Session 1

Socio-Economic and Political Framework in the European Union for Sustainable Farming Systems

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ANALYSING THE ECONOMIC CONSEQUENCES OF SUSTAINABILITY IN FARMING SYSTEMS

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ABSTRACT

In many economies where a supported agriculture contributes but a small percentage of national income and where the mainly non-agricultural population has interests in the management of the rural environment, there is increasing interest in the concept of sustainability. Public pressure manifests itself in many ways, including adjustments to agricultural support systems which may include elements of cross-compliance or modifications to the economics of farming systems, which in turn lead managers to reduce inputs. Better knowledge on the part of such managers in relation to the complexities of the environmental management of their crops may allow them to maintain gross margins at reduced levels of inputs and yields. Such changes, whilst maintaining farm incomes, may reduce the demand for inputs, including labour. Research results tend to be location-specific so, with highly variable ecologies across regions, it is very difficult to forecast the regional economic impacts of the adoption of sustainable systems. At the national level, aggregate reductions in the production of some commodities would assist in the achievement of the GATT agreements to reduce subsidised exports.

INTRODUCTION

The case for a move from existing farming systems to "sustainable" farming systems is based on the argument that, in the long run, current systems are leading to an undesirable rural environment in social, economic and ecological senses and thus a decline in the utility of a representative member of society (Turner, 1993). An undesirable social environment because fewer people are employed in agriculture, more people living in rural areas have less to do with agriculture and those who do remain are socially isolated and suffer a decline in rural social services (Pretty and Howes, 1993). The economic problems arise from the supported nature of agriculture with declining farm incomes relative to other sections in society, but where the CAP is still of major significance to the EU budget. The ecological problems arise from the contribution of pollution from heavy use of pesticides and fertilisers, and from the specialised nature of much of animal agriculture leading to problems of disposal of natural wastes and the loss of diversified habitat for natural predation (Hodge and Dunn, 1992).

An implied theme in the sustainability literature appears to be the distinction between closed systems versus open systems in agricultural production. Sustainability appears to involve a move towards a more closed system whereby byproducts are consumed on the farm and the market intrudes only at the final product stage. This could entail a diversified, mixed livestock and cropping system whose archetype might be the subsistence farmer occasionally selling food products in order to gain money to pay for tools or schooling for his children. At the other extreme, there is the specialist producer selling only a single product, all of whose inputs are bought in the market. Modern technology now permits economies of scale both in production and in transport between regions. Thus the comparative advantage of particular localities is enhanced and specialisation takes place.

But it is necessary to be more specific about the characteristics of sustainable systems before discussing the impacts of their adoption. Pretty and Howes (1993) reviewed much of the sustainability literature and defined it in terms of five goals. These included (i) a more thorough incorporation of natural processes into the agricultural production processes, (ii) a reduction in the use of off-farm inputs, (iii) a greater use of the biological and genetic potential of plant and animal species, (iv) an improvement in the match between cropping patterns and physical limitations to ensure long-term sustainability of current production levels and (v) profitable, whole-farm management to conserve soil, waste, energy and biological resources. They also emphasised that they regarded sustainable systems as a "loosely defined" middle ground between "organic agriculture and high input industrialised agriculture" (Pretty and Howes, op.cit. p8).

MAKING THE CONCEPTS OPERATIONAL

Table 1. Some Suggested Changes to Farming Systems and Practices to Enhance Sustainability (after Pretty and Howes, 1993).

Changes to Husbandry Practices:-
Reduce pesticide usage by being more selective; adopt IPM
Patch spraying, beetle banks, wild flower strips
Use of natural predators; crop mixtures; resistant varities; multiline varieties
Improve fertilizer efficiency; timing and placement; adopt global positioning systems
Incorporate legumes and catch crops for maintenance of soil stability and fertility
Maintain hedges, coppices as windbreaks, wildlife corridors and reservoirs
Changes to Farming Systems:-
Adopt diversified farming systems involving both crops and livestock
Balance intensity of livestock production with arable area for disposal and use of wastes
Lengthen and diversify rotations to improve pest management and soil fertility and thus reduce requirements for external inputs.

