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The New Roadmap for Measuring & Valuing Carbon in the Agribusiness Sector

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June 10, 2009
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I. Agribusiness is a Significant Source of Carbon Emissions and Potential Reduction Opportunities

It is widely acknowledged that production agriculture, such as livestock rearing, crop cultivation, timber production, and ornamental horticulture production, contributes a significant amount of greenhouse gas (GHGs) emissions. An analysis of the National Inventory Reports (NIR) submitted to the United Nations Framework Convention on Climate Change (UNFCCC), as part of the Kyoto Protocol, indicates that greenhouse gas emissions in production agriculture range from 5 to 25 percent in developed countries and from 20 to 35 percent in large developing nations, like Brazil, China, and India.[1] At the same time, production agriculture also offers a number of opportunities for mitigating GHGs in the form of soil sequestration, biomass energy production, and waste management. The European Climate Change Programme (ECCP) has estimated that agriculture in the EU-15 has an identified GHG mitigation potential of 19 million tons of CO2 equivalent per year.[2]

These figures, while substantial, fail to capture agriculture's true GHG footprint and thus, understate the industry's potential for mitigating GHG emissions. Defining agriculture simply in terms of primary (first stage) production overlooks the integrated nature of the industry's value chain, which consists of production enhancement segments, such as chemical manufacturers and biotechnology firms, and the value-added sector, such as seed and feed companies, food and beverage manufacturers, processing facilities, pulp and paper mills, cotton and wool mills, and biofuel producers. Separating production agriculture away from the secondary industries also ignores the increasingly global nature of agribusiness, which now consists of an international network of supply chains, producers, processors, distribution networks, and multinational companies. Taking into consideration secondary industries, which, on average, contribute another 5 to 15 percent to GHG emissions in developing and developed nations, agribusiness accounts for approximately 10 to 35 percent of all GHG emissions. The following table summarizes the sources of agribusiness's GHG emissions. [3]

Table 1: Summary of Agribusiness's GHG emissions*

	Developed Countries	Developing Countries
Production Agriculture Ex: Livestock, crop cultivation	5 to 25 percent	20 to 35 percent
Secondary Industries (Production Enhancement & Value-Added) Ex: Chemical manufacturers, food and beverage producers, pulp and paper mills, biofuels	5 to 15 percent	5 to 15 percent

*These figures do not include GHG emissions associated with land use and forestry. According to the UNFCCC, land management in Brazil and Indonesia account for 62 and 84 percent, respectively.

[1] The GIC Group conducted an extensive analysis of the National Inventory Reports (NIR) and the European Union 2008-2012 National Allocation Plans (NAP) and reclassified emissions in order to derive these estimates for the primary and secondary agricultural industries.

[2] European Climate Change Programme. *The Second European Climate Change Programme Final Report: Working Group ECCP Review – Topic Group Agriculture and Forestry*. December 2006, page 1, < http://ec.europa.eu/environment/climat/pdf/eccp/review_agriculture.pdf>.

[3] These estimates are based on GIC's aformentioned analysis of NIRs and European Union's NAPs.

As with the reduction potential of production agriculture, there exist a number of possibilities for mitigating the GHG emissions of secondary agribusiness industries. These include improving waste management and energy efficiency, converting to biomass energy sources, and developing emissions mitigating products and technologies, such as low nitrogen seeds that would require less nitrogen-based fertilizer and alternative feeds that would reduce methane emissions from livestock. A similar case can be made for the forest products industry, which is composed of primary forestry activities and secondary production, including pulp and paper, cellulosic biofuels, lumber, flooring, and wood product manufacturing. Currently production agriculture and forestry are grouped together in discussions on carbon emissions regulations and offset programs. For example, there are international carbon mitigation projects, which are utilizing bagasse, a by-product of sugarcane, as a renewable fuel for pulp and paper mills. For the purposes of this discussion, the authors have grouped the agriculture and forestry products industries under one category—agribusiness.

Given the importance of the agribusiness sector to the global economy and the industry's significant role in addressing climate change, the authors of this paper believe a new framework is required for examining the economic and financial risks and opportunities the agribusiness sector faces in a carbon constrained economy. Thus, this paper has two objectives: 1) production agriculture and related secondary industries, including the forest products industry, ought to be considered as one sector—Agribusiness—for the purposes of analyzing, tracking, and estimating GHG emissions and mitigation opportunities; and 2) The diverse and broad nature of agribusiness requires a unique carbon price discovery mechanism that will afford industry firms, market analysts, and investors a greater level of transparency in measuring and valuing the costs and benefits of GHG emissions reduction efforts. Figures 1 and 2 illustrate how GHG emissions are layered throughout the agribusiness value chain.

