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COMPARING PROFITABILITY OF ORGANIC AND CONVENTIONAL FARMING: THE IMPACT OF SUPPORT ON ARABLE FARMING IN FRANCE

Paris, 13-15 October 1999

This paper compares the effects of support policies on conventional and organic arable farming in France. It is to be discussed at the JWP meeting on 13-15 October 1999.

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NOTE BY THE SECRETARIAT

This study, together with "The effects of support measures on the profitability of organic farming relative to conventional farming: a case study for the Netherlands" [COM/ENV/EPOC/AGR/CA(99)45/REV1], is a follow-up to the publication of the report on *Improving the Environment through Reducing Subsidies* (1998). Both studies examine the effects of prevailing agricultural support policies on the relative profitability of intensive "conventional" and extensive "biological" or "organic" farming practices, and provide some indications of their effects on the environment and on the demand for labour. Both studies are intended to provide inputs to the current work on sustainable agriculture in the Joint Working Party of the Environment Policy Committee and the Committee for Agriculture (JWP), and the OECD-wide horizontal project on Sustainable Development, which will result in a report to Ministers in 2001.

A first draft of this study [under cote ENV/EPOC/GEEI(99)4] was submitted to the 15th Session of the Working Party on Economic and Environmental Policy Integration on 4-5 May 1999, and was simultaneously issued for written comments by the JWP [under cote COM/ENV/EPOC/AGR/CA(99)46]. The paper has since been revised in light of country comments.

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ACTION REQUIRED: Delegates are invited to discuss the revised version of the paper and provide comments to the Secretariat.

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EXECUTIVE SUMMARY

1. Arable farming in France accounts for a considerable share, in fact almost one-third, of European Union arable crops. It is increasingly concentrated around the Ile-de-France area, and it is becoming more and more specialised. However, wheat yields have risen nearly fourfold since the late 1940s. This combination of growth and concentration can be attributed to the development of higher-yield varieties and the massive use of fertiliser and plant-protection products, with obvious implications for the natural environment. In the face of consumer concerns about the environment and growing demand for healthy produce, organic farming is an area with great potential. Its development, however, is being hampered by technical constraints and profitability considerations.

2. From the technical angle, converting from conventional to organic arable farming proves difficult because organic farming is a less credible model than the current intensive approach. Agronomists have developed and perfected a high-performance production system that has benefited fully from support under the EU's Common Agricultural Policy. With the shift in policy over the past few years, they have had to propose new forms of crop management, although these have generally been little more than variations on the old model. By rationalising inputs more carefully and aiming for 20 % less output, these new methods have proved just as profitable, particularly when prices are lower. However, they do call for special skills on the part of the farmers, who have to look out for weed and pest infestations.

3. Because organic farming places the emphasis on soil and microbial activity rather than crop nutrition, and refuses to use synthetic chemicals, it is based on a different rationale. The use of legume-based temporary meadows in the rotation to offset the absence of mineral fertilisers is a heavy constraint. Converting from conventional to organic farming leads to a sharp drop in the acreage given over to cash crops because of the necessary rotations, and hence a cut in the overall profitability. Because arable farmers have long given up livestock, they have to purchase expensive organic fertilisers off-farm. Finally, yields from organic farming are 30 to 50 % lower than from conventional farming.

4. All these factors explain why, in spite of higher unit prices for organic produce, there is no assurance that organic farming will be profitable. Comparing the two approaches is not easy given the limited available evidence. The only solution is to study farming models as they convert from conventional to organic systems, and to simulate their accounts. Using this approach, and assuming current pricing conditions, the two are found to be very similar in terms of profitability, with the organic approach even coming out slightly better under some conditions. Organic profitability is contingent on rotation options and the scope for developing temporary meadow, in particular for alfalfa. During the transition period, profitability of organic systems is lower, however, in spite of the support available.

5. In terms of economic analysis, specialised cereal systems can be viewed as the outcome of a trend in production structures that has focused on economies of scale. This trend, generated by differentiated price support, has narrowed down the range of goods, giving rise to economies of scale associated with the types of farming that enjoy administered prices and at the same time often harming the environment. The shift to organic farming is, on the contrary, based on pre-existing economies of scope in the form of crop rotation. The additional private costs associated with organic farming brings advantages

for the community at large. In other words, the range of goods provided by organic farming includes the co-production of positive externalities, which benefit consumers interested in finding what they see as healthy produce but also the general public, who enjoy a better environment. A more balanced system of price support and a factor-price structure more favourable to labour would better foster economies of scope, and hence encourage organic farming.

1. THE SITUATION IN FRANCE

6. In arable farming, France is a key European producer. Between 1992 and 1997 it accounted for 30 % of the EU output of cereals, 37 % of oilseed, and 62 % of protein crops. For potatoes and sugar beet the figures were lower, at 12 and 23 % respectively.

1.1. Concentration, specialisation and intensification

7. Arable farming is becoming increasingly concentrated in fewer farms. Between 1988 and 1997 the number of cereal farms fell by 35 %, while the corresponding acreage rose slightly by 137 000 hectares (ha) to now cover 9.24 million ha. 4.386 million ha of this is given over to soft wheat. Farm concentration has been even more spectacular for oilseed rape, with a 17 % increase in acreage over the same period owing to higher demand, but a decline of almost 40 % in the number of farmers (Agreste, 1998). There is strong regional focus to this trend, with one cluster of arable farms situated around the Ile-de-France region, with this area accounting for 13.5 % of cereal acreage. A second cluster, which has as many farms but far less acreage, is in southwestern France, with the Midi-Pyrénées region accounting for 7.8 % of cereal acreage.

8. This geographical specialisation is primarily due to soil-use conditions and land structures, but also to the swift pace of technical advance since the end of the Second World War. In France, for instance, the annual increase in wheat yields averaged 3.1 % between 1949 and 1996, from 18 quintals (q) in 1949/51 to 69 q in 1994/96. On average, this represents an increase of 1.3 q per hectare (ha) per annum. Figures for the Picardy and Champagne areas are even higher, with increases respectively of 1.5 and 1.6 q/ha per annum. 1998 was a year of exceptional yields, with a national average of 78 q — which broke the 1996 record by 7 % — and with yields commonly exceeding 100 q in the more fertile areas. Maize (corn) yields also quadrupled from 1960 to 1995, and oilseed rape yields doubled between 1965 and 1995 (Bonny, 1998). These figures reflect the efforts by agronomists to raise the productivity of arable crop systems wherever possible, although these efforts have been confined to the productivity of land alone, as is warranted when food demand is high and land is the limiting factor.

9. The fivefold increase in French cereal yields over the past 40 years has only been possible through the massive use of fertilisers and phyto-pharmaceuticals, of which France is one of the world's largest consumers (90 000 tonnes of active ingredients in 1997, at a value of FF 12.7 billion). Another reason is that irrigated acreage tripled between 1970 and 1995 and now covers over 1.6 million ha. This has had a particularly visible impact on water and soil quality, and on the natural environment in general.

1.2. Rising environmental damage

10. The impact of more intensive arable farming can be seen in the damage done to groundwater, rather than to surface water. Thus, the critical areas where nitrate levels exceed 50 mg per litre are the Paris Basin, Poitou-Charentes, and parts of Midi-Pyrenees, all of which have seen a sharp increase in cereals and industrial crops and in the use of irrigation. Pesticide contamination is greatest on arable land in the northeast quarter of France (IFEN, 1998). The most typical case is groundwater in the Beauce area, France's largest water table at 9 000 sq. km. 16 water catchments here saw nitrate levels rise steadily by 1 mg per litre per annum during the 1980s. As for pesticides, 8 catchments have registered atrazine levels exceeding EU standards of 0.1 microgrammes per litre.

11. With regard to soil, conventional farming and fertilisation methods have given rise to erosion in arable areas. Large areas of land have become impermeable because the use of heavier farm machinery, causing soil crusting and compaction. There is particularly clear evidence of this to the north of the river Seine, in the Rhône valley, and in southwest France. The decline in organic matter levels is beginning to give rise to concern. A national overview of soil tests carried out between 1990 and 1994 gives a picture of the situation at canton level (Walter *et al.*, 1997). It shows that all the intensively farmed land in Beauce and Brie, the Aquitaine basin, Roussillon, and the Rhône valley is quite low in organic carbon (less than 20 parts per thousand), indicating soil depletion, whereas mixed farming areas are richer in organic matter.

12. Given this situation, efforts have focused on persuasion, including the setting up in 1984 of a guidance committee to reduce nitrate and phosphate water-pollution (*Comité d'orientation pour la réduction de la pollution des eaux par les nitrates et les phosphates*, CORPEN). Their mandate was extended in 1992 to cover plant protection products. The committee, whose members include representatives from farming and the industries concerned, reports to the Ministries of both Agriculture and the Environment, to which it acts as an adviser. Its role is now broader with, for instance, an objective to develop a code of good agricultural practice as prescribed in the "Agricultural Nitrates" Directive. However, more and more calls are now being made for far-reaching changes in production systems, taking advantage of trends in the demand for healthier food. In this context, organic farming (OF) is a particularly interesting avenue to explore.

