Agricultural Economics, 1 (1987) 259–272
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Effects of the Energy Crisis on French Agriculture between 1974 and 1984

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(Accepted 10 February 1987)

Abstract

Bonny, S., 1987. Effects of the energy crisis on French agriculture between 1974 and 1984. Agric. Econ.,1: 259–272.

The effects that the energy crisis has had on the relatively energy-intensive French agriculture are discussed in this paper for the period 1974–1984. The economic significance of energy in agriculture and the economic effects of higher energy prices are examined. An analysis is made of developments in the use of different sources of energy in the agricultural sector: savings in petroleum products used for heat production, diversification of fuel sources for heating, growing consumption of wood for space heating, and increased use of electricity. The effects of the energy crisis on France's agricultural economy, particularly with regard to farm income, the choice of sites for agricultural production, and trade in agro-food products are discussed. Finally, a detailed breakdown is given of the changes in the use of production factors, caused by the increase in energy prices. Agriculture appears to have become more economical or more efficient.

Introduction

The energy crisis that followed the two oil shocks of 1973–1974 and 1979–1980 was a major topic of concern for France and other countries. In the agricultural sector, there were worries that the trend towards modernization in farming had lowered the energy efficiency, that more expensive energy would push up production costs in certain high-consumption activities, and that rationing of petroleum products could ultimately be required. The crisis raised a number of questions as to the future of an agricultural sector that had relied until then

0169-5150/87/$03.50

on low-price energy: very little was known about the effects that sharp energy price rises would have on that sector. Although the recent fall in energy prices may be only temporary, the energy situation has now changed radically, and it would be useful to take stock of the effect that the energy crisis between 1974 and 1984 has had on agriculture. After establishing the economic importance of energy in agriculture as a whole, a detailed analysis will be made of how consumption patterns of different energy products have developed, and of how the uses of those products have changed within the agricultural sector. The economic effects of the energy crisis will then be examined, with particular attention being paid to farm income, production choice and trade in agricultural and food (agro-food) products. Finally, an analysis is made of the changes in the use of the different factors of production that have come about as a result of the increase in energy prices.

The economic importance of energy in agriculture

Energy costs in agricultural production

The energy requirements of agriculture are both direct and indirect. Directly required in the production process itself are petroleum products and electricity, for example, while indirect requirements include the energy needed to produce inputs such as fertilizers, treatments, equipment, etc. Since the first oil shock, a number of research projects have attempted to assess the quantities of direct and indirect energy that are consumed in agriculture. However, to assess a sector of production in terms of sensitivity to energy price rises, one must calculate the proportion of energy costs (direct and indirect) in the overall value of production. That proportion is very difficult to establish, mainly because indirect energy consumption includes the energy consumption of all the agricultural inputs, and it is thus essential to know the energy costs – direct and indirect – included in the price of each input. Such breakdowns are largely unavailable, except in major segments of industry, and even if there is precise knowledge of the amount of energy required to manufacture a good, energy prices are not uniform. Indeed, the price of energy varies considerably according to what type of energy is used, how much is consumed, and the type of consumer involved (e.g. preferential electricity rates for certain types of subscriber). In 1981, for example, the average price of fuels consumed in industry was FF 1220/toe*,while high-tension electricity costs in industry averaged FF 2706/toe. Yet households (and many farmers) were paying an average of FF 2216/toe for gas oil (which is the most commonly used heating and transport fuel in agriculture) and FF 6400/toe for electricity.

Despite these difficulties, an attempt is made here to establish the direct and

*1 toe = metric ton oil equivalent (4.1855×10^{10}J).

TABLE 1

Petroleum products and total energy costs (direct and indirect) as a proportion of economic results in agriculture in 1973 and 1983

	1973		1983	
	Petroleum products	Total energy costs	Petroleum products	Total energy costs
Percentage of agricultural produce sold	1.5	4.2	2.9	8.0
Percentage of purchased inputs	4.6	12.7	6.4	17.9
Percentage of gross farm income	2.8	9.2	7.2	23.2
Percentage of net farm income[a]	3.4	11.2	10.5	33.8

[a]Net farm income = gross farm income − depreciation.
(In mid-1987, INSEC (Institut National de la Statistique et des Etudes Economiques) issued a new set of national accounts based on revised methodology and statistics. In this new set the economic importance of petroleum products in agriculture is a little greater than it appears in the above table, calculated from the previous set of national accounts).

