INRA SCIENCES SOCIALES

N° 2 –DECEMBER 2005

RESEARCH IN ECONOMICS AND RURAL SOCIOLOGY

Ambivalence of biofuel chains in France

From a situation of little importance in French crops (324,000 hectares in 2004 including 300,000 hectares of rapeseed), the surface area of energy crops should quickly grow in order to increase the level of incorporation of biofuels in fossil fuels to 5.75% by 2010 (recommended value of Directive 2003/30/EC, "promotion of biofuels"). The French government recently increased the authorized quantities of biofuel production. In the present context where oil prices are close to 70$ a barrel and where the fight against global warming has become a priority, biofuels are shown in quite a favourable light. However, considering, on the whole, their very poor energy yield per hectare of land and their high costs, we are led to temper the very optimistic analyses carried out on them. Essentially presented as energy chains, it should not be forgotten that biofuels are also an indirect way of supporting agribusiness and agriculture, under the responsibility of each country.

The main results summarised here concern France. They are obtained by using a dynamic and partial equilibrium model, OSCAR (Optimisation of the Economic Surplus of Renewable Agricultural Biofuels), developed by the INRA (France) (frame 1). The strong points of this model consist in a detailed formalization of food and non-food agricultural supplies, considering CAP evolutions and the impacts of biofuels on farming incomes as well as on farming jobs.

Biofuels, a brief summary

An overview of biofuels shows the prevalence of a continent (America) and of a biofuel (ethanol). The latter is made from sugar cane (Brazil) or from corn (USA). Palm oil could very rapidly make its mark on the biofuel market.

The European landscape differs in the choice of its biofuels and energy crops. For the choice of appropriate energy crops, these distinctions are due to economic and agronomic considerations as well as to the composition of their car industry and refinery structures for the choice of its biofuels.

In France, the original target of biofuel was to overcome the drawbacks of set-aside lands (CAP mandatory set-aside lands) decided in 1993 in order to control food supply. Rapeseed methyl ester was favoured because it permitted the cultivation of the greatest area of set-aside lands for a given amount of public financial support owing to its low yield per hectare (see table 1). More recently, policies to control greenhouse gases have shed new light on biofuels: they represent a centrepiece in the measures taken to reduce CO_2 emissions in transport.

Two main types of biofuels are industrially produced: ETBE[1] (ethanol from wheat or sugar beet) and RME[2] from rapeseed oil (or ester) (table 1). Primary biofuels (ethanol and oil) are processed to obtain secondary biofuels which are compatible with the requirements of motors offering increasingly high performances. ETBE is mixed with gasoline, and RME is mixed with diesel.

The substitution of a part of the fossil oil by RME helps loosen the constraint on diesel supply, which is subject to the biggest increase in demand. Moreover, incorporating RME improves the lubricating quality of diesel, which has become poorer and poorer in sulphur for environmental reasons.

Ethanol could also be directly mixed with gasoline, but this scenario is largely marginal: In France at present, it is excluded for technical reasons (instability of the gasoline-ethanol combination in the presence of water, increased volatility of the blend). However, these obstacles could be overcome quickly considering the technical knowledge of the French car manufacturers present in the big ethanol producing countries and if a specific distribution system for the gasoline-ethanol mixture was envisaged.

Biofuels are a little less energy-giving[3] than oil products, especially ethanol, hence the slight over-consumption of the blends leading to a slight economic depreciation of biofuels compared with fossil fuels.

For 2005, table 1 shows the yields per hectare of primary and secondary biofuels for the three crops concerned. Rapeseed is the least productive one of them. If the

[1] Ethyl-Tertio-Butyl-Ether.
[2] Rapeseed Methyl Ester, commonly called rapeseed ester or Diester.
[3] The measurement of their energetic content is given by the inferior calorific power (ICP): quantity of heat provided by the whole combustion of a combustible unit, being supposed that the water vapour is not condensed and the heat is not recovered

upward trend in observed yields lasts (2nd line), production per hectare will go on rising, but more for ethanol than for rapeseed ester. This is why the large production of ester planned in the biofuel programme will take up a lot of arable lands. By way of information, palm oil production is four times higher.