1.3. Organic farming: contrasted development

13. In 1985 France accounted for 60 % of organic acreage in the European Union, but this figure had fallen to just 10 % by 1995, comprimising just 100 000 hectares. By the end of 1998, an estimated 7 000 French farmers were practising or moving over to organic farming, covering an area of 220 000 hectares. In other words, only 1 % of farms and 0.8 % of farmland in France! Two countries, Sweden and Austria, are currently approaching the 10 % mark, while another two, Switzerland and Finland, are at 5 %; in Denmark, Germany, and Italy the figure is over 2 % (Riquois, 1997).

14. From the technical angle, 58 % of organic farmland was under grass in 1996, reflecting the expansion of organic beef which had been further reinforced by fears about "mad cow disease", and 25 % was planted with cereals and oil protein crops, with the remainder spread almost equally between the other annual crops and permanent crops. Organic arable farming is clearly not developing as fast as livestock. This is somewhat inconsistent, since organic meat must come from livestock fed on ingredients not grown by conventional methods if it is to receive OF status.

15. Furthermore, the demand for organic bread, biscuits, and breakfast cereals is rising sharply, and major outlets and the agro-food industry are showing a keen interest in this market, which in France is expected to rise from its current level of FF 4 billion to FF 15 billion by 2002 (Marre, 1998). Given the

shortage of domestic supply, the trend is towards imports, and in 1997 35-40 000 tonnes of organic cereals are estimated to have been imported from other EU countries (Italy and Spain), Eastern Europe, and North America. Yet some imported produce is suspected of not meeting "organic" standards, or of containing genetically modified organisms (Bureau, 1998). The combination of these two factors seems to indicate that the time is right for the development of a system of organic arable crops in France, simultaneously alleviating the pressure that agriculture is putting on the environment.

16. This report is set out as follows. The next section looks at the limited relevance of conventional farming solutions to counter the rise in environmental damage. The third section examines in detail the technical principles behind OF and the problem of applying them to highly specialised cereal systems which long ago abandoned the technological synergies that generate economies of scope in OF. The fourth section provides figures to compare the profitability of the two approaches (conventional and OF), using real farm accounts. This profitability analysis is based on private farming costs and output, but it is also highly contingent on current arrangements for government support. In the fifth section, the analysis is thus viewed through the the framework of current farm-policy developments based on the double dividend. The sixth section sets out the conclusions.

2. FROM CONVENTIONAL TO "INTEGRATED" FARMING

17. The conversion of modern farms, involved in "conventional" cereal growing, to organic methods raises a number of technical problems, in that agronomists have spent the past few decades perfecting an intensive farming model that has been fully tried and tested. Any attempt to question this approach to farming must not only take into account the sociological aspects linked to a form of excellence, but also propose a competing model that is equally efficient and profitable. Below we give details of the thinking behind the intensive model, and the "softer" version known as "integrated farming". We shall then look at the main technical features specific to organic farming.

18. As we have seen above, the drive to raise productivity was quite coherent in economic terms given existing product-input price ratios and the fact that environmental costs were disregarded. But changes in both of these areas (saturation of effective demand, decline in administered prices, spread of pollution) has led to a dual reaction:

- in the short term, farmers have continued to optimise economic efficiency; and
- in the medium- to long-term, other technical avenues are being explored. The aim is to adapt the previous intensive model to the new price structure and try to reduce damage to the environment.

2.1. Still striving to increase productivity

19. Contrary to intentions at the time, the main result of the fall in cereal prices brought about by the 1992 reform of the Common Agricultural Policy (CAP) was a strong incentive to reduce technical inefficiencies, with producers probably aiming for allocative efficiency as well. For instance, the steady rise in yields has more than offset the decline in cereal incomes caused by area payments. Furthermore, there are still potential yield gains to be made, in particular by phasing out technical and structural inefficiencies (i.e. by extending farms), and this could help to partly offset the future decline in prices (INRA-ESR 1997, Marre 1998).[1]

20. This downward adjustment in prices has been facilitated by the very structure of the conventional farming system, which perfected a highly coherent intensive model aimed at maximising a crop's potential for photosynthesis. The effort initially focused on developing more productive varieties, i.e. those with a higher biomass ratio of grain to straw. The harvested share of total biomass, for instance, has risen from 34 % at the turn of the century to 51 % today. To improve light energy intake, sowing dates have been brought forward, by about two weeks. To capture more energy early on in the cycle, sowing densities have been increased. All this requires more fertiliser use. But as these varieties are less resistant to disease and pests, they require more control. This creates a spiral of heavy fertilisation and systematic treatment. For instance, the consequences of using too much fertiliser (e.g. the appearance of diseases such as mildew or

1. It is important to note that these findings apply to France, and they are not necessarily valid to the same degree for all European Union countries. The full consequences of the CAP reform are very complex, with repercussions at several levels that will not be discussed here.

glume blotch, more competitive weeds) may be cancelled out by the intensive use of plant protection chemicals (Meynard and Papy, 1993). Growth regulators prevent lodging and match plant needs more closely, but crops require more and more nitrogen fertiliser, a source of potential pollution.

2.2. Ever costlier risk management

21. This coupling of mineral fertilisation and phyto-pharmaceuticals is systematic insurance against production and health risks, but the environmental costs are now becoming prohibitive. On the one hand, intensive growing raises serious problems of competing cultivation operations. Thus, the early sowing of wheat may overlap with potato or beet harvesting. Similarly, more numerous dressings (with fertiliser or pesticide) during the season may clash with other crop operations. To avoid this overload on labour and equipment, farmers have increased the power of their equipment and bought new machinery. The sharp increase in yields has also led to the purchase of higher-capacity harvesters. Apart from the problems of soil compaction, all this means more fixed costs which have to be offset by ever-higher output, hence the strong incentive to extend farms. As direct area payments have been integrated into French land prices since 1993, and have thus had the effect of pushing them up, the purchase price of land may include sunk costs whenever farmers anticipate ceilings and degressive arrangements for direct payments.

22. In fact, far from improving the environmental situation, the adjustment in the intensive system caused by lower prices has tended to make this production method less reversible.

2.3. More rational crop management

23. In the new context of controlled output and environmental protection, agronomists have proposed a change to the intensive model in the form of coherent crop management suited to lower yield targets. Such methods can provide comparable, and in some cases higher, gross margins per hectare than the more intensive model. This form of extensification corresponds to what is sometimes known as "integrated systems". More precisely, these systems are defined *"as a whole-systems approach to land use for agricultural production which seeks to cut down on off-farm inputs (energy, chemicals) by making better use of natural resources and taking advantage of natural regulation processes"* (Viaux, 1998).

24. In practical terms, this means using more disease-resistant but less productive varieties, or a mix of varieties sown less densely. At the same time, farmers are advised to use smaller amounts of fertiliser and chemicals, but this requires more skill on their part. By lowering yield targets from 80 q to 65 q per hectare, for instance, fertilisation can be reduced by 45 kg per ha and, for the same sowing date, the amount of seed can be halved (Saulas and Meynard, 1998). Under these conditions, the crop is less sensitive to lodging and disease, thereby making it possible to do away with growth regulators altogether and to apply chemicals less frequently.

25. Agronomic experimentation has shown that economic returns from integrated systems become worthwhile when the price of wheat falls, as it has now done (early 1999). The baseline method A corresponds to the conventional model, with a high yield target of some 90 q per hectare. Method B has a target yield 15 q lower with a mix of less densely sown varieties. Less nitrogen fertiliser is used, and no growth regulator at all. To limit the number of fungicide applications, it is assumed that the farmer examines the state of his crops during the period prior to flowering and applies fungicides advisedly. This takes time and technical skill. Table 1 indicates the corresponding costs and gross margins, on the basis of a high wheat price (FF 100 per q) and the price in early 1999 (FF 67 per q). The compensatory payments introduced under the 1992 CAP reform are not included, as they do not affect this comparison.

Table 1. Costs and gross margins for intensive and integrated models

	Yield (q/ha)	*Standard deviation (q/ha)*	*Costs (FF/ha)*	*Gross margin (wheat at FF 100/q)*	*Gross margin (wheat at FF 67/q)*
Method A	89.3	10.1	2 312	6 618	3 671
Method B	77.6	8.7	1 379	6 381	3 820

Source: Saulas and Meynard, 1998.

26. Table 1 shows that returns under the two prices differ more for the intensive conventional system. Furthermore, the more environmental method becomes more profitable when prices are markedly lower. Other experiments conducted in Nord-Picardy and Normandy by the French cereals and fodder institute (*Institut Français des Céréales et Fourrages*, ITCF) have shed further light on this relationship between economic returns and intensification by studying a much wider range of cases (Viaux, 1998). They cover an average of 27 trials in 18 different places between 1989 and 1993. Four approaches were studied:

- *Intensive system*: maximum yields sought (105 q) and systematic treatment to avoid any incidents.
- *Conventional system*: high yield (95 q) likely one year in ten; treatment to avoid the most common incidents.
- *Low-cost system*: a relatively high yield (85 q) likely one year in two; regular in-field observation to limit input use.
- *Very low cost system*: 70 q yield likely eight years out of ten; minimal input use.

27. Table 2 summarises these approaches and gives gross margins on the basis of a high price of FF 100 per q and the current price of FF 67, regardless of area payments.

