Kungliga Tekniska Högskolan

BioGrace

Ethanol from sugarcane: Analysis from Brazil case.

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Introduction

The concern about emissions of GHG gases is growing as faster as the demand of energy. The use of energies that reduce the emission of CO_2 has become a practice. The use of ethanol from sugarcane in Brazil has grown. Since July 2009, circulate in the country more than 8 million vehicles, which can run on 100% ethanol or any combination of ethanol and gasoline, the cars are popularly called "flex".

Brazil is the second largest producer of ethanol in the world, the world's largest exporter. In 2008 the Brazilian production was 24.5 billion liters, equivalent to 37.3% of global ethanol production. Together, Brazil and the United States leads the production of ethanol and in 2008 was responsible for 89% of global production and nearly 90% ethanol fuel.

The total production of sugarcane in Brazil for ethanol production was 185.976,2 thousand tons in 2010. Producing 15.4898.240,5 thousand liters of ethanol. (CONAB,2011)

Objective

The objective of this study is to analyze de GHG emission reduction in the hole process ethanol from sugarcane in Brazil. With the program Biograce and the guidelines established for the European Commission we can figure out how sustainable the process that we have in Brazil are. To achieve at least 60% of GHG emission reduction based on the standard values, we work with the land use change and improved agricultural management. Through some scenarios we can compare how we can improve the process in Brazil and see which part of the production of ethanol generates more GHG

Discussion

To make the scenario is first necessary to define the standard values, this values date are from the literature review we made from the production of ethanol by sugarcane in Brazil.

The sugarcane cultivated area for the production of ethanol in 2012/2013 is estimated to be 8.527,8 thousands hectares (Ministério da Agricultura, 2012). At the year 2011/2012, the production of sugarcane was 78.000 kg/hectare (CONAB,2011). Are expended 2000 kg/hectare seed of sugarcane (SOARES, 2009).

The moisture content of the sugarcane is 50%, 45% fibrillar structure, 5% inorganic components. Are produced 700-800 liters of vinasse per ton of sugar cane (MARABEZI,2009). According to CAMARGO et all. (2009), the density of vinasse is 1.143 kg/l, so calculating we found 52726,9 kg of vinasse per hectar. After juice treatment 6-8kg (dry basis) of filtercake mud per ton of cane are produced (MARABEZI,2009), or 461,30 tonnes of mud cake per hectar.

According to MACEDO et all. (2008), the agro chemicals that was used in 2005/2006 at the production of sugarcane was:

- N-fertiliser 48 kg ha^{-1}
- CaO-fertiser 1900 kg ha^{-1}
- Filter mud cake 461 kg ha^{-1}
- K_2O-fertiliser 171 kg ha^{-1}
- P_2O_5-fertiliser 125 kg ha^{-1}
- Pesticides 0,16 kg ha^{-1}

For each tonnes of sugarcane burned with a efficiency of 80% are produced 2,7 kg of CH_4 and 0,07 kg of N_2O. So calculating we found 177 kg per hectar of CH_4 and 4,61 kg por hectar of N_2O.

In Brazil in the production and transportation of sugarcane is not common the use of water channels. The transport are done by trucks using diesel. As we know diesel is a huge carbon font emission but the Brazilian government wants to increase the share of biodiesel in this trucks. This can be a opportunity to make the production more sustainable.

Calculation per phase — Track changes: OFF

When using this GHG calculation tool, **the BioGrace calculation rules must be respected.**
The rules are included in the zip file in which you downloaded this tool. The rules are also available at www.BioGrace.net

Quantity of product — Yield
764.400 $MJ_{Sugar\ cane}$ ha^{-1} $year^{-1}$
1,000 MJ / $MJ_{Sugarcane,\ input}$
0,283 $kg_{Sugarcane}/MJ_{ethanol}$

