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The economics of oil-seed crops for energy use: a case study in an agricultural European region

Abstract. There's a strong link between the production of biofuels and energy crops. The first of these activities may contribute to the appearance of new products in agriculture, besides giving a boost to activities such as provision of services and aiding in the diversification of economic activities in rural areas. Farmers' final decision to include energy crops into or exclude them from their productive alternatives depends on various factors of a different nature (political, legal, technical, economic or socio-cultural). This paper analyzes the socio-economic aspects related to the introduction of oil-seeds (sunflower and rape seed) as energy crops in one of the most important agricultural regions in Spain (Castile and Leon). Thus, using RRA (Rural Rapid Appraisal) and the Economic Accounts for Agriculture (EAA), the study provides an evaluation of the main economic accounts of these crops and an idea of their profitability, impact on the level of employment and environmental consequences.

Key words: energy crops, profitability, Rural Rapid Appraisal (RRA), Economic Accounts for Agriculture (EAA), renewable energy.

Background

Agriculture and energy policy constitute two closely linked elements. Energy crops may act as a strategic tool giving support for the provision of raw material and thus contributing to encouragement for participation by biofuels in energy supplies and achievement of the objectives of the current energy policy. Simultaneously, they would boost a sector (agriculture) that is clearly in crisis because of the impossibility of finding market-viable alternative products. Thus, energy crops might become a new output that permits the survival of the activity, with the associated social and environmental functions that it carries with it, as recognized by previous literature and by Directive 2003/30/EC itself [Directive… 2003]. In fact, Agenda 2000 already supported these objectives, through authorizing the use of set aside (introduced in 1992 reforms) for non-food crops, as also new economic incentives for sowing energy crops (energy crops aid). Later reforms of the CAP accentuated even further the crucial role of energy crops through the introduction of a number of measures such as decoupling. Summarizing, three mechanisms: decoupling, the adjusted regime for set-aside and the premium for energy crops, included in Council Regulation 1782/2003/EC [Council… 2003], have been interacting over the last few years to promote the introduction of energy crops. More recently, in an attempt to fit the upcoming CAP to the European Union (EU) citizens' requirements [The Common… 2010], the European Commission presented a new document 'The CAP towards 2020' [Communication… 2010] reinforcing the above mentioned aspects and stressing that the

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future CAP should contain a greener and more equitably distributed first pillar and a second pillar focussing more on climate change and the environment. Thus, further efforts in the field of biomass and renewable energy production will be required to meet the EU energy and climate agenda.

Agricultural policies certainly play a very important part nowadays in determining the profitability of agriculture, especially in less developed areas, as it's the case of Castile and Leon. At present, the single payment scheme has become the main mechanism for direct support for farmers' incomes. This payment system, together with the new proposals for the CAP, especially with reference to cancellation of subsidies for energy crops and abolition of obligatory set-aside and decoupling, set up a new framework which may well be of considerable influence in the case of this region. In such zones, the yields and costs of production lead to a very small profit margin for certain products, which the subsidy for energy crops (no longer in existence after 2010) had much more weight than in other European regions for [Vannini *et al.* 2006]. Hence, the elimination of compulsory set-aside opens up the possibility of using land previously covered by energy crops for any market orientation whatsoever, due to the competitiveness between the two markets (food and energy markets) which is the basis of the scarce development of energy crops up to the moment. This would give rise to a consequent need to implement new incentives if the intention is to consolidate regional supplies, this being an aspect also stressed in other studies [El biodiesel… 2007; Panoutsou 2007].

In any case, the final decision to include or exclude energy crops when considering alternatives for production lies with the entrepreneur (the farmer) and if energy crops are to be grown, farmers must perceive some advantage in the financial results of growing them [Robles & Vannini 2008]. In relation to this point (economic viability and readiness of farmers to sow such crops), regional studies hitherto undertaken [Rodríguez López et al. 2006; Rodríguez López & Sánchez Macías 2007] would seem to concentrate exclusively on an assessment of the range of prices that the manufacturing sector is willing to offer and the producers to accept. They do not appear to take into consideration variables which may have a considerable impact, such as production costs and the variations in the prices for the inputs used in the production process, or the different kinds of growing systems, among others. Furthermore, these studies [Rodríguez López & Sánchez Macías 2007; Rodríguez López et al. 2006], although recent, were carried out under political and socio-economic conditions appreciably different from the present state of affairs, which makes it necessary to evaluate the sector within this new context. In any case, these studies point to a need to encourage research techniques that will allow a reduction in costs, the incorporation of actions of an environmental nature directly related to energy crops, like those tending to avoid any degradation of soils or of the natural surroundings, and a boost for the culture of sustainable farming and energies [Rodríguez López et al. 2006].

