INRA SCIENCES SOCIALES

N° 2-3 – SEPTEMBER 2007

RESEARCH IN ECONOMICS AND RURAL SOCIOLOGY

The impacts of biofuels on European agriculture

Although the importance of biofuels for energy safety and the combat against global warming is strongly debated in Europe, no one contests that they have a beneficial effect on European agriculture. We assess the impacts of full enforcement of the European Directive promoting these biofuels on the various European markets and on farm incomes. This assessment takes into account the possibilities of importing these products from the world market, as well as the induced effects on livestock. We show substantial effects on large crop markets and very little effects on cattle-breeding markets. Total farm income increases in relation to associated public expenditure, but in a limited way.

Purpose of the research

In the European Union (EU), biofuel production and use are today as much furthered by European measures (assistance to energy crops, possibility of cultivating mandatory set-aside lands) as by national ones (lower taxation on consumption in comparison with that applied to fossil fuel; setting of compulsory incorporation rates). Public support for biofuel development meets two objectives, at least. On the one hand, diversifying the supply of energy used in road transport activities and, therefore, being less dependant on fossil oil imports, the current price of which is anticipated to rise in the medium/long term. On the other hand, reducing European greenhouse gas emissions, in accordance with the commitments contracted through the KYOTO Protocol. However, biofuel efficiency towards both targets is highly disputed in relation to other solutions (such as the reduction of car energy consumption or the development of alternative energies). On the other hand, it is widely acknowledged that biofuel development should be of benefit to the European farm sector by supplying new outlets to its productions. The general purpose of research is to assess the induced effects (productions, supplies, prices, trades, incomes) of the European agricultural directive adopted in 2003, which states an indicative objective of biofuel incorporation of 5.75% of total fuel consumption by 2010.

Review of the literature and contributions of research

Many surveys take an interest in the effects of biofuel development. The great majority of them assess the needs in arable areas to meet the European Directive target for biofuel promotion, according to different assumptions regarding the evolution of farm yields. These surveys agree that there will be competition between uses of farm products for food and energy. However, the other induced effects on European agriculture, like those on the prices of the raw materials used to produce biofuels, the indirect effects on traditional food or cattle-breeding markets, or the effects in terms of employment and farm income are now very seldom assessed. In its message to the European Council and Parliament on the present situation regarding biofuel, to our knowledge the European commission (2007) gives the most complete assessment of the effects of biofuel development up to 7% of total fuel consumption by 2020. This evaluation particularly shows that, all things being equal, this sort of biofuel development will lead to an increase in domestic prices of soft wheat of around 8%, rape oil of 100% and to a drop in soya cakes of 41%. Furthermore, the increase in arable areas for biofuel production is predominantly on set-aside lands on account of the Common Agricultural Policy (CAP), but also partly to the detriment of food production areas. Last, with the standard modelling assumptions, the E.C. assesses that, in Europe, the scenario will entail the net creation of 105,000 jobs, with the creation of 140,000 jobs in the farm sector, counterbalanced by job losses in the fossil-oil chain.

Therefore, this evaluation gives us very precious information regarding certain agricultural impacts on biofuels. The simulations hereafter aim to test their reliability and to complete them by assessing the effects on other agricultural variables.

First of all, this EC survey does not evaluate the induced effects on animal sector markets; it just mentions that a greater by-product supply (soya cakes, spent grains) from biofuel production will be available for animal feed and

that this should reduce the production costs in these sectors. However, for the United States, Elobeid et al (2006) find the opposite result: across the Atlantic, biofuel development would have negative effects on their livestock chains, which are penalized by the increase in cereal prices. In fact, there are numerous and conflicting livestock-induced effects. For instance, biofuel development raises the value of the energy component of farm goods and lowers that of the protein component. The net effect on animal intake production costs depends on the force of both effects, on the initial proportion of these two components in the animal intake cost, on the raw materials actually used and on their substitution degree. Thanks to rising prices, another example is the anticipation of an increased profit in large cropping activities, which favours investments in agricultural capital (machines) that can also be used in the animal chains. Animal production may be dragged along in the wake of large cropping activities. The methodology used in this research will enable us to assess these different effects on livestock sectors.