28. Table 2 shows that, when the price of wheat is high, there is some homogeneity in economic returns in terms of gross margin for the first three systems, with the low-cost system coming out slightly better. The very low cost approach, however, comes out much worse. In the current situation, when prices are low, the low-cost option is clearly the best, followed immediately by the very low cost option. It is the highly intensive option that comes out worst in this situation. The comparison of the two low-input approaches must also take into account the somewhat random nature of yields. The general conclusion is that low prices disadvantage the most intensive option, while high prices make the very low cost option the least profitable. It is worth noting that under the new CAP support arrangements for arable crops, less intensive systems are almost as profitable as they used to be when the area payment of around FF 2 400 per hectare was included. Accordingly, this payment – which was conventionally viewed as compensation for forgoing production – could also be viewed as compensation for forgoing pollution.

Table 2. Gross margins per hectare of wheat according to the degree of intensification

	Highly intensive	*Conventional*	*Low cost*	*Very low cost*
Sowing date	5-10 October	5-10 October	5-10 October	10-15 November
Sowing density	380	300	220	150-200
Target yield	105	95	85	70
Actual yield	100.2	93.3	84.9	72.2
Nitrogen per ha	240kg in 4 applic.	190kg in 3 applic.	160 in 2 applic.	100 in 1 applic.
Weed-killer	Autumn + spring	Autumn + spring	When appropriate	Can be omitted
Fungicide	4 applications	3 applications	2 applications	1 or 0 application
Insecticide	3 applications	2/3 applications	2/3 applications	0/1 application
Regulators	3/4 applications	2/3 applications	1/2 applications	0
Costs	FF 3 230	FF 2 537	FF 1 674	FF 1 031
Margin (FF 100/q)	FF 6 790	FF 6 793	FF 6 816	FF 6 189
Margin (FF 67/q)	FF 3 483	FF 3714	FF 4 014	FF 3 806

Source: based on Viaux, 1998.

2.4. Complex and limited factor substitution

29. The implementation of low-input crop management entails monitoring the crop closely. This means detecting the risk of disease in the field to see whether or not the crops need to be treated. Diagnostic kits for foot rot can help farmers make decisions, but visual monitoring is still necessary. Similarly, there are diagnostic tools to work out nitrogen feed requirements for wheat, making sophisticated fertilisation management possible. But precision application calls for quite an investment in terms of time spent in monitoring and sampling, as well as in training. The relevant question is how much less (or more) time needs to be spent in the field than was formerly spent on the tractor systematically applying chemicals. Savings on machinery use must also be taken into account, as well as possible overlaps in the cultivation calendar.

30. It should be noted that the thinking behind integrated farming referred to above is fairly restrictive in that the main emphasis is on off-farm inputs, with relatively little focus on the natural regulation processes mentioned in the Viaux definition. In other countries the approach is different. In Switzerland, for example, integrated farming is not based on more resistant varieties and less plant-protection treatment, but the consideration of the farm and farming practices as a whole. There the integrated approach presupposes an optimal fertiliser balance, systematic rotation of at least four crops within specified dimensions, protection against soil erosion, and a limited number of authorised treatment products. These restrictions on farming methods pose no enforcement problem since they determine eligibility for direct payments. This, then, is an environment-conditional system with an underlying principle fairly far removed from that of organic farming, in which it is left to the market, once the transitional phase is over, to offset the additional costs entailed by this mode of production.

3. THE TRANSITION TO ORGANIC FARMING

31. The factors described above bear witness to the limited adaptability of conventional farming systems given tighter environmental and competitive constraints in the short term. In the medium term there is still the question of whether soil fertility can be maintained, and hence whether agriculture is sustainable. That these production methods are not particularly suitable can also be seen from the increased demand for more nutritious, healthier farm produce. The emerging social and economic situation favours the large-scale expansion of organic farming (OF), although the principles of this approach were originally developed almost a century ago.

32. From the producer's point of view, it is a complete reversal: while integrated production translates into marginal adjustments to intensive systems (see above), OF shapes its approach and production methods to be in full harmony with natural processes. Techniques that were formerly empirical have now been validated by scientific advances, mostly in soil biology and plant physiology.

3.1. Brief technical description of OF

33. In France, OF is officially *"farming without the use of synthetically produced chemicals"*. This definition stating what organic farming is not, rather than what it is, appears in French legislation (framework Farm Act of 4 July 1980) and has the merit of being simple, but it does not set out the basic principles behind OF. Based on a sophisticated knowledge of soil biology, these principles relate largely to plant nutrition and pest control.

34. More than a simple growing medium, the soil is a living environment where micro-organisms transform organic matter and insoluble minerals into substances that can be assimilated by plants. Organic inputs and natural minerals rich in trace elements are therefore the "raw materials" of fertilisation. The main one is compost, obtained through the decomposition of raw organic matter (manure, droppings, green waste). Based on an aerobic fermentation process, compost needs to be aerated several times, taking into account its rising temperature. This method of organic fertilisation accordingly requires extra labour, both for preparation and for spreading.

35. This use of microbial activity (Soltner, 1998) avoids upsetting microflora with chemicals such as synthetic fertilisers or phyto-pharmaceuticals. Soluble mineral fertilisers are easily assimilated by plants, but this upsets their biochemical composition and weakens their resistance to pests. By and large, the basic aim of organic pest control is a physiologically sound crop. It takes a whole-rotation approach, and is designed to protect biodiversity, including microbial flora. Parasite control is also preventive and involves the choice of resistant varieties such as Renan or Pactole for wheat, which have been available for a decade or more. But the yield is about 10 q less than the most productive varieties, which explains why they are not used much in conventional farming. Varietal mixes, which give satisfactory overall resistance for varieties with similar features, are another option. When treatment is required, simple plant-based substances are used, pyrethrins for instance, and also rotenone, extracted from the plants *Derris* and *Lonchocarpus*. These substances affect the insect's nervous system. But they are not specific, and may be harmful to useful insects such as ladybirds. Another substance is *Bacillus thuriengis*, which destroys butterfly caterpillars. Aphids are also controlled with repellents. Copper preparations are used to combat

mildew, glume blotch, wilt and rust. Sulphur is an effective means of treating mildew. The use of metaldehyde is authorised to protect against slugs.

36. Weed control involves sequential cropping, alternating between smother crops and cleaning crops. The additional techniques used are pre-sowing tillage to encourage weed emergence for easier weed control; timely tillage; mechanical and even heat control of weeds. By and large, farmers aim for good yields in spite of weeds, rather than seeking to eliminate them altogether, which cannot be achieved even in conventional systems.

37. All of these precepts are the basis for OF crop systems, which give a prominent place to legumes that can fix atmospheric nitrogen, thereby saving on fertilisers for the crops grown at the same time or after them. Alfalfa and white clover are best at fixing nitrogen, followed by peas, field beans, and grass/legume mixes. Alfalfa, for instance, has a significant residual effect for about 4 years, during which it provides the equivalent of 50 to 55 kg of N per ha per year. This is combined with the use of green manure as a cash crop. This means growing a legume alone or with grasses, or a crucifer such as forage rape, in between a winter crop like wheat that is harvested between late July and early August and a spring crop like maize or sunflower that is sown in April. These plants can then be shredded and added to the topsoil, improving it in terms of structure and nutrients. Crop rotations can also be chosen to suit local soil and climate conditions.

3.2. Difficult transition for specialised cereal systems

38. In terms of both organic fertiliser requirements and rotation constraints, OF is similar to the mixed-farming model in that it is best to combine livestock and arable farming and to recycle by-products. This leads to the first problem encountered in the transition to organic farming of highly specialised conventional cereal systems, which are not easily reversible.

39. If the main cash crop is wheat, it is useful to plant a legume as the preceding crop, in order to ensure that nitrogen is put back and the soil is clean. The same applies for maize, with wheat following the maize planting. Rotation is thus longer under the OF cereal system than for conventional farming, generally lasting from 7-8 to 12 years. The initial or break crop should be a short 3-year legume-based rotation; then wheat plus green manure; a coarse grain; a row crop; wheat again; then a return to temporary meadow. Under a longer rotation, there will be alfalfa for 3 years; followed by a coarse grain with white clover; an oilseed (sunflower, rape); another crop of wheat followed by green manure; then a coarse grain with white clover; a legume or protein plant; wheat; a coarse grain with white clover; then back to alfalfa (de Silguy, 1997).

40. In major cereal-growing areas like the Paris Basin, intensive systems resemble monoculture, with short, 3-year rotations. The break crop is a row crop (maize, rape, sunflower, protein peas, potato, or sugar beet), followed by wheat, then a coarse grain; or wheat on wheat, then a row crop, if possible a different one than the first. Preceding crop choices are dictated by agronomic constraints and economic considerations. Sugar beet, for instance, is very worthwhile but can only be grown by farmers with quotas, whereas a good preceding crop like potato requires processing plants in the vicinity, or scope to market the crop to consumers.

41. When this type of farm converts to OF, the choice of a break crop poses a problem, since oilseed rape, which has a gross margin per hectare at least as high as wheat, has to be ruled out because it requires herbicides to prevent second growth. Oilseed rape requires quite a lot of nitrogen (7 units per quintal, compared with 3 for wheat) and yields are cut by about half, making this crop a poor choice. Maize (corn) need not be ruled out, but there will be problems if no plant protection products are applied, not to mention

nitrogen problems.[2] The best solution is for maize to follow temporary meadow, actually in the place of wheat.

