



# US Cotton Carbon Life Cycle Assessment: Cotton Production Practices in 16 States

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# Life Cycle Assessment: Quantifies Processes



**Goal:** Quantify inputs and outputs for a system in terms of a standardized unit of measure.

The scope and structure of the LCA are directly dependent upon the unit of measure (functional unit):

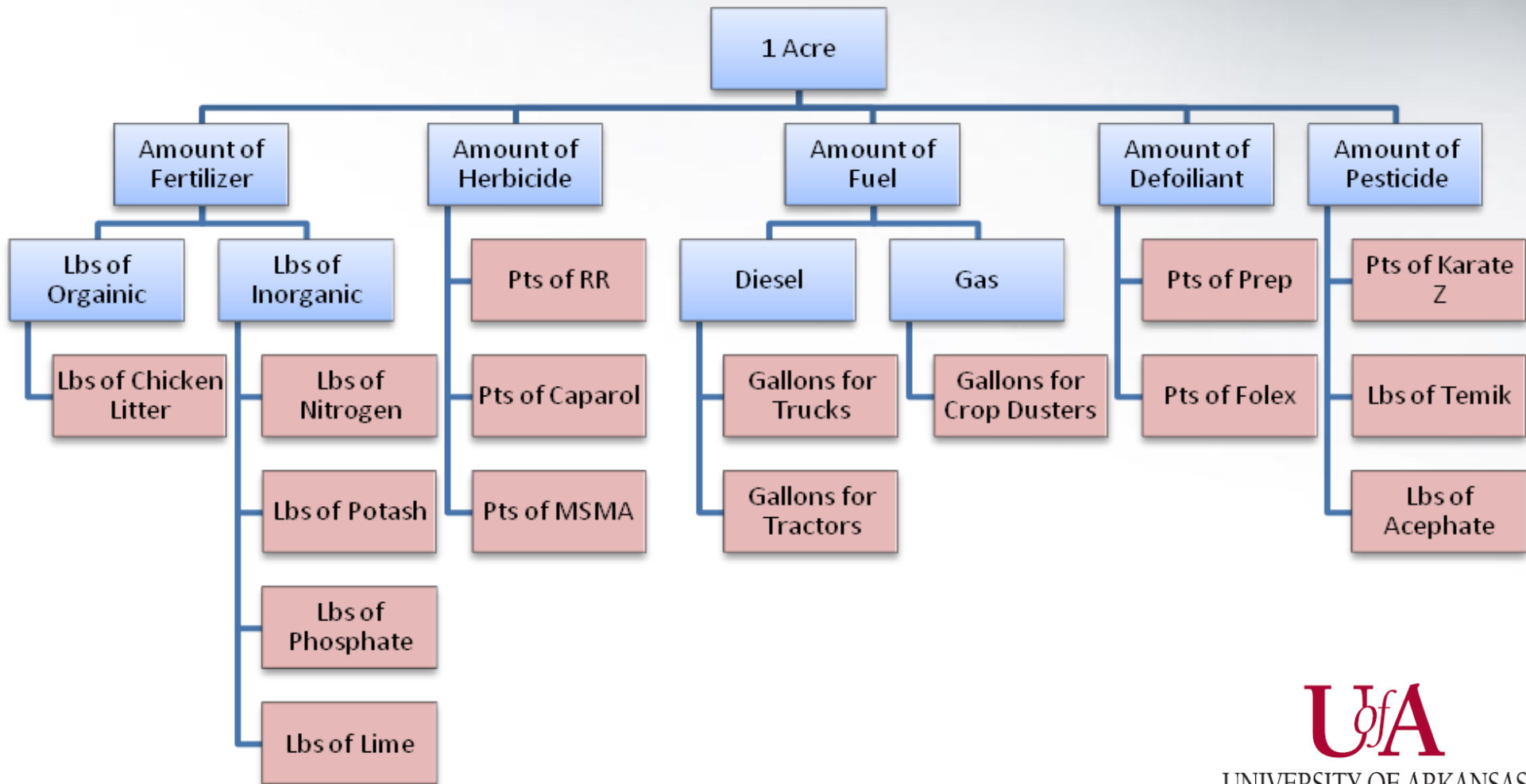
1. Energy embodied in a single product;
2. Greenhouse gas produced per unit product;
3. Volume of water consumed per mass of product...

