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Agriculture and the Challenges of Energy

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Purpose

Energy in agriculture is all too often seen as a purely cyclical issue whereas it brings more complex challenges in terms of economic stability for agricultural holdings, impacts on the environment and climate, on food supply chains and spatial planning. The present brief describes the main results of a prospective study led by the Centre for Studies and Strategic Foresight (at the French Ministry of Agriculture). A group of experts used the scenario method to imagine possible futures of the agriculture-energy system in 2030 and help identify priorities and options for public action.

Energy at the Heart of French Agriculture

Energy is of major importance for the future of agriculture in France although it receives relatively little analytical attention. Control of energy consumption is an economic issue for agricultural holdings, which consume energy both directly (fuel oil, electricity and natural gas) and indirectly (energy for the manufacture and shipment of farm inputs). All in all, French farming consumes around 11 Mtoe (million tonnes of oil equivalent) a year: 5.3 Mtoe directly and an estimated 5.4 Mtoe indirectly. Taking all French holdings together, expenditure on fuel and lubricants represents 8.3% of intermediate consumption, 13.1% of the costs of fertilisers and 21.6% of livestock feed. The share of energy consumption in production costs varies widely according to the type of production: 23% of intermediate consumption relates to fertilisers and soil improvement for cereal and protein crops; 67% results from feed purchased for granivorous livestock holdings between 2005 and 2008. For an identical output, there are wide variations in energy costs at the farm level depending on production systems and practices. The prices for these inputs may also vary widely, reflecting those of fossil fuels. A high oil price may therefore have major consequences for the economic balance of holdings: the double burden of low farm prices and high energy prices may cause unavoidable and difficult situations. The issue of energy also involves logistics, the organisation of agricultural supply chains and the distribution pattern of farming activities across regions. This is so because the distances separating production areas, consumption areas and sources of input supply are reflected in energy consumption.

Moreover, energy and climate are intertwined issues. Agriculture could contribute to national targets for containing global warming by cutting its emissions, producing renewable energy and sequestering carbon in soil. On the other hand, ambitious climate and environment policies may increase fossil fuel prices.

A Collective and Systemic Approach for the Scenario Method

Since the interaction between agriculture and energy is complex, this subject was addressed using a collective approach based on the scenario method.

The 'Agriculture Energy 2030' group involved around forty participants with a wide range of skills and backgrounds from concerned ministries (Agriculture and Fisheries, Sustainable Development), public agencies (ANR, ADEME, FranceAgriMer), technical institutes (CTIFL, IFIP, Institut de l'élevage), the farming world (FNCIVAM,

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FNCUMA, SAF), research bodies (CEMAGREF, INRA), civil society (FNE) and the private sector (Total, ANIA).

This foresight exercise is centred on agriculture. It leaves out both fisheries and forestry, and the agrifood and retail distribution industries are only marginally considered in the exercise. In addition, climate change is only considered for its direct link with energy, that is, greenhouse gas (GHG) emissions caused by direct and indirect energy consumption and renewable energy production. Issues relating to biomaterial and bioproduct production have also been considered in the core analysis. Finally, the analysis restricts itself to mainland France because the French overseas territories have very specific agricultural and energy features of their own.

The choice of time frame to 2030 is a trade-off between the desire to capture cyclical effects and the necessity of working with a manageable, not too distant time scale. Within this basic framework, the Agriculture Energy 2030 group identified five components made up of 33 variables relevant to explaining the possible futures of the agriculture-energy system.

A study card was created for each variable to set a number of hypotheses as to its future development. This exploratory work was based on the identification of past trends, emerging trends and the main areas of uncertainty to be considered when looking forward into the future. Proceeding very conventionally, these hypotheses were combined for each component to produce micro-scenarios, which were then combined to generate global scenarios. For greater consistency and to cast a more informative light on the issues surrounding agriculture and energy, the global scenarios were quantified using a model (Climagri) to estimate French farming production, energy consumption and GHG emissions by 2030. These scenarios are not predictions of the future and reflect even less the preferences of the expert group or the French Ministry of Agriculture. They were used as conjectures to alert actors and decision-makers.

A Set of Four Scenarios to Highlight Energy Challenges in Agriculture

Scenario 1: Regionalisation and frugality to confront the crisis

A profound energy crisis undermines conventional business models. The international context is tense and focused on protection of domestic markets. Around 2020, the management of public policies is entrusted to a greater extent to regional authorities, which are seen to be closer to the development issues of their territories. By 2030, the agricultural world has changed profoundly and faces a number of external constraints: energy prices at sustained high levels, a budget crisis and loss of legitimacy of the central government, a withdrawal to home regions and a contraction in international trade. Agriculture adapts as a matter of urgency, employing a strategy focused on the local level, accompanied by major institutional reform.