42. This type of rotation, and the need to add compost or organic nitrogen, make it more difficult to convert highly specialised arable systems to OF. For instance, temporary meadow is only worthwhile if there is livestock on the farm or in the vicinity. Similarly, alfalfa requires an outlet either on the farm or at a nearby drying plant, but the energy costs of dehydration are known to have made processing less worthwhile. In the Paris area, alfalfa can be sold to riding stables, but of course this option is not open to every farmer.

43. The lack of manure on farms or in the vicinity mean that supplies of guano or other organic fertilisers have to bought in, at a high price. Guano, for instance, applied at rates equivalent to 40 units of nitrogen per hectare, costs between FF 30 and 40 per unit of N, 10 times more than ammonium nitrate. Fertilisation therefore costs about FF 1 200 per hectare. According to figures supplied by the monitoring network ROSACE (*Réseau d'Observation des Systèmes Agricoles pour le Conseil et les Etudes*) in the Centre region, fertilisation costs per hectare of wheat are thus FF 1 200 to 1 600 on organic farms, compared with FF 800 to 1 000 on conventional farms.

44. Generally, converting to OF means tapping pre-existing technological synergies between livestock and arable farming. The additional fertilisation costs in specialised systems stem from the fact that they do not have the economies of scope available to mixed-farming systems, i.e. lower costs thanks to the simultaneous production of a range of products, own-farm produced inputs (fodder), and recycled by-products (manure from livestock, straw from cereals). This point will be developed further in Section 5.

45. As for yields from OF systems, agronomists maintain that these are 15 to 25 % lower than yields in conventional farming (Soltner, 1998). The figures appear to refer to experimental situations, however, since empirical evidence shows much greater differentials. For instance in Lower Normandy in 1996, an excellent year, organic farms (of which there are admittedly very few) reported soft wheat yields of 45 q to the hectare, whereas the regional average that year was as high as 81 q. Members of France's organic farming federation (*Fédération Nationale d'Agriculture Biologique)* report 30 to 50 % differences in yield (Vérot, 1998). Such gaps between the agronomists' figures and actual returns may stem from the low skill levels of farmers switching over to OF, but potentially more so from a lack of realism when transposing experimental findings. Similar figures for Germany also show fairly wide yield differentials between organic farms monitored over four years and conventional farms. Thus, in the case of winter wheat, the average yield is 42 q per hectare for organic farms and 67 q for conventional farms. For all cereals combined, the figures are 38 q and 60 q respectively (Nieberg and Pals, 1997).

46. Because of the intensive use of fertilisers and pesticides, conventional agriculture has successfully reduced production risks. The use of these inputs can be seen as similar to a harvesting insurance, which the farmers opt out of for organic production. From this perspective, new instruments that would allow risk insurance and income insurance would prove particularly useful for OF. It should be noted that the conversion period presents particular difficulties, in that training is needed, and that there is in this phase an increased production risk. Farmers moving from conventional agriculture to integrated agriculture come across to some extent the same types of difficulties since they reduce appreciably the use of inputs that work against uncertainty.

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2. It is worth noting that between 1986 and 1994 the average number of weedkiller applications rose in France, apparently because of a fall in the price of certain chemicals such as atrazine, which are no longer covered by patents (Poiret, 1996).

47. With regard to the organisation of work, the switch to OF clearly translates into new organisational patterns, without any certainty as to whether or not labour requirements increase since local conditions vary so widely. Table 3 provides some indication of the changes likely to affect an arable system.

Table 3. Working time required in conventional arable systems and organic systems

	Conventional system		*Organic system*	
	No. of runs	*Time per ha*	*No. of runs*	*Time per ha*
Wheat	10	3 h 45	7	4 h 30
Coarse grains	8	4 h 40	6	4 h
Sunflower	10	5 h	9	5 h 30
Grain maize	10	5 h 40	9	6 h
Alfalfa	3	0 h 30	3	0 h 30
Field beans	6	2 h 15	5	2 h 05

Source: Fayolle, 1998.

48. Table 3 shows that fewer runs are made for organic cash crops, because no phyto-pharmaceuticals are applied; however, each operation takes 5 to 10 % longer. Temporary meadow, which is less labour-intensive, takes the place of cereals and oil protein plants in this type of rotation, so overall the outcome is much the same. Similar comparisons of Germany's cereal systems show that working time is 37 % more for organic farms, partly due to non-chemical weed control but also to changes in the production system with increased rotation of potato and vegetable crops, which are naturally more labour-intensive (Nieberg and Pals, 1997).

49. With regard to equipment, OF practices require some special investment, such as in a chain-harrow, which has a wide range of uses, or a heat weeder which is useful for row crops like maize. These two cost FF 22 000 and FF 20 000, respectively, before taxes. A swath turner for compost is far more expensive, costing between FF 100 000 and 200 000, but it may be more economical to outsource this work.

4. COMPARING THE PROFITABILITY OF THE TWO APPROACHES

4.1. What kind of comparison?

50. As we have seen, there is little organic agriculture in France, particularly in arable farming. Consequently it is hardly surprising that only a limited amount of evidence can be found on this method of production. However, in order to ensure any comparisons made are valid, they must be based on economic conditions that are as similar as possible. For instance, the question of product value can make a great difference. Organic wheat can be sold to a co-operative or directly to a processor who will pay a higher price. There is evidence that millers pay FF 40 more per q. for wheat than co-operatives. Private sales of supplementary produce, such as potatoes, may sharply affect income. From the technical angle, the comparison must also be based on farms that have the same scope for irrigation and fertilisation.

51. As a result, great care needs be taken in comparing what little information is available, especially since there is a lack of clarity regarding the financial performance of OF farms. For reference, some of the relevant figures available for 1996-1997 are presented below.

52. In Lower Normandy, a farm with 117 ha of organic cereals combined with livestock farming (beef) has a gross operating surplus (GOS) of FF 346 700, or FF 2 963 per ha (Normandy Region Chamber of Agriculture, 1997). For the same size farm practising conventional methods, the farming accounts network RICA (*Réseau d'Information Comptable Agricole*) gives a GOS of FF 4 755 per ha. But these figures are for 1996, a year of exceptional wheat yields (over 90 q to the hectare).

53. In Poitou-Charentes, converting a conventional farm covering 98 ha, with scope to irrigate 20 ha, to organic farming pushed the GOS up from FF 222 000 to 259 900, i.e. from FF 2 265 to FF 2 652 per ha (Poitou-Charentes Chamber of Agriculture, 1998). However, RICA gives a GOS of FF 3 587 per ha for intensive farming, on an average of 116 ha, in the same region. Hence there is a problem with comparisons, with significant variations depending on the data source used.

54. In the Centre region, the ROSACE network has estimated the income of a whole series of organic cereal farms. For a 100 ha system, of which 20 ha are irrigated, and a livestock unit, the GOS per ha is FF 2 973. For a 175 ha system, of which 47 ha are irrigated, the GOS per hectare is FF 3 269. For a 75 ha system, of which 52.5 ha are irrigated, the GOS per hectare is FF 5 200. Finally, for a 85 ha system with no irrigation, the GOS per ha is FF 2 941 F. For comparable farms using conventional methods (averaging 124 ha, of which 13.6 ha are irrigated), RICA gives a GOS of FF 3 456 per ha.

55. Because these figures differ so widely, they can only paint a broad but not very informative picture. More importantly, however, they show that a comparison of income alone is not very telling. Estimating a production function for OF in econometric terms is still not feasible, given the small number of organic farms monitored in the arable sector. It is also out of the question, as we have seen, to undertake statistical analyses comparing incomes in both cases. The only operational approach is to take standard examples of conventional farming and look at the implications, other things being equal, of a shift to OF. This means devising basic farming models and reasoning on the basis of comparative statics.

4.2. Comparative profitability based on farming models

56. Using the Fayolle (1998) approach again, two standard arable, stockless farms are compared below — one that is representative of farming in the Limagne plain (Puy-de-Dôme and Allier regions) and one that could serve as a benchmark for the Paris Basin. For these categories, the technical and economic standards established by the regional network of reference farms provide features for the systems chosen. Using surveys of relatively similar OF farms, simulations were made to determine what the income would be for mature systems at current prices (Fayolle, 1998).

57. Tables 4 and 5 show the standard models for conventional farming in 1996 and 1997. The first model (1) is a relatively conventional, short-rotation arable system covering 70 hectares, with one unit of labour. The second (2) is larger in size (100 ha) with one unit of labour and scope for irrigating about 15 hectares. These sizes are fairly similar to those of farms in the RICA arable crops system. The "agricultural area in use" averages 120 ha in Ile de France, 110 ha in the Centre region, 123 ha in Champagne-Ardennes, and 72 ha in Midi-Pyrénées.

Table 4. Conventional system (1): 70 ha, no irrigation

	1996			*1997*		
	Useable farmland	*Yield*	*Price per q*	*Useable farmland*	*Yield*	*Price per q*
Wheat	32 ha	85 q/ha	FF 86	38.5 ha	65 q/ha	FF 85
Grain maize	19 ha	85 q/ha	FF 90	20 ha	90 q/ha	FF 75
Sunflower	12 ha	30 q/ha	FF 120	8 ha	26 q/ha	FF 140
Fallow	4 ha	-	-	2 ha	-	-
Sunflower as agro-industrial fallow	3 ha	28 q/ha	-	1.5 ha	26 q/ha	-

Source: Fayolle, 1998.