Goal and Scope of LCA must be formulated at the outset of the project, and the **functional unit must be defined**.

LCA Process is described in ISO 14040 and 14044 Standards.



# Life Cycle Inventory (LCI) For a Given Production Practice



# Life Cycle Inventory (LCI) For a Given County

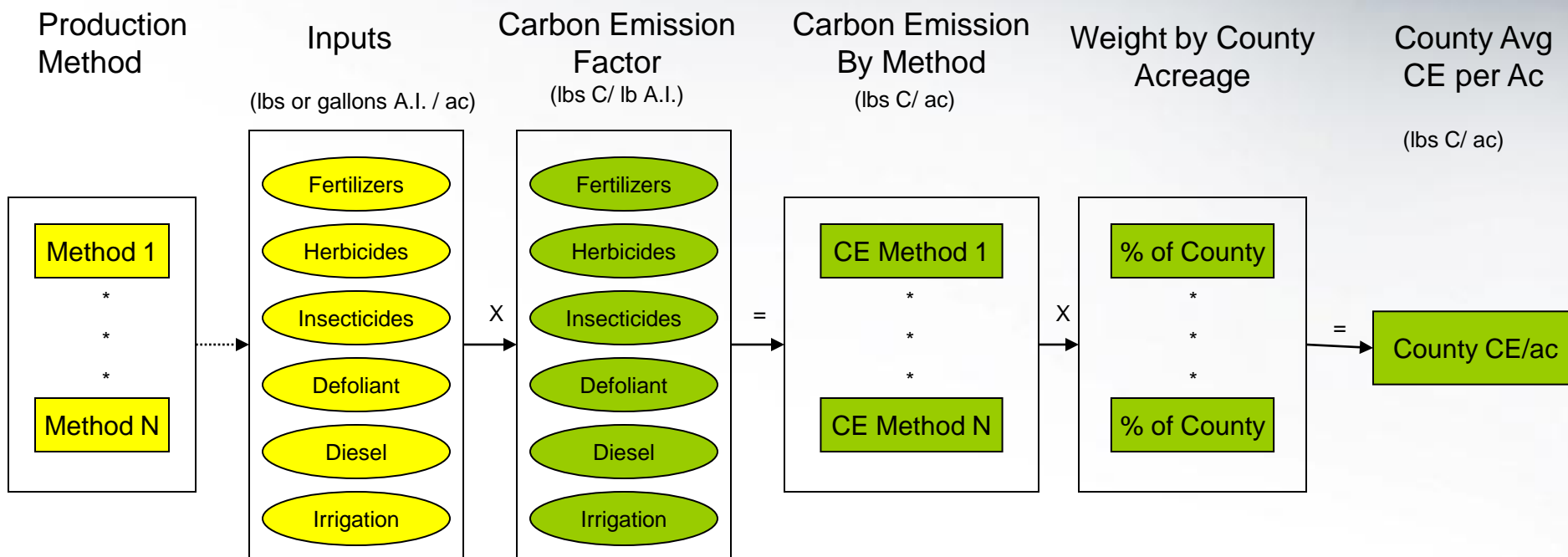


# Cotton LCA: Analysis



---LCI---

-----LCA-----



## Data Sources

Crop Production Budgets from Ag Extension

