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How will farming adapt to future energy challenges?

Energy is a major element in the competitiveness and sustainability of the French farming sector. It stands at the heart of a new model for productive and ecologically responsible agriculture. In this regard, it has been a central focus for various programmes and action plans conducted by the Ministry of Food, Agriculture and Fisheries: among others, the Energy Performance Plan (PPE) launched in 2009. The Agriculture & Energy 2030 exercise is part of this process and is directed at highlighting opportunities and risks for the agricultural sector where energy is concerned over the next twenty years. The present note describes the main links between agricultural activities and energy-related issues, in addition to the approach to strategic foresight that has been adopted. Strategic foresight is neither totally scientific nor pure imagination; it starts out from past and present facts in order to anticipate probable futures and prepare the way for decisions capable of facilitating or preventing the advent of those futures.

The links between agriculture and energy are complex. To start with, farming consumes fossil fuels (petroleum products, natural gas) and it has a structural dependence on outside sources of supply. The uncertainty surrounding the future development of the energy context, alongside the threat of exhaustion of fossil fuel reserves in the more or less foreseeable future, heightens the advantages of a better understanding of the nature of those links and changes in them over time. In addition, the agricultural sector has resources (e.g. land, biomass) that provide it with major potential for the production of renewable energy. However, the energy issue also involves the location of agricultural activities in terms of national and international transportation of agricultural products and inputs. The means for achieving improvement (energy-saving technology, changes in production systems, reorganisation of sector supply chains) are being looked into now or are already available. French farming's ability to meet these challenges will be crucial to the future of the sector and its competitiveness.

Given the major issues involved, the Centre for Studies and Strategic Foresight (CEP) of the Ministry of Food, Agriculture and Fisheries wished to set up a working group to consider energy-related challenges for agriculture over the next twenty years. How will agricultural holdings adapt to the changes entailed by the energy transition? What conditions will they be able to cope with? How might they take advantage of them? How will the actors' strategies change and what should be the preferred focuses for action by the public authorities?

Following a phase of diagnostic analysis of past and present trends, the group worked on the various probable futures to the 2030 horizon. This will lead on to a series of recommendations directed at enlightening the public debate and the decision process. After dealing with the main links between agriculture and energy (1), this note sets out the broad lines of the strategic foresight exercise involved here (2). Later publications will describe other aspects of that exercise.

1 - Agriculture seen through the prism of energy issues

There are numerous links between agriculture and energy and it would be illusory to attempt to review them all here. We will go no further in this context than to refer to three that are particularly important for the years to come. They relate to production costs, the location of farming activities, and agriculture as a producer of energy.

Energy prices and production costs

In 2005, the French agricultural sector was consuming 9.2 Mtoe/year, or 5.7% of the total figure for final energy consumption in France[1]. Where farming is concerned, a distinction is made between direct and indirect energy consumption. Energy used directly in the form of fuel for machinery, heating for buildings (livestock housing, greenhouses) and the like accounts for 3.7 Mtoe/year, or €7,800 per holding, and breaks down into consumption of petroleum products, gas and electricity. Although direct energy performance[2] has improved by 2% every year since 1970 thanks to technological developments relating to tractor fuel consumption and building insulation[3], this positive trend should not blind us to the complexity of the links between agricultural production and energy.

1. *Direct and indirect energy. Energy group conclusions* [in French], French Agricultural Academy, 2007.
2. The ratio between direct energy consumption and production volume.
3. Saadi T., "Direct energy consumption on agricultural holdings" [in French], *Agreste primeur,* no. 224, April 2009.

In fact, energy prices exert their biggest impact on production through indirect channels. The manufacture and shipment of inputs, machinery and building materials involve substantial quantities – the available figures being estimates in many cases – of fossil fuels, the cost of which makes itself felt in operating expenses and particularly in the prices charged for inputs (nitrogen fertiliser and animal feed concentrates). The energy assessments of agricultural holdings[4] show that over 60% of total energy consumption is in this indirect form.

A close look at the contribution of energy to production costs leads to the identification of an initial area of uncertainty. Direct energy expenditure alone accounts for 8.7% of an agricultural holding's variable costs[5], and the volatility of market prices for fossil fuels is a source of yet more complexity for any analysis of the impact of energy prices on farm income. In recent years, turbulent oil markets have led to variations in the price of domestic fuel oil from €100/hl in 2008 to €60/hl in March 2009[6]. The French Academy of Agriculture thus estimates that at an oil price of $150 per barrel farm income would fall by 20%[7].

