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

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Watkinsville GA

Quincy FL
Warm and Humid Region in the USA

- > 750 mm annual precipitation
- > 12 °C annual temperature
Climatic Characteristics in the Southeastern USA

Temperature (°C)

- Alexandria LA: 19.0 °C -- 1486 mm
- Belle Mina AL: 15.2 °C -- 1391 mm
- Columbia SC: 18.2 °C -- 1105 mm
- Orlando FL: 21.6 °C -- 1263 mm

Precipitation (mm)

Month
Similar Climatic Zones Around the World
Sustainable Agricultural Systems

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

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. **Integration**, 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.
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\(^{-1}\))

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

Rotational Effect of Pasture on Corn Production


<table>
<thead>
<tr>
<th>Compared with continuous corn</th>
<th>Rye</th>
<th>Vetch</th>
<th>Alfalfa</th>
<th>Bermuda</th>
<th>Fescue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen savings (kg ha⁻¹)</td>
<td>7</td>
<td>120</td>
<td>17</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Rotation effect (% yield increase)</td>
<td>17</td>
<td>1</td>
<td>17</td>
<td>10</td>
<td>23</td>
</tr>
</tbody>
</table>
Rotational Effect of Pasture on Disease Incidence of Stem Rot

Rotational Effect of Pasture on Soil Erosion and Water Runoff

### Scenarios Being Investigated

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

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahiagrass</td>
<td>Grazed bahiagrass</td>
<td>Peanut</td>
<td>Cotton</td>
</tr>
<tr>
<td>hay</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Images of sod rotation and associated university logos are present.*
Scenario

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

<table>
<thead>
<tr>
<th>Years Following Bahiagrass</th>
<th>Peanut Yield (kg ha⁻¹)</th>
<th>Yield Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;4 – (P-P-P-P-P)</td>
<td>3450</td>
<td>--</td>
</tr>
<tr>
<td>3 – (B-P-P-P-P)</td>
<td>3405</td>
<td>-1</td>
</tr>
<tr>
<td>2 – (B-B-P-P-P)</td>
<td>4054</td>
<td>18</td>
</tr>
<tr>
<td>1 – (B-B-B-P-P)</td>
<td>5096</td>
<td>48</td>
</tr>
</tbody>
</table>

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

**Scenario**

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

<table>
<thead>
<tr>
<th>Crop Rotation</th>
<th>Total Cotton Biomass (kg ha(^{-1}))</th>
<th>Nitrogen Concentration (g kg(^{-1}))</th>
<th>Nitrogen Uptake (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-B-P-C</td>
<td>13.0</td>
<td>17.6</td>
<td>226</td>
</tr>
<tr>
<td>C-P-C-C</td>
<td>8.4</td>
<td>17.3</td>
<td>144</td>
</tr>
<tr>
<td><strong>LSD(_{(p=0.05)})</strong></td>
<td>2.3</td>
<td><strong>NS</strong></td>
<td>41</td>
</tr>
</tbody>
</table>

B, Bahia Data from Quincy FL in 2003 (D.L. Wright)
P, Peanut
C, Cotton
Scenario

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

Nitrate-N in soil water (mg kg\(^{-1}\))

<table>
<thead>
<tr>
<th>Depth</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ammonium-N in soil water (mg kg\(^{-1}\))

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

<table>
<thead>
<tr>
<th>Yield component</th>
<th>Ungrazed</th>
<th>Grazed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton lint (kg ha(^{-1}))</td>
<td>1178</td>
<td>1260</td>
</tr>
<tr>
<td>Peanut (kg ha(^{-1}))</td>
<td>4144</td>
<td>4200</td>
</tr>
<tr>
<td>Cattle gain (kg ha(^{-1}))</td>
<td>--</td>
<td>167</td>
</tr>
<tr>
<td>Value of gain ($ ha(^{-1}))</td>
<td>--</td>
<td>304</td>
</tr>
</tbody>
</table>

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

### Scenario

#### 2. Stocker cattle on winter cover crop – Moultrie GA

<table>
<thead>
<tr>
<th>Soil property</th>
<th>Ungrazed</th>
<th>Grazed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (Mg m(^{-3}))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under conventional tillage</td>
<td>1.71</td>
<td>1.71</td>
</tr>
<tr>
<td>Under conservation tillage</td>
<td>1.72</td>
<td>1.75</td>
</tr>
<tr>
<td>Hydraulic conductivity (cm h(^{-1}))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under conventional tillage</td>
<td>4.4</td>
<td>&gt; 3.4</td>
</tr>
<tr>
<td>Under conservation tillage</td>
<td>2.4</td>
<td>&lt; 3.0</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>System</th>
<th>Cotton Yield (Mg ha⁻¹)</th>
<th>Peanut Yield (Mg ha⁻¹)</th>
<th>Peanut Net Return ($ ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisel + disk</td>
<td>3.78</td>
<td>4.30</td>
<td>371</td>
</tr>
<tr>
<td>NT only</td>
<td>2.85</td>
<td>3.00</td>
<td>41</td>
</tr>
<tr>
<td>NT + subsoil</td>
<td>3.77</td>
<td>4.50</td>
<td>462</td>
</tr>
<tr>
<td>Variety trials</td>
<td>4.11</td>
<td>121</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

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.
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

<table>
<thead>
<tr>
<th>Cropping System</th>
<th>Gross Income (Cattle/Total)</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ ha(^{-1})</td>
<td>%</td>
</tr>
<tr>
<td><strong>Sorghum-rye</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ungrazed</td>
<td>141</td>
<td>0</td>
</tr>
<tr>
<td>Grazed</td>
<td>614</td>
<td>79</td>
</tr>
<tr>
<td><strong>Wheat-pearl millet</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ungrazed</td>
<td>240</td>
<td>0</td>
</tr>
<tr>
<td>Grazed</td>
<td>801</td>
<td>67</td>
</tr>
</tbody>
</table>

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