Figure 1) Agribusiness's Emissions Map

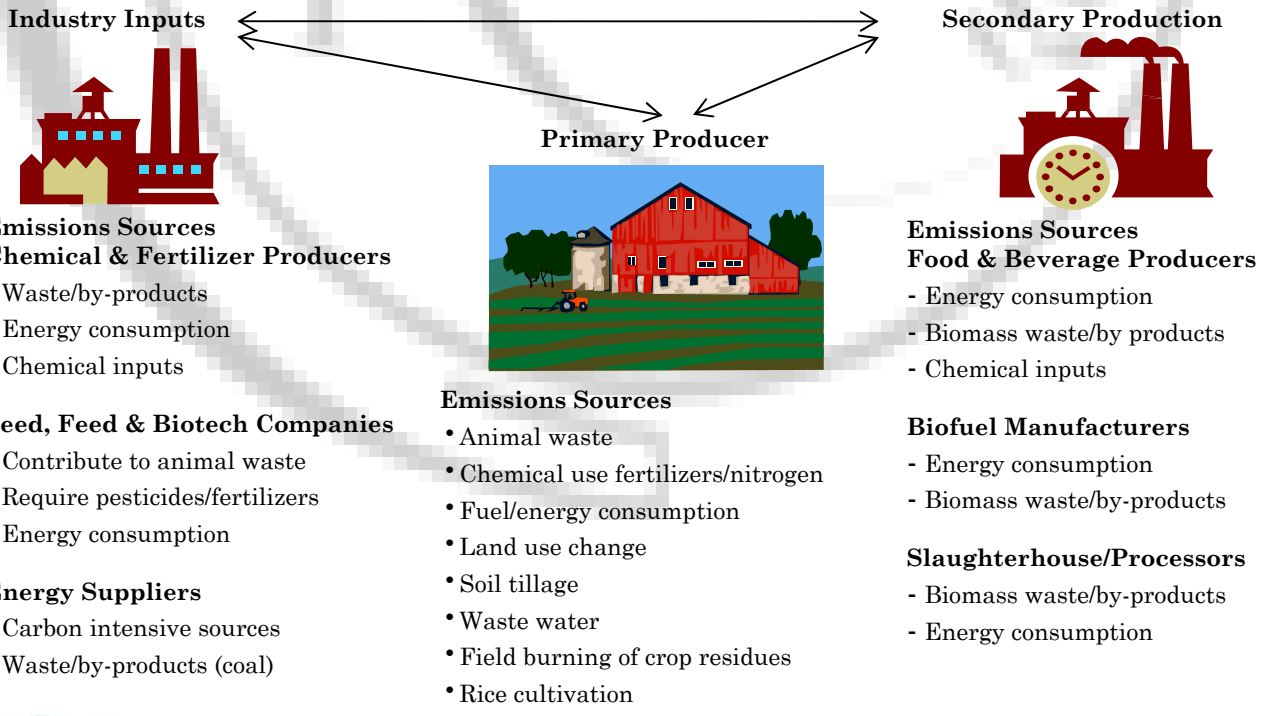
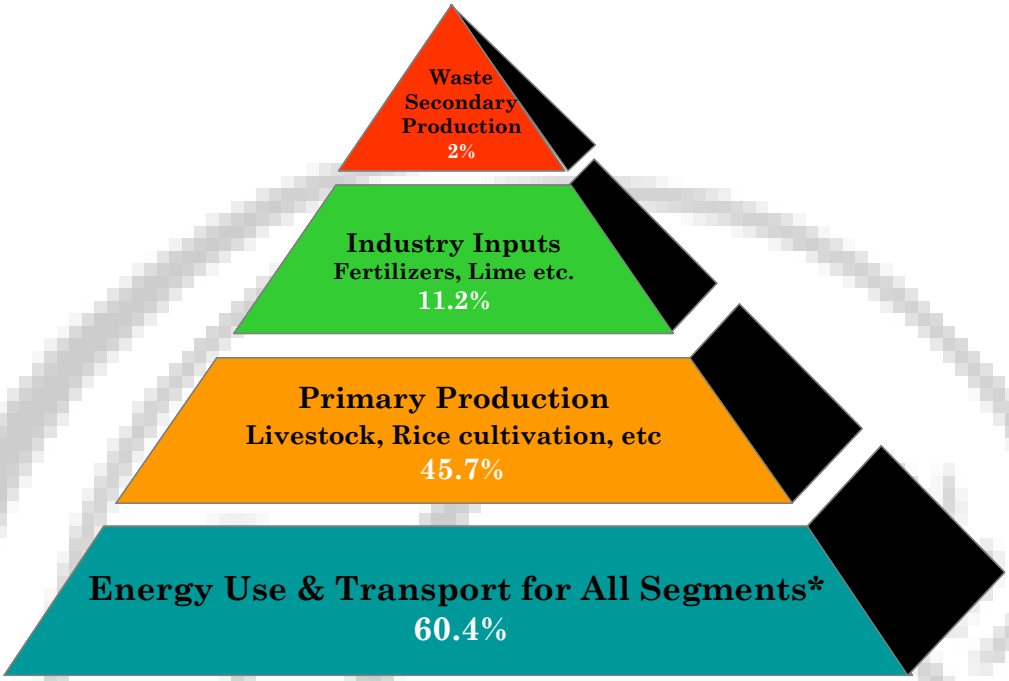