indirect costs of energy in France's agricultural production, based on an estimate of the energy costs in each input (Bonny, 1986). In 1983 and 1984, when a farmer delivered produce worth FF 100, he had spent an average of FF 2.9 on petroleum products and FF 8 on direct and indirect energy consumption. Ten years earlier, those figures would have been FF 1.5 and FF 4.2. In economic terms, therefore, energy has played and continues to play a minor role in agricultural production when one considers its qualitative importance (without fossil fuels, Western agriculture would virtually grind to a halt!). However, direct and indirect energy costs are high when they are examined in relation to farm income (see Table 1). In other words, increased energy costs are partly responsible for a fall in farmers' income, as can be demonstrated by the following simple calculation: in 1979, petroleum products represented 5.1% of gross farm income, and total energy costs represented 16.8%. Since prices of the petroleum products used in agriculture rose by 30% in real terms between 1979 and 1981, and the wholesale price of energy products used in industry rose by 25% over the same period, gross farm income would have fallen by 4.4% if there had been no other price adjustments or modifications in levels of production and consumption, and if higher energy prices had a proportionate effect on the price of agricultural inputs. In fact, gross farm income fell by 6.4% in real terms as a result of other factors that either brought down incomes (e.g. increases in non-energy costs, such as payroll taxes and financial costs, or a fall in farm prices), or else helped maintain those incomes (less wastage of energy and inputs, price rises of inputs, such as nitrogen fertilizer, that did not reflect the real proportion of energy in the global cost breakdown). The influence of higher energy prices on the reduction in farm income between 1974 and 1982, will be discussed in more detail further on.

TABLE 2

Energy intensity of various French economic sectors in 1983

Sector	Energy intensity[a]
Industry (total average)	164
Heavy industry (steel, chemicals, etc.)	643
Light industry (textiles, mechanical construction, etc.)	62.5
Tertiary	33
Agriculture	93

[a]Energy intensity: energy consumption in metric ton oil equivalent (toe) per 10^6 French francs added value in constant 1970 prices.

Energy intensity in agriculture and other sectors

The ratio generally used to compare the sensitivities of different economic sectors to changes in energy prices or supply is considerably simpler to calculate than the relative importance of direct and indirect energy costs discussed above. This ratio is known as energy intensity and refers to the relationship between the quantity of direct energy consumed and the added value of the sector. Compared with the other sectors of French economy, agriculture is moderately energy-intensive (93 toe per million FF added value), situated between the tertiary sector (33 toe) and the industrial sector (164 toe), and, within the industrial sector, between heavy industries (643 toe) and light industries (62.5 toe) (see Table 2). However farmers pay almost as much for their energy as households, i.e. around twice as much as industries (see examples of electricity and fuel oil above). Thus, compared with the other sectors of the economy, agriculture is fairly sensitive to higher energy prices.

Energy intensity can also be used as a basis for comparing different agricultural production systems or different types of produce. In the 1970s, the work of Pimentel (Pimentel et al., 1973) was often used to make similar comparisons on the basis of energy efficiency (the ratio between the edible energy output and the energy consumption of inputs). That ratio, however, does not rely on economic factors and therefore does not indicate how sensitive different types of produce or production systems are to higher energy prices. In this respect, energy intensity is a more meaningful indicator, since it takes into account the economic value of the calories that are produced and has the advantage (and the disadvantage) of relying on current economic philosophy.

The rise in energy prices between 1974 and 1984

The present analysis of the effects of higher energy prices on French agriculture concentrates on the period 1974–1984. The effects of the first oil shock were felt in 1974, and those of the second oil shock in 1979–1980. Between 1973 and 1983 the price in France of 1 tonne of imported crude oil rose from FF 115 to FF 1743, in other words it increased 15-fold (current prices) or 5.3-fold in real terms. Within France, energy prices rises were offset by taxation adjust-

ments and were therefore less sudden. The most widely used energy product in agriculture, gas oil, cost FF 0.29/l on 1 July 1973 and FF 2.59/l ten years later. In other words, the price of gas oil had risen 8.9-fold at current prices, or 3.25-fold in real terms. Non-petroleum energy products rose less steeply. Non-energy agricultural inputs also became more expensive in current prices (not always in direct relation to the proportion of energy in their global cost breakdown), while in real terms, price increases were more moderate: overall, the price of purchased inputs increased by 7% between 1970 and 1984 (and by 2.8% between 1973 and 1984). Nevertheless, farm prices fell by 15.3% in real terms between 1970 and 1984 (and by 22.4% between 1973 and 1984, i.e. by an annual rate of 2.1% over the 12-year period). This fall in farm prices thus accentuated the relative increase in energy and purchased input prices. The energy crisis is not the only reason for the developments that took place in the agricultural sector between 1974 and 1984, but this report focuses on the specific effects of the energy crisis on that sector.