Energy results are positive, but the contribution of biofuels to energy independence is low

The production of biofuels requires consumption of fossil energy throughout the production chain. Therefore, it is necessary to check whether biofuels will induce savings in fossil energy when they replace fossil fuels. Energy balances allow us to check this. If balances are over 1, gains in fossil energy will be higher than expenses. However, it is difficult to assess these balances because by-products are produced at the same time as these biofuels, and are used either in animal feed (spent grain, rapeseed cakes) or in chemical industries (glycerol). As the productions of biofuels and co-products are closely linked in industrial processes, it is impossible to find out the real quantity of fossil energy consumed in order to obtain by-products.

In the balances presented by the French Ministry of Energy and the French Agency for the Environment and Control of Energy, the difficulty outlined above is bypassed by adopting an accounting method (table 2, 2nd column). It consists in assigning the by-products, on an inclusive basis, with a certain quantity of fossil energy consumed by the chain, according to an applied rate. This rate is the relationship between the quantities of co-products and fuels. This energy assigned to by-products is deducted from the energy assigned to biofuels, which improves, proportionally speaking, the energy_balance of the latter.Other applied rates could be used resulting in other energy balances.

Faced with this difficulty, the only satisfactory method is a systemic approach consisting in assigning by-products with the fossil energy needed to produce the goods that these by-products will replace (for instance, the rapeseed-cake from the ester chain will replace the soya-cake imported to feed animals). Unlike the previous one, this method will measure the real effect of the insertion of an energy chain into the economic fabric on the consumption of fossil energy. This method was recommended by M. Shapouri as early as 1995, and has been accepted for the recent study conducted by EUCAR (European Council for Automotive R&D), CONCAWE (Conservation of Clean Air and Water in Europe) and JRC (European Joint Research Centre) in the framework of the European Union (table 2, 3rd column). With this hypothesis, energy yields are nowhere near as good, especially with ethanol.

Considering the biofuel needs planned for 2010, (that is to say 9.3 million hl of ethanol and 27.5 million hl of ester) and on the basis of the energy outputs in table 2, the net contribution of biofuels to oil savings is between 1.5 Mtoe (million tons of oil equivalent - substitute value for by-products) and 2.0 Mtoe (mass prorata for by-products). The ester chain has quite a good energy output per volume of biofuels but these results become very modest in terms of hectares of land. The total contribution of biofuels to oil savings is low, given that in 2004, agriculture consumed 2.9 Mtoe of final energy (all forms of energy taken into account) and France 92.8 Mtoe of oil.

Risk of competition with food crops

Now that the targets of biofuel production are clearer, it is interesting to measure their consequences on the agricultural areas utilized. Table 3 shows the estimated needs in farming surface area to produce the quantities of energy crops corresponding to the incorporation target (suggested by the European Union) of 5.75% biofuels by 2010. Traditionally reserved for set-aside lands (main reason for their implementation), it is clear that energy crops will spread beyond this area (at present set-aside lands represent about 1.5 million hectares but the surface area may vary according to political decisions) to meet this target. In this perspective, competition might appear between food and non-food crops.

Studied using the INRA's dynamic model OSCAR (see frame 1), this competition mainly arises between rapeseeds (for food and non-food use), owing to the constraints inherent to farming production, and to a lesser degree between rapeseed and cereals. This competition emerges as soon as ester production reaches 8 million hectolitres (graph 1), which is quite soon in the increase in importance of the biofuel development programme which forecasts an ester need of 27.57 million hectolitres, and before the total set-aside area of 1.5 million ha is reached (table 3: the production of 13.15 million hl of ester requires a surface area of 880,000 ha). This situation is linked to the fact that in the model, a large part of the set-aside areas is not used for non-food rapeseed crops for the following reasons: constraint of a maximum of 30% rapeseed in rotations (practices observed), 30% of the set-aside lands is considered as unexploited (sloping ground, land too far away from the main body of farm, and so on) and 34% of the producers, with no experience in rapeseed, are excluded from production. Moreover, the additional subsidy of 45 euros per hectare granted to areas switching from food crops to energy crops (up to 1.5 million ha on the European level) contributes to the substitution of food rapeseed by energy rapeseed: the rotations of crops are the same; only the use is different. The subsidy is justified by the fact that these productions contribute to combating global warming or even to the regulation of cereal markets (the export of cereals costs the European Union an average of 5 euros per ton). The framework of this analysis is probably a little rigid. In particular, we may think that the number of rapeseed producers is likely to rise thanks to farming development programs. Even though they are slightly more profitable than food crops, energy crops cannot totally replace the latter because they are set by quotas according to the quantities of biofuel production authorized by the State.

