Economic and Environmental Possibilities of Sugar Beet In Spain: Towards Bio-ethanol Production?

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Economic and Environmental Possibilities of Sugar Beet In Spain: Towards Bio-ethanol Production?

LOYOLA

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Introduction

Since 2006 sugar beet in Europe has suffered a deep transformation. In Spain, sugar beet has been the main raw material for sugar production, being a familiar farming. In that context, the possible survival of great part of this farming is derived to bio-ethanol elaboration in according to the new EU strategy. We have made an empirical approach to learn about future viability of the sector with environmental efficiency analysis (Greenhouse Gases emissions) caused by sugar beet farms with the aim of studying environmental non-market goods derived from bio-ethanol production. Goods that take part of the environmental function of this economic activity as a positive externality.

Sugar beet farming in Spain: the survey

THE QUESTIONNAIRE: three basic parts: a) owner identification and farms general characteristics; b) sugar beet farms expenses and c) income linked to sugar beet farming.

SAMPLE DESIGN: was based on five basic principles: a) Sugar beet farming surface and territorial distribution, b) Farms size, c) Production economic value, d) Minimum number of individual observations, e) Geographical distribution. We opted for using proportional sample (Festinger, 1998). They were analyzed two productive regions with a level of significance and representativeness: Andalusia and Castilla-León.

SAMPLE CHARACTERIZATION: four different farming/farm; dedicating an average of 27.5% of its surface to sugar beet farming; 77% of farms sugar beet farming is less than 40% of the total agricultural area and only 13.25% of them dedicate the whole area to this farming. Total expense per ha in Castilla-León is significantly less than in Andalusia (Andalusia salary expenses per ha are higher). North farm dimensions are smaller and familiar than South farm. In Castilla-León productivity level is higher (27%) in the north than in the south because varieties planted in the north have a higher average productivity per ha. So sugar beet farming in the north present a better economic situation.

EXPERTS' OPINION: three Focus Groups. They concluded that sugar beet future is conditioned and, especially from an energetic point of view, only suitable varieties that could reduce 10% of expenses and achieve a significant increase of yield (to 150 t/ha).

Environmental efficiency analysis: DEA

Data Envelopment Analysis (DEA) is a mathematical programming measure technique which assesses the relative efficiency of comparable decision-making units –producers– or DMUs. A DMU is efficient if and only if the performances of other DMUs do not improve the input allocation or output production without worsening some others inputs or outputs (Cooper et al., 2004). In this research, DEA is used to model the environmental efficiency from GG emissions of using sugar beet to bio-ethanol production in Spain, corrected by means of the nitrogen fertilizer emissions in cultivation (Piot-lepetit et al., 1997, and Zhang, 2008). Three bad inputs are exclusively considered.

INPUTS AND OUTPUTS: The optional input variables are the following: SUP= Hectares surface; SYP= Seeds and seedlings annual costs; FER=Fertilizers annual costs; FIT= Phytosanitary annual costs. And the outputs were the following:

MDB= Greenhouse gases reduction by bio-ethanol use in CO_2 t beet equivalents;

MDP= nitrous oxides emissions (N_2O) by fertilizers use in CO_2 t N/kg equivalents

Studies on GG emissions by substituting petrol for bio-ethanol

Research	Crop (t/ha)	Bio-ethanol performance (t/ha)	Production Efficiency Bio-ethanol (l/t raw material)	Bio-ethanol (l/ha)	Emissions saving (CO_2 t/ha equivalent) Mixtures E10	% Km saving Mixtures s E10
Levy, 1993	66	5.28	101.3	6,600	3.54	35%
	78	6.24	101.3	7,800	7.22	56%
European Commision, 1994	87	3.75	54.1		2.12	50%
GM et al., 2002	--	--	--	--	6.50	41%
Rajagopal y Zilberman, 2007	100	--	110	7,370	--	--
Woods y Bauen, 2003	45-80			4,800-7,800		0-70% (2)