Literature

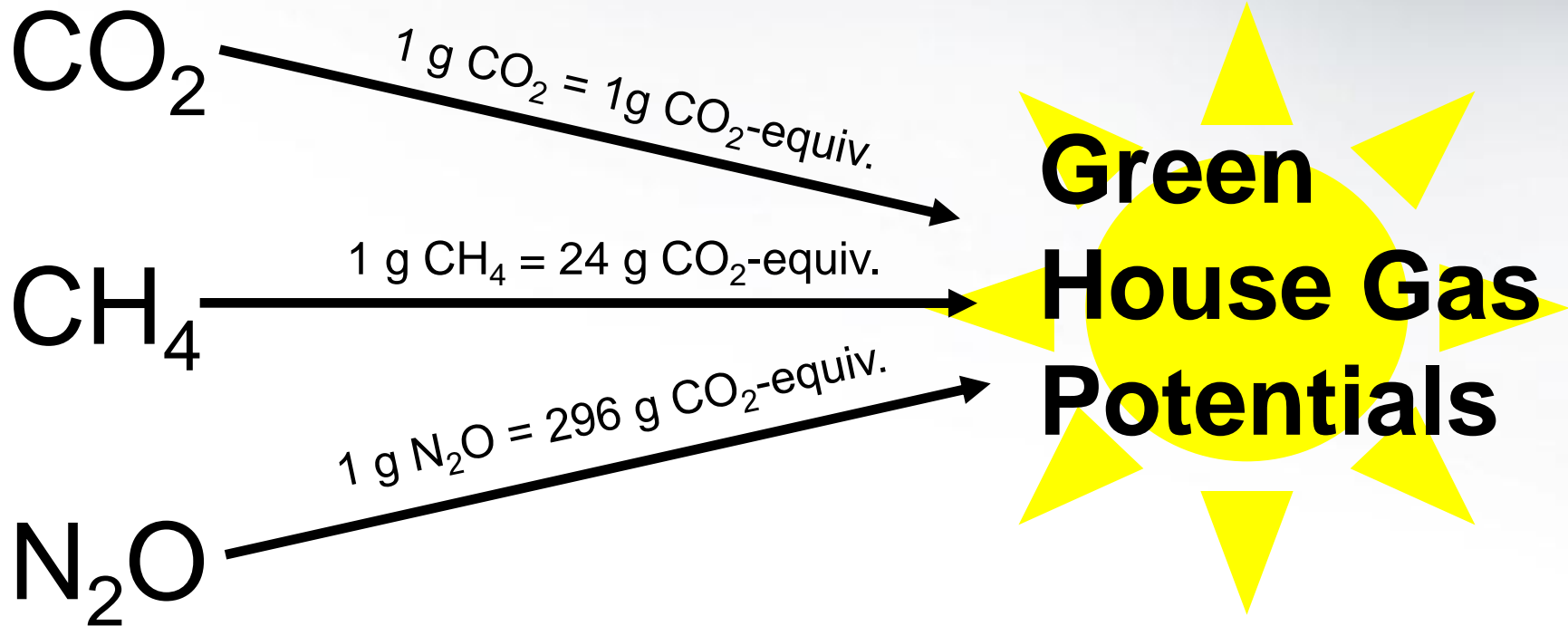
Calculation

Extension Specialists

Calculation



# Life Cycle Assessment: Reconciling Functional Units



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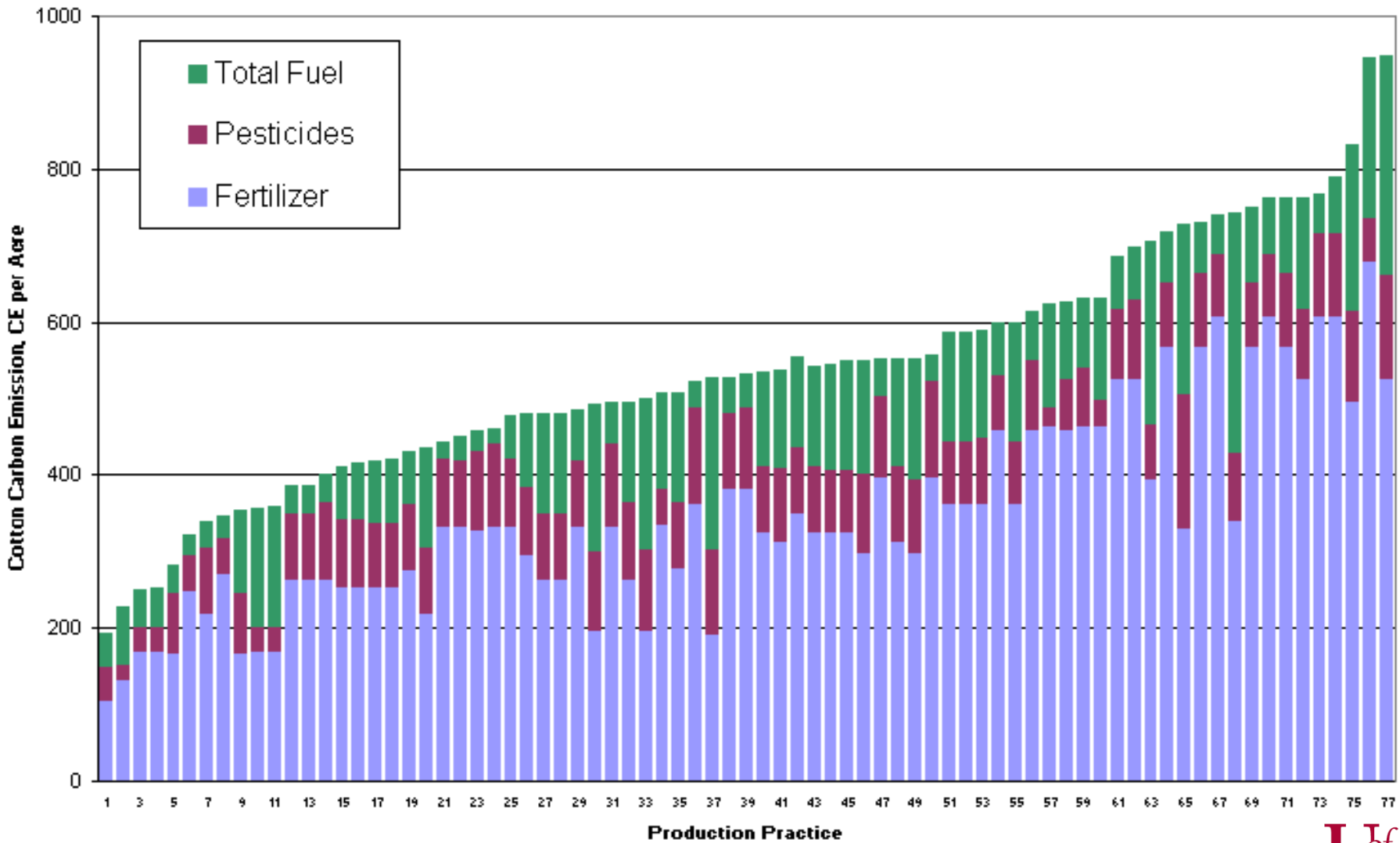
# LCA: Emission Factors



Input	Carbon-equivalent	Source
<b>Fuel</b>		
Diesel	6.05 lbs C/gal	US EPA
Gasoline	5.29 lbs C/gal	US EPA
<b>Fertilizer</b>		
Nitrogen	1.30 lbs C/lb	Lal, R. 2004
Nitrogen N <sub>2</sub> O*	2.00 lbs C/lb	IPNI 2007, IPCC
Phosphate	0.20 lbs C/lb	Lal, R. 2004
Potash	0.16 lbs C/lb	Lal, R. 2004
Lime	0.17 lbs C/lb	Lal, R. 2004
<b>Herbicide</b>	6.44 lbs C/lb	Lal, R. 2004
<b>Insecticide</b>	5.44 lbs C/lb	Lal, R. 2004
<b>Defoliant</b>	6.44 lbs C/lb	Using Herbicide Value
<b>Growth Regulator</b>	5.44 lbs C/lb	Using Insecticide Value
<b>Fungicide</b>	5.44 lbs C/lb	Lal, R. 2004