This competition could lead to a rise in food and energy rapeseed prices. In the United States, in the case of corn, Gallagher (2000 and 2003) showed that there is a possible rise in corn prices if ethanol takes the place of a large part of an additive to gasoline of fossil origin, methanol, which is suspected of environmental damage. This price rise increases corn producers' income; on the other hand, it penalizes, albeit to a lesser extent, the income of stockbreeders who are corn consumers. However, in Europe, stockbreeders and cattle feed industries could gain from the development of RME and wheat ethanol because of a fall in the price of rapeseed cakes and spent grain. However, this fall in the prices of by-products would make RME and wheat ethanol more expensive since the valorization of co-products is deductible from the biofuel costs. For Europe, it would be advisable to study the effects of an ambitious worldwide production of biofuels on European agricultural prices and on the trade of farm products.

Non-competitive biofuels for an oil price of 65 dollars

The biofuel costs plotted on graph 2 are calculated from the farm-gate to the finished product, in depots, before distribution to retailers. These costs, assessed per litre, are formed by the purchase prices of raw materials (wheat, rapeseed, sugar beets) and the logistics and industrial costs minus by-product revenues. They are drawn up in the context of competition between food and energy crops: ester rapeseed is cultivated both on set-aside lands and food plots. This competition necessarily brings the purchase costs of wheat and rapeseed energy crops at least to the level of food crops at farm-gate prices, respectively 88 and 198€/t. Because of the special quota regulations, the price of sugar beet, that is to say 20 euros/t, is a calculated price allowing every sugar beet grower to profitably produce ethanol on arable lands (study carried at the INRA on the COM reform in sugar). From what we know, this theoretical price is close to the actual price. This pattern of energy crop prices is plausible since, in the long run, industrial companies will wish to avoid any compartmentalization between food and non-food markets.

In graph 2, the economic valorizations of biofuels are given by the black curve. They are estimated when they come out of the refinery depot by applying a fall in fuel prices in order to take into account the overconsumption by motors using additive blends of biofuels. Therefore, biofuel valorization is lower than fossil fuel price, in particular ethanol against gasoline (see substitution rates in table 1).

The comparison between costs and valorization clearly shows that biofuels are not competitive without specific support. The main biofuel, ester, would become competitive against diesel if the oil price reached 75 to 80$ per barrel (1 euro = 1.2 dollars). An increase in oil prices does not favour so much the competitiveness of Ethanol and still less that of ETBE because of their poor energy balance.

An economic overcompensation of the chains through the partial exemption of ITOP

In addition to the agricultural subsidies granted by the CAP, biofuels enjoy a partial exemption of the ITOP (Interior Tax on Oil Products) which applies to fossil fuels. This exemption is 0.33 euros/l for ester and 0.37-0.38 euros/l for ethanol. This tax exemption allows biofuels to be profitable when oil prices fluctuate between 15 and 20$ per barrel. Today, such a level of exemption is no longer necessary. Considering the present oil context and the previous hypotheses on the prices of energy crops (that is to say prices equivalent to the corresponding food crops), the minimum exemptions that should be implemented may be assessed by the gap between biofuel costs and their increase in value such as they are on graph 2. For an oil price of 65$, these exemptions are more or less equivalent between ETBE, ethanol in direct use, and ester. Given that the tax exemption concerns ethanol, and that from a litre of ethanol you obtain 2.27 litres of ETBE, the tax exemption per litre of ethanol more than doubles for that chain. This estimation can be seen in table 4, for an oil price of 65$ a barrel. The minimum exemptions are much lower than the current ones, especially for the chains of ester and ethanol in direct use. They are higher for ethanol via ETBE because of the additional cost of ETBE production.