Pretty and Howes also made a number of suggestions as to what changes might take place in farming systems and practices in order to further sustainability. Husbandry changes include reductions in pesticide and fertiliser use by improved ecological management of the social and non-cropped areas. Systems changes include a diversification of crops within arable rotations plus a

return to more mixed livestock and cropping systems. Some of their suggestions are listed in Table 1.

A difficulty with suggestions of this type is that it is easy to confuse means and ends. Are these practices to be regarded as ends in themselves? If so, how does one know when a "sustainable" system is achieved? Who makes the judgement? What indicators are to be used and what tradeoffs between them are acceptable? It does seem that the subject area is suitable for a Logical Framework Analysis (Coleman, 1987) in which ends are clarified, means are identified and targets set. Without agreement on indicators, it will surely be difficult to make the desired progress.

AN ECONOMIC FRAMEWORK FOR FARM SYSTEMS CHANGES

It is possible to categorise these changes towards sustainability in terms of their economic characteristics (White et al., 1993).

Efficiency changes

These include the adoption of practices which involve a change in the use of an input which leads to sustainability gains. Reductions in nitrogen applications thus give sustainability gains if nitrate leaching into groundwater or runoff into watercourses is reduced. If maintenance of profitability is the criterion, then a sustainability practice will be adopted by farmers so long as the value of the reduction in yield is less than the value of the fertiliser saved.

The same principle applies to the application of pesticides. Whilst the relationship between pesticide inputs and yield is very much more complex, it is still true that farmers will adopt the practice so long as gross margins are maintained.

Substitution changes

These involve the replacement of one input by another with the aim of improving the sustainability of the farming system. Examples might include the use of nitrogen generated by legumes within a rotation as a substitute for inorganic nitrogen, or the substitution of mechanical weeding for the use of herbicides in intensive vegetable production.

In order to estimate the economic impact of such a change, we need to know the rate of substitution between the two inputs for a given level of output. For example in the mechanical weeding case, it is clear that initial reductions in herbicides might relatively easily be substituted for mechanical weeders. But further reductions would become increasingly difficult. The optimal point is where the extra cost of more mechanisation is just equal to the costs foregone by reducing the use of herbicides.

Redesign of cropping and livestock systems

The redesign of systems involves the addition or, less likely in the sustainability debate, the deletion of products, or changes in enterprise size within the farming system. The optimal product mix for a farm is based on the available resources plus the relationships between the various products. Sustainability clearly implies a reduction in external inputs and an increased reliance on the interrelationships between the production systems of a number of commodities. Possibilities include the introduction of legumes into the rotation, the use of diversified crop and livestock farming systems, and diversification of cropping systems to reduce pest problems.

For the farmer, the point of maximum profit is where the rate of substitution of one product for the other is equal to the ratio of the product prices. In other words, where the increase in total gross margin arising from increasing the area of one crop just extinguishes the consequent reduction in total gross margin from the other crop (Barnard and Nix, 1979, p38).

This kind of analysis can be used to explain the reasons for specialisation where there are returns to scale in production. Given the fixed cost structure involved in the production of milk (labour, fixed equipment) and in the production of cereals (labour, machinery), it is clear that a farm of, say, 50 hectares would find it difficult to operate a diversified system profitably. The relationship between the two enterprises is such that the requirement of resources for even a small dairy enterprise would seriously impede the ability to carry on an efficient cereals enterprise. In such a case, the diversified farmer would probably have to employ contractors to farm the cereal area, thus increasing his exposure to external inputs.

PROGRESS IN GENERATING THE REQUIRED INFORMATION

Data Requirements

The above three-way categorisation also enables us to specify the types of data needed. In each case, we need to know how the suggested shift will impact upon both the economics and the sustainability indicators following, of course, their adequate definition. Where efficiency changes are being considered, we need to know how the gross margin will change, and what will be the effect on the sustainability indicators. When substitution changes are being considered, we need to know how the costs of production will change and the impact on sustainability of the simultaneous change of both factors. A less harmful input may be substituted in place of a more harmful one. Knowledge will be needed about how the change affects the particular ecological surroundings in which the change will take place. Clearly this will vary from locality to locality, depending on soil type, topography and other factors. Finally, when the redesign of systems is being considered, the mechanisms of the interactions between the crops in terms of the sustainability indicators has also to be known. This will include knowledge of mineral balances of N, P and K between the different crops, as well as pest/predator relationships under the various possible cropping combinations. It seems likely that obtaining the data will be neither straightforward nor cheap, even given the definition off appropriate sustainability indicators.