Next, the EC assessment gives only partial results, including the market equilibrium of large crop produce. So we do not have clear information about the development of the cereals, sugar-beet or oleaginous markets. Thus the final effect on the European farm sector will necessarily depend on these exchanges as well as on the potential biofuel imports. In this respect, the EC evaluation suggests that these imports could represent 27% of the European biofuel supply, essentially in the biodiesel chain. This figure results from biofuel trade modelling where imported product prices, net of customs duties, may be notably lower than domestic prices (up to 25%), without giving cause for massive imports. Although price differences may effectively exist in the short term, the arbitrations carried out by agents attempt to make use of them, which means that they have a tendency to cancel each other out in the medium/long term. The simulations transferred below are thus based on another biofuel trade modelling, in which the net prices of imported and domestic products are decisive. We shall also transfer the effects on large crop product exchanges.
Lastly, the EC assessment gives the effects in terms of farm job creation, but not farm incomes. These two variables are obviously linked at the macro-economic level, but that does not necessarily imply that it is to the advantage of every farm. There are recurrent discussions on farm incomes, in particular relating to the CAP reforms, and it is important to identify the contribution of biofuel development to these incomes. All the more since it is widely acknowledged that any support to farm sector at least partly results in land capitalization. In other words, assessing incomes on farm impacts and their distribution in the different agricultural production factors (land, working capital, and farm work) is another contribution by the present research.

Methodology: computable general equilibrium modelling

The assessment of the impacts of the European directive promoting biofuels on European agriculture is carried out from the GOAL model, developed at the INRA, Rennes, France, essentially to analyze possible CAP reforms and/or potential trade agreements. This model is a computable general equilibrium model (CGE), focused on the primary farm and agrifood-processing sectors of the 15-member E.U. This methodology is mainly distinct from that used in the EC survey because all the abovementioned effects are simultaneously and not successively simulated with different models.

Compared to other currently operational CGE models (such as the MIRAGE model (from CEPII), or Linkage (fromWorld Bank)), the GOAL model mainly differs on three levels. First, it provides very detailed coverage of European farm products and sectors by distinguishing 74 products and services in the food chain. This first characteristic enables capture of the numerous interactions at work in agriculture, specifically between the arable crop and livestock sectors. Secondly, the specification of economic agents' behaviours, as much for product supply as for final demand (derived) for goods (factors), is done from elastic and globally constant functions. In more concrete terms, this technical property allows us to account for the sector's specificities, such as the relative price inelasticity of farm product supply or that of the demand for food goods. Thirdly, the numerous CAP tools, which interfere in the functioning of farm markets and/or in that of farms, are modelled in an additional and explicit way. These tools include those applied to trades (export subsidies, specific and *ad valorem* customs duties, tariff rate quotas, mainly), instruments of farm income direct supports (the right to single farm payment, aids coupled with production factors) as well as monitoring supply instruments (set-aside lands, production quotas).

However, we must admit that this CGE model does not isolate the energy sectors (which are included in a "rest of economy" aggregate). It particularly implies that this model does not allow assessment of the absolute efficacy of the European directive promoting biofuels. On the other hand, it does not prevent the weighing up of the effects on the European farm sector (Gohin and Moschini, 2006).

Simulations: definitions and results

The benchmark

In the great majority of cases, CGE model parameters are calibrated from the economic flows observed during a given year. Our GOAL model is based on the flows of a social computable matrix built for 1995. Even if calibrating on more recent results may *a priori* seem more appropriate, it would not solve all the difficulties linked to the assessment of the European Directive promoting biofuels. Indeed, this directive fixes an indicative incorporation target for 2010 and not for today. It is necessary to first project the European farm sector to that year without biofuels, and then introduce them to assess their effects. Furthermore, the European farm sector today is much disturbed by the enforcement of the latest CAP reforms. These reform effects will progressively spread over time. So, it seems more appropriate to assess the effects of the European Directive promoting biofuels once the CAP reform effects are stabilised.