Agricultural products are also affected by price volatility. An upward trend can offset a cut in income caused by increases in costs due to energy. In 2009, the falling impact of expenses on income has been counteracted by a fall in prices for farm products[8]. An extreme situation – i.e. one in which income is squeezed between low prices for agriculture products and high prices for energy – cannot therefore be ruled out.

However, this overall structure masks great diversity between different types of production. Greenhouses (market gardening and horticulture) and off-land livestock farming are the sectors most vulnerable to any hike in energy prices. For the same type of production, different agricultural techniques have diverse impacts and comprehensive energy assessments[9] reveal major disparities between "economical" and "intensive" systems. Means for achieving energy savings can be identified for each system of production; these relate equally to how equipment and inputs are used on the one hand and, on the other, how the farming system is organised.

Energy, location of production and sector organisation

Energy prices also affect agriculture through goods transport costs. At national level, increases in these costs (especially for the collection of raw materials) constitute one factor among others in the concentration of production activities. The road transport industry, on which trade in French agricultural products is highly dependent, and to a lesser extent the shipping industry, pass on increases in oil prices. This leads to a reformulation of the question of energy dependence to take the geographical dimension into consideration. In a context in which transport costs are high, agricultural production activities may group together in areas where products are processed and consumed. If faced with rising energy expenditure (prices, tax, etc.), the most vulnerable sectors (greenhouses, off-land livestock farming) might undergo relocation. The energy issue also involves the logistics and organisation of sector supply chains. The trend toward relocation of activities might also be aligned with the growing expectations of urban populations, with a preference for supplies from the local area. However, the carbon footprint of short supply chains could run counter to the idea whereby less distance between producer and consumer is synonymous with energy savings. The importance of the "final kilometre" in life cycle analyses (LCA) for food products also reveals the importance of consumer choices and behaviour[10].

Since rises in energy costs are passed on down the entire pricing system from production to retail distribution, with a further hike at every stage (collection, storage, processing, transport), the challenge for regulation will be to assist changes in the various activities to take into account such chain processes.

Agriculture as a producer of energy

Agriculture is well placed to contribute to the production of energy due to its biomass resources as well as its buildings and land areas (farmed or not) capable of being used for energy production installations (wind turbines, photovoltaic arrays, geothermal systems). The development of renewable energy on farms forms part of national and international policies to mitigate global warming. Estimates have been made of this potential[11].

The growth of biofuels since the end of the 1990s needs to be analysed in cost terms by comparing agricultural prices with prices for fossil fuels. Currently, biofuels are costly to produce and increases in cereal prices places limits on their economic viability[12]. With wheat at €200 per tonne, the production of ethanol will be viable if the price of a barrel of oil rises to $150. A sharp rise in oil price might therefore be conducive to a rapid expansion in the use of such biofuels. As has already been mentioned, the instability of the oil market constitutes a further source of uncertainty for the agricultural sector.

The biofuels issue refers back not only to climate policies but also to broader environmental questions. Although the potential of first-generation biofuels is encouraging ambitious development programmes in Europe and other world regions, it is also controversial (in terms of economic viability, reduction in greenhouse gas emissions, plus the on-going debates surrounding the issue of changes in land use). The potential of the development and dissemination of innovations for a second, or even third, generation of biofuels is difficult to define today and raises even thornier questions in the context of further time horizons.

The latter point leads to a reconsideration of the relationship between agriculture and the rest of society. While

4. ADEME [French national environment agency], *PLANETE overview report,* 2006.
5. i.e. expenses that rise or fall in proportion to production, as opposed to fixed overheads. Saadi T., *Agreste primeur*, op. cit.
6. *Agreste primeur,* no. 224, *op. cit.*
7. Indeed, a 1% rise in the cost of energy and fertiliser reduces producers' net income by 0.5%. French agriculture faced with a sharp increase in energy costs [in French], French Academy of Agriculture, January 2008.
8. Le Rey E., Saadi T., "Sharply declining income despite falling costs" [in French], *Agreste primeur,* no. 234, December 2009.
9. PLANETE energy diagnostic analyses designed with the support of ADEME, the French environment agency.
10. Rizet C., Browne M., Cornelis E., *Logistics chains and energy consumption: a study of furniture and fruit/vegetables* [in French], INRETS/ADEME, 2008.
11. SOLAGRO, *Control of energy consumption and energy self-sufficiency on French agricultural holdings: current status and prospects for future action by the public authorities* [in French], 2005.
12. French Academy of Agriculture, *op. cit.*

the harm caused to the environment by certain agricultural techniques are frequently pointed out, the production of renewable energy of agricultural origin might offer a new social function capable of enhancing farming's image in society. At the same time, consumers' sensitivity to improvements in agricultural techniques aimed at reducing energy consumption, along with greenhouse gas emissions, provides an incentive to move in the direction of more economical modes of production.