Some Experimental Results in Low Input Agriculture

Over the past 15 years MAFF, together with a number of collaborating agencies and companies, has supported a major set of programmes to develop farming systems which, while remaining profitable, safeguard the environment as far as possible. Since much of the debate has concerned the reduction of potentially harmful external inputs, it is not surprising that this is an area on which emphasis has been placed.

Table 2 lists five of these programmes which have often been aimed at elucidating the 'ecological' impacts of modified input levels as much as their profitability. As time has passed, and as scientists have increasingly recognised the potential for system changes rather than simple input reduction, the move has been towards system redesign in the form of the manipulation of rotations or the introduction of new crops.

Table 2. Some Experiments to Investigate Changes in Arable Agriculture

	date	Treatment	Treatment Levels	
BOXWORTH	1983-9	Pesticide levels	"minimum"	"supervised"
			"full insurance"	
SCARAB	1990 -	Pesticide levels	"current"	"low"
TALISMAN	1990 -	Rotations	"standard"	"green"
LIFE	1990 -	Rotations	"conventional"	"integrated"
		Input levels	"standard"	"low"
Link - IFS	1992 -	Rotations	"conventional"	"integrated"

Sources: Grieg-Smith et al(1992), Cooper(1990), Jordan and Hutcheon(1993), Prew(1992)

But there is still a long way to go. It has to be recognised that, as far as efficiency changes are concerned, we are dealing with a continuous relationship between input levels, yields and sustainability indicators. Whilst two levels, such as "current" and "low", will give some idea as to where the curve might be, it will not be much help in locating an optimum trade-off between sustainability indicators and yield. Likewise, ideas about feasible rotations are continuously changing (Jordan and Hutcheon,1993) so, by the time the results are available, new knowledge may have outdated the experimental rotations. Nevertheless, such experiments are essential because they can provide the basic science which underlies the complex interactions between crops and which is essential in the development of sustainability indicators. Once this knowledge is available, progress in the redesign of systems can be speeded up by adopting a modelling approach.

CONSEQUENCES OF THE ADOPTION OF SUSTAINABLE FARMING SYSTEMS

We now address the likely economic impact of the adoption of sustainable systems at the individual farm level, the regional level and the national or supranational level. For various reasons it is difficult to make any quantitative estimates, but it may be possible to identify the general directions of change and to indicate those factors which appear likely to be important in determining the magnitude of change.

The Farm Level

The major determinants of change at the farm level will be the existing farm system; the soil type, climate and topography; and the surrounding natural ecology. Where farming systems already depend on a diversified crop and livestock complex, and where there is integration of natural processes, there will be less need for change. However, where a high input system involving relatively few enterprises has developed, major change may well be needed if the objectives listed earlier are to be achieved. It is difficult to see, for example, large scale arable units in the Eastern Counties of the UK making major alterations including the incorporation of livestock into the system without a considerable impact on farm income. Likewise, changes would have to occur in the structure of pig production if limits were to be placed on the ratio of animals to hectares of arable land as in the Netherlands or Denmark. Whilst dairying in the west of England might be regarded as relatively sustainable, stocking rates would have to decline if inorganic fertiliser applications were to be reduced. An initial conclusion therefore must be that there will be considerable variability in impact, depending upon the existing conditions in a particular locality.

It is important to remember that, other things being equal, the adoption of these changes will usually lead to some loss of income for farmers. This is because, if it were otherwise, farmers would already have adopted the recommended practices and there would be less need for change. The *ceteris paribus* assumption is important, though. In practice there are two major variables which need not remain constant.