Sharing of profits between agriculture and downstream chains

The tax exemption surpluses presented in table 4 give an estimate of the profits of those involved downstream, from collection through to incorporation of biofuels into fossil fuels. It is logical to compare these gains with those of agriculture. We should remember that, in 1993, agricultural objectives were clearly displayed to justify the development of biofuels.

The sharing of profits in favour of agriculture essentially depends on two factors: the agricultural prices of energy crops and the nature of the areas used for these crops - CAP set-aside lands or areas given over for food production. The prices which will be used to estimate this sharing are the ones which were used for the estimation of biofuel costs (graph 2), that is to say 198€/t for rapeseed, 88€/t for wheat and 20€/t for sugar beet, as explained above. These prices apply whatever the location of the energy crops, on CAP set-aside or on arable lands. To meet the demand for energy crops, farm producers will first put a part of the CAP set-aside lands into cultivation again (graph 1) before replacing food crops, because this choice is economically more interesting. This substitution for set-aside lands will last as long as the impact on farming incomes stays higher than the bonus of 45€ per hectare granted when energy crops replace food crops. This is why, at present, the 300,000 hectares of rapeseed ester almost totally fall within the set-aside lands. The profit sharing results (given in table 5) are based on this mechanism.

As long as energy crops replace CAP set-aside lands (table 5), farm producers get additional farm income per hectare of wheat or rapeseed ranging from 200 to 300€; these incomes are more or less equivalent to the average income per hectare of cereal farm-holdings. In this way, farmers retrieve the part of income lost due to the CAP law on set-aside lands enforced in 1993. The increase in farming income per hectare of energy sugar beet exceeds the increase in income of other crops because of the methods used to estimate prices; it is the opposite per litre of biofuel because of the high production of ethanol per hectare of sugar beet (100l/ton). A comparison of these agricultural gains with the downstream ones requires an expression of the supplementary farming income per litre of biofuel. We can see that the additional farming income per litre of biofuel is quite clearly lower than downstream gains produced by the tax exemption surpluses.

As soon as these crops replace food crops, the economic spin-offs for agriculture diminish sharply. The increase in farming incomes per hectare of wheat and colza falls to 45 euros (aid to energy crops) and that of sugar beet to 149 euros. The gain per litre of biofuel becomes very low (0.02-0.03€/l). Profit sharing between agriculture and the downstream sector is unequitable in this scenario.

To summarize, as long as biofuels allow farmers to cultivate their CAP set-aside lands, the economic spin-offs are interesting for them; on the other hand, when energy production starts to whittle away food areas, the economic stakes become quite marginal. It must be added that the economic spin-offs of biofuel chains chiefly concern the cereal regions, which are generally well-equipped in agro-industrial structures, and much less the mixed farming regions.

Costs and profits of the biofuel programme for the economy, a very controversial issue

An estimate of the impacts of the biofuel programme on general economic activity and among other things, on job creation, is a very controversial issue. PricehouseCoopers announces the creation of 3,800 jobs and added value of 207 million euros induced by the present ester programme (about 4 million hectolitres). For the American Midwest and for further production of 14 million hectolitres of ethanol, P. Gallagher indicates 5,500 jobs created in industry and services – but few in agriculture – and a positive balance of 200 million dollars.

On the other hand, a study by the Department of Budget Estimates of the French Ministry of Finance (Lévy-Couveinhes report, July 2000) leads to negative macroeconomic conclusions unless oil prices reach at least 60$ a barrel, and contests the job creations resulting from sector-based measures.

These large differences in results stem on the one hand from divergent methods, and on the other hand from whether or not the opportunity cost of public funds (consideration of alternative uses of public money intended to support biofuel chains) is taken into account.

The macroeconomic models which would allow a more in-depth analysis of the production of energy from biomass because they are free of these simplifying hypotheses are not yet up to scratch. Using the OSCAR model, we therefore carried out a very simplified analysis of the macroeconomic effects originating from the ester chain for a programme of 27.5 millions hectolitre (needs of 2010) (frame 2).

The results come to 1,800 jobs created, including 300 maintained in agriculture, and added value of 0.09 euros per litre of ester. Taken as a whole, these impacts are quite weak because of the competition between food and non-food crops. Finally, all these elements put end to end give the balance in table 6 which concludes that the situation is balanced. To use the expression of economists, the ester programme would not modify economic well-being.