Figure 2) The Agribusiness Emissions Pyramid[4]



**Includes the carbon emissions from biofuels and ethanol production and usage*

II. Agribusiness's Position in Established Carbon Markets

Among the currently established carbon markets, only the Kyoto Protocol, which covers emissions tied to six greenhouse gases through the Clean Development Mechanism (CDM) and Joint Implementation (JI) programs, includes a diverse array of agribusinesses. The CDM program, the larger of the two with a project pipeline of 4,869 carbon offset generating projects, is largely organized around mitigation methodologies and which GHGs are reduced rather than the industrial sectors that are impacted by participating in the program.[5] By comparison, the European Union Emissions Trading Scheme (EU ETS) only targets carbon dioxide emissions, and thus, production agriculture with the majority of its emissions tied to methane and nitrous oxide, is excluded from this cap and trade system.[6]

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[4] The Agribusiness Emissions Pyramid was developed by the GIC Group from the analysis of the NIRs and the subsequent reclassification and estimation of emissions by primary production and secondary agribusiness industries.

[5] The sheer size and volume of the CDM pipeline as compared to the JI program limits the latter's inclusion in the development of the price discovery mechanism that is discussed in this paper. Consequently, in terms of the Kyoto Protocol's carbon offset program, the discussion will focus on the CDM pipeline and the Carbon Emissions Reduction (CER) credits tied to agribusiness projects.

[6] The Netherlands in its Phase II National Allocation Plan for 2008-2012 allocated a portion of its allowances to three installations producing nitric acid. This is essentially a pilot for including nitrous oxide in the EU trading scheme.

In the EU ETS, only the CO2 emissions of secondary industries, such as food manufacturers, lime producers, and pulp and paper plants, are covered by the tradable European Union Allowances (EUAs).

Despite the shortcomings of the current carbon markets, there exists enough data on agribusiness emissions to segment the industry and provide a basis for developing an independent carbon pricing tool for valuing emissions and offsets from this sector. As signatories to the Kyoto accord, the EU member states annually submit their national greenhouse gas inventory reports (NIR) to the United Nations Framework Convention on Climate Change (UNFCCC). These inventories help form the basis for each country's National Allocation Plan (NAP), which, in turn, outlines the allocation of allowances to the covered sectors and details how each country will meet its GHG goals per the Kyoto Protocol. Although production agriculture is not accounted for in the EU ETS, emissions from this sector are reported in the NIRs. An analysis of the reports shows the combined agribusiness emissions from the production and secondary sectors to be approximately 19% of all EU-27 GHG emissions. Similarly, 1,488 of the 4,869 projects (30%) in the CDM pipeline are agribusiness related. The majority of these offsets are derived from biogas and biomass energy projects in industries, such as sugar, pulp and paper, livestock production (swine and cattle operations), starch mills, palm oil, rice and other field crops, and the food and beverage manufacturing sector. A small minority are in the agricultural chemical industry.

