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Calculation of CO_2 Emission Derived from Land-Use Change from Soybean Production at Rio Grande do Sul state, Brazil

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Calculation of CO_2 emission

One of the environmental impacts that present great concern nowadays, the green-house gases (GHG) emissions affects decision-making from both government and private sector [1-3]. Within this concern, the soybean biodiesel production had an exponential growth has been the target of discussion in the scientific community, mainly because soybean oil represents main raw material answering for 79.1% of biodiesel supplying in Brazil [4,5]. Besides that, some studies point out that impacts due to GHG emissions differ greatly if the changes in the land used were accounted for. Moreover, according to Grillo et al. [6] the regional specificities are key factors to analyze environmental impacts of biofuels based on a life cycle assessment. Due to the distinct energy sources, transport facilities, farming practices and LUC, the results might present significant variations of one country to another or even in the same country, like Brazil with its continental size. However, there are few studies that embrace the biodiesel agricultural phase from soybean cultivated specifically in RS [7].

This work presents an assessing of dLUC impacts in Rio Grande do Sul state (RS), related to soybean advance over other cultivations and grassland areas in RS in a period of 20 years (between 1992 to 2013). The region is the third biggest soybean producer in Brazil and in 2012/2013 this state harvested 12.5 million tons of soy amount higher than Paraguay soybean production, the sixth biggest world producer. dLUC impacts was calculated following the Intergovernmental Panel on Climate Change (IPCC), more specifically the Tier 1 approach that based on only in basic data of land use (census, statistics, etc.). So, initially the last 20 years of land use associated to soybean production were investigated to identity the total of dLUC area. In the case of this study were used official data of RS Land Use, Agricultural Census database, Historical series of corn, rice and soy from National Supply Company of Brazil, the Rice Crop Estimate Report 2013/2014 from Rice Rio Grande do Sul Institute and the Rice and Soybean Yearbook with the intention to estimate the transition (pasture-farming) and advancement of soybean over other areas designed to other farming cultures. Later, GHG impacts of dLUC were calculated following IPCC method.

Due to lack of information about the soil conservation conditions related to grasslands before the soybean advance, it was created three scenarios based on three references of grasslands situations (R1, R2 and R3). In these cases R1 represents the best condition considering that all grasslands derived from improved pastures with high conservation, R2 presents an approach more conservative with moderate conservation and R3 would be the other extreme with grasslands presenting severe degradation and therefore lowest stock carbon.

The results show that there was an increase of soybean area of 49% between 1992 and 2013. In this same period it possible to observe a decreasing of pasture areas and an increasing of forested areas that points out for a soybean advance over grasslands areas. However, when the data is cross-checked with rice and corn plantation areas, it is possible to observe that soybean expansion occurred also in this kind of cultures corresponding around 6% of soybean total area over rice cultures and around 12% of corn areas. While the advance in rice cultures was motivated because two thirds of rice areas must be kept set-aside, i.e., without cultivation and therefore allowing an advance of soybean, the corn cultures faced low prices period - 75% of the corn demand is designated to animal production market, stimulating soybean preference for the producers due to the competitively of this last culture. The rest of the advancement took place in grasslands areas. Thus, besides soybean advance over different cultures, only areas originating in grasslands are considered to LUC accountability. For that reason, the advance over rice and corn cultures was disregarded, because IPCC do not consider them as a dLUC. In consequence only 15.4% of the total soybean harvested area was defined as LUC. In relation to the GHG emission calculation due to LUC in RS, it was made some definitions such as: the soybean culture did not advance over forested areas and the rice and corn areas corresponding to 53% of the total advanced soybean area. Consequently, only 47% of the total soybean advancement area took LUC and, for that reason, for each hectare of cultivated soybean,

15.4% are areas that contribute to GHG emission in function of dLUC stock carbon. Based on these pieces of information, it is possible to estimate that RS has changed among 0.03 to 1.03 tCO_2 eq.ha-1.ano-1 from LUC considering the best and the worst scenario. In this contest, the results of this study are vastly different compared with other studies. According to Grisoli et al. the LUC emissions in RS in order to 2.05 tCO_2 eq.ha-1.ano-1, while Castanheira and Freire affirms that pasture-farming transition (soybean in no-tillage system) is responsible for emissions in order of 0.18, 3.11 and 6.78 tCO_2 eq.ha-1.ano-1 as it relates to conservation references of pastures R3, R2 and R1, respectively. Actually these differences arise, because these studies considered soybean advance over forested and perennial crops areas, not considering the expansion over seasonal crops, i.e., corn and rice.

In conclusion, during this research, a soybean growing, mainly on seasonal croplands, that result in a different accounting in relation to current inventories that show soybean cultivation moving forward on forested areas was found. In this case, it was verified that this work, following The Intergovernmental Panel on Climate Change (IPCC) methodology, the land use change (LUC) occurred in only 15.4% of the area, where soybean cultivation moved forward for 20 years.

Finally, this work also suggests future discussion for methodologies that encompass soybean cultivation advanced over wetland areas, focusing potential impacts of soybean areas over rice lands, according to what is pointed out in this study.

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