Conclusions

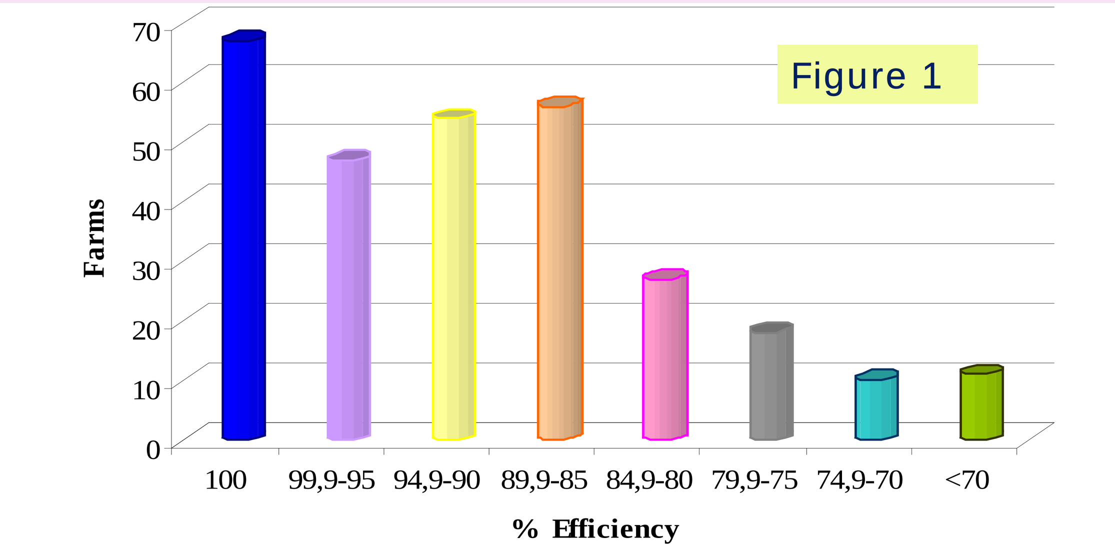
As a consequence of CAP application, certain beet producers have been expelled from the market, being practically limited to two zones in Spain: Andalusia and Castilla-León. In this context, farmers, professional associations and Spanish research centres for beet cultivation have made a great effort which has led to an increase on crop yield per ha obtained from the I+D+i investment with important varietal and technological improvements. Three are the main expenditures: seeds, fertilizers and phytosanitary. Average expenditure per hectare in the North zone, Castilla-León, is higher than in the South zone, Andalusia.

On the other side, energetic farming support can be granted whenever it is destined not to food production. Besides, this support can be joined to environmental goods provision because sugar beet production destined to ethanol production helps greenhouse gases reduction. From GG emissions point of view and considering variable scale yields, the 22% of farms have been efficient and those which are inefficient need to reduce fertilizers and phytosanitary use to improve nitrous oxide emissions to atmosphere.

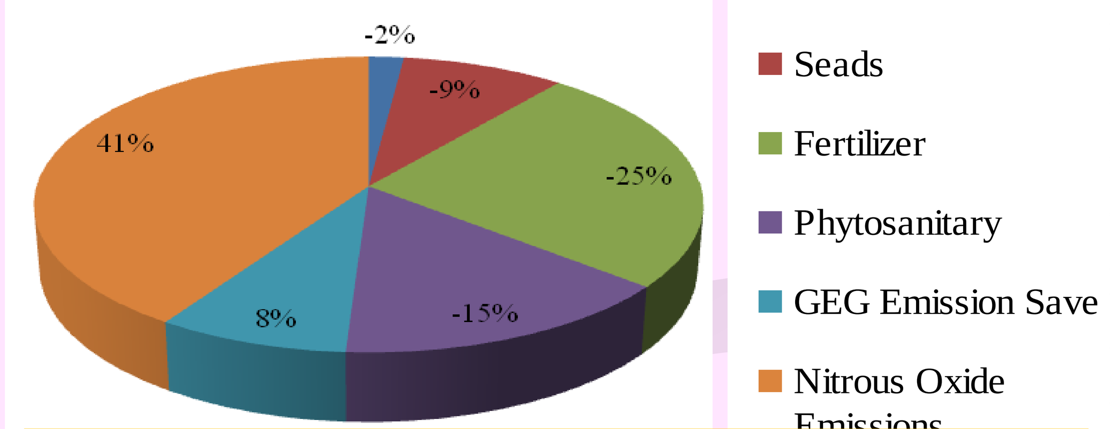
Larger farms could seem to be more efficient in that aspect. However, small and medium size farms are the most efficient ones. Andalusia farms present a higher GG emission saving. Sugar beet consumption is situated over European production and surface destined to Bioenergetics farming has been considerably reduced since 2008. Future trend seems to be directed to import any type of crop to be used as raw material suitable for bio-ethanol production. Therefore, there is the possibility of disappearance of sugar beet production in the European agrarian model.