Table 5. Conventional system (2): 100 ha, with scope to irrigate 15 ha

	1996			*1997*		
	Useable farmland	*Yield*	*Price per q*	*Useable farmland*	*Yield*	*Price per q*
Wheat	53 ha	85 q/ha	FF 86	57 ha	65 q/ha	FF 85
Grain maize	15 ha	85 q/ha	FF 82	15 ha	90 q/ha	FF 75
Sunflower	5 ha	30 q/ha	FF 120	5 ha	26 q/ha	FF 140
Winter rape	5 ha	28 q/ha	FF 140	5 ha	31 q/ha	FF 140
Irrigated maize	12 ha	100 q/ha	FF 85	12 ha	108 q/ha	FF 77
Fallow	7 ha	-	-	4 ha	-	-
Rapeseed as agro-industrial fallow	3 ha	28 q/ha	-	2 ha	31 q/ha	-

Source: Fayolle, 1998.

58. In conventional system (1), wheat accounts for between 46 and 55 % of the rotation depending on the year, and even more in the irrigated system (53 to 57 %). If maize is added, the shares are considerable (around three-quarters). After conversion to OF, these shares will diminish considerably, with wheat accounting for only 30 % of acreage, because of the amount of temporary meadow in the rotation. For irrigated system (2), the previous rotations are used on 85 ha of non-irrigated land. The 15 hectares with scope for irrigation can be used for a special rotation with soyabean, grain maize, and wheat, although this is more a possibility than an actual practice.

59. In the organic systems, the wheat yields selected for comparison are 45 q per hectare in 1996 and 40 q in 1997, again compared with 85 and 65 in conventional farming. If the wheat follows a crop other than legumes, the yields are 5 q less. As for irrigated grain maize, organic yields fall to 60 q, and soyabean yields to 20 q. For field beans, the figure is 25 q for both years. Sunflower had a yield of 23 q in 1996 and 20 q in 1997. For oats, the figures are 35 and 30; for barley, 38 and 35. For alfalfa the yields are 70 q in 1996 and 60 q in 1997.

60. Prices for the organic produce (in French francs per quintal) have been set as follows: 180 for wheat; 160 for maize; 200 for sunflower; 140 for barley and oats; 300 for buckwheat; 150 for field bean; 230 for soyabean; and 72 for alfalfa. Using these figures, and taking into account farm practices and costs as observed in the ROSACE network, we obtain income figures for both the conventional and organic systems. Table 6 gives the GOS and compensatory payments for system (1) covering 70 ha, and system (2) covering 100 ha, with scope to irrigate 15 ha, for each type of production.

Table 6. Income comparison for two arable systems, conventional and OF, in 1996 and 1997

	System (1) 70 ha		*System (2) 100 ha with irrigation*	
	1996	*1997*	*1996*	*1997*
Conventional				
Payments	179 845	165 927	259 250	245 866
GOS	222 228	180 618	360 088	293 397
Organic farming				
Payments	114 383	112 018	192 485	187 032
GOS	229 540	195 349	369 198	331 659

Source: Fayolle, 1998.

61. For system (1), income expressed as GOS is very similar for both types of production in 1996 (with organic income 3.3 % higher). The gap widens in 1997 (+ 8.2 %). 1996 yields are of course very high, and the gap between 1996 and 1997 prices for conventional wheat is very small. For system (2) with irrigation, OF comes out slightly better in 1996 (+2.5 %), and significantly better in 1997 (+13 %). We should point out that in every case 1997 income is lower than 1996, and significantly so. This is due to the differences in yield from one year to the next. Unsurprisingly, the irrigated system has a higher GOS, given the productivity gain derived from irrigation. However, labour may well be inadequate, at certain times of the year at least, since only one unit of labour is allowed for, as in the 70-hectare system (1). This assumption is not necessarily realistic.

62. In spite of its lower output, organic farming performs slightly better in economic terms owing to somewhat lower fixed costs and, more importantly, variable costs that are twice as low. The fact that no expensive phyto-pharmaceuticals are used makes all the difference here. Conversely, the compensatory

payments received by organic farmers are much lower than in conventional farming, since the inclusion of temporary meadow in the rotation means that farmers in areas specialising in arable crops forgo around FF 2 400 per hectare in area payments for cereals and oil and protein products. In the simulations, income forgone averages FF 60 000 per annum, give or take 10 %. Despite this, the profitability of organic cereal systems under current conditions is estimated to be quite comparable to, or even slightly higher than, that of conventional systems. However, the estimate is obtained assuming all else remains the same, an assumption that is challenged in the following sub-section.

4.3. Comparative statics

63. Generally, the comparative profitability of a system is largely a question of rotation options and the price differential (conventional/OF), which can vary substantially from one year to another.

64. Because of its impact on the relative share of cash crops, rotation plays a key role. To test the economic impact of various rotation options, we simulated the effects that three different rotations would have on the GOS:

- *7-year rotation:* 3 years of alfalfa and 4 years of food crops (wheat, sunflower, wheat, and oats), which is the rotation used when comparing conventional and organic systems.
- *8-year rotation:* 3 years of alfalfa and 5 years of food crops (wheat, barley, sunflower, wheat, and oats). It should be pointed out that this rotation requires land with few weeds or pests.
- *4-year rotation:* 1 year of field bean and 3 years of food crops (wheat, barley, half sunflower/half buckwheat).

65. Table 7 summarises the outcome of simulations for these three rotations, on the two systems analysed above.

Table 7. Impact of rotation on the income of organic farms

	7-year rotation	*8-year rotation*	*4-year rotation*
System (1)			
Payments	FF 112 018	FF 119 666	FF 176 204
GOS	FF 195 349	FF 192 248	FF 187 600
System (2)			
Payments	FF 187 032	FF 199 138	FF 268 310
GOS	FF 331 659	FF 315 855	FF 336 957

Source: Fayolle, 1998.

66. For system (1), the classic 7-year rotation is the most profitable, although the difference between this and the 8-year rotation is minimal at less than 2 %. The relative decrease when the rotation is extended by one year is due to an increase in variable costs stemming from the additional crop, a coarse grain, whereas its gross margin is low compared with wheat. Introducing a low-profitability crop reduces the share of temporary meadow in the rotation, but also that of wheat. The 4-year rotation is even less worthwhile, since the increase in acreage generates higher fertilisation costs, especially since the legume

break crop is only grown for one year. This does not apply to system (2), covering 100 ha with some irrigation, where the 4-year rotation proves more profitable. Here, there is a relatively smaller decrease in crop income than in the non-irrigated system, compensatory payments are substantially higher, and so is the GOS. The difference in compensation between the 7-year and the 4-year rotation amounts to FF 64 000 in the 70 ha model and FF 81 000 in the 100 ha irrigated model.

67. The question of rotation and its financial implications hinges on the valuation of temporary meadow, a key feature of organic farming along with the elimination of synthetic inputs. In the simulations, the price of alfalfa was set at FF 72 per quintal. In Poitou-Charentes the price is set at FF 60 per q of dry matter, and the margin at FF 4 100 per ha (Poitou-Charentes Chamber of Agriculture, 1998).

68. These figures are possible only in livestock areas where dried alfalfa can be used by organic livestock farmers, unless there are other special local outlets (e.g. riding stables), as discussed above. However, regional specialisation led arable areas to give up beef farming long ago, making temporary meadow less worthwhile. In its OF models, the ROSACE network in the Centre region also features systems with alfalfa as a break crop, but with a gross margin per hectare of only FF 3 415 compared with FF 4 090 in the Limagne example. The alfalfa is also irrigated, giving a yield 50 % higher than in our example. By applying the Centre area's gross margin to system (2), the GOS in OF drops from FF 331 659 in 1997 to FF 302 364, just 3 % more than in conventional farming. On the basis of system (1), i.e. with no irrigation and hence unchanged yields, and Centre prices, the GOS of an organic holding would fall from FF 195 349 to FF 152 419, some 24 % below that of a conventional farm.

69. In addition to the temporary meadow issue, there is the problem of the price differential between conventionally grown and organic wheat, and its impact on the viability of non-conventional arable systems. It should be borne in mind that the prices used in the previous estimates were respectively FF 85 and FF 180 per q for 1997. Similar price differentials are found in several other countries. In Denmark the differential is 100 % (Hau and Joaris, 1999) and in Germany much the same (Nieberg and Pals). In the United States the range seems to be narrower, at about 75 %. However, with the planned decline in support for cereals, there may well be changes in the comparative profitability of organic farming. Furthermore, if the supply of organic produce increases significantly, this will also affect prices.

70. Using the models for Limagne, the necessary conditions for an organic holding to achieve the same level of GOS were detemined (Fayolle, 1998). It was found that, on the basis of a classic baseline system with a wheat yield of 85 q per ha and sold at FF 80 per q, organic farming will achieve the same GOS with a yield of 45 q per ha sold at FF 173 per q. If the organic yield drops to 40 q per ha, the price of wheat will have to increase to FF 194 per q, a difference of over FF 20.

