CEREALS STRAW POTENTIAL USE FOR MITIGATING INDIRECT LAND USE CHANGES EFFECTS OF BIOETHANOL CONSUMPTION IN SPAIN

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INTRODUCTION & OBJECTIVE

Indirect Land Use Change (iLUC) impacts of biofuels refer to the effects of potential additional emissions due to land use changes triggered by the expansion of energy crops in response to increased biofuel demand (Figure 1). These impacts relate to the unintended consequence of liberating more carbon emissions due to land use changes around the world. These emissions are mostly GHGs, thus relevant to the climate change impact category in Life Cycle Assessment (LCA).

A previous study [1] on iLUC emissions of bioethanol consumption in Spain showed a great interval of GHG emissions (16 to 56 g CO_2 eq/MJ). Cereals straw was considered as waste, so no iLUC effects were taken into account. This research aims to calculate the potential quantity of sustainable straw in cereal crops (wheat and corn), and the potential reduction of total life cycle GHG emissions, including iLUC, if different cereals straw uses are considered: fertilizer substitute when it is incorporated to the same crops, and raw material to produce second generation bioethanol and electricity.

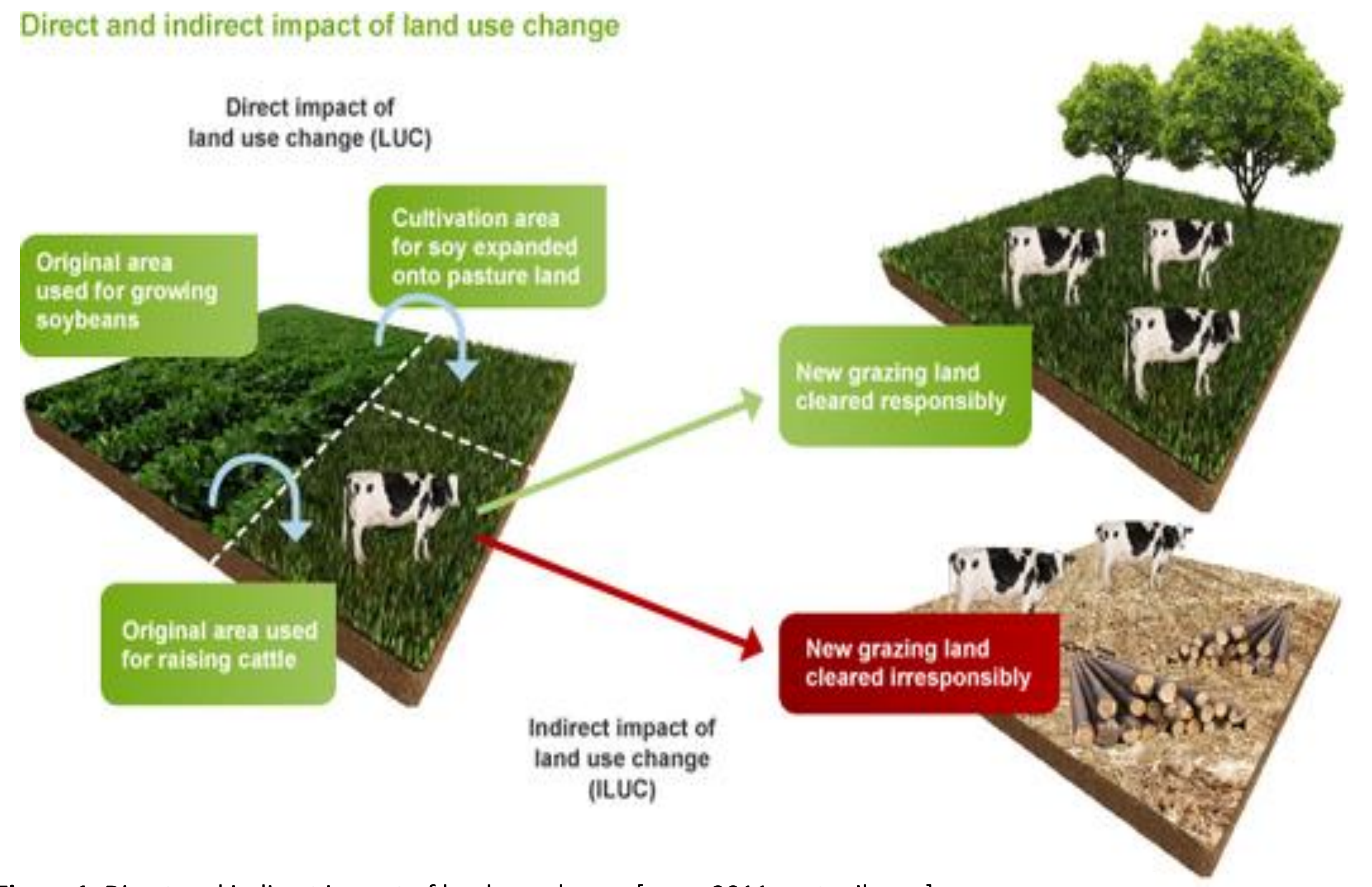

Figure 1. Direct and indirect impact of land use change [www.2011.nesteoil.com].

MATERIALS & METHODS

Figure 2 shows the production process of bioethanol considering the system limits expansion for co-products in order to include the production and use of DDGS which replace protein and energy in the feed market, and the consideration of straw as alternative use.

The method for estimating the theoretical and sustainable straw potential follows the approach taken by the JRC-EC [2]. It should be necessary the obtention of crop production data in order to estimate the theoretical potential by using the ratio straw-to-crop.

The method for estimating the potential reduction of GHG of alternative uses of straws follows the substitution method in case of multi-production in LCA. In case of fertilizer, the value of 72 kg CO_2 eq/ton of dry straw has been considered [3], while a ratio of 4.5 to 1 [2] and a mean value of 55 Mg CO_2 eq/TJ [4] has been taken in to account when straw is used to produce bioethanol an electricity, respectively.