To the strictly economic results above, we must add the positive environmental externalities coming from the reduction of greenhouse gases. At present, the monetarization of this advantage is made easier by the existence of a market for the rights of CO_2 emission, the price of which is around 20€/t CO_2. However, this evaluation remains virtual since it relies upon a fluctuating market of emission permits and not on the real damage caused by greenhouse gases. The results below are obtained from analyses on life cycles made by ADEME and DIREM (see table 7).

The virtual valorization of CO_2 restrictions helps justify only a part of the public funds granted to the chain.

By placing itself at this second level of analysis, the ester chain, an essential link in the biofuel programme, is in the general economic interest thanks to its positive contribution to the reduction of greenhouse gas emissions. However, this result is closely linked to the given oil price of 65$ a barrel. A drop of only 10% in the barrel price would lead to the cost-advantage balance in table 6 becoming negative and cancelling out the positive effect resulting from the reduction of greenhouse gas emissions shown in table 7.

Conclusion

First-generation biofuels constitute a fairly ineffective energy production. This was acknowledged in 2004 by the American National Commission on Energy Policies which recommended abandoning corn ethanol for ligno-cellulose ethanol. It is too early to say whether this result can be extrapolated to France. The results of the national research programme on the valorization of biomass which has just been launched should bring new developments on this matter.

If the "non-food" sector encroaches on the "food" sector – as is more than likely in the future – the microeconomic accounts of biofuels are in deficit, even if the price of oil reaches 65$ a barrel (1€=1.22$). In other words, public aid is necessary for the economic balance of the chains. However, the present support granted in the form of an ITOP exemption could be notably reduced, given the high prices of the oil barrel, especially in 2005.

The microeconomic competitiveness of biofuels requires high oil prices of between 75 and 80 dollars per barrel. The maximum price of oil (Brent), which was reached in 2005, is lower than this. The high 2005 prices resulting from an increase in the demand for oil may favour capacity investments; a decrease in oil prices could result from this, which would automatically increase the microeconomic deficit of the biofuel chains. The International Agency for Energy, in the World Energy Outlook of 2004, suggests a scenario of the oil price at 35$ a barrel in 2030 (in constant dollars 2000). According to the Agency, this average price level remaining steady over a long period would lead to investments allowing a structural change in energy demand, including a reduction in world energy demand for oil of up to 15% (that is to say the equivalent of the present demand from the United States). This hypothesis of the long-term lowering of prices results from the level of reserves, the progress in oil extraction technologies, the promotion of new sources of non-conventional oil (asphalt sands, heavy oils) and from the large reserves of energy savings.

The microeconomic repercussions for farm producers are above all tangible as long as the set-aside lands are valorized; beyond, these repercussions decrease sharply. These repercussions chiefly concern the large cereal regions of the Paris basin and much less the mixed farming regions. This is why the production of oil in rural plants for direct use in fuel could develop after the recent withdrawal of a certain number of statutory obstacles. In the mixed farming regions, it could become a way of creating added value at the local level and reinforcing the links between cereal growers and stockbreeders in the same region within the framework of the implementation of "traceable" animal chains.

In fact, an ambitious biofuel programme such as the one proposed for 2010 is much more of an economic challenge for "biofuel-oil industries" than it is for farmers, unless a driving effect on agricultural prices occurs. Considering the importance of the biofuel programmes which are implemented not only on the European level but also on a worldwide level (Brazil, USA for ethanol, Malaysia-Indonesia for palm oil), this positive effect may be possible.

Macroeconomic assessments shed a more favourable light on biofuels. Very positive for certain authors (PriceWaterhouseCoopers, Gallagher USA), they merely seem satisfactory according to our estimations. These broad economic results are positive provided that the oil price reaches 65$ a barrel and that the monetary value of the reductions of CO_2 emissions is taken into account. However, at present this sole valorization is not enough to justify public backing. The production of biofuel restricted to the set-aside lands would have benefited from much more flattering economic assessments (but it cannot achieve the objectives of the European Union).