This is the reason why we first build a European agriculture benchmark for 2015, which ignores the

national and Community steps in favour of biofuels. We then introduce these steps in order to identify their effects. Naturally, they will strongly depend on the market situation that could prevail at that time. So it is important to spend time on it. We reach this benchmark through the Goal model with underlying assumptions on the technical progress development in all sectors, on food habit changes or macro-economic conditions. That benchmark only integrates the adopted CAP reforms that have been passed so far. So, it introduces neither the first discussions on the CAP "check up" nor the furthering of the sugar reform, nor any change in bilateral or multilateral trade agreements.

In this hypothetical benchmark, the European market characteristics of main farm and agrifood products are indicated in the first lines of tables 1, 2 and 4. According to all these assumptions, the E.U. is able to export more than 17 MT of soft wheat without any subsidies because the domestic price is equal to the world price. On the other hand, the E.U. corn grain remains in deficit and there is a persistent difference between both prices; here, the import quotas are restrictive. In the oleaginous sector, the E.U. is still a net exporter of rape oil (nearly 1 MT) but remains a large importer of oleaginous cakes. On the sugar market, both the 2006 reform and the WTO panel ruling lead to a reduction in domestic production. All the same, it reaches nearly 14 MT and still exceeds domestic consumption. So there are still European sugar exports, which partly correspond to the re-export of sugar imported in a preferential way. The beef sector is in deficit with out-of-quota imports which amount to more than 300,000 tons, all import types together. On the other hand, the E.U. pork meat shows a surplus. Lastly, the European dairy market remains characterized by surpluses of fat, shown by subsidized butter exports. On the other hand, skimmed and whole milk powder markets are balanced and domestic prices are equal to world prices.

The European directive promoting biofuels

Although this directive is only indicative, in this research work we assume that the incorporation targets will be reached in order to weigh up the maximum effects on European Agriculture. In concrete terms, we assume that the impact leads to public demand for rape oil for biodiesel production of 8 MT and that the bioethanol demand is for 7.3 MT. These demands, financed by new taxes on households and firms, may be satisfied by imports or by domestic production, the arbitration between both sources only depending on the net prices of specific custom duties. In the case of bioethanol, domestic production is partially made up of sugar processing and partially of soft wheat processing. Let us stress that this processing produces by-products used in animal feed. Moreover, we assume that these energy productions may be made on CAP mandatory set-aside lands; on non set-aside lands, they benefit from aids for energy crops limited to 1.5 M. ha. Lastly, this simulation only considers biofuels in Europe and without any WTO agreement, which could force a significant tariff-protection reduction of the European bioethanol market.

In tables 1, 2 and 4, these scenario results are shown in the second lines (expressed in percentages in relation to the benchmark) and for the bioethanol market which is nonexistent in the benchmark in table 3. As expected, the European biofuel demand brings about big changes on large crop markets. In this way, total wheat demand is exploding (19.5%), leading to a price increase (11.3%). Domestic production responds positively (5.5%) but most of the shock is absorbed by a cut in exports (58.2%). At the supply level, this wheat production increase creates a tension on the land market, in spite of the possibility of cultivating on mandatory set-aside lands. Therefore, we get a fall in maize (grains) production (2.5%) and an increase in domestic prices. The effects on average yields per hectare are very low because cultivated set-aside lands have lower agronomical potential.

European bioethanol production is also partially obtained from the European production of sugar. This is made out-of-quotas, which has no significant consequences on the part under quota. Prices are then unchanged in relation to the benchmark. In table 3, it appears that all the bioethanol demand is from inside the E.U., thanks to the specific tariff protection on imports. But the reduction margin on specific custom duties is narrow.

The effects on oleaginous products are also spectacular but less than those assessed by the E.C. Indeed, the increase in rape oil demand leads to a 47.9% increase in price. Domestic oil seed production increases greatly in Europe (76.2% for rape), which is insufficient to meet the additional demand. From being a net exporter, the E.U. becomes a net importer of this oil. Globally, because of significant substitutions in human demand, the effects on the other vegetable oils follow the same movement.

These productions of biofuels generate by-products (spent grains, pulps, cakes), which form part of animal feed. The inflow of such quantities leads to a price fall (for example, 12.4% for rape meals). But this effect is counterbalanced by the increase in cereal prices in the production costs of compound feed. Even so, we get small progress in animal productions (for instance, 0.5% for pork production) which can mainly be explained on the one hand by a ratchet effect from large cropping products over livestock activities and on the other hand, by a greater increase in animal excrement value.