RESULTS

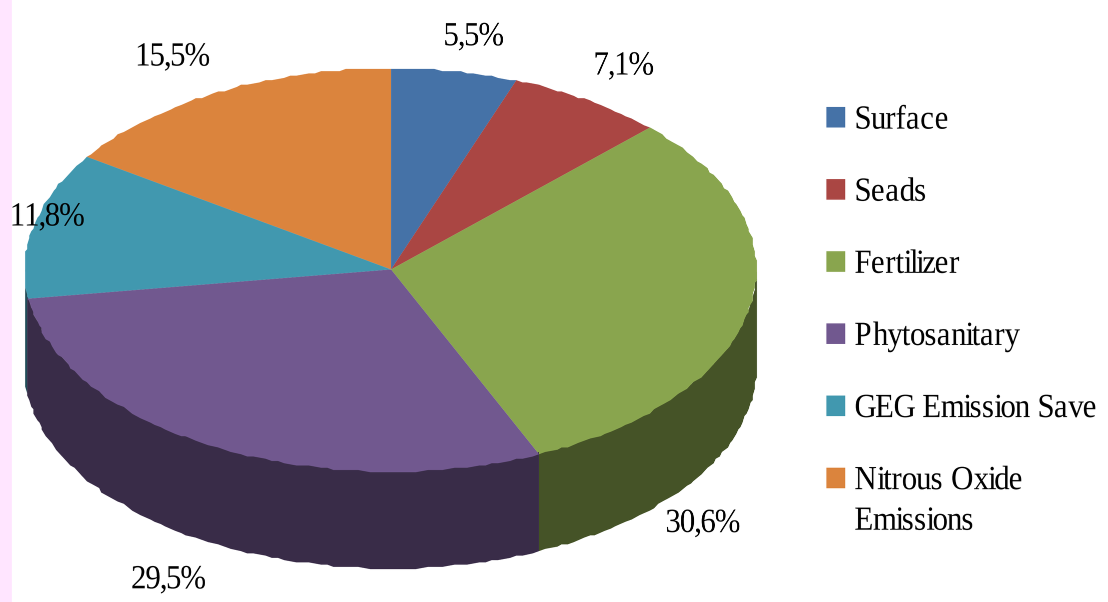
In the estimated model, there are 66 efficient farms from the GG emissions point of view which represents the 22% of samples. So, these DMU represent an efficiency of 100% (θ^*=1) and they do not have to make improvements as they have zero gaps (s^{-*}=0 y s^{+*} =0). Efficiency media index has been 90.55% and the dispersion, measured through the typical deviation is 7.6, situating most farms index over 85% while 14% of the farms have efficiencies lower than 80%. We should emphasize that only two are situated under 60%. Distribution of efficiency values is shown in Figure 1