The first is the level of knowledge of the farmer and the second is the set of policies under which farmers operate. If farmers are shown that sustainability can actually increase their incomes albeit at the cost of improved managerial skills, then they are likely to adopt its practices. But if there remains a cost to the adoption of these practices, even though there are public benefits, we can expect farmers to be less enthusiastic. This applies particularly to those farmers who are already under financial pressures from, for example, the small size of their operation or the lack of other opportunities for generating family income (Gasson, 1988).

Table 3. Pesticide Application on Wheat 1982 - 1992, kg ai per ha

Year	Fungicide	Herbicide	Insecticide	Molluscicide	Seed treatment	Total
1982	1.37	5.80	0.23	N/A	0.06	7.46
1988	1.64	4.16	0.15	0.06	0.00	6.01
1990	1.38	2.77	0.11	0.02	0.02	4.30
1992	1.33	2.20	0.08	0.02	0.05	3.66

Source: MAFF, Pesticide Usage Surveys

The second variable is the set of support policies adopted by government. The reform of the CAP in 1992 involved a move from product price support to area payments, with the aim of maintaining incomes whilst reducing production via the set-aside provisions. A clear implication has been that, with reduced product prices, the marginal revenue from the last unit of variable input will be reduced, and so farmers are likely to reduce the level of inputs. It is too early to quantify this particular effect, since aggregate use of inputs of fertiliser and pesticides has been decreasing

since around 1988. Furthermore, table 3 shows how pesticide use on wheat has been declining over the past decade, possibly also in response to declining real product price. Finally, the devaluation of the pound against the ecu in 1992, resulting in higher than anticipated product prices and area payments, has confounded this effect. But there is some evidence that one impact on arable systems of the reforms may be an increase in the amount of pulses and legumes in crop rotations (Donaldson et al., 1995).

We conclude, therefore, that under a "no policy change" scenario, and without some investment in the agronomic managerial skills of farmers, the impact of sustainability upon farm incomes is likely to be quite variable but generally negative. Cain et al. (1995), investigating the loss of profits consequent upon the mandatory adoption of specified practices, confirm this. A question which immediately arises is: what sort of policies would lead to the adoption of sustainable systems? Does it have to be mandatory practices or management agreements, or are there alternative market-based policies? This aspect must clearly be part of the agenda of any publicly funded research programme into sustainability.

The Local and Regional Level

Similar factors also affect the degree and direction of the impacts at regional level. Since much of the research currently being carried out is location-specific, it is difficult to know whether or not a system which is sustainable in one part of the country is necessarily sustainable in another. We can, therefore, not be specific about the regional impacts but we can speculate about the effects on the supply industries and their markets, the commodity processing industries and their markets, and finally the consumption impacts caused by changes in agricultural income.

One of the principles of sustainability involves decoupling the farming systems from purchased inputs. These will generally include fertiliser and pesticides but may include other goods and services such as machinery. This seems likely to lead to further contraction in the markets which have seen the wholesale elimination of family-owned local merchanting businesses over the past decade or so. There is some suggestion that demand for labour (for weeding and hedgelaying; Pretty and Howes, 1993) would increase, but these highly seasonal operations seem unlikely to do more than provide casual jobs at certain times of the year. If yields are reduced then demand for harvest and postharvest labour will also be reduced.

If the adoption of sustainability involves reductions in the amount of product, there are likely to be consequences in the commodity processing sector. With a reduction in inputs and hence yields, there is likely to be under-utilised capacity in the processing sector, much of which is located regionally. In addition, transport costs per tonne would increase, leading to increased concentration in the processing sector. This sector is already subject to rapidly changing technology and significant economies of scale. Sustainability would probably exacerbate the changes currently taking place. McCorriston (1995) has developed a methodology for investigating these downstream effects of changes in environmental policy. Furthermore, it would be important to maintain quality levels since, if sustainability involved an increase in variability of quality of product (Fenemore and Norton, 1985), there might be a loss in competitiveness with respect to high quality product imported into the region. Making a rather different point, Hanf and Verreet (1994) remind us that the substitution rate between a decrease in pesticides residues in food and drinking water and an increase in mycotoxins in food products is as yet unknown.