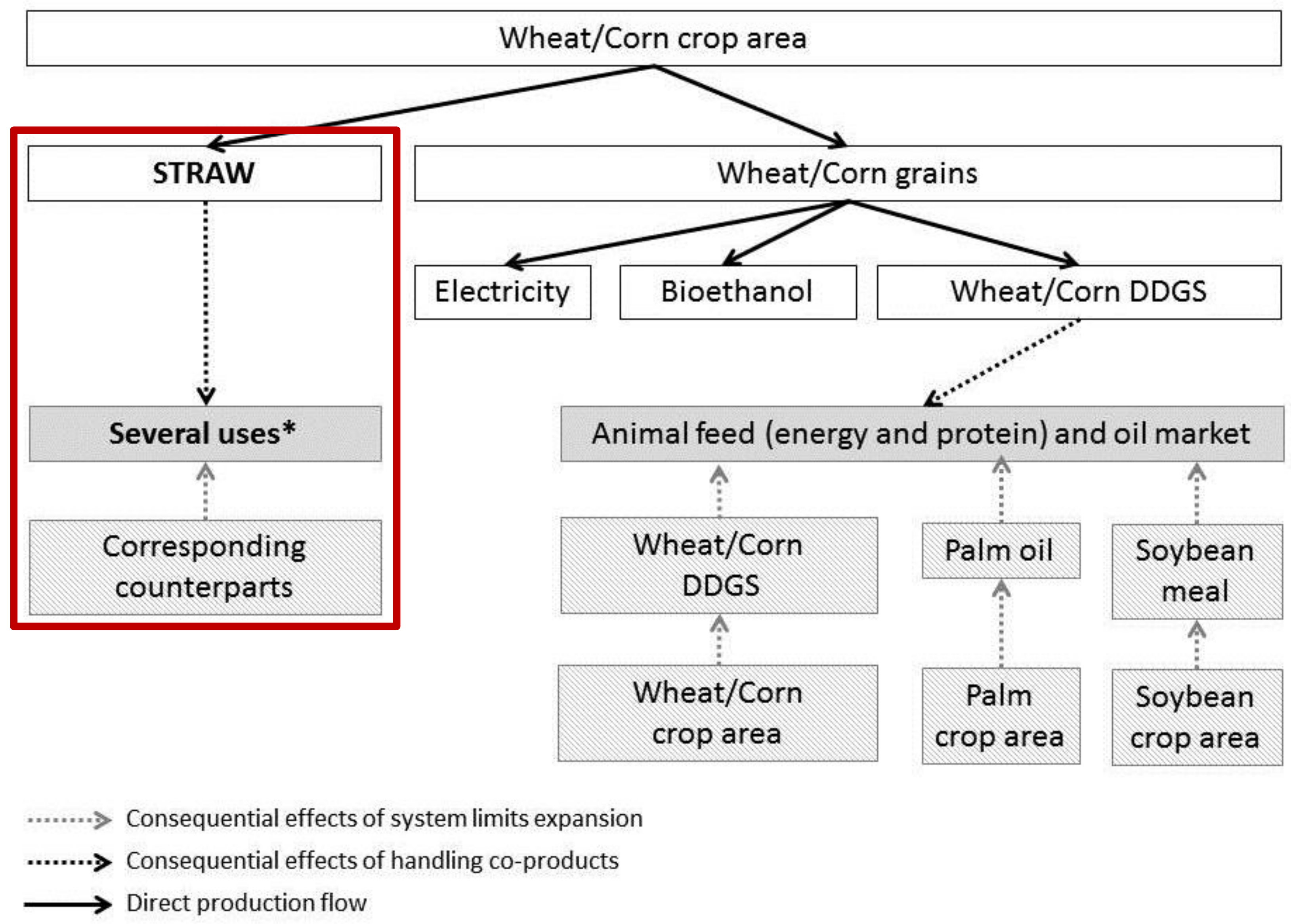

Figure 2. Diagram flow of bioethanol production from wheat and corn, co-products and definition of system limits expansion (adaption and modification from [1]).

RESULTS

Theoretical and sustainable straw potential

Two main sources of origin of crops have been selected according to the most important suppliers of raw material to Spain: United States and France. Table 1 shows the annual results for each case.

Table 1. Ratios and annual estimated theoretical and sustainable straw potential for each crop (million of tonnes).

Crop type	Straw-to-crop ratio	Theor. straw potential	Sust. straw potential
Wheat			
France	0.27	10.75	5.37
USA	0.13	7.56	3.03
Corn			
USA	0.29	95.45	38.18
France	0.91	9.82	4.91

Potential reduction of GHG of alternative uses of straw

Results from total LCA of bioethanol and those from Table 1 has been used as the base case for applying the three scenarios above described. The annual life cycle GHG emissions range is: 4.61E+11 (1.51E+11) – 8.40E+11 (5.30E+11) g CO_2eq (iLUC values in brackets). Table 2 shows the corresponding GHG savings.

Table 2. Total annual GHG emissions savings (g CO_2 eq) and the percentage of reduction in the considered scenarios.

Scenario	GHG emissions savings	Reduction (%)
Fertilizer	1.14E+11	25-14
Raw material to bioethanol	3.03E+11	66-36
Raw material to electricity	5.20E+11	112-62

DISCUSSION & CONCLUSIONS

- Cereal straw is widely available in the involved countries and can be sustainably harvested in large quantities of which a significant amount can be used as a low ILUC bioethanol feedstock.
- Straw-to-crop ratio is a variable that could have a high uncertainty, so the final figures of the sustainable straw potential could vary significantly. Nevertheless, these identify the highly added value of waste management in order to minimize GHG emissions and their corresponding environmental impacts.
- Regarding the GHG emissions savings of the alternatives, all of them seem to be appropriate to reduce the impact significantly. These credits are acceptable when the totality of straw is considered to be used as alternative, that is to say, in the most optimistic scenarios.

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