In this new context, the present paper aims to analyse the economic accounts for the production of the main local energy crops (rape seed and sunflower), using different systems for production (traditional cultivation, minimum tillage and direct sowing).

Methodology

The methodology implemented to undertake the work being reported here is based on the Rapid Rural Appraisal (RRA) and the methods employed for calculating economic accounts for agriculture (EAA), as explained by European Parliament and Council of the European Union [Regulation… 2004] and Commission of the European Communities [Commission… 2008].

RRA is a semi-structured research method half way between quantitative and qualitative research techniques, allowing a reduction in the time and cost required for obtaining data. This technique, extensively used in the area of rural development [Marketing… 1997], is employed for gathering information and formulating new hypotheses. It has proved particularly useful in those situations in which there is a lack of knowledge and data, like that under consideration here. The method generally combines the use of various different research techniques. Thus, application of RRA methodology in the present study has allowed cross-checked and tested information to be obtained through the use of varying techniques. These included direct observation of the situation, gathering of quantitative data and use of secondary sources of information as an initial step prior to in-depth interviews with experts and farmers. In-depth interviews are widely used in social science research García Ferrando et al. 2000] as a way to gain access to necessary information that is lacking in secondary sources. In accordance with Mayntz's classification [Mayntz et al. 1996], individual in-depth oral interviews were chosen, on the basis of their capacity to extend knowledge of a minimally structured problem and of the sort of interviewees involved. This was because the kind of interviews in question is used with experts in a particular subject, a structured questionnaire being unsuited to fulfilling the aims of this research [Olaz 1998].

The data obtained in this way were used to undertake an analysis of circumstances and of the economic viability of energy crops, applying the EAA methodology. In this respect, two situations were investigated, termed Scenario 1 and Scenario 2. The first corresponds to the prices for inputs and end products relating to the 2006 harvest, using the price trends that emerge from market developments up to that point. The second corresponds to the situation during more recent harvests (2007 and 2008), when prices both for inputs and for the crops themselves underwent a considerable increase (crop prices more so). In both scenarios, it was assumed that the unit involved was a typical farm of 75 hectares of agricultural land[2], with two differing systems of production (unirrigated and irrigated) being considered, in combination with three possible systems for cultivation: conventional cultivation and alternative approaches suited to sustainable agriculture that respects the environment, these being minimum tillage and direct sowing.

EAA calculate three balancing items: net value added, net operating surplus (net mixed income) and net entrepreneurial income. Regarding this last one (entrepreneurial income), some considerations must be taken into account in order to adapt the results to the case of sole proprietorships. Thus, we have considered land as farmer's own, for this system is the most popular in Castile and Leon (and in whole Spain too [Ecuesta… 2007]). No paid and no received interest were considered, but replaced by the opportunity cost of the own land and the rest of fixed assets (machinery, construction, etc). Table 1 sets out the relationship between these items. Data to calculate the different results of the EAA

[2] The choice of this size is motivated by the fact that, according to statistics from the Spanish National Statistical Institute [Encuesta… 2007], the majority of farms growing herbaceous crops have agricultural land lying in the range 50 to 100 hectares.

(according to Table 1) have been obtained from the information supplied by an expert panel cross-checked with secondary sources.

Table 1. Economic accounts

Production account	Generation of income account	Generation of current profit
Crop output (producer price*yield)	Net value added	Net operating surplus/net mixed income
- Intermediate consumption	- Compensation of employees	- Non salaried labour
	- Other taxes on production	- Opportunity cost of the own capital
- Consumption of fixed capital	+ Subsidies on production	= Current profit after distribution
= Net value added	= Net operating surplus/net mixed income	
- Other taxes on production		
+ Subsidies on production		
= Net value added at factor cost/factor income		

Source: authors' own concept based on the EU legislation [Directive… 2003; Regulation… 2004; Commission… 2008].

Moreover other indicators were calculated.

Employment Rate: it represents the labour required by the crop cultivation. It is measured in two different units: agricultural working unit (AWU)/hectare and hectare/AWU.

Break Event Point (BEP): it is the point at which cost or expenses and revenue are equal; there is no net loss or gain.

Ratio: subsidies on product/crop output. It represents the importance (in percentage) of the subsidy linked to the energy crop over the total crop value.