Comparative use of different energy sources in the agricultural sector in France subsequent to the energy crisis

A detailed study has been made of the changes in the ways in which different energy sources have been used in agriculture since the energy crisis (motor force for work in the fields, non-mobile engines, heat for drying, dehydration and space heating for livestock buildings and greenhouses). All available indicators have been used in this study, and particular attention has been paid to the findings of two investigations into energy consumption that were conducted in 1977 and 1981 (SCEES, 1979; SCEES, 1985). The investigations were based on a representative sample of more than 10 000 farmers, and demonstrate the following points:

- Major savings have been made in the use of petroleum products for heat requirements in agriculture and in space heating of farm residences. Those savings have been brought about by energy conservation measures and by conversion to other fuels (see Table 3);
- The use of gas oil as a fuel source has remained stable, although the total power requirements of the country's tractors has continued to rise (from 38.1 GW in 1973 to 54.1 GW in 1984). Farmers are purchasing fewer tractors, but the average unit power of the tractors used has increased considerably, from 38.5 hp (28 kW) to 50 hp (37 kW) between 1973 and 1984. This increased power has brought time savings, and overall fuel consumption has not increased. However, as a result of the crisis in the farm machinery sector, high-economy machinery has not been developed as fully as it has been in the automobile industry.
- Fuels used for heat sources have been diversified. In corn drying, for example, gas (natural or propane-butane) has partly replaced gas oil, while in several

TABLE 3

Estimated oil savings in various sectors of French agriculture (especially for heating)

Petroleum products consumption in farms (Mtoe)	1977	1981	1984-1985	77-81	81-85	77-85
Total consumption of petroleum products	4.51	3.94	3.65	−13%	− 7%	−19%
Agricultural consumption of pertoleum products	3.18	2.96	2.90	− 7%	− 2%	− 9%
domestic consumption of gas oil (for heating only)	1.11	0.79	0.45	−29%	−43%	−59%
Energy consumption in greenhouses	1977	1982	77-82			
Estimated total energy consumption (Mtoe)	0.75	0.65	−13 %			
Estimated area heated (including antifreeze) (ha)	3430	5000	+46 %			
Estimated average consumption per ha (toe/ha)	220	130	−41 %			
Specific energy consumption for dehydration	1972	1975	1983	1984	75-84	72-83
Alfalfa (kg)[a]	-	300	-	167	−44 %	-
Beet pulp (kg)[a]	334	-	183	-	-	−45 %
Corn drying: percentage of gas oil used by collecting organizations	1979	1985				
Dryers using gas oil (% of total dryers)	88	73				
Gas oil drying capacity (% of total capacity)	77	52				
Amount of corn dried using gas oil (% of total corn dried)	-	37				

[a]Consumption of heavy fuel oil per metric ton of dehydrated product.

instances coal has replaced heavy fuel oil in the dehydration of fodder crops. Various energy sources are now used instead of gas oil in greenhouses.

- There has been a rise in the use of wood (essentially for heating farm residences) (from an estimated 1.95 Mtoe in 1977 to 2.20 Mtoe in 1984). Wood is also increasingly used by the non-agricultural population in rural areas. According to an investigation carried out in 1984, around one-fourth of all households in France use wood for heating purposes (45% of which use wood as a principal heating fuel, while the rest use it for supplementary heating).
- The use of electricity has increased, particularly for livestock activities (hot water, air conditioning in buildings, etc.) and for the various non-mobile engines used in farming. Electricity consumption was 2.6 TWh in 1977; it rose to 4 TWh in 1981 and to 4.3 TWh in 1984–1985.
- Examination of indirect energy consumption reveals that the demand for fertilizers has not developed uniformly. The situation is not the same for all types of fertilizers. Demand for nitrogen fertilizers has continued to rise, although more slowly than before, while the use of phosphate fertilizers has decreased because prices of those products have followed petroleum prices fairly closely. Demand for potash fertilizers has remained stable. Thus, during the 1973–1974 season N,P and K fertilizers were used at a respective average rate of 63, 75 and 63 kg per ha of fertilizable land, while during the 1984–1985