It can be seen here that the interfaces between agriculture and energy are complex and changes in them over time will not be linear - hence the benefits of strategic foresight on this topic.

2 - A forward-looking, systemic approach

The sheer importance of the energy issue for agricultural production gives it strategic status. However, it is an issue that is frequently forgotten or downgraded in strategic foresight exercises. Conversely, we have chosen to make it a core issue in our work on scenarios to the 2030 time horizon.

Energy and strategic foresight

While the environmental dimension has been present for some years in work devoted to strategic foresight in the agricultural sphere, energy is a subject that has received little consideration. It has made an appearance only in a few recent exercises, and even then it has not always been seen as a structurally important variable. Not only is it not systematically included in the scenarios that are constructed but it is even regularly associated with "radical upset" scenarios. For example, the scenario put forward for the period to 2025 by the La Bussière group[13] involving a possible approach to agriculture targeting "high environmental performance" is shaped by constantly rising oil prices.

To our knowledge, only the Academy of Agriculture has conducted a prospective analysis focused on this subject, exploring the impact of high energy costs on French farming. Nevertheless, this looked at only one hypothesis: a gradual rise in oil prices up to $150/barrel and the major cyclical fluctuations this would entail.

On the other hand, the Royal Institute of International Affairs, Chatham House, in the United Kingdom has studied the consequences for agricultural production of several hypotheses for oil prices (up to $200 a barrel)[14] and has developed these into scenarios.

The Centre for Studies and Strategic Foresight (CEP) at the French Ministry of Food, Agriculture and Fisheries decided to assign a dominant role to energy-related issues in its study. While considering the questions already raised with regard to government action, the objective is to produce scenarios for on-going changes in farming and agricultural policy over the period to 2030. In a context of rising prices for fossil fuels and carbon, the ultimate purpose of the exercise is to define possible approaches to the future energy transition in farming. In other words, the aim is to help agriculture cope with tomorrow's energy challenges.

Strategic foresight does not involve attempting to foresee or predict exactly what will come about in ten or twenty years. Indeed, no method or tool could ever hope to be so precise. The key task is not to imagine in detail everything that might happen tomorrow, but to anticipate the broad lines of various probable futures in order to preserve our capacity to take action to cope with what actually occurs. Strategic foresight is neither totally scientific nor pure imagination; it starts out from past and present facts in order to anticipate probable futures and prepare the way for decisions capable of facilitating or preventing the advent of those futures. Useful anticipation rarely foresees what actually happens; instead, it leads to decisions being taken. Any such strategic foresight exercise is fundamentally political and linked in with the "art of government": lack of concern for the further future inevitably means being limited by immediate worries.

There are several approaches enabling important changes already under way to be spotted, among them trend analysis, strategic analysis, the Delphi method and the scenario method. We have chosen the last of these. Neither too rudimentary nor too sophisticated, it is well suited on the one hand to socio-economic topics and, on the other, can take crises and radical changes into consideration. It is good at stimulating the imagination and involving people outside the limited circle of experts and is therefore well suited to public foresight analysis and the guidance of policy decisions. Based on systemic analysis, it enables sectoral hypotheses to be constructed while also including changes in the more general context. Building scenarios is of course not a goal in itself, it is simply one way of putting order into ideas, recounting future histories and identifying the levers for action.

Choice of time horizon is always critical in this type of exercise. The year 2030 is a compromise between, on the one hand, the desire to look beyond the cyclical effects often present where agriculture and energy are concerned and, on the other, the need to work to a time scale sufficiently close at hand to be manageable.

The Agriculture & Energy 2030 exercise

The Agriculture & Energy 2030 group has around thirty members from a range of backgrounds, disciplines and standpoints, from the government ministries involved (Food, Agriculture and Fisheries; Ecology, Energy, Sustainable Development and the Sea), from public agencies and institutions (the national research agency, ANR; the national environment agency, ADEME; and the public agency for agricultural products and fisheries FranceAgriMer), technical institutes, the farm industry (the national federation for centres of initiative for the promotion of agriculture and rural areas, FNCIVAM; the French agricultural think-tank SAF; and the national federation of cooperatives for the utilisation of agricultural materials, FNCUMA), research organisations (the national environmental science and technology research institute, CEMAGREF; and the national institute for agricultural research, INRA), civil society (the national federation of societies for the protection of nature and the environment, FNE), and the private sector (Total, National association of food industries - ANIA), among others. The group met every month over a period of one year (June 2009 – June 2010).