III. The Need for a Sectoral Approach in Measuring and Valuing Carbon Emissions in Agribusiness

This patchwork treatment of the agribusiness industry in the international carbon markets creates significant challenges. First, the approach of covering some segments of this sector in a cap and trade scheme and leaving others uncovered, as in the case of the EU-ETS, makes it difficult for integrated agriculture companies to assess properly their financial risk exposure or value the carbon assets/liabilities of a potential acquisition target. Second, the absence of a sectoral policy in the Kyoto CDM scheme limits the economies of scale necessary for substantial reductions in emissions. Third, the overall size of the agribusiness sector, in terms of its economic value and emissions footprint for both large advanced developing countries and developed nations, suggests that this industry requires an independent price discovery mechanism for sizing, valuing, and monitoring its market potential in a carbon constrained economy. Fourth, one of the major carbon reduction strategies—carbon capture and storage (CCS) technology—is only at the pilot phase, and its projected costs to reduce emissions are among the highest cost options.[7] In contrast, the agribusiness industry contains a number of emissions mitigation and carbon sequestration opportunities at a significantly reduced cost. Chart 1 presents the projected marginal abatement costs for a number of emissions reduction strategies.[8] A close look reveals the low cost opportunities offered by agribusiness. Furthermore, the majority of categories with negative abatement costs are those that will involve consumer incentives, such as government funded rebates to purchase energy efficient products.

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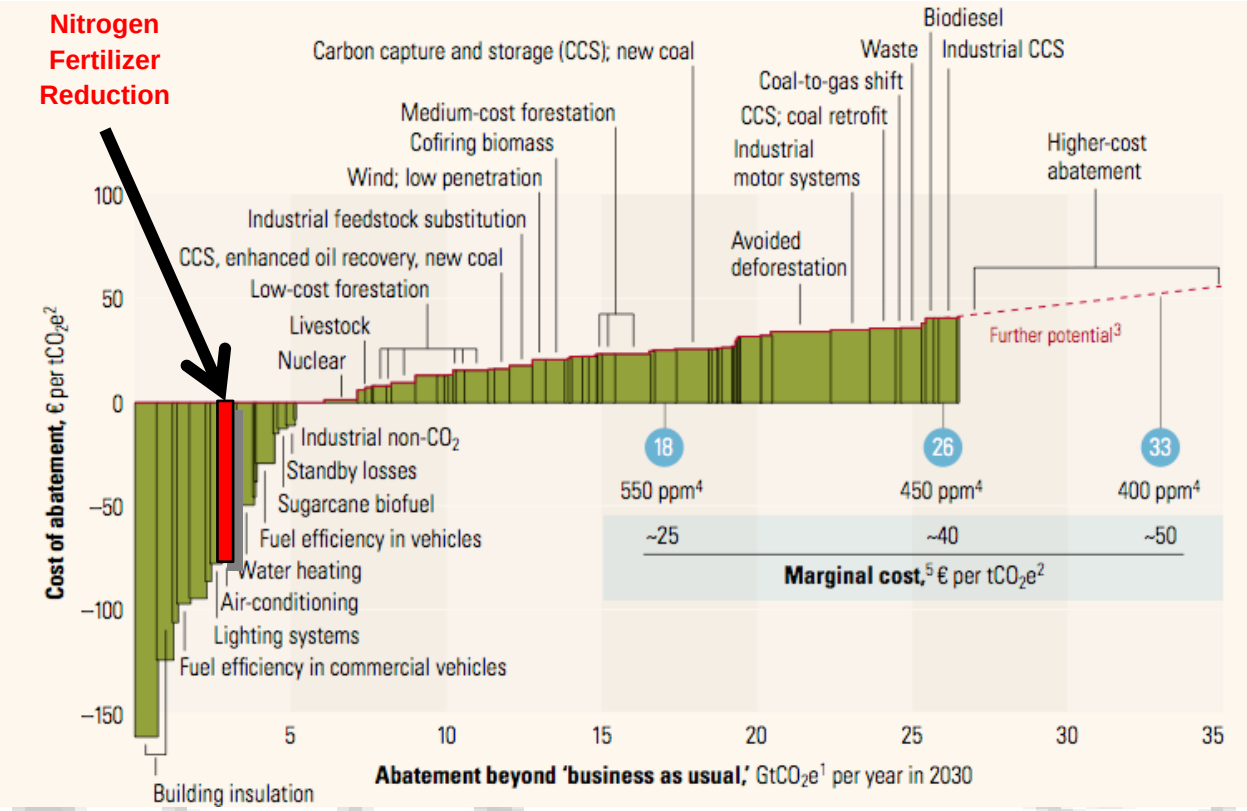
[7]The following article discusses the challenges faced by a pilot carbon capture and storage project in China. The article mentions carbon capture and handling costs to be about $50 per ton. Clarence Fernandez, "China's Hauneng Pushes Carbon Capture But Costs Bite," Reuters 25, May 2009 <http://www.reuters.com/article/GCA-GreenBusiness/idUSTRE54O15Y20090525?pageNumber=2&virtualBrandChannel=0&sp=true>.