71. Under the same initial conditions, with yields of 85 q and 45 q respectively, when the price of conventional wheat drops to FF 75, organic wheat breaks even at FF 160. With conventional wheat at FF 70, the organic wheat price must be FF 147; at FF 65 for conventional, organic wheat must be sold at FF 135. When the initial yield conditions are altered, e.g. 85 q in conventional farming and 40 q in organic, a further premium of some FF 20 per q is required for the organic system to break even with the conventional. Conversely, with a conventional wheat yield at 75 q and organic at 45, organic wheat breaks even at unit prices some FF 20 lower.

72. For given conventional and organic yields, the lower the price of conventional wheat, the lower the price ratio required to obtain the same income. This is in line with the conclusions drawn in the comparison (Section 1) of highly intensive and low-input systems. Thus the movement of cereal prices towards world prices can be said to be relatively beneficial in terms of OF profitability.

73. The comparison set out here was based on a conventional system versus a mature organic system. Yet it takes several years to introduce the new rotation, during which time the farm will not fully benefit from the prices obtained for produce with OF status, but still experiences the much lower yields. Income would accordingly fall during the conversion period. This is in fact one of the reasons why support is granted for conversions. It amounts to FF 1 190 per hectare per annum, for two years, for cereals and oil-protein plants, in return for a commitment from the farmer to practise OF for 5 years.

74. An estimate of during such a conversion period was calculated for simulations of a 98 ha farm, with scope to irrigate 20 ha, in Poitou-Charentes(Poitou-Charentes Chamber of Agriculture, 1998). Initially, the rotation and other features for 1997 are as follows: 31 ha of wheat with a yield of 68 q; 5 ha of barley with a yield of 63 q; 11 ha of irrigated peas with a yield of 60 q; 9 ha of irrigated sunflower with a yield of 27 q; 21 ha of dryland sunflower with a yield of 20 q; 12.5 ha of dryland maize with a yield of 75q; and 8.5 hectares of fallow. It takes 4 years to switch over fully to organic farming, converting about 30 % of useable farmland every year, depending on cropping patterns, so as to attenuate the effects of the conversion. The end result is 25 ha of wheat, 4 ha of spring barley, and 8 ha of winter barley, all of which have a yield of 40 q. There are 4 ha of irrigated peas at 40 q per ha, and 20 ha of dryland sunflower at 20 q per ha, 4 ha of dryland maize at 55 q per ha, and 4 ha of irrigated maize at 75 q per ha. There are 4 ha of triticale at 50 q per ha, and 4 ha of potatoes at 50 tonnes per ha. Finally there are 5 ha of fallow, and 16 ha of alfalfa at 80 q of dry matter per ha. The conversion is phased in gradually, with crops overlapping on non-irrigated land and, in the second year, the addition of coarse grain that is paid more as animal feed. This is because European regulations authorise use of plant products from land in year 2 of conversion to be fed to organic livestock for up to 20 % of total feed. On irrigated land, conversion to organic systems can be achieved more directly, since the question of temporary meadow is handled differently.

75. During the conversion period, income figures vary. Ordinary income prior to tax in this example would be FF 144 200, FF 147 500, FF 144 100 and FF 146 000 for the first four years of the conversion. Once the system is mature, ordinary income prior to tax is FF 158 000, compared with FF 133 400 in a conventional arable system.

76. Incomes in the Limagne model are not as good (Fayolle, 1998). During the conversion period, system (1) — which covers 70 ha — obtains slightly less income before tax than the conventional system, unlike the Poitou-Charentes example. In both cases, income before tax is always lower during the conversion period than in a mature system. The real figures may actually be worse, since the farmers have to learn the new techniques.

77. While these examples provide some useful information, little factual information is currently available on the full costs of a changeover to organic farming, particularly given that the learning process also has to be included. Here, research, training, and development has a vital role to play in the spread and success of new and more environmentally friendly systems of production, of which organic farming is only one of the possibilities.

5. WHAT DOUBLE-DIVIDEND STRATEGY SHOULD BE USED TO DEVELOP ORGANIC FARMING?

78. Specialised cereal systems can be viewed as the outcome of changes in production structures, generated by differentiated price support. This change takes the form of a narrower range of goods, which generates the economies of scale possible in farming activities that benefit from administered prices, but also harms the environment. Conversion to organic farming, on the other hand, is based on pre-existing economies of scope expressed in terms of crop rotation. The private additional cost of OF has corresponding advantages for the community at large. In other words, the range of goods offered by OF includes the co-production of positive externalities. These will be further examined below.

79. In sectors with little or no protection, but subject to a set of tax rules, the inclusion of externalities is now based on a double-dividend strategy. The classic definition of this (Goulder, 1995) is the substitution of environmental taxes for other taxes and levies (on labour, capital, etc.), thereby:

- discouraging activities that are harmful to the environment
- reducing the economic distortion caused by taxation in general.

80. By the same token, current farm policy reforms seek to replace a distorting administered price system with subsidies that encourage agriculture to co-produce environmental goods. In practice, this policy shift is hampered by the fact that conventional intensive systems are not easily reversible. This makes a double-dividend strategy necessary, particularly when devising incentives to convert to organic farming.

5.1. Recent structural developments: from economies of scale to economies of scope

81. A look at trends in production systems over time shows that it was usual to co-ordinate the farm's activities for agronomic reasons to maintain fertility, and on economic grounds to improve risk management. Mixed farming limited damage to the environment. Livestock production was traditionally combined with arable farming; the availability of crop by-products for animal feed, the use of bedding and manure to maintain organic matter levels and soil fertility all reflected this on-farm co-ordination with the by-products of one activity serving as inputs for another. From an economic point of view, these technological synergies are defined as pecuniary externalities, i.e. externalities with a market value which, in organic farming, take the form of savings on input purchases (fertiliser and cereals for own-farm use) or other factors. Crop rotation, for instance, helps to protect plants and maintain the fertiliser balance. Furthermore, the use of these various synergistic systems may generate positive externalities that are in this case technological and benefit the community at large. One example is the creation and upkeep of landscapes. Thus, the attractiveness of France's "bocage" (pasture/woodland) landscapes, for instance, owes much to farming systems that combine livestock-rearing with specific land use. Apart from this aesthetic function, savings on the farm can lead to other positive externalities, with benefits in terms of ecology and natural risk control including biodiversity, ecological niches, protection against soil erosion, water regulation, and greater assimilative capacity.

82. In the immediate post-war period, farmers still found it economically worthwhile to use the pecuniary externalities of the farm itself, for instance because of the presence of economies of scope. These economies are possible whenever the cost of producing several goods together is lower than the cost of producing those same goods separately. It is the combination of goods (scope) that generates a cost saving for a wide range of reasons: production complementarities stemming from the existence of combined goods (cereal grain and straw), quasi-public factors[3] (specific items of farm equipment), etc. Technological innovations and the administered-price structure that subsequently governed the CAP helped eliminate the various production complementarities referred to above. For instance, cereal price support encouraged farmers to substitute technological innovations for existing complementarities; one example was the increased use of pesticides, which gave far more efficient crop protection than mere crop rotation. In other areas, genetic enhancement has produced species or varieties that require very specific inputs in order to express their potential. In some cases, this excludes certain items formerly reintroduced as inputs, such as crop by-products, or animal manure used as fertiliser. Furthermore the disutility, or hard work, sometimes associated with production complementarities merely served to speed up the introduction of technological innovations.

83. Thus cereal specialisation can be explained to some extent by the gradual erosion of economies of scope. The guaranteed price regime and substantial technological innovation over the past few decades have done away with many of the interlinked goods traditionally found on farms. These are now provided by industrial firms upstream and downstream from farming. The family farm accordingly contributes less to the agricultural and agro-food process, and provides fewer of the environmental amenities described above. The disappearance of these amenities is in some cases viewed as a negative externality, depending of course on how the property rights relating to such externalities are allocated. To these can now be added the undesirable nature of certain by-products (e.g. livestock manure), the massive use of pesticides and chemical fertilisers that are harmful to biodiversity, and their accumulation in ecosystems, which may eventually have harmful effects on human health.

5.2. Social advantages of arable OF

84. By definition, OF is assumed to have a beneficial impact on the environment, namely fewer negative externalities and more amenities. In this regard, Boudais (1998) has tried to evaluate in concrete terms the differences in impact between the conventional and organic approaches, using a series of simple indicators relating to water quality, soil fertility, and natural resources.

85. The effects on water quality are gauged from nitrogen and phosphorus balances, nitrate pollution risks, and crop protection methods. Organic soil fertility is gauged via the use of pesticides, organic nitrogen as a share of total nitrogen, and the proportion of temporary meadow. Physical fertility is measured by the proportion of legumes and bare earth in winter. Finally, the impact on resources is assessed via biodiversity, in terms of the number of species cultivated, the amount of natural grassland, hedges, woodland, and so on. Indicators measuring energy use, mineral fertiliser use and irrigated acreage give a picture of resource management.

86. The indicators are aggregated using a ranking system from 0 to 10, with the result providing information on the potential impact of production methods. This work provides information on cereal-growing in the Aquitaine region by comparing 8 conventional farms with 4 organic farms for the year 1997/98. The findings are given in Table 8.

