A SCAN LEVEL COTTON CARBON LIFE CYCLE ASSESSMENT:

Has Bio-Tech Reduced the Carbon Emissions From Cotton Production In the USA?

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With funding from Arkansas State Support Committee

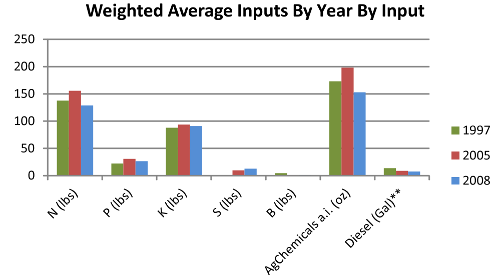
COTTON INCORPORATED

Introduction

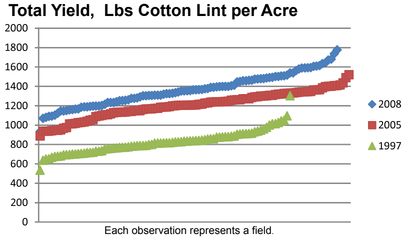
This study estimates the Greenhouse Gas (GHG) emissions of cotton production from three years at one Northeast Arkansas farm spanning 12 years under different production methods. Using a Life Cycle Assessment (LCA) approach, this analysis assessed carbon-equivalents (CE) emissions of cotton production from cradle-to-gate. This analysis included all forms of power, both direct and indirect, required to produce a pound of raw cotton lint in the field.

Input	Carbon-equivalent	Source
Fuel		
Diesel	7.01 lbs C/gal	US EPA, Ecoinvent 2.0
Gasoline	6.48 lbs C/gal	US EPA, Ecoinvent 2.0
Fertilizer		
Nitrogen	1.30 lbs C/lb	Lal, R. 2004
Nitrogen N2O	1.28 lbs C/lb	IPNI 2007, IPCC 2007
Phosphate	0.20 lbs C/lb	Lal, R. 2004
Potash	0.15 lbs C/lb	Lal, R. 2004
Lime	0.06 lbs C/lb	West and McBride 2005
Boron	0.20 lbs C/lb	SimaPro
Herbicide	6.30 lbs C/lb	Lal, R. 2004
Insecticide	5.10 lbs C/lb	Lal, R. 2004
Fungicide	5.10 lbs C/lb	Using Insecticide Value
Defoliant	6.30 lbs C/lb	Using Herbicide Value
Growth Regulator	5.10 lbs C/lb	Using Insecticide Value

Weighted Average Inputs By Year By Input

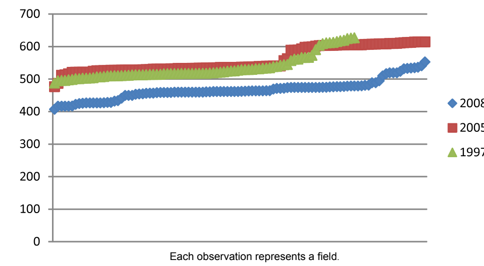


Total Yield, Lbs Cotton Lint per Acre

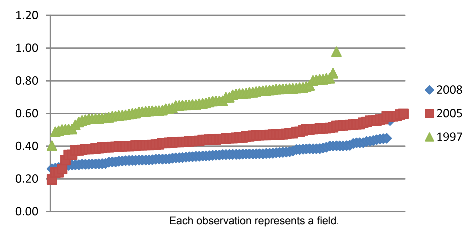


	Total CE (lb/ac)	Yield	CE/lb
1997	536	822	0.67
2005	561	1242	0.47
2008	464	1326	0.34

Total Carbon Equivalent Emissions (lbs) per Acre



Total Carbon Equivalent Emissions (lbs) per Lb Lint



Methods

Data Collection

Using actual application records from a single farm with many fields, we estimated both direct GHG emissions from combustion of diesel and gas and N2O emissions from N-fertilizer as well as indirect emissions from embedded carbon in agrochemical, fertilizer and fuel inputs. We created average emissions per acre and per pound yield weighted by their acreage for three years. Years differed primarily by cotton seed type and tillage method. Fuel use was standardized to assume same tractor efficiencies. Dryland acreage was removed to avoid bias due to different fields irrigated by year. Yield was adjusted each year based upon the farm's yearly yield trend to account for higher or lower production than typical due to weather, pest pressure or other factors.

Carbon emission factors came from US EPA and Lal 2004, *Carbon Emission from Farm Operations* Environment International (30) 2004. It was assumed that 1% of N applied as fertilizer is released as N2O. Carbon sequestration was assumed to be in equilibrium.

Practices

Conventional varieties were grown with conventional tillage in 1997. No-till and reduced till were used in 2005 and 2008. Varieties in 2005 were Bollgard Roundup Ready and in 2008, varieties were Bollgard 2 Roundup Ready Flex. Bollgard technologies can reduce insecticide applications and Roundup Ready technologies can reduce the number of herbicide applications and tillage operations.

Results and Discussion

Greenhouse Gas Emission per Acre

Analysis shows that there are significant reductions in GHG emissions per acre from 1997 to 2008. Total GHG emissions per acre decreased from an average of 536 lbs/ac to 464 lbs/ac from 1997 to 2008. These comparisons are based off differences in input usage for over 300 individual fields. One of the main drivers of this GHG reduction is the adoption of imbedded seed technology which requires less trips across the field for herbicide and pesticide treatments and tillage.

Greenhouse Gas Emissions per Pound of Lint Produced

As input usage decreased over time the observed yields increased. This can be attributed to many factors (efficiency, management practices, etc.) as well as increased yield potential from seed technology. The combination of increased yield and decreased input usage results in a reduction in the amount of GHG emitted to produce a pound of lint. The carbon equivalent per pound of cotton produced reduced from 0.67 lbs in 1997 to 0.34 in 2008.

Conclusions

Our analysis, which used actual on-farm data for a large cotton producer in the Arkansas Delta, indicates that in the period from 1997 to 2008 the GHG emissions per pound of cotton lint produced has decreased by approximately 51%. This decrease can be attributed to both an increase in yield as well as a decrease in inputs. The decrease in inputs can be attributed to several factors (management practices, increased input efficiency, etc.) as well as imbedded seed technology. With the introduction of Bollgard and Roundup technologies, producers are maintaining (if not increasing) yields while decreasing the amounts of inputs, which decreases their GHG emissions per pound of cotton lint produced. These results are significant in that they illustrate that as producers adopt imbedded seed technology to increase profits a positive externality may be that they are reducing their environmental impact from a GHG perspective.