[8] Eric Rey, Arcadia Biosciences, company presentation on opportunity for reducing demand for nitrogen fertilizers with new seed technology, 2009. The chart was adapted from the McKinsey & Company 2007 report, entitled *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* , page 20.

Chart 1: Projected Abatement Costs & Agribusiness's Overall Position



By contrast, reducing nitrous oxide emissions from fertilizers and methane from livestock will require the development and implementation of mitigation technologies and shifts in business practices. Given the interrelated nature of production agriculture and the secondary segments and the manner in which carbon emissions are layered throughout the different sub-sectors, a substantial change that reduces emissions at any point in the value chain will reverberate across the industry. Thus, improvements in livestock feed or the development of water-efficient crops would not only impact the emissions at the producer level, but would alter the entire carbon footprints for food retailers and manufacturers. Another pertinent example involves the issue of indirect land usage and carbon leakage that would result from shifting more field crops away from food production to biofuels. In this manner, the development of higher yield seed technologies would provide a dual impact: First, it could allow for greater utilization of biofuels, which have a lower carbon footprint than fossil fuels, and second, it could limit the amount of new land that would have to be brought into production to replace the acreage that has been shifted away from food and feed production.

IV. Defining the New Road Map for Measuring and Valuing Carbon in Agribusiness

In order to measure sufficiently and value adequately the greenhouse gas emissions associated with agribusiness, a new paradigm is needed. This model must be sector specific and capture the unique features that influence carbon emissions and corresponding offset opportunities in the agribusiness industry. The authors of this paper have developed such a protocol. This new approach combines

rigorous measurement of emissions and identification of reduction strategies that go beyond business as usual (BAU) practices with an independent carbon price discovery and valuation tool that assesses the economic risks and benefits associated with a company's carbon footprint.

The first component of this new approach entails developing measurement protocols and techniques to create baseline profiles for the various sub-sectors of the agribusiness industry. The challenge with agribusiness in this regard pertains to the variability in emissions that occurs due to geographic and climate differences. For example, fertilizer consumption and soil quality vary greatly across the continental U.S. As a result, assessing and quantifying soil emissions in a particular crop will yield different results for a farm in the Mississippi Delta and a farm in the Central Valley of California. Accounting for this variability is also crucial in estimating and projecting the offset potential of a particular technology or emissions reduction program, such as improved soil management. Once statistically acceptable margins of error that account for regional variabilities have been established, baseline profiles for each agribusiness sub-sector can be created. The baseline profiles for each sub-sector are then aggregated across the agribusiness industry and weighted factors are calculated for each sub-segment.

The second component involves an independent carbon price discovery mechanism that incorporates specific drivers of GHG emissions in the agribusiness sector. As a financial instrument, this benchmark index offers a forward looking analysis of agribusiness's carbon footprint by integrating the weightings of each agribusiness sub-sector, as discussed above, with macroeconomic and industry factors that impact these industries' carbon emissions. The index, known as the GIC Agriculture Carbon Index (GIC-ACI), is designed to provide a global carbon pricing tool for valuing GHG emission allowances and offset credits associated with agribusiness. As such, the index consists of weighting factors for production agriculture and secondary industries, as well as land-based offsets relevant to agribusiness. This latter component is known as land use, land use change, and forestry (LULUCF). Apart from the sub-sector weightings, the index contains a regional component that accounts for agribusiness-related emissions for developed and developing economies. These weighting values are dynamic and are designed to change as carbon emissions and the composition of each region's agribusiness industry and land use patterns shift and adapt to climate change policies. Table 2 summarizes the weighting factors for the index.

