# 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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## Abstract

This study estimates the Greenhouse Gas (GHG) emissions of cotton production from 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 to the farm gate. This analysis included emissions, both direct and indirect, required to produce a pound of raw cotton lint harvested at the side of the field.

We use data from a farm in Northeast Arkansas with detailed records of over 7,000 acres of cotton under cultivation. Data includes production and yield data from 1997, 2005 and 2008 for approximately 100 fields. Seed types are conventional in 1997, Roundup Ready ® Boll Guard in 2005 and Boll Guard II Roundup Ready® Flex in 2008. Tillage was conventional in 1997. In 2005 and 2008 tillage included no-till and reduced till.

Using actual application records, we estimated direct GHG emissions from combustion of diesel and $N_2O$ emissions from N-fertilizer as well as indirect emissions from embedded carbon in agrochemical, fertilizer and fuel inputs. Fuel use is estimated from the Mississippi Budget Generator using the specific tractors and implements combined with the number of passes per acre per tractor and implement. Fuel use for the same operation was standardized across years to standardize tractor efficiencies. Fertilizer, pesticide and other agrochemical application rates are based upon the actual application of the active ingredient. Carbon equivalent estimates are taken from engineering literature for each of the different inputs. Irrigation is held constant since it is assumed that all seed types and tillage use the same irrigation and because irrigation needs may vary dramatically over the years based on climatic conditions, rather than seed and production practice. We created average emissions per acre and per pound yield weighted by their acreage for three years. 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.

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 on 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 fewer trips across the field for herbicide and pesticide treatments and tillage.

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.

Our analysis 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.