In the final analysis, the economic and energy-giving results of first-generation biofuels are not decisive enough to make these renewable energies an alternative anything more than limited to the exhaustion of oil resources. Under these conditions, like in the United States, the second-generation biofuels using ligno-cellulose resources, by-products and crops bring much more hope. In fact, they could need less land, improve energy outputs and benefit from lower costs. In the first place, a stock of 5 million tons of wheat straw (that is to say a quarter of the annual French production of cereal straw) is available, while preserving the fertility of the soil and the demand of stockbreeders. This resource of 1.5Mtoe primary energy would supply enough ethanol to meet the needs of 2010 such as they are stated by the European Union. The wood-chain by-products could also increase the stock of biomass, while extending the areas of biofuel production. Later, dedicated crops (specific cereals, miscanthus, quick-rotation coppice) are envisaged. In addition to the European programmes, a research effort on the national level has recently been launched on the matter. Within 10 to 15 years, the first technologies for the conversion of biomass into biofuels should see the light of day.

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For further information

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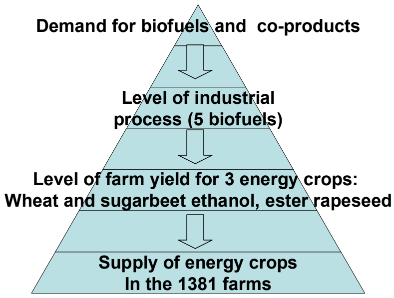
Published by the INRA Social Sciences, Agriculture and Food, Space and Environment Publishing unit
Editorial Director: Hervé Guyomard – Editor: Didier Aubert (Chief Editor), translation and composition: Ariel Gille

Frame 1: A partial equilibrium model "OSCAR" (Optimization of the Economic Surplus of French Renewable Agricultural Fuels)



OSCAR is a partial equilibrium model which aims to describe the detailed activities of French biofuel chains. For a fixed demand for biofuels (and by-products), the model determines the supply of energy crops in each of the 1380 model-farms (from French FADN, Farm Accountancy Data Network) and allows us (among other things) to determine the opportunity cost of the energy crops and biofuels by minimizing the total cost.

Frame 2: An approach to the macroeconomic effects of the ester chain

We assume different strong hypotheses:

- agricultural prices are supposed to be steady
- the tax exemption is limited to its minimum (see table 4), which slows down in proportion to the transfers between the taxpayers and chain protagonists; this is why, in table 6, the cost for the taxpayer is only 0.09€/l instead of the present tax exemption at 0.33€/l.
- the boomerang effects of these transfers on consumption, or even on investment, are left to one side,
- no significant negative effect is mentioned, either on the side of the food industries which compensate for the deficit of the national food crop production through imports at steady prices, or on the oil side insofar as the ester programme reduces the imports of diesel,
- last, the opportunity cost of public funds equals zero, which renders the strong political desire to develop biofuels.

In this context, in the case of industries, the analysis only considers the jobs and added value created at the level of the industries grinding rapeseed and esterifying oils. The tax exemption being fixed at a minimum compatible with the microeconomic balance of the chains, the industrial added value is equal to the remuneration of fixed factors of the biofuel industry, that is to say the salaried costs of the created jobs and the other fixed costs.
In the case of the farming sector, the analysis only considers the farming incomes and jobs provided by the proportion of crops cultivated on set-aside lands. We assume that only the energy crops on set-aside lands are likely to create jobs and generate additional incomes. As a matter of fact, in the case of energy crops replacing food crops, there is no reason to foresee any economic boost effect through increased consumption of farm inputs, the inputs for non-food crops being the same, in nature and quantity, as the ones used by substituted food crops.

Table 1 - Biofuels, a few technical aspects

Crops	**Sugar beet**	**Wheat**	**Rapeseed**
Yield 2005 in t	79,4	8,1	3,3
Evolutions of yields in ton/year	0,98	0,12	0,02
primary biofuels	**Ethanol**	**Ethanol**	**Oil**
Yields 2005 hl/ha	79	28	15
density *	0,79	0,79	0,91
Secondary biofuels	**ETBE**	**ETBE**	**Ester**
Yields hl/ha 2005	180	64	15
density	0,75	0,75	0,88
Substituted fossil fuels	**gasoline**	**gasoline**	**diesel**
litre of substituted fossil fuels per 1litre of biofuel *	0,83	0,83	0,92