The growing self-sufficiency of production systems inevitably involves input reduction, more extensive livestock farming and diversification. The search for complementarity between crops and livestock or between types of crops across holdings and regions becomes a general reality. By 2030, this transformation is not harmonised across the French territory and there are major regional disparities. Lower levels of specialisation and production lead to a limited export capacity. French farming makes major cuts in its energy consumption (down by 32%). Renewable energy produced on the farm supplies additional income, but its development depends on local potential and dynamics. Extensive use is made of biomethanation and wood-for-energy, but expansion of biofuels is held back by high agricultural prices.

Scenario 2: Twin-track agriculture and energy realism

Against a backdrop of high energy price volatility and further trade liberalisation, public support for agriculture declines with a refocusing on remuneration for the public goods provided by agriculture. These changes have very different impacts on holdings depending on whether or not they meet local demand for the local supply and provision of public amenities. Two forms of agriculture exist side by side in 2030:

- “Business Farming” (mainly on the plains of the Northern , Western and Central France): these farms manage to be competitive and to position themselves on export markets. Intensification and restructuring result in a high-precision, high-input farming system. Energy use is optimised on these farms as a response to economic drivers. Energy optimisation is benefited by private-sector market supply of technology and counselling services.

- “Multifunctional agriculture”: these farms diversify their activity and are remunerated for the environmental services they provide (water, biodiversity, landscape, carbon storage). Their main activities are extensive livestock, organic and mixed crop-livestock farming. Such holdings adopt strategies focused on self-sufficiency and low energy use close to those in Scenario 1.

Overall, there is little change in energy consumption. Renewable energy production expands moderately, with investments being held back by price volatility. Biofuel production is more strongly developed in integrated and innovative industrial sectors.

Scenario 3: Health-centred agriculture with no major energy constraints

In 2030, urban consumers are more numerous and more influential. With the backing of the large retail chains, they have succeeded in imposing a major reduction in the use of pesticides by agriculture on grounds of the protection of

human health rather than protection of the environment. In the absence of major energy constraints and strong environmental policies, urban sprawl continues to expand. Agricultural supply chains are shaped by their downstream components, with quality schemes and mandatory specifications becoming highly prescriptive with regard to reduced pesticide use. Producers adjust more or less. Some sectors are negatively affected by this new constraint. The most isolated rural regions experience significant abandonment of agriculture. Conversely, the major cities invest in periurban farming to meet the demand for open spaces and local food supply. A specialised and technically sophisticated agricultural model involving integrated pest management has developed. It aims at high production levels and at abating pesticide use at the same time. In parallel, organic farming develops significantly. The absence of any major constraint in terms of policy or energy pricing results in a slight fall in overall energy consumption since production inputs are partially substituted by efficiency gains in machinery. The production of biofuels expands strongly, driven by the early arrival of second generation technologies.

Scenario 4: Ecological agriculture and energy savings

Approaching 2015, the need to make sharp reductions in the environmental impact of human activity leads to a consensus both in the developed world and slowly in the emerging countries. European households adapt their consumption patterns out of concern for preservation of the environment and in response to prices that now include the environmental cost of products. The implementation in 2016 of a common EU-US CO_2 market with border adjustment mechanisms triggers a massive shift towards ecological modernisation. In this context, agriculture evolves toward new production models with smaller environmental impacts; the trend is supported by a reformed agricultural policy. This change, however, is both difficult and gradual. The initial resistance of the farming world delays the behavioural changes. Major mutations in the whole agri-food system are also required. From 2020 on, French agriculture becomes 'ecologically intensive' on the wide cereal-growing plains of the country: for example, crop diversification, general use of nitrogen-fixing crops at the beginning of rotation sequences and no-tillage become common. In hilly and mountainous lands, farmers are paid for environmental services and are encouraged to meet self-sufficiency at the farm (diversified systems based on mixed crop-livestock farming) or across whole regions (complementarity between farms). Biomethanation and renewable energy production are strongly developed.

Future Requirements for Policy

The expert group sketched out 'come what may' strategies that can be expected to remain valid in any future context. The use of fertilisers is a core element of energy balance, and the technical means for reducing nitrogen inputs are well known (long crop rotation sequences and diversified crop choices, use of green manure, organic sources of nitrogen and so on). Their general adoption requires awareness-raising and educational efforts directed at the farmers along with networking to support farmers in exchanging experiences. The need for changes may call for the use of strong normative or economic instruments.

