Carbon Footprint of Biofuel Sugarcane Produced in Mineral and Organic Soils in Florida

Jose-Luis Izursa
Ed Hanlon
Nana Amponsah
John Capece

UF UNIVERSITY of FLORIDA IFAS

EDISON STATE COLLEGE HENDRY/GLADES CENTER

HENDRY COUNTY SUSTAINABLE BIOFUELS CENTER

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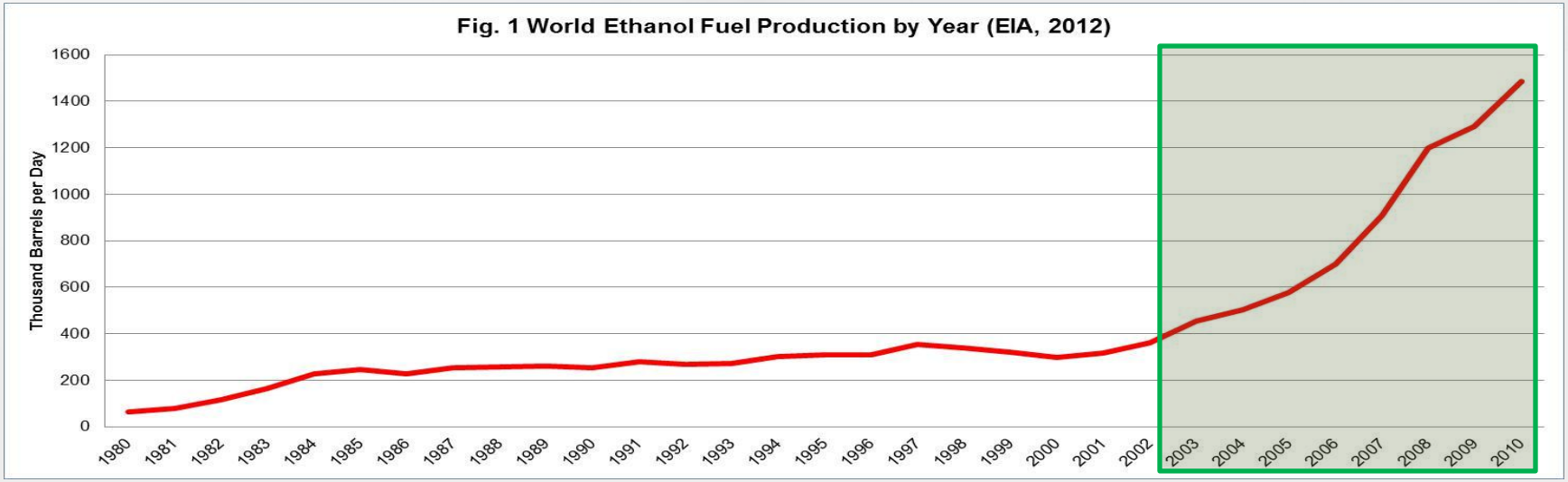
1. introduction

Why biofuels?

- Accessible form or renewable energy
- Increased popularity of biofuels
  - Started with oil crisis in 1970
  - Permanent increase since 1980



- Increase in oil prices
- Government policies, targets, subsidies, etc.
- Energy security and climate change

Biofuel sugarcane and climate change

- The role of biofuel sugarcane on climate change
  - Reduce or sequester Greenhouse Gases (GHG)
- The challenge to the agricultural sector is
    - Reduce net emissions
    - Increase feedstock production
    - Meet growing demands for food, fiber and biofuels
- Initial steps:

What are LCA and CFP?

- LCA is a standardized method for systematic analysis of flows (i.e. mass and energy) associated with the life cycle of a specific technology, service, process, etc.
- CFP is the sum of all GHGs released during the life cycle or part of the life cycle of a product, expressed as CO_2 equivalents (CO_2e).