Cultivation of sugarcane	Value	Unit	g CO_2	g CH_4	g N_2O	g $CO_{2,\ eq}$	per kg sugarcane g $CO_{2,\ eq}$	per ha, year kg $CO_{2,\ eq}$
Yield								
Sugar cane	78.000	kg ha^{-1} $year^{-1}$						
Moisture content	50,0%							
Energy consumption								
Diesel	1.063	MJ ha^{-1} $year^{-1}$	0,34	0,00	0,00	0,34	1,19	93,2
Agro chemicals								
N-fertiliser (kg N)	48,0	kg N ha^{-1} $year^{-1}$	0,49	0,00	0,00	1,03	3,64	284,0
Manure	0,0	kg N ha^{-1} $year^{-1}$	0,00	0,00	0,00	0,00	0,00	0,0
CaO-fertiliser (kg CaO)	1900,0	kg CaO ha^{-1} $year^{-1}$	0,82	0,00	0,00	0,90	3,17	246,9
Filter mud cake	461,0	kg ha^{-1} $year^{-1}$	0,00	0,00	0,00	0,00	0,00	0,0
K_2O-fertiliser (kg K_2O)	171,0	kg K_2O ha^{-1} $year^{-1}$	0,33	0,00	0,00	0,36	1,27	99,1
P_2O_5-fertiliser (kg P_2O_5)	125,0	kg P_2O_5 ha^{-1} $year^{-1}$	0,44	0,00	0,00	0,46	1,62	126,7
Pesticides	0,16	kg ha^{-1} $year^{-1}$	0,01	0,00	0,00	0,01	0,02	1,8
Vinasse	52727	kg ha^{-1} $year^{-2}$	0,00	0,00	0,00	0,00		
Seeding material								
Seeds- sugarcane	2000	kg ha^{-1} $year^{-1}$	0,01	0,00	0,00	0,01	0,04	3,3
Field N_2O emissions	4,61	kg ha^{-1} $year^{-1}$	0,00	0,00	0,02	4,98	17,61	1373,8
CH_4 from trash burning	177,00	kg ha^{-1} $year^{-1}$	0,00	0,64	0,00	16,05		
Total			**2,44**	**0,65**	**0,02**	**24,13**	**85,30**	**6653,7**
Result		g $CO_{2,eq}$ / $MJ_{Ethanol}$				24,13		

Field N_2O emissions can be calculated in the sheet N2O emissions IPCC

Picture 1: Values for Ethanol by Sugarcane in Brazil

To make the scenarios about the land use change and improve agricultural management we change the way of the management and the input to see the difference.

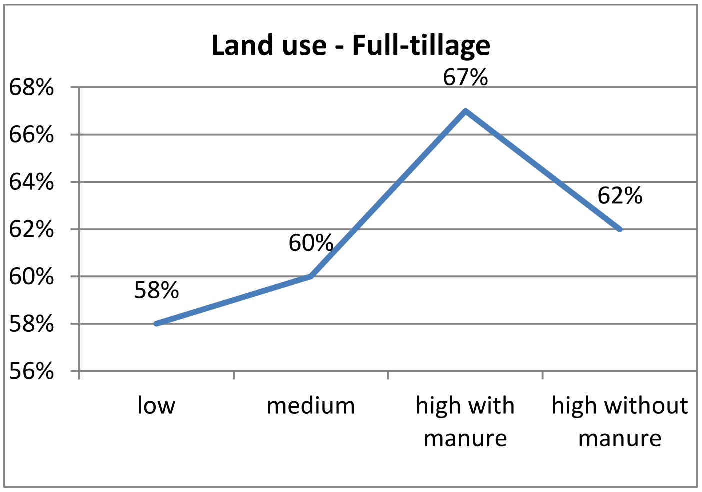
For example in the land use change:

When does the land use change occurs ? 2012

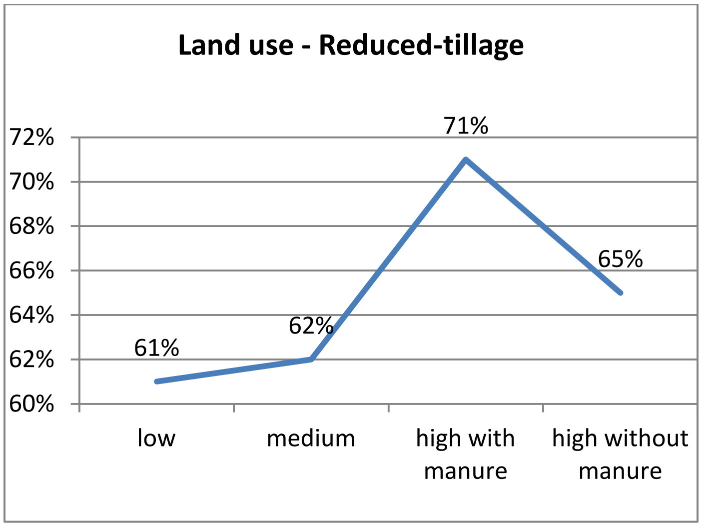
	Actual land use		Reference land use	
Climate region	tropical moist		tropical moist	
Vegetation/crop (land use)	Cultivated/cropland		cultivated/cropland	
Above and below ground vegetation				
Ecological zone (if relevant)	Tropical moist deciduous forest		tropical moist deciduous forest	
Continent (if relevant)	South america		south america	
C_{VEG}	5	ton C / ha	5	ton C / ha
Carbon stock in mineral soil				
Climate region	tropical moist		tropical moist	
Soil type	High activity clay		High activity clay	
Soil management	reduce tillage		full-tillage	
Input	high with manure		medium	
SOC_{ST}	47	ton C / ha	47	ton C / ha
F_{LU}	0,48		0,48	
F_{MG}	1,15		1	
F_I	1,44		1	
Resulting carbon stock	CS_A = 42,4	ton C / ha	CS_R = 27,6	ton C / ha
Resulting LUC	e_l = -2,71	ton eq. CO_2 / ha / an		

Picture 2: Land Use Change reference values

The reference data is the reference of Brazil case and this values we can find on the guidelines for calculation. So we change some values in the actual land use about the soil management and input to see the results that we can have. For results we can find the GHG emission reduction for reduce tillage and full tillage case.