Results

Scenario 1 (trend up to 2006 harvest)

Tables 2 and 3 show the detailed results for economic accounts under this scenario; in them it may be observed that if the prices received and paid by farmers up to 2006 are taken as the basis, none of the crops considered would be able to generate profits, even taking into account the €45 community aid payment (which is no longer available after 2010). Both on unirrigated and on irrigated land, rape-seed gives better results with regard to the net mixed income generated (for all the production systems analysed), this revenue being higher on irrigated land and with alternative cultivation systems. Sunflower seed gives a positive net mixed income only on irrigated land and also with minimum cultivation and direct sowing systems on unirrigated land, with negative results under conventional cultivation. This would imply losses for the farmer, who would not even cover the costs of intermediate inputs and the use of fixed capital.

The opportunity costs of fixed assets (land, machinery) are not covered in any of the cases studied, let alone the making of any profit. This is because the amounts remaining after deduction of the cost of non-salaried labour involved in the net mixed income do not reach a level sufficient to cover this opportunity costs. As none of the crops is able to provide adequate remuneration to the production factors land and capital, their cultivation would be inadvisable from an entrepreneurial point of view. This is due to their very limited profitability, arising on the one hand from low prices and yields, and on the other, due to the size of farm considered (75 hectares), which does not allow capital investments to be fully profitable. In fact, when excluding the opportunity cost of investments, the profit would be positive in the case of rape-seed and sunflower seed on irrigated land and under alternative cultivation systems, that is, it would be possible to pay adequate wages for non-salaried labour and leave a profit margin for the entrepreneur (although very small, especially if the amount of investment required is kept in mind). Increasing the size of farms is a key factor in making investments more viable and achieving better financial outcomes[3].

Break even point (BEP) for rapeseed lies in a range between 2500 kilograms per hectare (kg/ha) on unirrigated land, somewhat lower than the BEP found in some other Spanish studies, where rapeseed BEP oscillates from 2600 to 2900 kg/ha [Lafarga et al. 2009]. On irrigated land BEP is about 5200kg/ha to 5500kg/ha. The equivalent figures for sunflower seed are around 1800 kg/ha on dry land, this value being close to some other Spanish studies [Lafarga et al. 2009] where it oscillates between 1500 kg/ha and 2000 kg/ha. On irrigated land BEP falls at 4500kg/ha, decreasing somewhat when alternative cultivation systems are used. Such yields are a long way ahead of those found on most of the farms growing these crops at present.

These results largely explain a feeble regional development of these crops. This is true in the European Union as a whole, if only the cultivated areas not covered by the set-aside scheme are taken into account [Commission… 2006]. For rape-seed, subsidies accounted for more than 9% of the revenue generated from unirrigated land and 5% from irrigated land. For sunflower seed, these percentages lay between 15% for unirrigated land and 5.6% for irrigated land respectively. The disappearance of these aids entails, on the one hand, a shrinkage in income of the proportions quoted and, on the other hand, raising of the BEP in proportions ranging from 4% (irrigated land) to 9% (unirrigated land) in the case of rape-seed, and from 4% (irrigated land) to 10% (unirrigated land) in the case of sunflower seed. Thus, the disappearance of subsidies is unlikely to involve an absolute block to the development of these crops. However, such aids did constitute a certain compensation for those production methods that yielded a net positive income. For example, in the case of sunflower seed on irrigated land they made it possible to pay back the costs of non-salaried labour in alternative cultivation systems, although not the opportunity costs.

Scenario 2 (situation during the last few harvests)

During recent harvests, there has been an increase in the price of energy crops. This trend seems to have become consolidated in respect of rape-seed. If the analysis is repeated with these price levels, the results improve notably, especially with regard to rape-seed. With prices rising from around EUR 0.21 per kilogram to a level of the order of between

[3] In fact, an increase in the size of the farm to 100 hectares would mean that all the crops would at least pay their non-salaried labour costs.

EUR 0.42 and EUR 0.48 per kilogram, even though an increased cost for inputs has to be taken in consideration, net income reaches figures of around EUR 800 per hectare for irrigated land and EUR 400 for unirrigated land. This implies an adequate remuneration for the factors land and capital, together with profits for the entrepreneur that range from about EUR 200 per hectare from unirrigated land and EUR 400 for irrigated land. Its inclusion among alternative choices, whether seen from a technical and environmental viewpoint or from an entrepreneurial angle, then becomes feasible. This is not true for sunflower seeds which with prices of about EUR 0.30 per kilogram continue to show negative figures for profits in all cultivation systems.