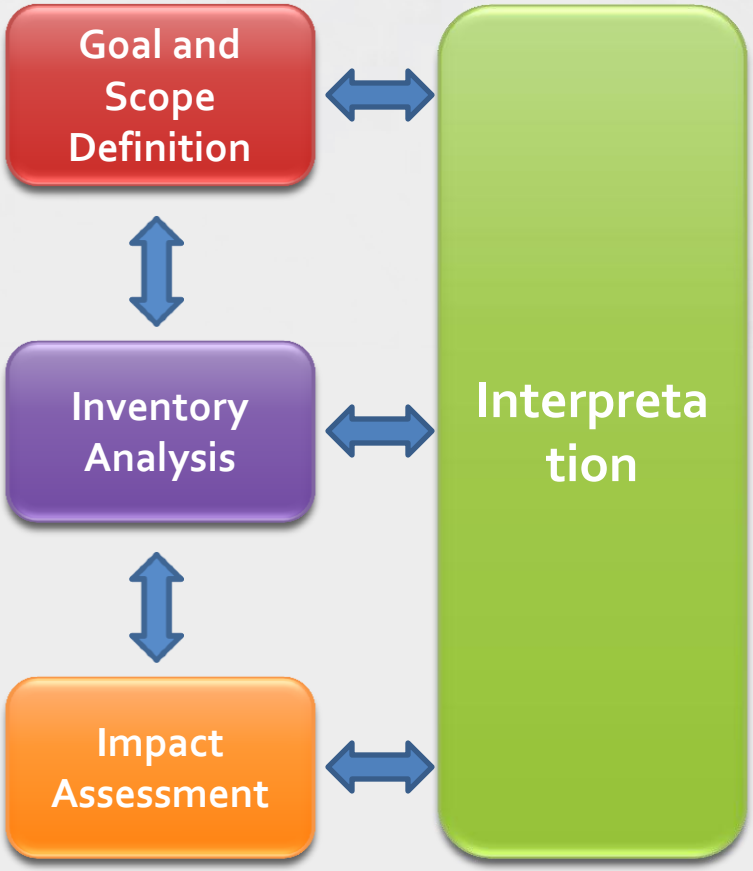


Figure 2 . Phases of an LCA - (ISO, 2006)