A programme of this kind is conceivable only at the cost of some simplification of the focus of the strategic

13. Agriculture, environment and regions. Four scenarios for the period to the 2025 time horizon, [in French] *La Documentation française,* 2006.
14. Chatham House, *Food Futures: Rethinking UK Strategy,* 2009.
http://www.chathamhouse.org.uk/publications/papers/view/-/id/695/

foresight analysis. In agreement with the members of the group, it was decided at a very early stage to restrict the scope of the exercise. Reduction of greenhouse gas emissions in agriculture and the adaptation of agriculture to climate change were thus excluded from the remit of the system under consideration. This does not mean that those issues were avoided, but simply that they were considered only as background factors. It was also decided to focus on agriculture, and more specifically on the manner and conditions of the production and initial processing of agricultural resources, along with the whole range of agriculture's social, economic, cultural and environmental functions. The exercise did not for this reason include fisheries, whose issues are too different to be addressed within the same framework. Forestry, agrifood industries and retail distribution were also excluded. Once again, this does not mean that those sectors were absent from the group's reflections, but that the relevant variables were considered simply as background factors. Finally, it was decided to limit the analysis to mainland France, given that agricultural and energy issues are very different in Corsica and France's overseas territories.

Once these choices had been made, the work involved gathering the available information and documentation and then arriving at an overall assessment of the main past and present trends. The group then went on to identify all the variables to be taken into account, including both core and dependent variables. In the end, 33 variables were selected and grouped into five component categories (see Figure 1 below).

At the heart of the Agriculture & Energy system, we naturally find the variables relevant to agricultural production, a distinction being made between those directly related to energy (in red) and those of a more agronomical character (in green). Another component, termed "Agriculture & Society" (light blue) is best positioned upstream of this core. This covers variables such as the farming population, the organisation of sector supply chains and consumer behaviour. Where the component "Transport, Logistics and Location" (in purple) is concerned, this is best placed downstream from agricultural production, and includes variables such as the relative locations of production, processing activities and goods transport. This basic structure is fleshed out with two components whose character is more general. The first is a set of contextual variables (dark blue), among which are oil prices, farm prices and major international negotiations, and the second comprises public policies and collective modes of action at regional, national and EU levels (orange).

Each of these 33 variables has been studied in depth, with a detailed definition, the indicators for measuring it, the actors involved, past trends and hypotheses as to the most probable future developments. Cross-correlation of the hypotheses internal to a component led on to the definition of micro-scenarios specific to that component. Such micro-scenarios are coherent, plausible narratives for the future, but they are limited to the single sub-system under consideration. Cross-correlation of the micro-scenarios then leads to the construction of four general scenarios. These will be discussed in a note in the near future.

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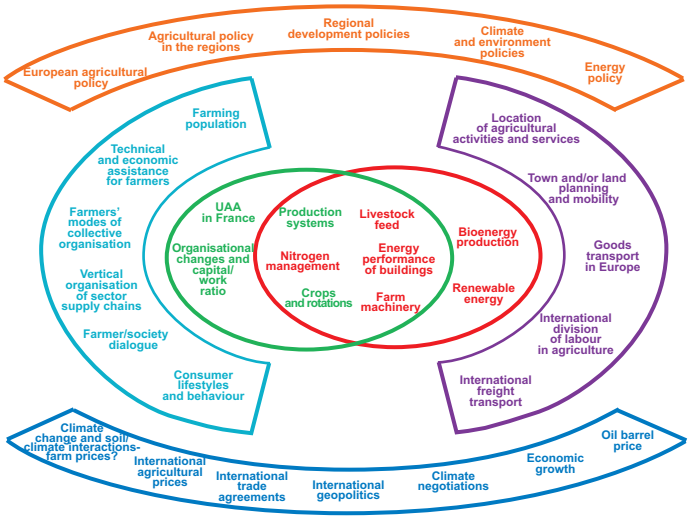
The energy issue is strategically important for French agriculture and public policy applied by the Ministry of Food, Agriculture and Fisheries. It is among the key components of a new model for productive and ecologically responsible agriculture. Based on a complete inventory of the links between agricultural activities and energy issues, the strategic foresight exercise conducted is directed at an analysis of structurally important trends and dynamics, possible radical changes, novel strategies adopted by actors, risks that need to be anticipated and opportunities to be grasped in the years to come. While important as such, this look into the future is also a way of defining the problems of the present with greater clarity, and a way of channelling our efforts here and now. At root, the year 2030 is less important than the public policies that will need to be set in train between now and then: the journey is more important than the destination.

Figure 1 - **Diagram of the five components of the system studied**



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