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3. Quasi-public factor: certain factors which, if acquired in order to produce a good, are available at a lesser cost for the production of other goods.

Table 8. Environmental impact of arable farms using conventional and OF methods in the Aquitane region, 1997/98

	OF	*Conventional*
Nitrogen balance	6.5	
Nitrate risk	6.1	7.7
Phosphorus balance	8.0	9.4
Crop protection	5.8	10.0
Organic fertility	3.5	5.7
Physical fertility	3.0	4.0
Biodiversity	4.1	4.6
Resource management	4.0	6.4

Source: Bourdais, 1998.

87. For conventional cereal farms, there is a wide spread of results ranging from average to harmful, particularly because of the potential risk of nitrate pollution. It is here that conventional farming has the worst indicator and the greatest differential with OF (disregarding crop protection, which in conventional farming is bound to stand at 10 because of the use of chemicals). Another point worth noting is that the organic method does not come out particularly well in terms of physical soil fertility and biodiversity. Although oversimplified and based on a small number of cases, Table 8 gives quite a clear picture of the environmental advantages of OF. Overall, it can be said to offer a significant gain above all in terms of water quality, soil biology and resource management, in short, better risk prevention.

88. However, amenities produced by organic farming are usually the result of a general process, and not specifically targeted activities. Of course, OF does not solve all the environmental problems associated with agriculture, and the promotion of OF should not preclude the use of agri-environmental policy measures that are more specifically targeted. Even so, the re-creation of economies of scope through the encouragement of organic farming has the great advantage of reducing transaction costs very steeply, and these costs represent a significant proportion of the sums involved. Thus, in the United Kingdom, they were estimated to account for one-fourth of the budget for the SSSI (Sites of Special Scientific Interest) agri-environmental programme. Using a more inclusive definition of administrative costs, this share has been put at 43 % (Whitby, 1996). In general, agri-environmental measures tend to entail high transaction costs.

5.3. Inadequacies of the current changes in government support

89. An economist's answer to externalities is internalisation, i.e. proposing government instruments, policies, and initiatives that can integrate these externalities into market interactions on a least-cost basis. Fromthis perspective, the 1992 CAP reform can be viewed as "environmentally friendly", at least by its most ardent supporters. The administered-price structure had generated most of the negative externalities, and the cut in prices was presented as a means of internalising them. This is a clear illustration of what Ronald Coase wrote about in "The Problem of Social Cost" (1960): *"...the kind of situation which economists are prone to consider as requiring corrective government action is, in fact, often the result of government action."*

Reversibility: a political illusion

90. Since the 1992 reform, intensive farming has clearly not been discouraged (see Section 2). This is largely because the new system of direct payments for cereal growers is in fact a differentiated land rent based on the agronomic potential of farmland and does not, in fact, remunerate environmental conservation at all. The most favoured areas have captured this land rent in land transactions. Thus, the price of arable land started to rise in 1993 in some of France's cereal-growing areas, and a continuing trend is now obvious. In 1997 the price of land rose nationally by 3.1 % in real terms, or 1.8 % in constant francs. This rise is helping to maintain intensification and land concentration and making it more difficult financially for young people to enter farming. In the least favoured regions, the low level of support can only accelerate the decline of agricultural employment. Since 1992, France has lost 200 000 farms and 300 000 farmers and farm workers (BIMA No. 1470, April 1998).

91. This "least-cost" convergence of farming and environmental policy goals may sustain the illusion that policy instruments in both areas converge and will in fact be adequate in the medium term. An example of this is the set-aside policy instituted in 1992 to control output. The various arrangements for set-aside differ markedly from the traditional concept of fallow as a source of amenity[4], and this is why they are currently the subject of research (Sébillotte *et al.*, 1993).

92. Aside from the difficulty of reversing intensification and specialisation trends, the 1992 CAP reform would have been an ideal opportunity to achieve at least some coupling of government support for farming with the contribution farming can make to environmental conservation.

Limitations of current forms of de-coupling

93. Coupling government support with environmental conservation, and de-coupling that same support from output, is the philosophy behind CAP reforms under Agenda 2000. But coupling support with environmental goals is proving difficult in practice, not very efficient, and costly in budgetary terms because of the high administrative costs.

94. This is why tying environmental conservation to support is being left more to the discretion of individual EU Member States, at the risk of bypassing market forces that could in some cases efficiently produce environmental goods and services in conjunction with agriculture, as is the case with organic farming.

95. De-coupling widens the gap between the productive and the environmental functions of agriculture which, whether we like it or not, are inherently linked. The situation today is one in which government support, dictated by export constraints for staple commodities, is generating most unnatural crop rotation practices across Europe — over-irrigation in order to receive higher direct payments and set-aside that varies according to cereal surpluses, regardless of the need for fallow to help maintain the soil's physical and organic fertility. This mechanistic vision of de-coupling has lost sight of the real linkages between the various aspects of farm production, and is now torn between the need to be competitive, the lack of any distinction between livestock farming that is extensive (grassland) or more intensive (fodder maize, concentrate), and the structural diversity of European agriculture.

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4. In fact, the "bare fallow" (no plant cover) authorised under the new CAP is quite harmful to the environment, since it may facilitate nitrate and pesticide run-off into surface water.

96. In fact conversion to OF means once again placing rotation at the heart of agricultural production and environmental conservation. The section 5.4 below looks at the extent to which available policy instruments could be incorporated into a double-dividend strategy that would benefit conversion.

5.4. Available policy instruments

97. In this regard, Coase (1960) first addresses the legal issue of attribution: who is liable for pollution, who has "ownership"? The fact that there are externalities is very often reflected in the lack of property rights, which are very difficult to establish in many cases. Who owns the landscape? Who is accountable for sustainable soil fertility? Assuming then that the rules on liability have been defined and the property rights for an externality have been allocated (as in the polluter pays principle), it is then a question of internalising the externality by making it a part of market interaction where possible. Taking a second-best situation, Coase draws away from Pigou and envisages four possible options. In the following sections, these are applied to the case of organic farming.

Bargaining over rights

98. The first option is the one envisaged in the "Coase theorem". This involves bargaining over the property rights for externalities (e.g. buying/selling pollution rights) to achieve a social optimum, taking into account the transaction costs involved. Let us return to the choice between conventional or organic cereal-growing. What would the first option mean in practical terms? The rights and liabilities that stem from it must first be clearly established, but this has still not been done. Rather than having a consumer's right to health in the form of grain (bread) that is free from any harmful residues, it is generally more a question of the farmer's right to produce without any special environmental constraints. The introduction of such constraints can be viewed as bargaining for compensation. Benefits (compensation) to the farmer could take the form of agri-environmental measures or steps to offset a cut in guaranteed prices. As trading the right to produce, and hence to pollute, for environmental conservation is an implicit process, there is still a grey area legally regarding conventional farming's liability for environmental damage. Until the rules have been clarified, the consumer can limit the impact of the food externality by choosing to pay a premium for organic cereals assumed to be free of contamination. So Coase's first option, i.e. internalisation, takes the form of implicit bargaining resulting in agri-environmental measures about whose effectiveness there are still some questions.

Intra- or inter-firm co-ordination

99. Coase's second option is intra- or inter-firm co-operation, restoring a better environmental balance (i.e. a social optimum), whenever the costs of such reorganisation are lower than the transaction costs incurred from bargaining over property rights. Organic farming represents this kind of reorganisation within the agricultural business, sharply attenuating negative externalities and once again encouraging technological synergies that generate amenities. The co-ordinated production induced by OF has logical implications for an ecological entity such as a water catchment area and would benefit from being extended to an entire production area, via consecutive structuring of demand for the intermediary goods generated by OF (see above, the inclusion of fodder crops in rotation).

100. As an example of incentives, one option would be to change the structure of administered prices. Without primarily seeking to produce or reduce specific externalities, this was already part of the May 1992 reform, since one of the aims of the cut in cereal prices was to encourage their use in animal feed.

101. Inter-firm co-operation can be encouraged through appropriate government policies. Formerly, relative prices, technologies, and structural policy encouraged economies of scale to the detriment of the economies of scope that characterised mixed farming, a rationale closely resembling OF. This is illustrated by trends affecting the major farm types in France, not including those growing perennial crops (cf. Dupraz and Vermersch, 1997). To simplify matters, the analysis presented below is confined to arable farms, livestock farms, and mixed farms. Table 9 shows trends in their relative shares from 1970 to 1994.

Table 9. Trends in the shares of specialised and mixed farms, 1970-1994

	1970	*1978*	*1985*	*1987*	*1992*	*1994*
Arable farms	5 %	10 %	26 %	30 %	31 %	32 %
Livestock farms	61 %	64 %	55 %	54 %	54 %	53 %
Mixed farms	34 %	26 %	19 %	16 %	15 %	15 %

Source: Dupraz and Vermersch, 1997.

102. Table 9 shows the trend towards specialisation. From 1970 to 1994, arable farms rose from 5 to 32 % as a share of the total, excluding perennial crops, while there was a decline in livestock farms and above all in mixed farms, the latter of which fell from 34 to 15 %. In terms of concentration, farms with specialised arable crops accounted for 40 % of all arable farming in 1970, but by 1994 the figure had risen to 79 %. For livestock farms, the respective figures are 64 and 75 %.