* density=mass of a litre of biofuel divided by the mass of a litre of water
** on the basis of reports of the Inferior Calorific Powers

Table 2 - Energy results

Energy yields according to methods taking by-products into account		
	Accounting method*	Systemic Method **
Wheat ethanol	2,04	1,19 **
Sugar beet ethanol	2,04	1,28 **
RME	2,99	2,5 &

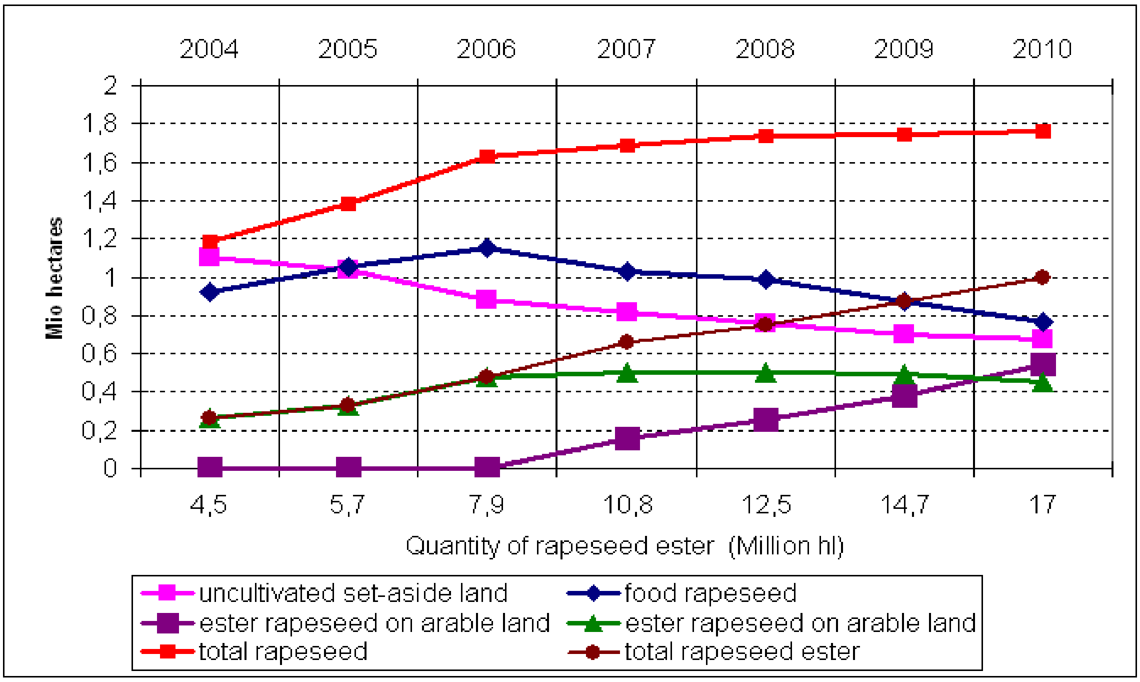
* = Department of Energy and Mineral Resources of the French Agency for Environment and Control of Energy2002
** = Weel to Wheels report 2004, CONCAWE, EUCAR, JRC, European Union
(& modified by INRA- France)

Table3 - Estimate of the needs in farm land to get 5.75% biofuels in fossil fuels (gasoline, diesel)*