BEP for rape-seed drop relative to the previous scenario, reaching figures of about 1500 kg/ha for unirrigated land and 3000 kg/ha for irrigated land. For sunflower seed, they come to around 1200 kg/ha and 3200 kg/ha respectively, dropping lower as alternative cultivation systems are introduced. This brings yield levels which are close to values currently achievable by farmers.

The part played by aids in the financial results is even less crucial than in the previous scenario. This is because the amount of income generated has risen considerably, owing to the increased prices, so that the percentage that subsidies represent in the total revenue drops noticeably in comparison with the former scenario. In fact, with subsidies abolished none of the crops that produced a positive profit flips into the opposite situation; the only change is that the profit is cut by EUR 45 per hectare.

Other items: occupation levels and the environment

In all cases, the amount of labour required is rather small because of the extensive nature of cultivation and because of its mechanization, especially in respect of sustainable farming systems. Employment indices (Table 3) are at very low levels, similar for both crops, and varying only in accordance with the production techniques chosen. Evidently, such indices are higher with respect to irrigated land and they drop as the amount of cultivation undertaken is reduced, through moves along the range running from conventional cultivation to minimum cultivation and from this to direct sowing.

In relation to environmental aspects, these are extensively produced crops not involving a massive use of inputs and based on sustainable cultivation systems. Experts point out that their implementation will contribute to maintaining rural populations, with the ensuing survival of culture and traditions, and to rebalancing the territorial organization, as pointed out by previous literature [Launder 2002; Ericsson et al. 2009]. Nonetheless, a possible negative environmental impact might occur if there was an intensification of production, or if production of energy crops led to monoculture. This situation would doubtlessly bring about a reduction in biodiversity accompanied by an increase in the occurrence of weeds, pests and diseases, leading to an expansion in the use of pesticides and fertilizers as well as an increase in the amount of residues arising from them, with consequent effects of air, soil and water pollution.

Bearing in mind these positive effects and that the delivery of public goods and services will be a key element in a reformed CAP, an introduction of an appropriate subsidy for those crops, which do not get to be profitable (sunflower, cereals, rape seed under some conditions), would be advisable. This idea is supported by other studies which reveal the importance of setting up an economic support at least at introductory stages of market development [Panoutsou 2007].

Table 2. Economic accounts results, scenario 1

Scenario 1 results	Irrigated rapeseed			Non irrigated rapeseed			Non irrigated sunflower			Irrigated sunflower		
	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing
Production account, EUR												
Crop output	798.00	798.00	798.00	420.00	420.00	420.00	250.00	250.00	250.00	750.00	750.00	750.00
Intermediate consumption	439.92	407.54	414.13	288.97	263.69	282.80	218.56	218.27	220.18	445.05	422.39	421.46
Fixed capital consumption	164.33	164.56	155.80	51.83	45.51	43.30	47.18	41.18	40.96	167.89	162.46	158.48
Net value added	193.75	225.90	228.07	79.20	110.80	93.90	-15.74	-9.45	-11.13	137.06	165.15	170.06
Taxes	104.13	104.13	104.13	3.47	3.47	3.47	3.47	3.47	3.47	104.13	104.13	104.13
Subsidies on products	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
Net value added at factor cost/factor income	134.62	166.77	168.94	120.73	152.33	135.43	25.79	32.08	30.40	77.93	106.02	110.93
Generation of current profit, EUR												
Net operating surplus	106.46	138.61	140.78	92.57	124.17	107.27	-2.37	3.92	2.24	49.77	77.86	82.77
Non-salaried labour	56.46	42.96	41.46	23.46	14.46	12.96	19.50	9.00	9.00	52.08	44.58	41.10
Opportunity cost of the own capital	406.06	404.94	402.30	187.37	184.47	183.94	184.64	182.30	182.25	405.42	402.91	401.47
Current profit after distribution	-356.07	-309.29	-302.98	-118.25	-74.76	-89.64	-206.51	-187.38	-189.02	-407.73	-369.63	-359.80
Current profit after deducing just non-salaried labour	50.00	95.65	99.32	69.11	109.71	94.31	-21.87	-5.08	-6.76	-2.31	33.28	41.67
Current profit after deducing just the opportunity cost of the own capital	-299.61	-266.33	-261.52	-94.79	-60.30	-76.68	-187.01	-178.38	-180.02	-355.65	-325.05	-318.70