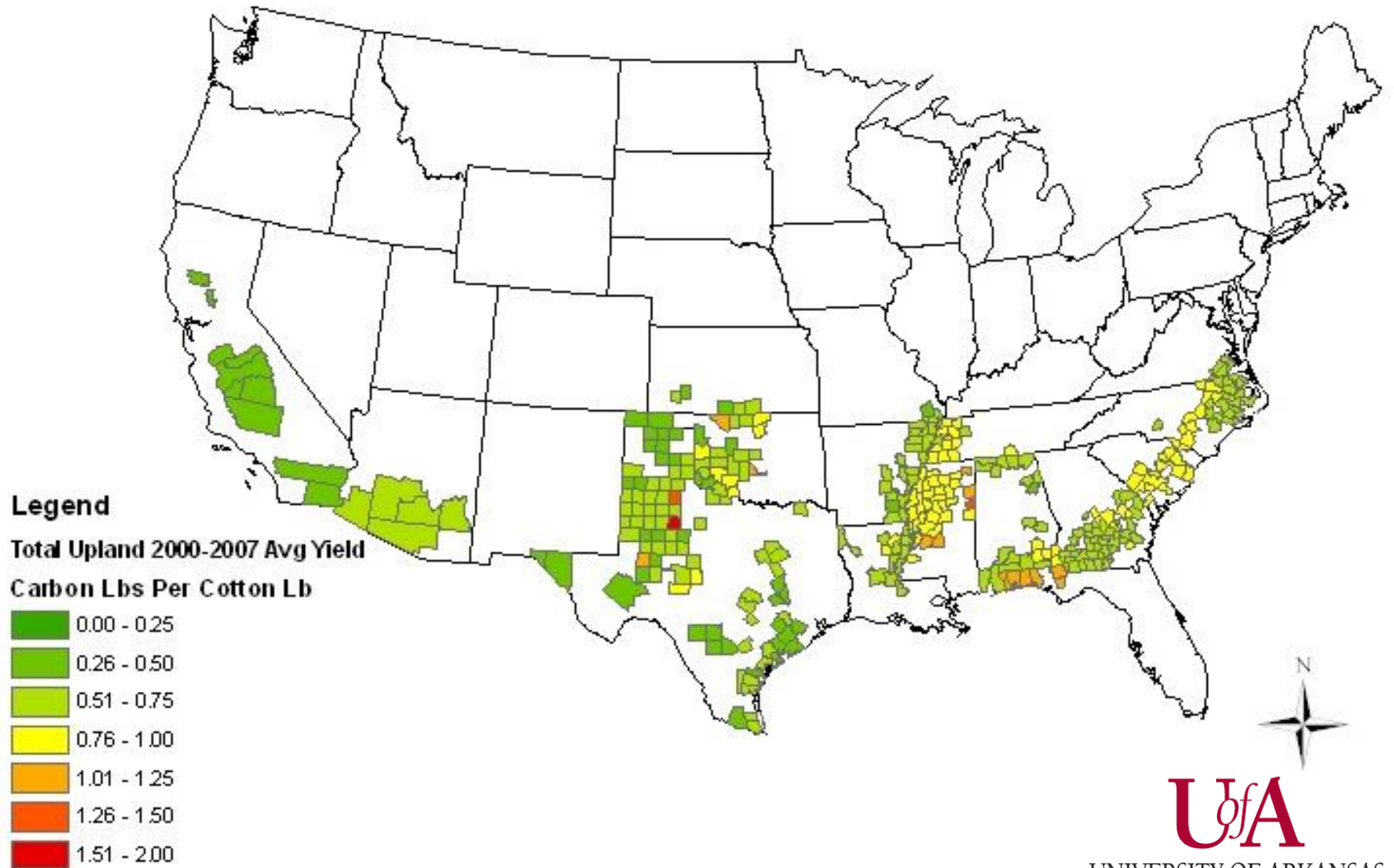
# Carbon Emission By Production Practice



