Strategies for a More Carbon-Friendly Coffee Value Chain: The case of Costa Rica's AAA coffee.

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Introduction

Today, the effects of climate change are clearly perceivable, and even though we cannot attribute all of these changes to human activities, we must recognize that the accelerated concentration of carbon dioxide particles (CO_2) in the atmosphere – which reached 389ppm[1] in September 2011 – and the implications of altering natural lifecycles, have not occurred randomly. Humans have much responsibility for this situation.

Of all human activities, agriculture directly contributes to approximately 10-12% of global greenhouse gas emissions (GGE), according to the latest IPCC report. Methane (CH_4) and nitrous oxide (N_2O) levels increased by close to 17% between 1990 and 2005.[2]

Historically, and up until recent decades, Costa Rica has been a country mainly focused on agricultural exports. Products, such as coffee, are particularly important to the country's export portfolio. In 2010 dry green coffee exports were ranked 7th in terms of importance and represented 7.8% of the total value of agricultural exports and 2.8% of the country's total exports.[3]

Likewise, the impact caused by agricultural and livestock sectors on total GGE in 2005 represented 39% of the country's total emissions. These sectors are a major contributor to emissions, even surpassing transportation emissions (31%).

Situation

Today, several initiatives to quantify emissions in agricultural production exist; however, there are no examples that link them to different parts of the export coffee value chain. This value chain not only includes production, but also processing, drying, packaging and exporting processes.

Based on this lack of information, it is difficult to answer questions, such as: what are the most relevant sources of emissions? Is it feasible to reduce the impacts of this activity significantly? Or even, what is the activity's true impact in terms of agricultural emissions?

In order to answer some of these questions and make concrete contributions to reduce emissions related to planting, processing and exporting coffee, we decided to analyze emissions in the coffee value chain.

Purpose of the Study

To develop a model to estimate emissions for the coffee value chain so that the main sources of GGE can be identified to later propose concrete management actions that reduce the activity's impact on total emissions in the agro-industry sector.

Methodology

This study was developed using GGE from production processes for AAA coffee from 2009-2010.

The methodology to define the study's coverage and scope followed the steps described in the National Climate Change Strategy (NCCS).

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[1] Earth System Research Laboratory
[2] Inter-governmental Panel on Climate Change
[3] Ministry of Foreign Trade in Costa Rica, online statistics.

Once coverage and scope were defined for each one of the components in the coffee value chain, we identified emissions sources and determined the best method to quantify and estimate emissions created by each source during the specified timeframe.

For these estimations we used quantification tools defined and approved by the United Nations Framework Convention on Climate Change (UNFCCC);[4] the Department of Environment, Food and Rural Affairs (UK-Defra);[5] and the International Organization for Standardization (ISO)[6] in accordance with the relevance and level of adjustment of conversion factors that were provided. The Global Warming Potential (GWP) for different gases is identified in the NCCS.

Table N°1: Detail on Coverage, Scope and Emission Sources Identified by the Project.

COVERAGE / SCOPE	PRODUCTION	PROCESSING	TRANSPORTATION
SCOPE N°1. DIRECT EMISSIONS	- Fossil fuel consumption to transport coffee - Fossil fuel consumption to transport inputs - Use of agrochemicals - Agricultural emissions	- Fossil fuel consumption - Burning biomass in driers - Use of pesticides	- Fossil fuel consumption for domestic transportation by land - Fossil fuel consumption for transportation in Europe by land - Fossil fuel consumption for transportation by sea - Paper consumption in export offices
SCOPE N°2. INDIRECT EMISSIONS	- Electricity consumption	- Electricity consumption	- Electricity consumption
SCOPE N°3. INDIRECT EMISSIONS		- Emissions from organic matter/water during decomposition - Fossil fuel consumption for transportation of people - Paper consumption - Electricity consumption in administrative offices - Emissions from air transportation used by authorities - Emissions from composting mill byproducts	- Emissions for air transportation used by authorities

Source: Elaborated by the authors.

Results

We identified four clear links in the coffee value chain, of which three are carried out or managed in the country. These processes coincide with the proposed analysis areas, which were used to define and quantify emissions.