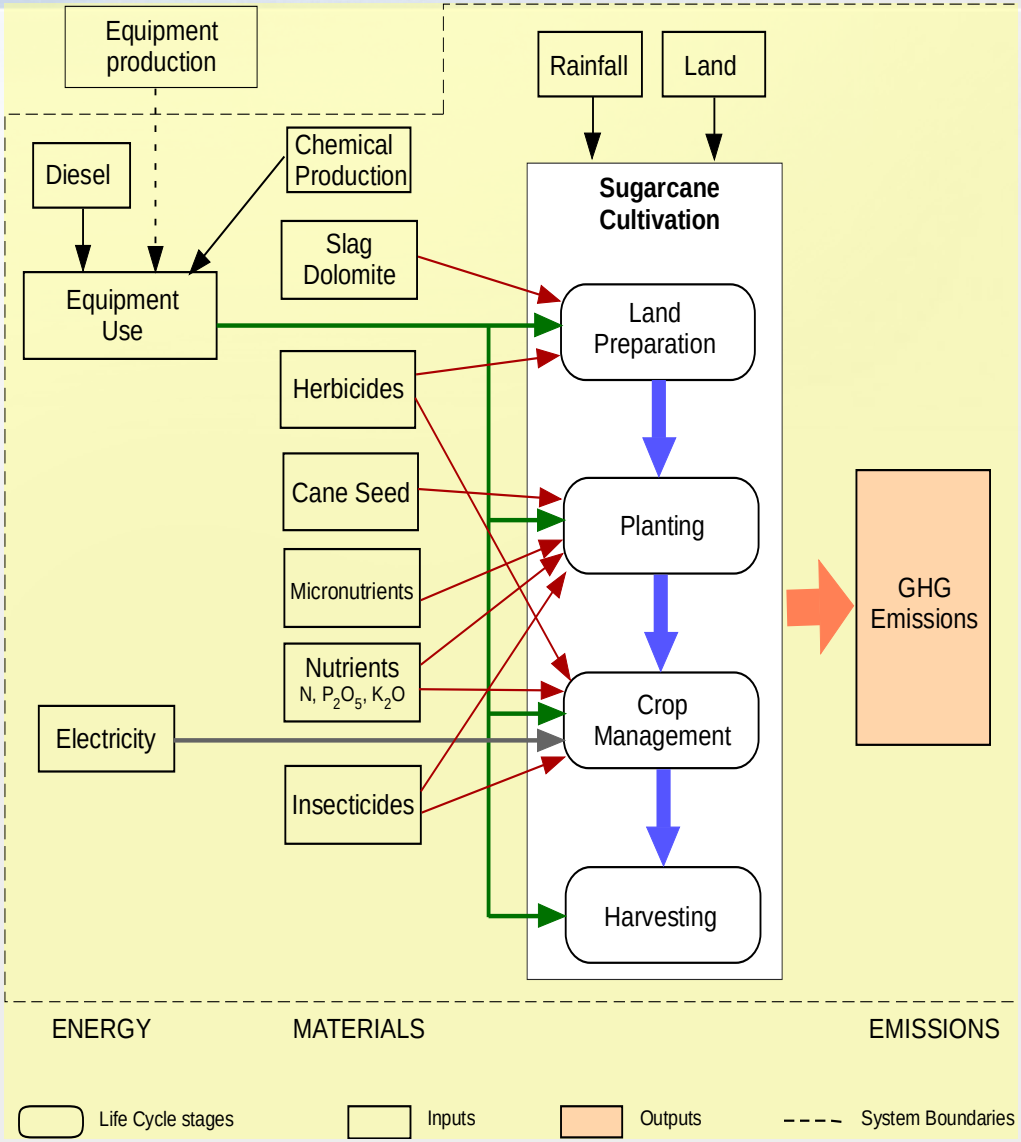
2. Materials and Methods

Study site

- EAA
- Practices commonly applied for cultivation in the EAA
- 2007/2008 and 2009/2010 for mineral and 2008/2009 for organic
- Data used from information collected from the growers and published in cost and returns reports (IFAS)

Taken from: http://pbisotopes.ess.sunysb.edu/

System Boundaries



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2. Materials and Methods (cont.)

Functional Unit

- kg CO_2e kg^{-1} of biofuel sugarcane per year
- GHGs considered:

GHG Emissions estimated

- Production and use of energy
- Use of equipment
- Application of fertilizers and pesticides
- Pre-harvesting biomass burning
- Organic land use

3. Results

General characteristics

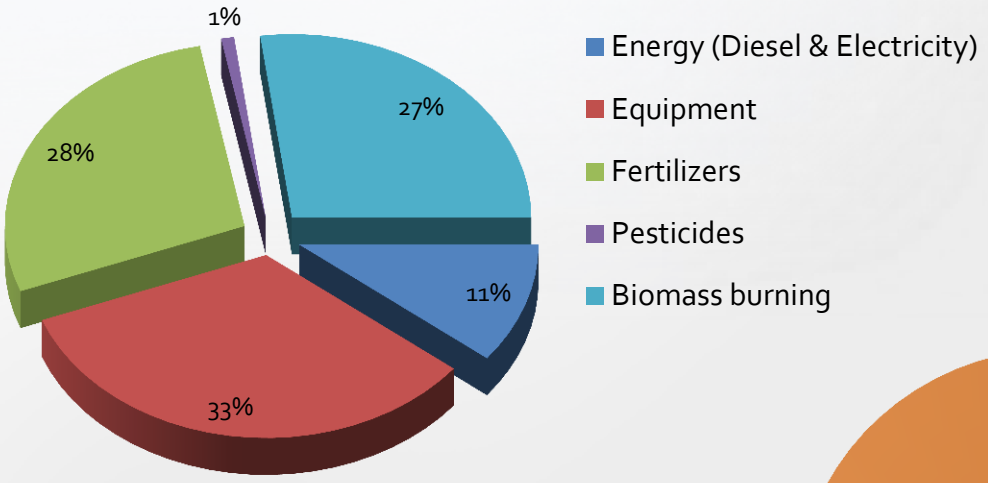
Characteristics	Mineral Soil	Organic Soil
Fraction to total (%)	20	80
Total area (ha)	29,947	119,787
Yield (kg ha^{-1})	69,000	86,000
Diesel for machine use (L ha^{-1})		
Land Preparation	115	115
Planting	164	164
Crop Management	333	333
Harvesting	89	111
Electricity (kWh ha^{-1})	118	118
Soil conditioners and fertilizers (kg ha^{-1})		
Calcium Silicate Slag	3,363	3,363
Dolomite	2,242	-
Nitrogen (N)	207	-
Phosphate (P_2O_5)	56	34
Potash (K_2O)	214	95
Pesticides (kg ha^{-1})		
Herbicides	14	15
Insecticide	8	8