By way of conclusion: the income effects

The effects on the European livestock sectors are thus limited while large cropping sectors are recording increases in prices and productions. It is logical, then, that farm incomes rise. More precisely, this scenario brings about a farm added-value increase of 3.2 billion euros, among which 1 is crystallized in production rights and land real estate, 0.7 in return on capital and finally 1.5 in farm labour remuneration. Part of this amount helps generate work in the farm sector: we estimate the creation of jobs at 42 000 units of farm labour.

Nevertheless, for the farm sector this gain is limited compared to the public expenditure injected into biofuel purchasing (10.5 billion euros in our scenario). The transfer efficiency (that is to say the ratio of farm gain to public expenditure) of internal support tools is far higher. That does not mean at all that the European directive

promoting biofuels is not a "good policy". This result simply indicates that it is far from being the best way to support the European farm sector, and consequently, that it is not possible to justify this policy only by its positive farm effects.

Alexandre Gohin
UR 122 ESR, INRA Rennes
alexandre.gohin@rennes.inra.fr

For further information

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

Table 1: Impacts on the vegetable oil products markets (benchmark value (first line) then deviation % in relation to that value (second line))

	Rape oil	Rape meal	Soya oil	Soya meal	Palm oil
Production (thousand T)	3357 68,9%	3955 68,8%	2180 -0,1%	9647 -0,1%	
Total demand (thousand T)	2485 310%	4478 23,4%	2021 8,4%	26671 3,4%	3631 -6,2%
Net exports (thousand T)	905 -584%	-62 -3062%	125 -117,5%	-18001 5,3%	-3631 -6,2%
Domestic prices (€/T)	483 47,9%	110 -12,4%	462 33,9%	175 -4,3%	464 38,9%
World prices ($/T)	570 47,9%	129 -12,4%	546 33,9%	207 -4,3%	548 38,9%

Table 2: Impacts on cereal, oleaginous seed and sugar-beet markets, (benchmark value (first line) then deviation % in relation to that value (second line))

	Soft Wheat	Corn	Rapeseed	Sunflower	Sugar-beet/sugar
Area (thousand ha)	13569 4,5%	3934 -2,9%	2131 76,2%	1534 29,2%	1554 13,4%
Yields per ha (T/ha)	6,9 0,9%	9,3 0,4%	3,4 0,4%	1,5 -0,4%	59,8 -0,4%
Production (thousand T)	93545 5,4%	36640 -2,5%	7207 76,6%	2324 28,6%	13877 13,0%
Total demand (thousand T)	76833 19,5%	38941 -2,0%	8400 68,9%	4854 13,2%	13095 14,0%
Net Exports (thousand T)	17413 -58,2%	-2500 5,0%	-469 0%	-2115 0%	430 -7,4%
Domestic prices (€/T)	107 11,3%	132 6,4%	204 42,6%	219 34,2%	404 0%
World Prices($/T)	128 11,3%	96 0,6%	245 42,6%	263 34,2%	281 0,1%

Alexandre Gohin UR 122 ESR, INRA Rennes
ISSN 1778-4379 n°2-3 September 2007

Table 3: Impacts on the bio-ethanol markets

	Quantity (thousand T)	Prices (€/T)
Bio-ethanol from wheat	6300	592
Bio-ethanol from sugarbeet	1000	608
Imported bio-ethanol	0	628
Domestic demand	7300	594

Table 4: Impacts on the animal product markets (benchmark value (first line) then deviation % in relation to that value (second line))

	Pork	Poultry	Beef	Butter	Compound feed
Production (thousand T)	19150 0,5%	8888 0,6%	6507 0,9%	1846 0,0%	121032 0,8%
Demand (thousand T)	18273 0,2%	8728 0,0%	6821 0,1%	1505 1,9%	121032 0,8%
Net exchanges (thousand T)	841 6,9%	128 6,8%	-307 -12,5%	342 -6,6%	
Domestic prices (€/T)	2648 -1,2%	2823 -1,2%	3811 -0,4%	2462 0,0%	257 0,7%
World price ($/T)	3177 -1,2%	3864 -0,7%	1927 -0,9%	1701 2,7%	