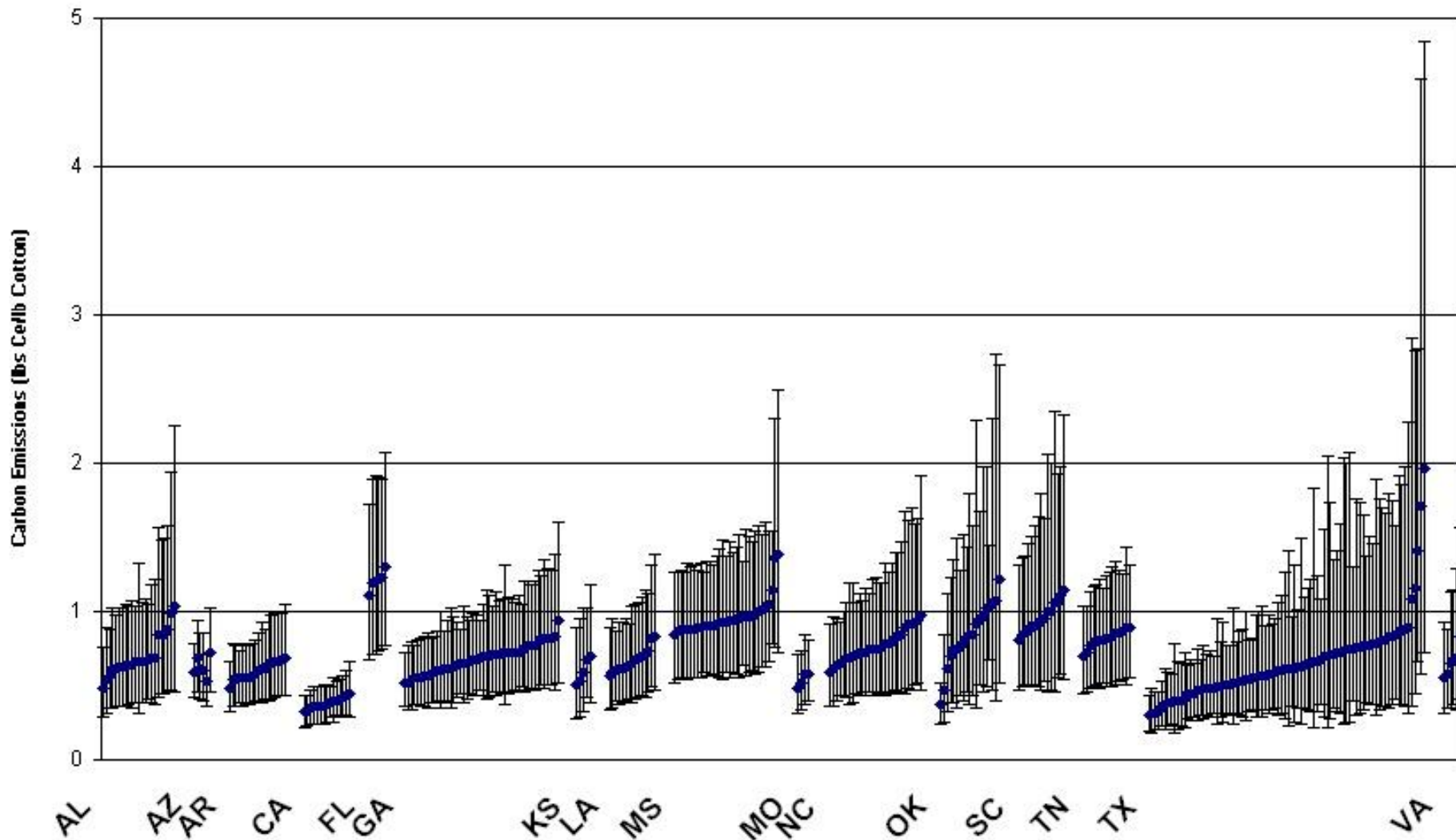


# Carbon Per Pound Cotton

Based on 2000-2007 Avg Yield



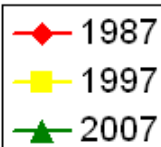
# Monte Carlo Simulation



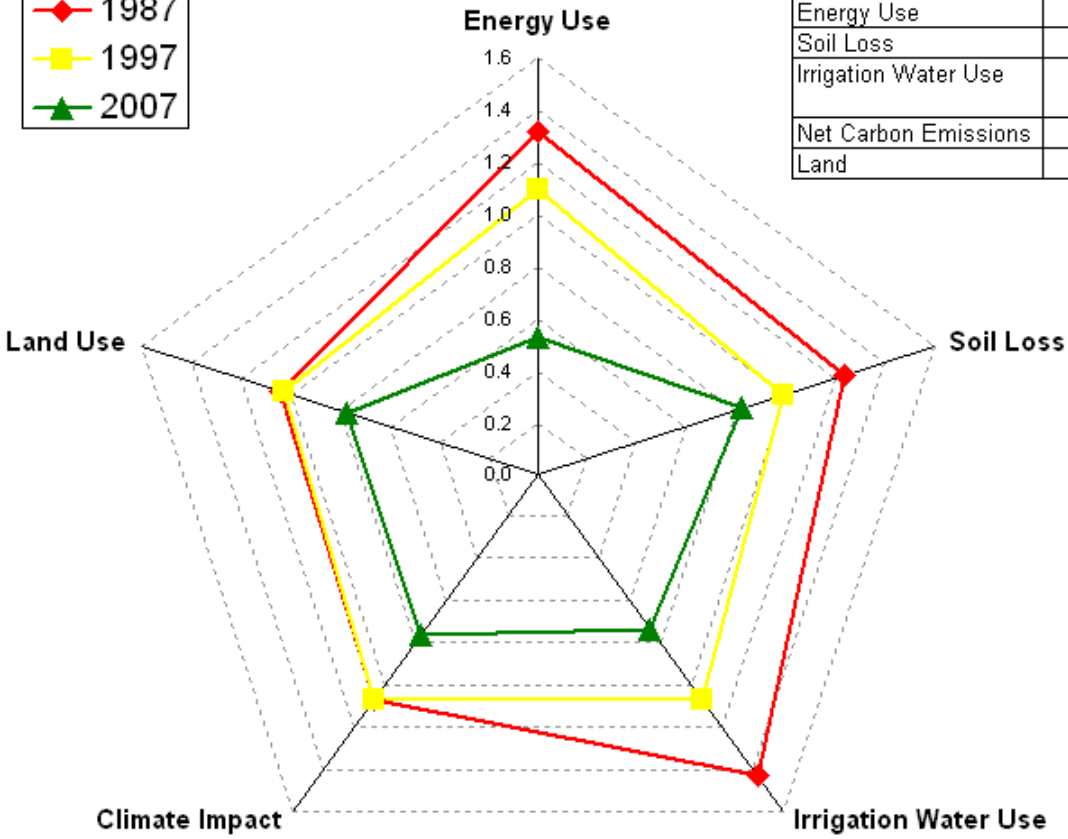
# Life Cycle Assessment Case Study: US Cotton Over Time



## Cotton Efficiency Indicators (Per Unit of Output, Index 2000 = 1)



Year	2000	Unit
Energy Use	0.012	Million Btu/pound
Soil Loss	33.2	Pounds soil/pound cotton
Irrigation Water Use	1.5	Thousand gallons/Incremental pound due to irrigation
Net Carbon Emissions	0.5	Pounds carbon/pound cotton
Land	0.002	Acres/pound



(Values are expressed as 5-year centered averages.)

Source: Keystone Center, Keystone CO