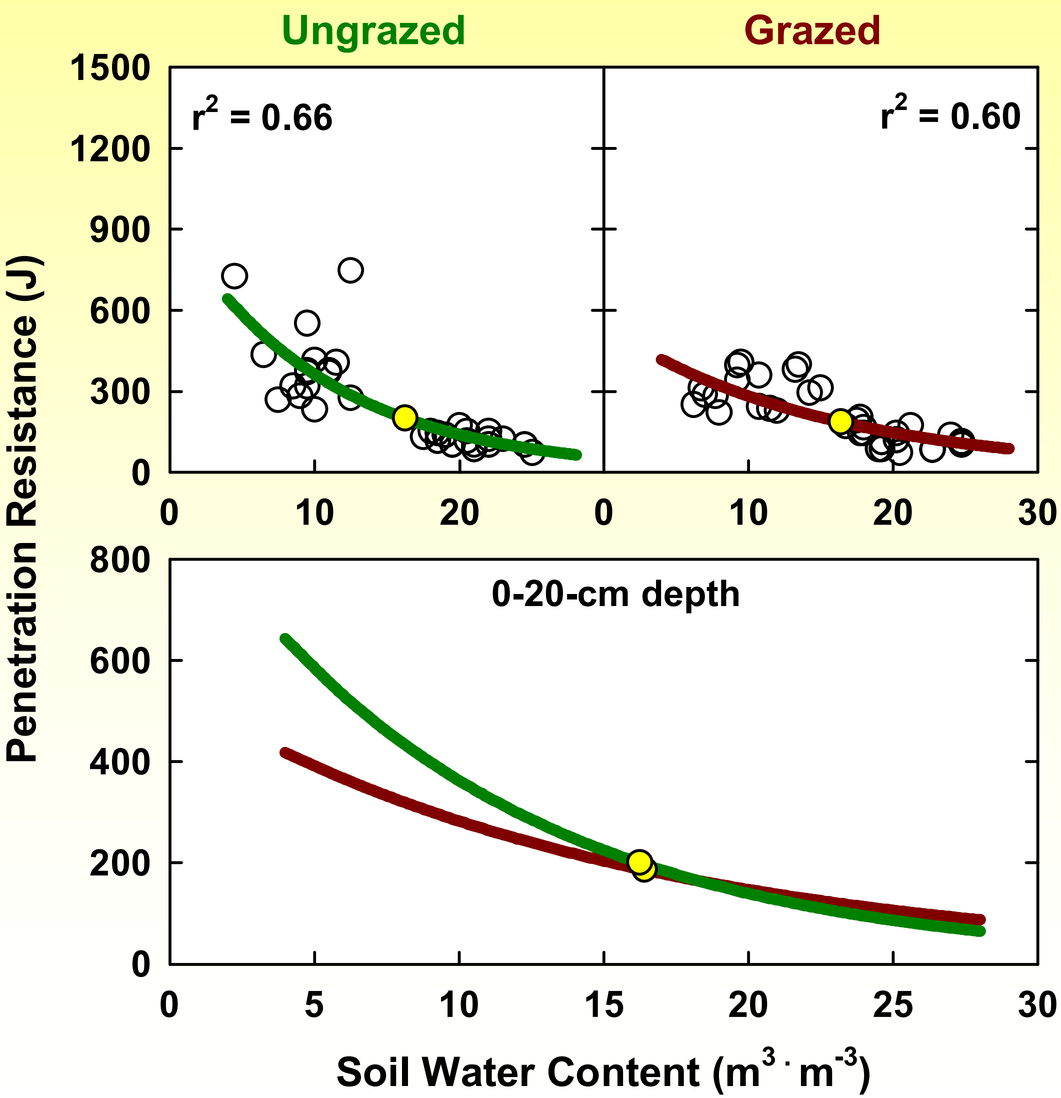
At initiation of this study, land was in long-term tall fescue pasture.

Land converted to cropping systems of wheat/pearl millet or sorghum/rye.



Scenario

3. Pasture / crop rotation in the Piedmont – Watkinsville GA



Soil penetration resistance (hardness) was highly related to soil water content.

Whether cattle grazed cover crops or not, had little impact on soil resistance, except at low soil water content.

Scenario

3. Pasture / crop rotation in the Piedmont – Watkinsville GA

Cropping System	Gross Income	(Cattle/Total)	Net Return
	$ ha^{-1}	%	$ ha^{-1}
Sorghum-rye			
Ungrazed	141	0	-35
Grazed	614	79	289
Wheat-pearl millet			
Ungrazed	240	0	65
Grazed	801	67	476

Assuming $0.08/kg for sorghum yield, $0.11/kg for wheat yield, $1.75/kg animal gain, $175/ha/yr for crop input costs and $150/ha/yr for animal input costs .

Conclusions

✓ Sod-based crop rotations effectively improve soil and water quality

✓ Cover crops offer unique opportunities to integrate livestock grazing with cropping systems

✓ Although soil compaction may be potentially harmful in some instances, the majority of data suggests that cattle grazing of forage crops will be beneficial to overall productivity and economic diversity

✓ The southeastern USA and other warm, humid regions have great potential in developing integrated crop-livestock production systems to improve the sustainability of agriculture