TABLE 4

Energy intensity in agriculture from 1977 to 1984-1985

	1977	1981	1984-1985	77-81	81-85	77-85
Energy consumption by farms (professional use) (10^3 toe)	3823	3953	4034	+ 3%	+ 2%	+ 6%
Petroleum products (10^3 toe)	3185	2963	2902	− 7%	− 2%	− 9%
Added value of sales (10^6 constant 1970 francs)	45368	51762	58442	+14%	+13%	+29%
Energy intensity	84.3	76.4	69.0	−10%	−10%	−18%

[a]Energy intensity = energy consumption in metric ton oil equivalent (toe) per 10^6 French francs added value in constant 1970 prices.

season these figures are 81, 55 and 65 kg. Overall consumption of fertilizers (N+P+K) per hectare has thus remained stable (201 kg).

- With the exception of wood, the use of renewable energy sources (particularly those based on biomass and agricultural by-products) has increased very little. At one time it was thought that the countryside would soon be fertile ground for the development of wind-turbine generators, solar arrays, small-scale hydroelectric schemes, methane digesters, corn cribs, wood- or straw-fired boilers or even tractors running on biogas or fitted with gas generators. In fact, except for the wide use of wood and corn cribs, very few of these small-scale projects have been carried out, and the accent has been laid on capital-intensive energy-saving projects with applications in dehydration, drying, greenhuses and energy production. Nevertheless, the research that has been carried out into renewable energy sources is likely to prove useful in the future (AFME, 1986).

Farmers and dehydration or drying facility managers have thus changed their energy habits in an effort to economize or diversify. Changes have been particularly noticeable in the case of those major consumers of petroleum products for heat production, where energy represented a large proportion of expenditure. Various public-sector organizations have provided support for these measures, particularly for greenhouses, corn drying and dehydration applications. The French Agency for Energy Management (AFME) was set up in 1982 and has assumed responsibility for a wide range of activities in this respect.

The consumption of petroleum products in agriculture has fallen, but energy consumption has risen overall, although not as quickly as during the 1960s and less quickly than agricultural production. There has thus been a reduction in the energy intensity of agriculture: less energy is now needed to produce one franc of added value in real terms (see Table 4). The effect that the energy crisis has had on the use of different energy sources in agriculture appears largely comparable to the effect it has had in other productive sectors of the economy, where the use of non-petroleum fuels has reduced the consumption of petroleum products, and where energy intensity has also fallen. However,

the energy crisis has not only affected agriculture in this way. It has had an impact on many different aspects of the country's entire agricultural economy.

The effects of the energy crisis on France's agricultural economy

Effect on farm incomes

Farm incomes in France fell in real terms between 1974 and 1980, and the per capita income of farmers was 25% lower in real terms in 1983 than it was 10 years earlier. Can higher energy prices help explain this fall? One method that can be applied to assess the influence of higher energy prices involves retrospective simulation: what would have happened if energy prices had not risen? The situation has been simulated in this way using an econometric model of French agriculture (MAGALI), and it has been demonstrated that, if the price of inputs had risen in line with inflation throughout the 1974–1982 period, and thus without the sudden increases that certain inputs experienced, farm incomes would have been 6–12% higher (depending on the years) than was actually the case (Albecker and Lefebvre, 1985). Clearly, higher energy prices are not only cause of higher prices of purchased inputs, but these two phenomena are closely linked. It appears that higher energy prices have contributed to the drop in farm incomes, but it is impossible to make an accurate assessment of the influence they have had.

Effect on the choice of activity

Certain agricultural activities have particularly high energy requirements, e.g. dehydration of fodder, corn drying, greenhouse heating. Other activities are more economical in terms of energy, e.g. leguminous crops that do not require nitrogen fertilizers. However, higher energy prices have not, in general, had a noticeable effect on the choice of agricultural activity (although the use of greenhouses has risen dramatically). However, certain activities have been moved to other locations.

Dehydrated alfalfa production has been stagnating for 10 years, and alfalfa cultivation has become concentrated in the Marne department of France's Champagne region. There was a particularly high concentration of dehydration plants in that area, and 55% of these facilities have now closed down. New uses of alfalfa are also being sought.