Table 2. continued

Scenario 1 results	Irrigated rapeseed			Non irrigated rapeseed			Non irrigated sunflower			Irrigated sunflower		
	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing
Other items												
Employment Rate (AWU/ha)	0.005	0.004	0.004	0.002	0.001	0.001	0.002	0.001	0.001	0.005	0.004	0.004
Employment Rate (ha/AWU)	193.84	254.75	263.97	466.50	756.85	844.44	561.23	1216.0	1216.0	210.14	245.49	266.28
BEP (ha)	5496	5273	5243	2563	2356	2427	1826	1750	1756	4631	4479	4439
Ratio subsidies on product/crop output, %	5.34	5.34	5.34	9.68	9.68	9.68	15.25	15.25	15.25	5.66	5.66	5.66

Source: author's own calculations.

Table 3. Economic accounts results, scenario 2

Scenario 2 results	Irrigated rapeseed			Non irrigated rapeseed			Non irrigated sunflower			Irrigated sunflower		
	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing	con-vent-ional	míni-mum tillage	direct sowing
Generation of current profit, EUR												
Net operating surplus	61.46	93.61	95.78	47.57	79.17	62.27	-47.37	-41.08	-42.76	4.77	32.86	37.77
Current profit after distribution	-401.07	-354.29	-347.98	-163.25	-119.76	-134.64	-251.51	-232.38	-234.02	-452.73	-414.63	-404.80
Current profit after deducing just non-salaried labour	5.00	50.65	54.32	24.11	64.71	49.31	-66.87	-50.08	-51.76	-47.31	-11.72	-3.33
Current profit after deducing just the opportunity cost of the own capital	-344.61	-311.33	-306.52	-139.79	-105.30	-121.68	-232.01	-223.38	-225.02	-400.65	-370.05	-363.70
Other items												
BEP, hectare	5710	5487	5457	2777	2570	2641	2006	1930	1936	4811	4659	4619
Increase of BEP above scenario 1, %	3.9	4.1	4.1	8.3	9.1	8.8	9.9	10.3	10.3	3.9	4.0	4.1

Source: author's own calculations.

Moreover, we must consider that a correct payment to farmers for the delivery of public goods and services will be a key element in the reformed CAP (European Commission, 2010A) and that it has the EU citizens' support [The Common… 2010]. Likewise, some interviewed groups state that growing these crops may involve an increase in the total area under cultivation in comparison with the present state of affairs. In these circumstances, it would be necessary to take into consideration the quantities of CO_2 emitted, arising from the mineralization of fertilizers and organic material.

Conclusions

Sunflower seed and rape-seed as energy crops are not able to generate entrepreneurial benefits, unless prices remain at least at the levels paid for recent harvests. In this case, rape-seed might indeed be a viable choice for entrepreneurs, with the financial results improving on irrigated land and with a move from conventional cultivation to minimum tillage, or onward to direct sowing. It may be observed that the break-even point drops as the amount of cultivation is reduced by the use of systems of direct sowing and minimum tillage. These techniques of growing together with further research aimed at adapting crops to local conditions is the only way of compensating for the disadvantages from which this region suffers in comparison with others, making it possible to attain yields that might make these crops profitable in situations in which they are not viable at present.

The CAP subsidies for energy crops have played no great role because of the limited amounts involved and the absence of any differentiation between unirrigated and irrigated land. However, they have contributed to a minor improvement in outcomes, so that their disappearance will entail a slight worsening of profitability, which may be decisive for some production choices (sunflower). In this sense, as pointed out by other authors [Panoutsou 2007], setting up an appropriate level of public economic support for the first stages of these crops could enhance the introduction of them. This idea could be supported by the multifunctional role of energy crops: From an environmental viewpoint, the production of energy crops on the basis of extensive farming systems combined with sustainable cultivation methods, as raw material for less contaminating fuels, would be of great environmental value.

In view of the limitations imposed by climate and markets on the possible introduction of crops into the range of options, both rape-seed, cultivated under all the systems investigated, and sunflower seed, on irrigated land with minimum cultivation and direct sowing systems, might have a part to play in diversifying risks in farming and crop rotation. This would have environmental and technical advantages, since they are able to generate a positive revenue that allows payment to be made for the labour used.

For this purpose, the government should consider the introduction of financial assistance that would aid in covering the costs arising from investments in land, machinery and installations. This help should be appropriate and it should differentiate between unirrigated and irrigated land, and even between crops. There should in addition be incentives that might facilitate an increase in the size of farms, with the aim of reaching viability thresholds.

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