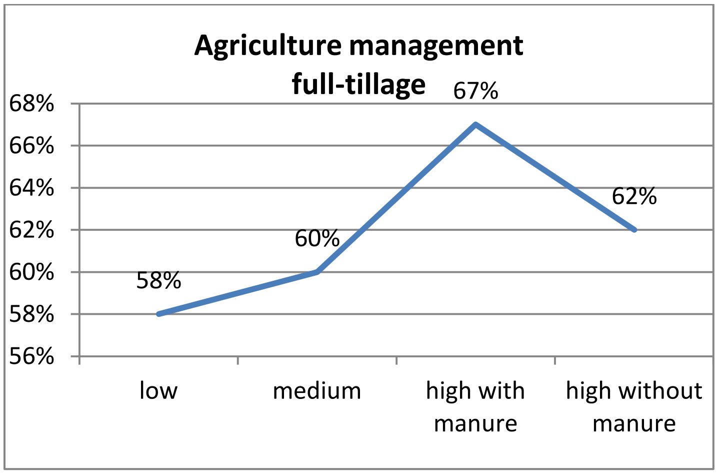


Graph 1: GHG emission reduction with different types of input for Full-Tillage

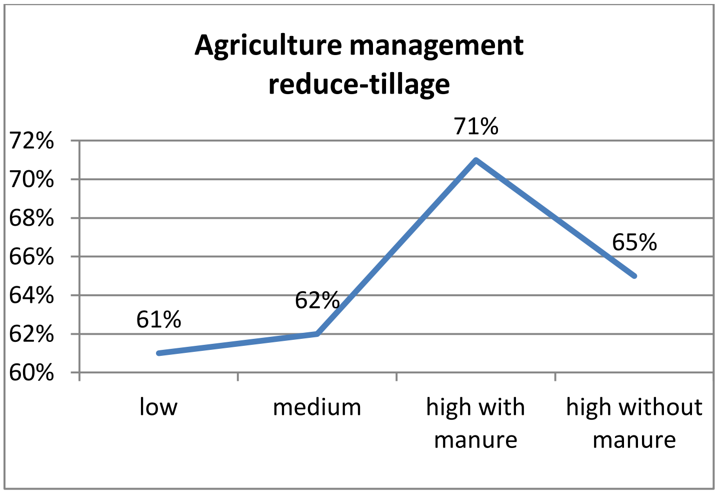


Graph 2: GHG emission reduction with different types of input Reduced-tillage

In the case of agriculture management we did the same analysis for both soil management. And our results are :



Graph 3: GHG emission reduction with different types of input for Full-tillage



Graph 4: GHG emission reduction with different types of input for Reduce- tillage

As we can see the best case of both studies is the reduce-tillage with the input high with manure. When we combine the best case of land use change and agriculture management 83% of GHG emission reduction.

Conclusion

As we can see on the table below the part of the production of sugar cane for ethanol that emits more GHG is the cultivation. Even if we work with land use change this will not affect too much on the process. The biggest problem in the cultivation is the emission of CH4 for trashing burn. But this process will be change for the mechanization until the year 2018, by the Brazilian government law. If we only cut off the CH4 emission on the cultivation the GHG emission reduction will grows from 60% to 79%. Another point that will affects the GHG emission reduction is the improvement of the agricultural management. This requires investments and studies about new technologies, that are already been done.

All results in $g\ CO_{2,eq}$ / $MJ_{Ethanol}$	Non- allocated results	Allocation factor	Allocated results	Total	Actual/ Default	Default values RED Annex V.D
Cultivation e_{ec}				**24,4**	**A**	**14**
Cultivation of sugarcane	24,13	100%	**24,13**			14,45
Transport of vinasse and filt	0,24	100%	**0,24**			
Processing e_p				**0,9**	**A**	**1**
Ethanol plant	0,85	100%	**0,85**			0,84
Transport e_{td}				**8,6**	**A**	**9**
Transport of sugarcane	0,46	100%	**0,46**			0,84
Transport of ethanol	7,73	100%	**7,73**			7,70
Filling station	0,44	100%	**0,44**			0,44
Land use change e_l	**-9,8**	100%	**-9,8**	**-9,8**		0
Bonus (restored degraded la	**0,0**	100,0%	**0,0**	**0,0**		0
$e_{sca} + e_{ccr} + e_{ccs}$	**9,8**	100%	**9,8**	**9,8**		0
Totals	**14,2**			**14,2**		**24**

Picture 2: Summary of the GHG emission share

At the transport of vinasse and filter mud cake, changing the percentage of the use of different kinds of transportation as: Tanker truck, tanker truck with water cannels and water channels the percentage of GHG emission will not change.

Reference

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