In processing, the main impact comes from the application of agricultural chemicals, creating 80% of emissions. It is worth noting that in order to estimate emissions from agricultural chemical

[4] Acronym
[5] Idem, previous footnote.
[6] Idem footnote #4.

applications, we worked with conversion factors that incorporated N_2O emissions produced as a result of using synthetic fertilizers[7]. We estimated emissions from the denitrification of agricultural land, but they were not included in the final amount since that would have meant they would have been counted twice.

However, the estimates of N_2O emissions resulted in 9.3Kg/Ha/Year, which is just above the estimate for shade-grown coffee[8], equaling 7.78Kg/Ha/Year. Our quantification resulted in emissions of 0.05Kg CO_2/Kg harvested coffee.

Table N°2: Farm, Emission Sources.

EMISSIONS FROM PROCESSING COFFEE	FARM
Fossil fuel consumption: diesel, gas, others	11.5%
Use of agricultural chemicals	79.8%
N2O emissions from agricultural land	0.0%
Electricity consumption (ICE)	8.7%
TOTAL	**100%**

Source: Elaborated by the authors.

Emissions from coffee production, in terms of units of carbon per processed unit, resulted in a range of 1.5 to 6.1 Kg CO_2/Kg processed coffee beans, at the two mills that were analyzed.

The variability basically resulted from emissions coming from the treatment of waste water since one of the mills processed almost twice the amount of waste water than the other. For both mills these emissions, and those created by air transportation for passengers, equaled almost 100% of their entire carbon footprint, leaving a marginal impact from other emission sources.

Table N°3: Mill, Emission Sources.

EMISSIONS FROM PROCESSING COFFEE	MILL A	MILL B
Fossil fuel consumption: diesel, gas, others	0.350%	0.864%
Burning biomass	0.004%	0.019%
Use/application of pesticides	0.000%	0.000%
Electricity consumption ICE	0.112%	0.215%
Emissions from organic matter/water during decomposition	97.640%	91.126%
Paper consumption	0.002%	0.004%
Emissions from air transportation for passengers	1.892%	7.772%
TOTAL	**100,000%**	**100%**

Source: Elaborated by the authors.

The transportation component, different to the two previous categories, presented a distribution of emission sources that was less pronounced. Still, emissions generated by air transportation for passengers and transportation by sea represented together 88% of total emissions.

[7] Cumulative energy and global warming impact from the production of biomass for Biobased products.
[8] National Inventory on GGE and Carbon Sequestration in Costa Rica, 2000 and 2005.

Table N°4: Transportation, Emissions by Source.

EMISSIONS FROM COFFEE TRANSPORTATION	FARM
Fossil fuel consumption, transportation mill/port by land	5.1%
Fossil fuel consumption, transportation port/storage by land	6.3%
Sea transportation	28.6%
Paper consumption	0.01%
Electricity consumption (ICE)	0.9%
Emissions from air transportation for passengers	59.2%
TOTAL	**100%**

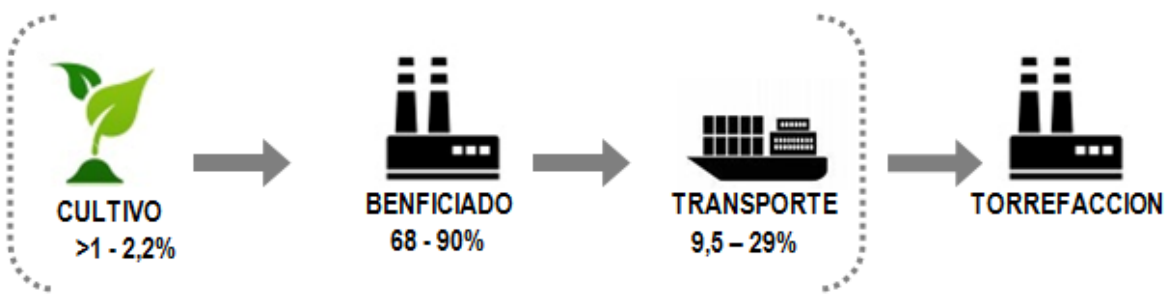
Source: Elaborated by the authors.