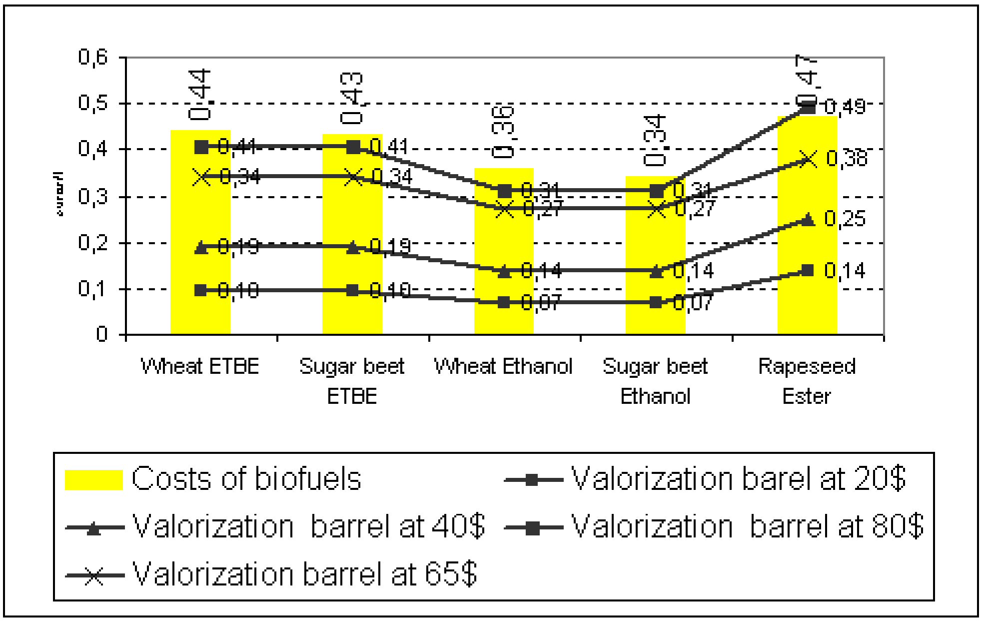
	unit	2004	2007	2010
Needs in Ethanol	Mio hl	2,68	5,95	9,27
Needs in Ester	Mio hl	4,93	13,15	27,57
Needs in ha Wheat+Sugar beet	10^3 ha	60	145	225
Needs in ha Rapeseed	10^3 ha	330	880	1800

* The areas in hectares were estimated by INRA (France) taking into account the improvement of farm yields on the basis of biofuels needs calculated by UFIP (French Union of Oil Industries)

Graph 1 – Competition between food and non-food rapeseeds



Graph 2 - Costs and valorization of biofuels according to oil price



Hypotheses:
1 euro = 1.212 dollar
Rapeseed at farm-gate price 198€/t, Wheat at farm-gate price 88€/t, Sugar beet at farm-gate price 20€/t
Substitution rate, ETBE/Gasoline: 1.12; Ethanol/Gasoline 1.42; Ester/gasoil: 1.08
Valorization of by-products: Wheat spent grains 91€/t, Rapeseed cakes 137€/t, Glycerol 300€/t
Unit of Ethanol 3.000 hl/j; unit of Ester 200.000 tons/year

Table 4 – An important economic support to chains

	Minimal exemptions €/l prix du pétrole 65$/baril	Exemptions of ITOP in €/l (2005)	Surplus of tax exemption €/l
Wheat Ethanol via ETBE use	0,22	0,38	0,16
Sugar beet Ethanol via ETBE use	0,20	0,38	0,18
Wheat Ethanol direct use	0,09	0,37	0,28
Sugar beet Ethanol direct use	0,08	0,37	0,29
Rapeseed Ester	0,09	0,33	0,24

Table – 5 Average impacts of production of energy crops on farm incomes,
In €/ha of energy crop and in €/l of biofuel

	Prices	Average Yields	Increase in farm income (energy crops on set-aside land)		Increase in farm income (competition with food crops)		Surplus of tax exemption= gains of actors downstream agriculture
Units	€/t	t/ha	€/ha	€/l	€/ha	€/l	€/l
Wheat*	90	8,2	302	0,10	45	0,02	0,16
Sugar beet*	20	79,5	606	0,08	149	0,02	0,18
Rapeseed	200	3,3	199	0,14	45	0,03	0,24

* ETBE chain

Table 6 – Cost-advantages balance in €/l, ester chain, situation 2010, oil price at 65$/b

Minimal exemption (Tax payers' surplus loss	-0,09
Variation of GDP Biofuel industry	0,05
Variation of farm income Farmers' surplus	0,04
Balance	0,00

Table 7- Monetary importance of the externality of greenhouse gas effects

	Ton CO_2 equivalent saved per/hl	Amount €/l	In % of the minimal tax exemption
Wheat Ethanol via ETBE	0,22	0,02	9
Sugar beet Ethanol via ETBE	0,22	0,02	10
Wheat Ethanol	0,10	0,04	46
Sugar beet Ethanol.	0,10	0,04	57
Rapeseed Ester	0,21	0,04	49