Corn production has been stagnant since 1973, but this can be largely explained by the fact that yield did not increase between 1968 and 1980. Further, at the beginning of the 1980's, corn production started to become concentrated in southwestern France, where drying costs are lower. More recently however, improved yields have made it possible to develop corn production in northern France.

Between 1970 and 1982, the use of greenhouses has increased phenomenally. This increase is linked to the high returns that can be achieved from this activity since out-of-season consumption of vegetables has risen. Despite the crisis, certain categories of consumers are buying more and more vegetables out of season, and imports of those vegetables have also increased considerably. However, today's greenhouses are much more economical than those that were used before the crisis (see Table 3), and the most substantial rise in production has been recorded in southern France (Pyrénées Orientales, Bouches-du-Rhône, Vaucluse) where sunshine is most plentiful, to the detriment of traditional vegetable growers further North (Brittany, Central France).

Other activities have been virtually unaffected by the rise in energy prices. Production of leguminous fodder crops continues to fall, although less steeply than before, despite the savings in nitrogen fertilizers and cattle cake that those crops allow. However, the prices of such fertilizers and cattle cake have risen only slightly. Protein-rich crops have made significant progress. They are ideal crops to precede wheat, particularly because they enhance the nitrogen content of the soil. Another advantage of protein-rich crops is the fact that EEC subsidies were available to ensure sufficient profit margins.

Effect on trade in agro-food products

Exchanges of agro-food products have been deeply influenced by the rise in energy prices. OPEC countries have often stepped up their agro-food imports, and some of these countries have experienced a sharp rise in their food dependency: Saudi Arabia, Nigeria, Egypt and Algeria ranked among France's top twelve customers. In 1972, the EEC exported less than 9% of its cereals to OPEC countries, against 21% in 1980. However, the recent fall in petroleum prices has had serious consequences for certain countries, such as Nigeria, whose export activities were centered around oil, and most of France's new markets in this sector have now slumped, causing critical situations in certain cases.

Competition between different producer areas has some times increased. For example, competition traditionally exists between the vegetables grown in French greenhouses, those produced in warmer countries with cheaper labor (Spain, Morocco, Greece), and produce imported from the Netherlands, where fossil fuel is less expensive and levels of technology are comparatively higher. The energy crisis has fired this competition and has highlighted the differences in costs linked to the abundance and price levels of solar energy, fossil fuels, labor and information. There is also fierce competition for nitrogen fertilizers: countries with abundant energy resources have managed to develop their export markets now their produce has become more competitive.

It is not easy for agriculture to fulfill the new role that has been thrust upon

it. When President Giscard declared, in 1977, that agriculture "must become France's oil", he implied that its farms must help pay the country's energy bill. In fact, between 1975 and 1979 the balance of trade in agro-food products covered only a very small proportion of the energy deficit and only 11–14% between 1980 and 1984.

The impact of the energy crisis on the use of the factors of production

Agriculture appears to have become more economical and more efficient...

Energy is not the only factor to have enhanced productivity. Since 1977, agricultural production has increased more quickly than the level of inputs, capital expenditure and energy consumption, and the partial productivity of each of these different factors has thus increased – or at least remained stable – in agriculture, without labor productivity decreasing. It should be remembered that the productivity of all these factors (excluding labor) had been falling since the 1960s (see Fig. 1), and it is thus fair to say that agriculture has become more economical, or more efficient, since less inputs are now needed to generate the same volume of produce. Quantities of energy and other purchased inputs are still increasing, but much more slowly, while capital expenditure is actually decreasing. A longer period is nevertheless required to ascertain whether agriculture has really become more efficient, since agricultural results are influenced by the fact that climatic conditions can bring exceptional harvests. Further, a phenomenon such as the fall in capital expenditure should be analyzed in greater detail, and research into this question is already under way.

...but the relative importance of each factor of production has remained basically the same

The development of French agriculture since World War II has been marked by the replacement of land and labor by energy (and capital). Have higher energy prices compromised that development? Examination demonstrates that this was not generally the case.