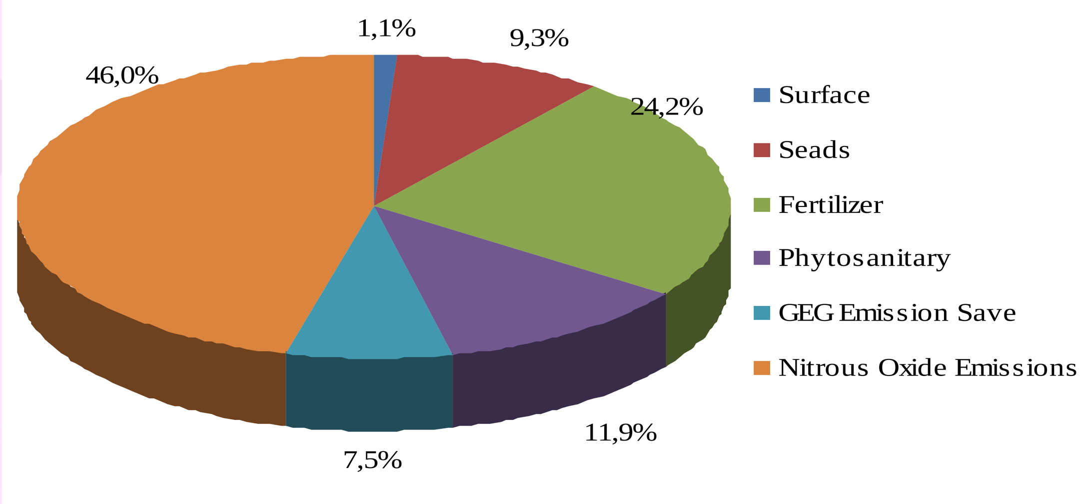
Potential average improvement



Average potential improvement in Andalusian



Average potential improvement in Castilla-León



Examples of efficient farms

DMUs	Ha.	Eficiency (%)	Inputs weight				Outputs weight	
			w_{Area}	w_{Seed}	$w_{Phytosanit}$	$w_{Fertilizer}$	w_{GG}	w_{N2O}
46	3.0	100	74.31	18.22	0.0	7.46	58.61	41.39
93	2.0	100	94.52	5.47	0.0	0.0	15.44	84.55
253	2.5	100	32.24	67.75	0.0	0.0	29.10	70.85
254	12.0	100	79.84	1.43	12.94	5.77	67.54	32.46
92	20.0	100	96.42	3.57	0.0	0.0	72.51	27.48
7	40.0	100	97.4	0.0	0.0	2.57	89.74	10.25
185	67.0	100	40.43	40.43	10.72	8.41	100.0	0.0

Examples of inefficient farms

DMUs	Ha.	Efficiency (%)			w_{Area}	w_{Seed}	$w_{Phytosanit}$	$w_{Fertilizer}$	w_{GG}	w_{N2O}
201	25.0	48.33			75.4	16.9	0.0	76.0	100.0	0.0
DMUs Reference					s_{Area} (%)	s_{Seed} (%)	$s_{Phytosanit}$ (%)	$s_{Fertilizer}$ (%)	s_{GG} (%)	s_{N2O} (%)
195	207	239	243		0.0	0.0	-49.8	0.0	106.9	184.3

DMUs	Ha.	Efficiency (%)	w_{Area}	w_{Seed}	$w_{Phytosanit}$	$w_{Fertilizer}$	w_{GG}	w_{N2O}
204	30.0	50.99	0.0	97.5	2.4	0.0	100	0.0
DMUs Reference			s_{Area} (%)	s_{Seed} (%)	$s_{Phytosanit}$ (%)	$s_{Fertilizer}$ (%)	s_{GG} (%)	s_{N2O} (%)
195	207	239	-3.1	0.0	0.0	-40.2	96.2	104.4

DMUs	Ha.	Efficiency (%)			w_{Area}	w_{Seed}	$w_{Phytosanit}$	$w_{Fertilizer}$	w_{GG}	w_{N2O}
37	6.0	60.49			96.0	0.0	4.0	0.0	73.2	26.7
DMUs Reference					s_{Area} (%)	s_{Seed} (%)	$s_{Phytosanit}$ (%)	$s_{Fertilizer}$ (%)	s_{GG} (%)	s_{N2O} (%)
66	73	111	268		0.0	-14.7	0.0	-42.1	65.3	64.3

DMUs	Ha.	Efficiency (%)			w_{Area}	w_{Seed}	$w_{Phytosanit}$	$w_{Fertilizer}$	w_{GG}	w_{N2O}
187	14.0	64.8			0.0	97.5	2.4	0.0	100	0.0
DMUs Reference					s_{Area} (%)	s_{Seed} (%)	$s_{Phytosanit}$ (%)	$s_{Fertilizer}$ (%)	s_{GG} (%)	s_{N2O} (%)
55	185	195	207	246	0.0	0.0	0.0	-32.6	56.0	54.1

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