There is an argument that regional sustainability might include local processing and the development of niche products in national or international food markets. Whilst there are many successful examples of such products (cheeses, wines, etc.), it is difficult to see them becoming a major generator of income in every locality.

It is important also to recognise the potential consumption effects of sustainability. We have seen that without changes in support policies, a mandatory move towards sustainability would likely reduce farm incomes. Such a move would have impacts on the local community because the spending of farmers and others would be reduced. Rural shops, already under pressure from supermarket development, garages, repair facilities and other rural enterprises, would thus suffer. Whilst there may be benefits in terms of environmental externalities to the rural non-agricultural population and to urban-based visitors to areas where sustainability is practised, it is difficult to see anything other than a widening of the gap between farm and non-farm incomes if specific support measures are not adapted. There is much regional variation in the importance of non-farm and off-farm income to the rural economy (Gasson, 1988). But is seems clear that where farm income is important - and this will include much of the more remote areas of the UK - the decline of the rural economy would not be halted.

Aggregating to the UK and European Level

As yet there is little basis for informed speculation as to the impacts of sustainability at the national or European level. Most of the experimental results are highly location-specific and may not necessarily apply across the very variable ecologies which are found both within the UK and across Europe. It thus seems clear that both the income and environmental effects of adopting sustainable systems, however they are defined, will be very variable since the levels of external input use across Europe vary greatly (Brouwer et al., 1993). The Mediterranean ecologies and farm structures may be expected to react very differently as compared with those found in northern Europe. However if policies were adopted which did stimulate a move in the direction of sustainability then the relative comparative advantage of different regions might change, leading to significant adjustments of location of production and of cropping patterns within particular locations. Forage-based animal production might become more concentrated in the wetter north-western areas of the continent, whilst fruit and vegetable production would be further concentrated in regions where solar energy and natural water supplies were plentiful.

Predicting the aggregate economic consequences is even more hazardous. If, as some of the UK data appears to suggest, it is possible to reduce yields and input levels without compromising gross margin levels, then production-related support costs would be reduced. Likewise, such production adjustments would make the GATT agreements on levels of aggregate support more easily achievable. Whilst this applies to supported crops, there might well be significant effects on the price of unsupported crops such as intensively grown fruit and vegetables.

CONCLUSION

Sustainability is a concept which has yet to be made operational in many agricultural situations. Whilst the aspirations involved are relatively clear, it is the case that a full range of indicators for different sets of ecological circumstances remain to be developed.

A major component is the reduction in the use of external and possibly harmful inputs in the agricultural system. Experimental results suggest that in some cases gross margins can be maintained using fewer inputs, but the identification and measurement of indicators of sustainability is still under development. Much of the work has related to comparisons between current practice and organic systems, whereas the sustainable system appears usually to be regarded as something in between, and so extrapolation from organic systems may be inappropriate.

A concern of the proponents of sustainability appears to be a move to mixed livestock and arable systems. What little low-input livestock experimental work exists has not generally involved a mixture of crops and livestock. The economies of scale in each of these branches, together with the existing farm size structure in UK agriculture would suggest that wholesale change in this direction is unlikely.

Extension of the experimental arable results would seem not to compromise farm income for some arable farmers. But it is not known what proportion of farmers fit in this category. Beyond these cases, it seems likely that in the absence of policy changes to support such a move the effect on farm incomes would be negative. We need to know what changes in policy would foster sustainability on the majority of our farms. The alternative seems to be payments for mandatory practices in the form of management agreements.

Given that the general ethos of sustainability involves a reduction in external inputs and a move towards internal self sufficiency, it is hard to avoid the conclusion that the immediate effects on the existing local rural economy would not be positive. It seems likely that there would be further concentration in both the upstream and the downstream sectors. Whilst it is sometimes suggested that sustainability might increase the demand for labour, that labour is likely to be unpaid, seasonal, or casual.

Finally, it is not yet possible to say what the effects of a move towards sustainability across the EU might be. Whilst the EU is the policy-making unit for European agriculture as a whole, the effects of its policies have differing consequences across the member states. Under present policies, if yields were reduced and income maintained then support costs would be reduced and the GATT agreements made easier to achieve.

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