This situation contrasts with the expected result: that emissions coming from sea transportation would account for most emissions in this component. However, comparing the outcomes of the study, which used UK-Defra's methodology and emissions factors for sea transportation that resulted in a ratio of 23.6 gr/Ton/Km, compared with data from MARISEC[9], of 21gr/Ton/Km, we concluded that our estimate is correct. For this component we found a ratio of carbon units per transportation units of 0.65Kg CO_2/Kg transported coffee.

Overall, total emissions per unit of coffee ranged from 2.2 to 6.8 KgCO_{2e}/Kg of coffee, which are higher than other crops in the country, such as pineapple, with 1.007 KgCO_{2e}/Kg of pineapple, and banana, with 1.087 KgCO_{2e}/Kg of banana.[10]

Generally speaking, the results from the three analyzed components provided evidence about the impact that certain emissions sources generated. When comparing emissions of carbon units per unit of coffee, based on coverage, we observed that the processing area, where most emissions are concentrated, represented between 68 and 90% of total emissions per Kg of coffee.

Figure N°1:
Relative Importance of the Origin of GGE in the Coffee Value Chain in KgCO_2 / Kg Coffee.



Source: Elaborated by the authors.

[9] Maritime International Secretariat Services Limited.
[10] Dole: Carbon Neutral Fruits.

Discussion

Wet milling is a common practice in Central America, where large amounts of coffee are processed for global consumption. Approximately 8.2% of the coffee produced and 10.6% of exported coffee between 2009-2010[11] was processed in a wet mill. This processing technique is also commonly used in large-scale producer countries, such as Colombia, where 6.6% of coffee produced and 8.6% of exported coffee[12] are processed that way. This situation allows us to see how relevant coffee production, and the coffee value chain, are to the region.

The large amount of organic matter in the mills' waste water results in negative impacts that are too great for runoff water to be dumped directly into local bodies of water without treatment. Based on the assumption that all countries have regulations to restrict dumping of untreated waste water, we can infer that most mills in the region have some type of waste water treatment system in order to operate legally.

The importance that coffee production has in the region, together with the assumption that most mills do some type of waste water treatment, leads to the question: what would be the impact of those treatment systems on emissions? And, how much of agricultural GGE can be attributed to coffee production? And finally, what is the best way to treat this water?

Conclusions

From this study we concluded that for the coffee value chain, most emissions came from a few sources, which accounted for most of the impact generated in terms of carbon units emitted per unit produced.

Coffee processing, or milling, accounted for the greatest source of emissions, and this was mostly the result of waste water treatment, representing more than 90% of emissions.

This analysis was not an exhaustive study that allowed us to determine the best waste water treatment system in terms of minimizing impacts on both water resources and the atmosphere.

Our findings showed the relevance that the coffee value chain has on current efforts to minimize GGE impacts and the repercussions that the development and implementation of appropriate treatment processes can have on decreasing impacts caused by this type of activity on those efforts.

For the other two coverage areas, there was one, or maybe two, other emission sources in which most of the potential impact of GGE were concentrated (values $\geq$90%).

Finally, the results showed the prominence of specific emissions variables for each coverage component in the coffee value chain. This helps establish a path to follow in order to continue deepening knowledge and developing research with results that allow us to take action. These actions include managing emissions through the use and application of technology and mechanisms or strategies in order to reduce and mitigate the impact of this activity on the environment.

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[11] Ministry of Foreign Trade in Costa Rica, online statistics.
[12] Idem previous footnote. Data for the same period.

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Glossary

ARESEP: Autoridad Reguladora de los Servicios Públicos – Public Services Regulatory Agency

BOD: Biochemical Oxygen Demand

BOD: Biological Oxygen Demand

CAPRE: Central America, Panama and Dominican Republic

CH_4: Nomenclature for molecules of methane

CO_2: Nomenclature for molecules of carbon dioxide

GGE: Greenhouse Gas Emissions

GTZ: Now GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit. German cooperation agency.

GWP: Global Warming Potential

Ha: Hectare, 10,000m^2.

ICAFE: Instituto Costarricense del Café – Costa Rican Coffee Institute

MINAE: Ministerio de Ambiente y Energía, now MINAET, Ministerio de Ambiente, Energía y Telecomunicaciones – Ministry of Environment and Energy, now Ministry of Environment, Energy and Telecommunications

NCCS: National Climate Change Strategy