– There are no instances of labor replacing fossil fuels, except in the underground economy (e.g. farmers produce more firewood in the slack season). This fact is not surprising, since energy prices rose less than wages between 1950 and 1984 (despite the sharp increases of 1974 – 1983). It can be seen from fig. 2 that the price of gas oil increased 2.4-fold in real terms between 1950 and 1984, while the guaranteed hourly minimum wage rose 3.2-fold over the same period. The process of replacement of labor by energy (and capital), which has been a constant feature of the development of agricultural economy since 1950,

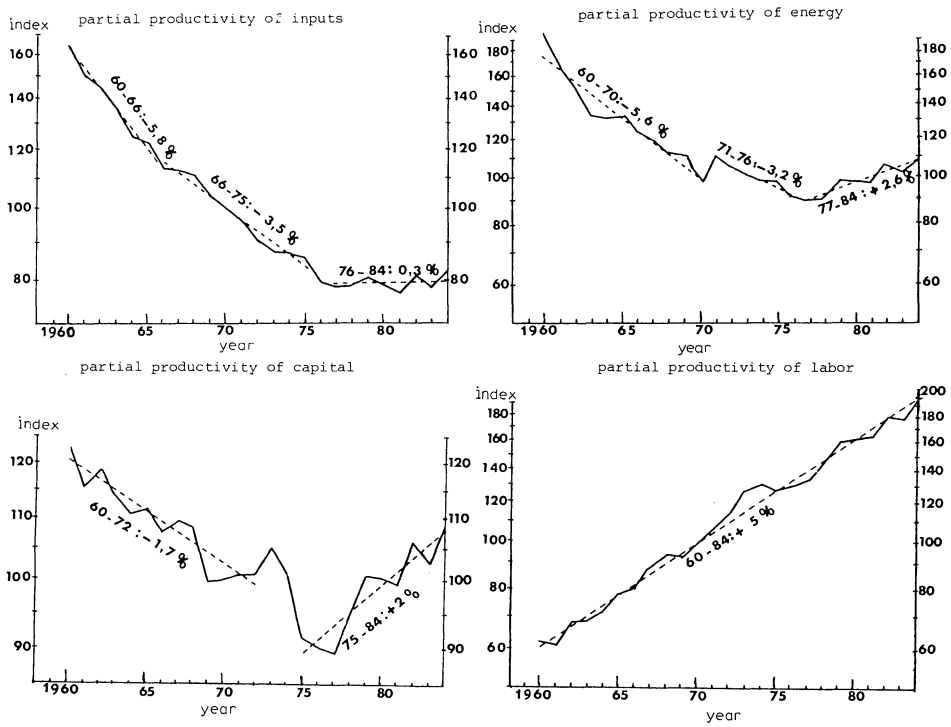

Fig. 1. Partial productivity of current purchased inputs, energy, capital and labor from 960 to 1984 (1970 = 100).

has been virtually unaffected. The proportion of energy in production costs, which was very small because of its low cost (cf. Table 1), has not risen sufficiently to make it economically worthwhile to replace fossil fuels by labor. In France the vast majority of the labor force (87% in 1985) consists of non-wage-earners, but the use of fossil fuels can bring a significant improvement in the productivity of labor, and has remained economically viable throughout the energy crisis.

– On the other hand, there has been a sharp turnaround in the land situation: since 1978, the price of agricultural land has fallen dramatically (by 40% in real terms between 1978 and 1985), after rising markedly (3.3-fold in real terms) between 1950 and 1978. The fall in land prices is above all a consequence of the drop in farm income, the difficulty of obtaining credit facilities (and the decrease in demand from non-farmers). The average size of farms has thus not increased significantly, rising from 22.2 ha in 1975 to 26.9 ha in 1985. Although the average size of full-time farms is larger (35.8 ha in 1985), a more significant increase would have been needed if more extensive farming (with lower input levels per hectare) were to be introduced. Land has therefore