Table 2: Sector and Regional Weights for GIC-ACI

Sector Weights	**Production Agriculture**: Ex. Crops & Livestock	Secondary Industries: **Enhancement Sector** Ex. Fertilizers & Seed	Secondary Industries: **Value-Added Sector** Ex. Food, Biofuels	LULUCF – Forest, Crop, Grazing and Pasture Land Acreage
Regional Weights	EU-27	US	Large Advanced Developing Countries Brazil, China, India, Indonesia, Malaysia, Mexico, & Russia	Rest of World – Developing & Developed Countries

The underlying macroeconomic and fundamental factors supporting the index were derived using a factoring model. This five factor growth model consists of three macroeconomic elements which examine how GHG emissions in agribusiness move with respect to domestic output, inflation, and commodities, including energy, and two fundamental components, which are particular to agribusiness. Table 3 summarizes the GIC-ACI GHG growth factoring model.

Table 3: GIC-ACI GHG Growth Factor Model

Macroeconomic Factors	Fundamental Factors
Domestic Output	Agriculture & Forestry Land
Inflation	Fertilizer Consumption
Commodity Price Composite	

As with the weighting factors, the underlying growth factor model is dynamic. The forward looking nature of the GIC-ACI index will be regularly updated to reflect changes in the five elements. The index can also be used to estimate the value of specific scenarios in the broader economy and how such scenarios are likely to impact GHG emissions in the agribusiness sector.

By combining the components of effective measurement and bottom-up valuation through a forward looking benchmark index, this new protocol provides individual firms, financial analysts, and product developers with a transparent full value assessment tool to quantify and value carbon liabilities and offsets in the agribusiness industry. As more national cap and trade schemes are implemented, the international carbon market will likely be redefined, making a sector-by-sector approach for addressing emissions the likely standard. From this perspective, a global agriculture carbon index would increase the fungibility of the emission allowances and credits tied to the agribusiness sector. More importantly, this new methodology provides agribusiness firms with a financial and risk management instrument that accounts for the fundamental factors associated with this industry's GHG emissions.

V. Applications and Value Proposition of the Ag Carbon Index and Full Value Assessment Approach

The potential end-users of the GIC-ACI Index and the Full Value Assessment Approach range from financial officers at multinational agribusiness firms to producer organizations and state agriculture bureaus. For individual agribusiness companies, precise measurement and valuation of carbon assets and liabilities have become increasingly more important when making investment decisions. By using the GIC-ACI and full value assessment methodology as part of the due diligence process, senior management can evaluate the carbon liabilities and/or offset assets on the balance sheets of potential targets in merger and acquisition deals. Similarly, increased consumer environmental consciousness and corporate social responsibility efforts have compelled many large corporations to analyze and reduce the carbon footprint of their supply chains. In this new environment, companies need a valuation approach that will allow them to assess and compare implementing a carbon reduction strategy versus buying emissions allowances or offsets from a third party. While this reality has yet to take hold across the entire U.S. market due to a lack of a national cap and trade system, the index and full value assessment still permit agribusiness firms to assess the trade-offs in reducing through mitigation activities versus offsetting their emissions footprints by purchasing carbon credits. In the case of an established carbon market, the index could be utilized as a hedging instrument to insure the future value of a stream of credits tied to an offset project. In this manner, a multinational firm with operations in a developing economy could invest in a mitigating technology and manage the risk of the

financial commitment by buying futures on the index and thereby protect the underlying value of the future stream of carbon credits expected for the particular offset project.

For the production enhancement sector, particularly biotechnology firms and seed companies, the index and the full value assessment approach provide a better method for projecting and valuing the impact of carbon mitigating technologies. Based on the carbon footprint profile of a particular sub-sector and the evaluated efficacy of a proposed technology, financial analysts can utilize the index to determine how such a product will impact a company's bottom line, either through the licensing of the proprietary technology or through its ability to generate carbon offsets. Furthermore, market analysts can use the index in conjunction with the full value assessment to forecast the reduction potential of a particular mitigation technology across an entire industry sub-sector. For example, a biotech firm develops a patented feed that reduces the methane emissions from livestock. The licensing value can then be calculated based on its emissions reduction potential in the agriculture sectors where the feed is utilized and the price of carbon, as forecasted by the index. Charts 2 and 3 present the potential size of each agribusiness sub-sector.