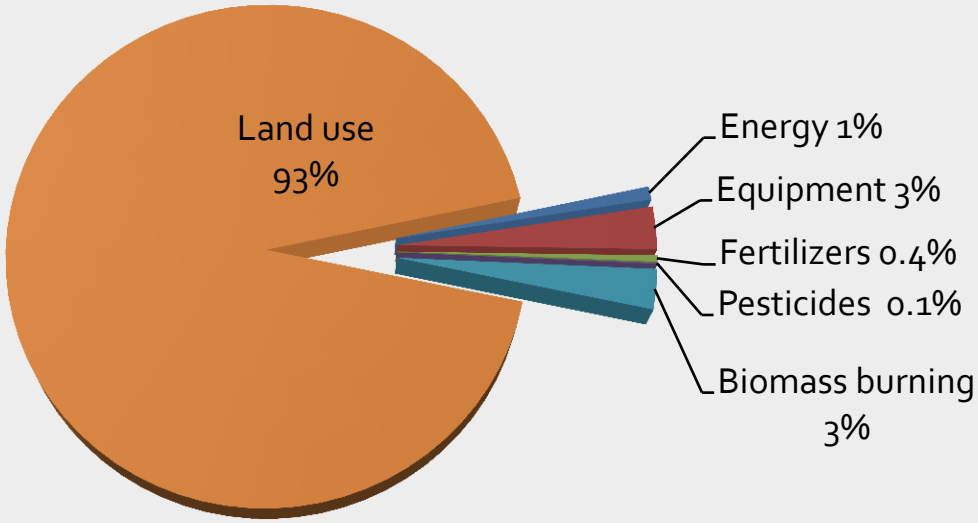
Greenhouse gas emissions

Emissions source	kg CO_2e kg^{-1} y^{-1}	
	Mineral soil	Organic Soil
Energy (Diesel & Electricity)	4.6E-03	3.9E-03
Equipment	1.5E-02	1.2E-02
Fertilizers & Soil Conditioners	1.2E-02	1.9E-03
Pesticides	3.8E-04	3.0E-04
Biomass Burning	1.2E-02	1.2E-02
Organic Soil Use	--	4.3E-01
TOTAL	4.4E-02	4.6E-01

Greenhouse gas emissions (cont.)

GHG emissions from biofuel sugarcane - mineral soil





GHG emissions from biofuel sugarcane - organic soil

4. Conclusion and Discussion

- CFP of biofuel sugarcane depends greatly on the type of soil and region

Crop	kg CO_2e kg^{-1} y^{-1}	Reference
Sugarcane mineral soil FL	0.04	Izursa *et al.*, 2013
Sugarcane organic soil FL	0.46	Izursa *et al.*, 2013
Sugarcane continental U.S.	0.05	Murphy *et al.*, 2010
Sugarcane Southern Brazil	0.03	de Figueiredo *et al.*, 2010
Sugarcane Eastern Thailand	0.49	Yuttitham *et al.*, 2011
Tomato mineral soil FL	0.19 – 0.27	Jones *et al.*, 2012

4. Conclusion and Discussion

"*Growing sugarcane on the organic soils of the EAA is by far the most significant contributor to GHG emissions in the growing of sugarcane in the continental U.S.*"
(Murphy *et al*., 2010)

The reason is subsidence

Photo courtesy of D. Morris in: (Baker *et al.*, 2007)

The rate of OM decomposition increases to the point that exceeds the rate of accumulation. As the soil is oxidized, the surface elevation subsides (decreases).

What could be done to reduce CFP?

- Use of by-products (i.e. bagasse and molasses) help to reduce GHG emissions → CFP
- Identification and utilization of BMPs that diminish the loss of carbon from organic soils
  - In the EAA, biofuel sugarcane minimize subsidence due to:
    - Its tolerance to short-term flooding
    - Rapid canopy closure reducing soil temperatures

What else?

- Maintaining a higher water table, to decrease subsidence and increase the longevity of soils
- Green manure crop
  - To retain soil nutrients
  - Return organic matter to the soil
- Harvesting green biofuel sugarcane
  - Without or reduced pre-harvest burning
    - Return considerable organic matter back to the soil
    - Consider additional crop management and resources
- Reduce the tillage process

Questions?

jlizursa@gmail.com

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