103. Mixed farming uses more labour owing to the internal organisation costs for the various activities. Yet the factors of production that contribute to economies of scale are those on which savings are made when output volume increases. The rise in the relative costs of labour, at least until 1987, led farmers to opt for capital over labour, and consequently to focus on economies of scale in arable farming rather than economies of scope in mixed farming. This accelerated the trend towards specialisation, at least until 1987, when the decline in the share of mixed farming units was halted. Then the impact of prices on farm accounts began to slow down specialisation in general, indicating that the process is to some extent reversible. However, it did not halt specialisation in arable farming, as the movement in factor prices was countered by the 1992 CAP reform, which helped arable farms by providing direct payments.

Direct government intervention

104. The fact that a large number of producers and consumers may be affected by environmental harm leads to a third option, namely direct intervention by government, which regulates polluting activities or introduces a system of fees. For the case at hand, this involves changing conventional farming methods and encouraging a corresponding development in OF. Coase naturally highlights the pitfalls of this administrative solution, pitfalls that can be observed in the farm economy.

105. Imposing government regulations may first of all affect the cost-competitiveness of farming enterprises, which nowadays face broader competition. Policymakers take this into account, since they too are under pressure from various lobbies (trade organisations, consumer groups, environmentalists, etc.) seeking to influence the final decision on the ownership rights of externalities. Furthermore, government regulations cover a wide range of cases in conventional agriculture. Depending on the geographical location of a farm, for instance, the use of polluting inputs such as synthetic fertilisers may create very different degrees of damage according to where in the water catchment area they are actually used. Imposing an optimal levy means in theory knowing what the marginal physical effects of the damage are, which is quite illusory in the case of non-point source agricultural pollution. Finally, producer efficiency

will largely determine how efficient measures such as taxation will be. For instance, a micro-econometric assessment of demand for nitrogen fertiliser shows that the less efficient the farmer, the more price sensitive demand will be. The main effect of taxation is a stimulus for the farmer to start reducing technical inefficiencies. In practice these often take the form of excess nitrogen in fertiliser balances. The producer is therefore encouraged to return to the production-possibility frontier (level of technical efficiency), or even to remain there on the tangency with the price hyperplane (allocative efficiency). Econometric estimates (Vermersch et al., 1993) show that once producers are on the production frontier, they react far less to taxation. In this example, reducing an externality can, to some extent at least, be viewed as a gain in profitability: again, this is the same rationale that underpins the trend in cereal yields following a cut in guaranteed prices (cf. Section 2.1).

Laissez faire

106. Finally, Coase envisages situations in which a comparison of the internalisation costs associated with one or other of the three preceding options, with the social good that ensues, leads to no action being taken at all. In other words, policymakers decide that the current allocation of property rights associated with various goods and externalities optimises the social good. Several arguments underpin this option, including problems in assessing present and future damage, and the lack of information on the behaviour of producers, all of which make it risky to estimate internalisation costs.

107. This fourth option resembles the "laissez faire" approach, which is particularly warranted from a Coasian viewpoint in that, with no regulation at all, it is as if the market is proposing a "natural" internalisation of the externality in the medium term, often flying in the face of any rule on legitimate liability. For example, even if some uncertainty remains as to the impact on human health of pesticide residues in conventional farm produce, this possibility has still contributed to strong growth in the demand for organic produce. In this market, then, the consumers take on liability through higher payments for potentially healthier produce. OF is thus still largely demand-driven agriculture.

Coasian policy options

108. Until the early 1980s, the fourth Coasian option was the one adopted by policymakers with regard to OF. Around that time, concern with protecting the environment gradually began to take over from some of the initial goals of the CAP which had since been achieved. As for the 1992 reform, it can be viewed as a combination of the various Coasian options presented above. But, more importantly, it seems to provide the possibility for policymakers to make an *ex ante* selection of the farming externalities they wish to see remunerated.

109. New government support in the form of direct payments is now seen as granting an implicit entitlement to produce, differentiated according to the region. In fact, through compensation (area payments, set-aside payments, etc.) policymakers are buying back all or part of that entitlement to produce. Furthermore, when one looks at how small in scope agri-environmental measures actually are[5], it is striking that acknowledgement of the farmer's right to produce prevails over the rights associated with environmental externalities. These production rights may also include a farmer's right to use certain natural resources such as water. This applies to specific support for irrigated crops, which receive more support than dryland cereals, and that support is based on a water price that underestimates the social value of the resource (Rainelli and Vermersch, 1997). This implicit but clear evidence that agricultural

5. Agri-environmental measures accounted for only 3.5 % of European Union expenditure on farming in 1996.

production rights take precedence over the rights of consumers to a high-quality environment is practically enshrined in government policy. From a Coasian standpoint, the acknowledgement of production rights is probably aimed at remunerating and therefore preserving pecuniary production externalities, i.e. concentrating specific forms of agricultural production, maintaining cost-competitiveness with a view to exports, etc. In other words, acknowledging environmental externalities runs up against the implicit allocation, in a number of forms, of these property rights, as claimed by a specific mode of farming, by an agro-food industry, or by a regional economy concerned with preserving existing pecuniary externalities, i.e. comparative advantage. In fact some regions present their production rights as a prerequisite for maintaining the rural fabric, indicating that technological or pecuniary externalities go beyond merely preserving the natural environment.

110. The new forms of agricultural support do have the advantage of being transparent, making it easier to see how socially cost-efficient they are, even if changes are subsequently required to the spread of farm externalities that will be remunerated. In fact, all this reveals *ex post* the trade-offs made by policymakers when it comes to maintaining or developing technological and pecuniary externalities.

6. CONCLUSIONS

111. While there is strong latent demand for a quality environment and healthy food, which organic farming is able to meet, there is evidence of a clear shortfall in supply. From an accounting point of view, the unresponsiveness of arable farming can be explained by lower profitability, in particular during the conversion phase. This stems from the emphasis on temporary meadow in OF rotations to provide non-mineral fertilisation. This type of crop carries less value than traditional crops that are granted compensatory payments, and OF farmers accordingly suffer a considerable loss of income. Thus, the system of compensatory payments currently in place contributes to the imbalance in profitability between conventional and organic farming.

112. These extra private costs can be offset by remunerative market prices (i.e. consumers willingness to pay higher prices for OF produce), although these are not guaranteed to last when supply, whether from home or abroad, increases. This is where a coherent economic policy, taking into account the negative externalities of conventional farming, could be developed that encourages production systems that do less harm to the environment. The fact that organically farmed arable crops allow society to make savings on environmental expenditures warrants special measures to support OF.

113. In terms of support for OF, the possible arrangements are threefold.

- First, the fact that OF is underdeveloped should be viewed in the context of the legal grey area that surrounds liability for agricultural pollution. The grey area actually relates to a policy transition period, as we have seen, when consumers and environmentalists seek more recognition for their property rights concerning the environment. Until now, it is as if those property rights had *de facto* been allocated to farmers alone, the only self-proclaimed stewards of the countryside.

- Second, and still in the short term, a new technical measure to provide compensation payments for temporary meadow on a par with those paid for all kinds of cereals, and for oilseeds and protein crops, would be a way of restoring the balance of support for agriculture in all its forms, even if this meant reasoning in terms of a constant package. Such a measure would be a primary move to reduce a form of distortion that currently penalises organic farming, although it would not solely target organic farming practices. It could also be accompanied by a secondary measure such as taxation of inputs responsible for pollution from intensive farming. The allocation of direct support to feed crops like alfalfa should not pose too many problems in the context of the WTO negotiations, since this would be drawing a little closer to flat-rate area payments, *i.e.* a system de-coupled from production.

- Third, incentives for OF are generally part of the trend to re-couple government support for economies of scale with economies of scope, i.e. the market and non-market benefits derived from combining different forms of production. This is because the first CAP, by instituting guaranteed prices, indexed government support to economies of scale, and hence to larger farms where agriculture was more like a widely subsidised heavy industry. Hence, the dual trend towards concentration and specialisation, which has had harmful effects on the environment. Guaranteed prices encouraged the use of potentially polluting inputs, to the detriment of more labour-intensive technical complementarities, such as the rational use of livestock manure. The outcome was more releases of effluent into the natural environment, an outlet to which farmers had virtually free access.

114. Other measures aiming at increasing human capital through the training of farmers and the dissemination of research results to them should be envisaged. This returns more generally to the role of information as a factor in the substitution of potentially polluting production inputs. The question is to understand how public authorities can promote better access to information.

115. Recombining the various products available on the farm, as organic farming does along the lines of the old mixed-farming model, restores the environmental balance. Agricultural economists have now grasped why specialisation and concentration have occurred in European farming and, in collaboration with agronomists, can formalise how these trends might be reversed in favour of the environment, via a new change in relative prices. This is in line with Coase's analysis, proposing product co-ordination, both within a farm enterprise and amongst more than one farm if the crop and livestock balance is viewed in terms of an entire water catchment or regional production area. Furthermore, re-coupling government support with the environmental goods organic farming can produce will necessarily mean incorporating the intertemporal constraint of rotation. Calling as it does for a new form of productive risk-taking (in particular with regard to plant health hazards), OF is an invitation to adopt a new form of risk-sharing and, in correlation, new forms of income guarantees that could be included in a revamped programme of government support.

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