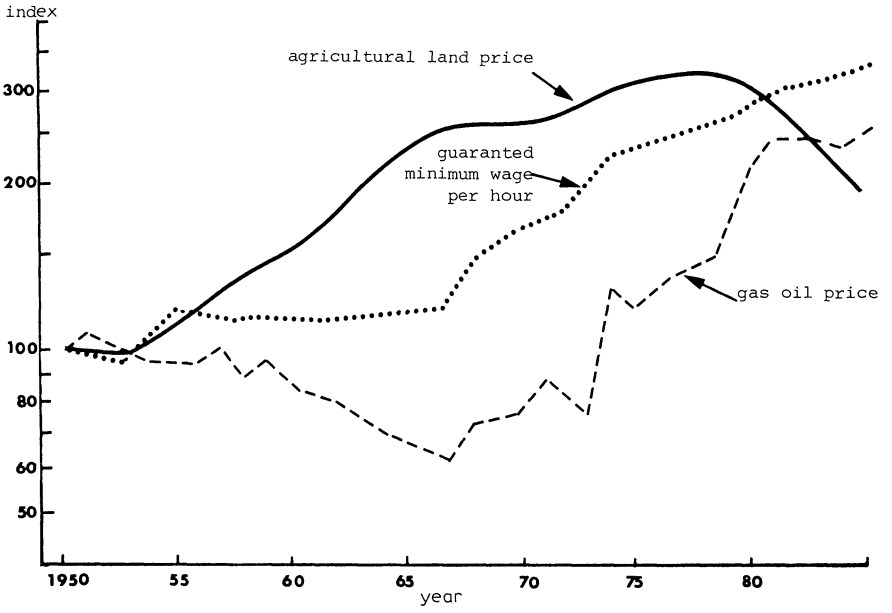

Fig. 2. Prices of agricultural land, hourly minimum wage and gas oil from 1950 to 1984 (1950 = 100) (index in constant francs, calculated by deflation of implicit GDP price).

not replaced energy, and farming has generally become more intensive. However, growth in consumption of fertilizers has slowed substantially, and the use of phosphate fertilizers has actually fallen.

– Capital has replaced energy in a number of activities involving high levels of energy consumption. In a fair number of cases, managers of drying and dehydration facilities and greenhouses have made investments linked to energy savings. However, this is not true of farmers (other than greenhouse managers), since their incomes have fallen. Certain farmers have nevertheless insulated their homes, and livestock buiding designers now attempt to reduce heat loss more than they did in the past.

Overall, there has been relatively little change in the relative importance of the factors of production, despite the substantial price rise of one of those factors. The initial cost of energy was so low (as a proportion of total production costs) that subsequent price rises had little effect on the combination of factors of production. It should be pointed out, however, that energy, inputs and capital are now used more rationally and more efficiently.

Conclusions

This report demonstrates that measures have been taken in the agricultural sector in an effort to come to terms with higher energy prices. Savings of petro-

leum products have been made, fuels have been diversified, the use of wood has increased, and the growth in the demand for fertilizers has slowed. Activities that consume the greatest quantities of energy (greenhouses, dehydration, drying) have remained strong, and have even developed in certain cases, but these positive results have often only been achieved through fairly heavy capital investment commitments. In terms of trade in agro-food products, attempts have been made, despite increasing competition, to open up new export markets in OPEC countries. On the other hand, there has been only limited development of renewable energy sources (except for wood). It would be useful to compare these effects with the effects that the crisis has had in other countries, but such a comparison is impossible at present, since very little relevant material has been published (to my knowledge) in other countries.

The measures that have been taken in France seem not only to have led to improved energy efficiency, but also to have brought more efficient use of inputs and capital. The partial productivity of energy and inputs had fallen since the end of the 1950s (see Fig. 1); however, since the late 1970s consumption of energy and inputs has risen more slowly than agricultural production. It would thus be fair to conclude that agricultural processes in France are more rational, and that there is less wastage, than at the beginning of the 1970s, but such conclusions can only be confirmed by a study covering a longer period of time. Efficiency has not increased sufficiently to offset the price differential between farm produce and agricultural inputs, since farmers' incomes are still lower than they were in 1973: at a time when heavy investments are needed in the agricultural sector and non-agricultural openings are limited by unemployment, this is a major problem.

One of the most important outcomes of the energy crisis is the awareness it has generated. There is now wider recognition of the physical limits to growth and of certain instances of wastage. This increased awareness has had positive effects, since various measures have been taken to reduce wastage – particularly energy wastage – and new research programmes have been launched, for example into renewable energy sources. In more general terms, the situation has led to a certain degree of reorientation of the objectives of agronomic research, expressed by the Director General of France's Institut National de la Recherche Agronomique in a publication whose title reflects a strong current of thought in France: "Towards greater economy and autonomy in agriculture" (Poly, 1977, 1978).

The energy crisis thus constituted a rather salutory shock. Increased awareness of the importance and implications of energy has brought energy savings, diversification of energy supply and less dependence on oil. The danger in 1987 is that energy management will now be abandoned on the grounds that such initiative is no longer relevant or useful now that oil prices have dropped. The next oil shock could come in the 1990s, so beware! (Lesourne and Godet, 1985)

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