The Agriculture Energy 2030 group has highlighted the advantages of biomethanation, on condition that the digestates are correctly recycled. The structuring and development of the relevant sector supply chains are major issues. Digestate centrifugation is one of the most promising avenues because it allows an easily transported solid phase rich in nutrients (ammonia, phosphate, potassium) to be isolated, along with a liquid phase that is rich in nitrogen but which must be used in nearby areas (spreading). Official approval for the products obtained in this way could provide a major boost.

Another advantage of biomethanation is the production of renewable energy (electricity and heat). The existing support schemes for the installation of digesters on farms should be accompanied by biogas purchase prices to offer greater incentives and forward visibility to investors.

Preference for local supply of protein for animal feed was seen as an advantageous strategy. The goal is to reduce the transportation of these inputs through on-farm production or local supply and to give preference to protein sources requiring low levels of inputs for their production. Grass-based livestock farming particularly deserves to be encouraged given its self-sufficiency and the numerous amenities it provides. Strategies aimed at expanding the use of grass in livestock farming and introducing legumes into pastures are of interest and should receive appropriate technical assistance.

Agricultural machinery constitutes a major area for fuel savings and a lever for change, which could be easily used. Investment in proper adjustment and maintenance of tractors, replacement of machinery and reductions in engine power should receive financial support while giving priority to pooled uses. Elimination of the need to till the soil (notably by means of zero-tillage) could be explored for the reduction of fuel consumption. Extensive effort on training and research is, however, required.

Innovation in the organisation of the agricultural sector to improve energy balances across production regions is needed. The group recommends that production systems should be diversified and products traded between holdings. Support would be appropriate for farmers committing to innovative modes of production (e.g., crop-livestock complementarity, organic farming, high environmental value) through proactive policies on land

and installations, especially in the most specialised regions. In addition, the provision of technical and financial support for the development of on-farm primary processing of water-rich products could help reduce transport-related energy consumption while at the same time diversifying farmers' income sources.

There is nevertheless a need to study case by case the energy efficiency and economic viability of this kind of development, which requires major investments and increases farm workload. The development of on-farm storage facilities and conservation technologies helps reduce wastage and thus provides another tool for action. Lastly, there are avenues to be explored for the improvement of the energy performance of short supply chains: delivery pooling, modal transfer, avoidance of empty return trips and so on.

The development of renewable energy production must be supported and channelled. Renewable energy, other than biomass can provide additional income, depending on farmers' investment capacity and local potential. Moderate purchase prices should help avoid excessive speculation and the risk of unbridled development of installations on agricultural land. Where biofuels are concerned, public support should favour the most competitive and best environmentally performing sectors. Such targeting of support would help ensure that budget leeway can be found to increase R&D efforts and assist investment in second-generation technologies. Support of this kind should be made conditional on compliance with demanding sustainability criteria. The rising importance of ligno-cellulosic biofuels will also require sustainable management and the mobilisation of large quantities of biomass. Farm fuel taxation might also be revised in order to offer greater incentives for fuel economy.

Reduction of the energy consumption of buildings is a necessity for the high direct energy consuming sectors. Large-scale investment should, for instance, be provided for the modification and effective insulation of buildings, the installation of heat economisers or biomass boilers and for lighting optimisation. Financial support in the form of grants or loans could be provided on condition of complying with thermal standards for buildings. A wide-ranging scheme could be implemented along the same lines as the PMPOA (French programme for the control of pollution of agricultural origin). Lastly, priorities for agronomic research and the dissemination of innovation in agriculture were highlighted. Indeed, considerable uncertainty remains and more knowledge should be gained on indirect energy consumption (especially for animal feedstuffs), end-to-end energy balances in agricultural supply chains, the logistics of agricultural and food products and the energy content of those logistics. In particular, current work on the development of short marketing chains for agricultural products should not neglect this aspect. Generally speaking, comparisons of the energy balances of different agricultural holdings must be continued and improved to help understand discrepancies in levels of consumption and energy efficiency in different production systems.

Varietal improvement should focus on the development of high-yield protein crops and less nitrogen-dependant cereals and oilseeds. Alongside this, research into production systems should address low-energy systems (e.g., integrated production, grass-based systems) and alternatives to tillage. Support for organic farming should go hand in hand with research into increased yields and methods for reducing direct energy consumption.

Innovation transfer is the keystone of any successful strategy. Governance of R&D should be broadened, for example, by involving practitioners in the R&D organisations. Developing a network of experimental farms is also essential for the definition and transfer of innovative techniques and technical benchmarks. Lastly, several factors are holding back useful initiatives to sustainably improve the energy efficiency of agricultural holdings and supply chains: energy price volatility, low taxation on energy products in agriculture and lack of knowledge. Efforts to communicate, raise awareness and provide training must accompany any action.

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For further information on this project, see http://agriculture.gouv.fr/agriculture-energie-2030,1440.