Chart 2: US Agribusiness Emissions by Sub-sector

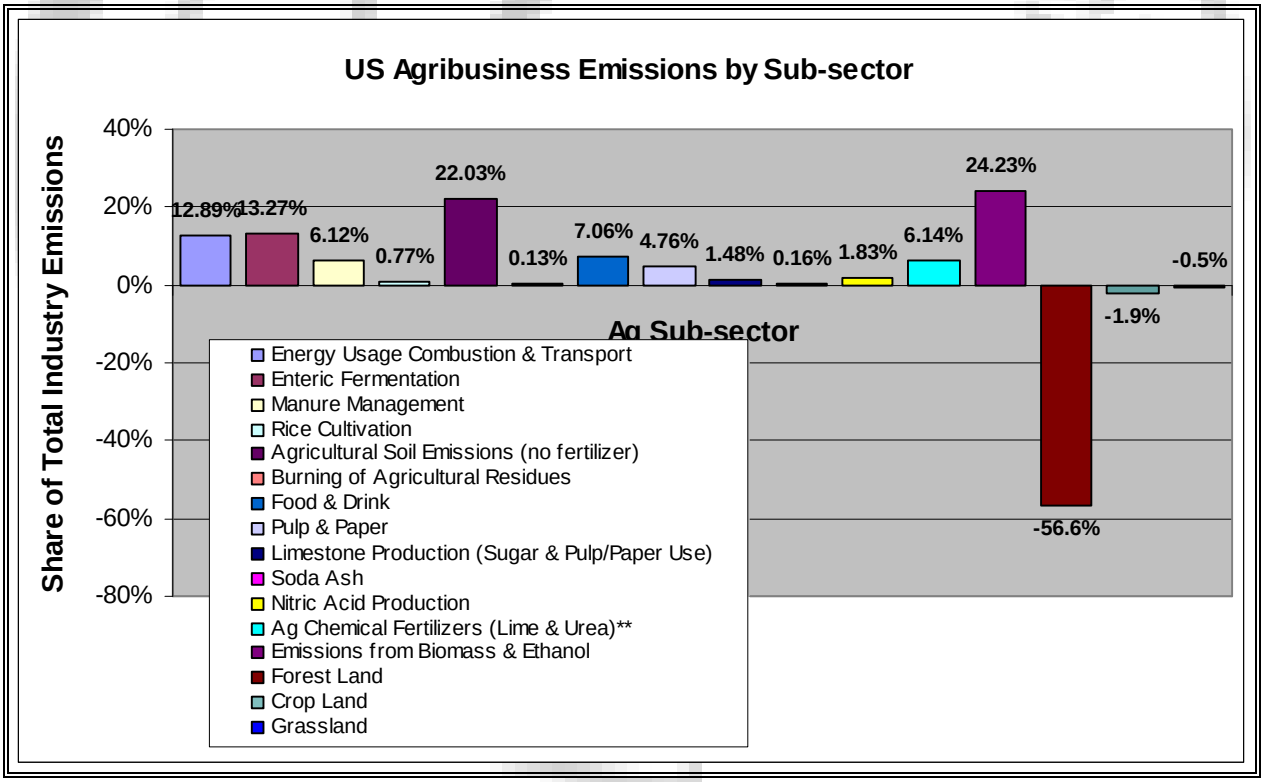
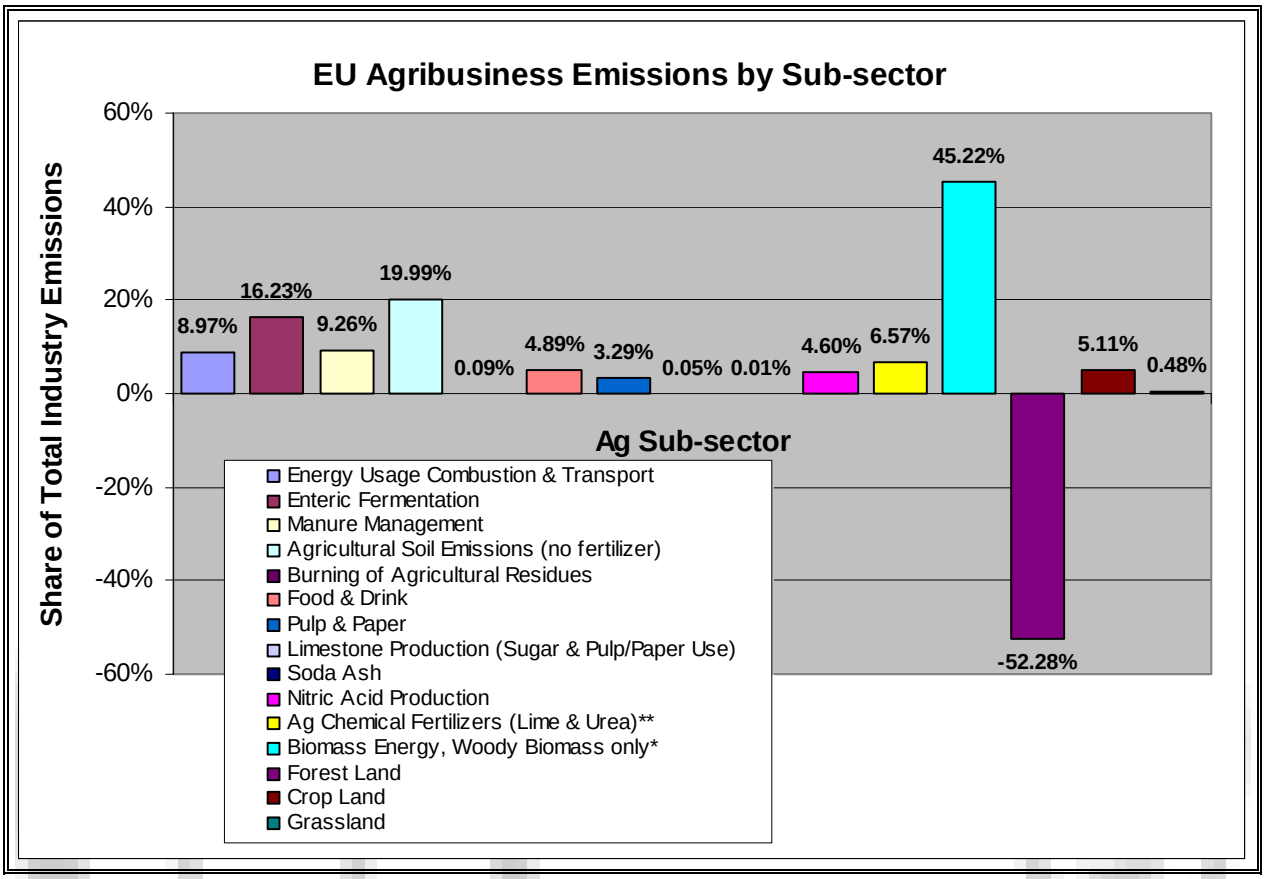


Chart 3: US Agribusiness Emissions by Sub-sector



For investors and funds that buy carbon credits, the index offers an alternative vehicle to hedge against the equity positions of firms impacted by the constraints of a new carbon economy. In addition, project developers investing in carbon offset projects in non-agribusiness sectors can use the index to cross-hedge their price exposure. By comparison, mutual funds seeking exposure to the carbon economy could utilize the index as a pricing point either for investing directly in offset credits or for investing in mitigation technologies and products. Finally, producer groups and government agencies can use the full value assessment and the index to help their constituents develop appropriate strategies for operating in a carbon constrained economy and maximize the value of the allowances and offsets. As an example, land use regulations are potentially a regulatory quagmire. To reduce distortionary impact assessments, the GIC-ACI index offers a fungible credit mechanism that can serve to maximize the value of allowances/credits associated with forest and crop land.

V. Conclusion

The issues of climate change and regulating greenhouse gas emissions present a number of challenges and opportunities for the agribusiness industry. From an environmental perspective, new precipitation patterns and changes in temperature promise to alter cropping practices and seasons in

such a manner that the economic impact portends to be quite severe for a number of economies that are highly dependent on this industry. From a market perspective, the regulation of carbon emissions presents both a threat and an opportunity for agribusiness. As noted, the production and secondary segments of this industry contribute large quantities of GHG emissions. At the same time, however, there exist a number of potentially low cost and substantially broad reduction strategies. For these reasons, a sector specific approach is necessary in order to measure and capture the financial value and risk facing agribusiness.