

Agriculture and its Environment: Are There Other Ways?

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SUMMARY

Although the Common Agricultural Policy has served its original purposes very well, the problems with overproduction, the environment and the EC budget are, by now, so profound that the need for a major overhaul is widely recognised. The aim of the present paper is to contribute to the discussion of this technical and political problem.

For this purpose some fundamental aspects of the agricultural production process are treated first. Within the European Community, there appear to be considerable possibilities for a simultaneous increase of production per surface unit and of its efficiency, so that in all situations where agriculture is practised as an economic enterprise the yield per surface unit will continue to increase. This increase in production has to be kept in line with the stagnating demand for use of land for other purposes. This is necessary, irrespective of whether prices are adjusted downward or production quotas are introduced.

Against this background two opposing perspectives of development are presented, in such a way that the dilemmas the European Community is faced with are clarified. These perspectives of separation and integration of functions were originally developed by the Dutch Scientific Council for Government Policy (WRR, 1983). They differ especially in their view of agriculture and its relation to nature and the environment and in the way that the problem of overproduction is coped with.

The discussion of the advantages and disadvantages of these opposite perspectives paves the way for a broad outline of another common agricultural policy that is characterised by both market orientation and solidarity and may lead to a competitive and sustainable agriculture and a fair reconciliation of conflicting agricultural and environmental goals.

INTRODUCTION

The common Agricultural Policy of the European Community (EC) was initiated more than 25 years ago at a time when the import of agricultural products was considerably larger than the volume of exports and food security for the still-increasing millions of Europeans could not be ensured. The purposes of the common policy were the increase of self-sufficiency and food security, a fair income for farmers and maintenance of equilibrium in the markets of agricultural products. The main policy instruments of the EC were, and are still, levies on the borders of the EC and intervention prices for the main products.

The existing overproduction proves that the aims of self-sufficiency, food security and income of the farmer have been higher on the priority list than market equilibrium. It is, however, impossible to justify the use of scarce resources for these purposes, because spin-offs of overproduction, like employment, income for the farmer or an equitable distribution of the gains and charges of the common agricultural policy can be achieved in other ways, without wasting physical resources.

This overproduction reflects the fact that the internal EC market for food products is, to a large extent, saturated. Expansion in some of the markets is likely to be offset by contractions in others, with the exception of more exotic food products and ornamental products for house, gardens and parks. There is now a considerable export of products for which intervention prices are being maintained, so that at the EC borders the difference between internal and world market price is no longer collected as a levy, but paid out as an export restitution. The very success of its policy has brought the EC considerable budgetary problems. Also, it has alerted the consumer to the fact that he is paying too much for his food. In the case of intermediate products there are still large imports of grain substitutes for animal use, vegetable oils and fats for margarine and cellulose products for paper. This would certainly have been different if there had also been protecting import levies implemented for these commodities at the EC border. In that case the growth of intensive livestock farming would have been much less in The Netherlands and the thrifty Dutch would have been using their own butter instead of margarine.

From the beginning, the EC was given the responsibility for price and market policy, but national governments remained responsible for the structural policies of farm improvement and of reallocation, reclamation and reconstruction of the land. The prices have been maintained at such a high level that, viewed from the national standpoint, structural improvements were often worthwhile. Therefore, this divided responsibility has

been contributing considerably to the problem of overproduction. The increased production per unit area and per man has been also due to an increased use of energy and other raw materials. This has led to increasing environmental pollution and impoverishment of the natural environment. In areas with perspectives for agriculture, land allocation and reconstruction has led to irreversible changes in the landscape which now threaten its diversity. In other areas the social and environmental fabric is jeopardised by lack of perspectives for agriculture. Finally, there are justified ethical concerns about the way in which animals are treated in some of the intensive animal husbandry systems. For these reasons it is doubted whether the continuity of agriculture is being maintained sufficiently.

Although the Common Agricultural Policy has served its original purpose very well, the problems are now so profound that the need for a major overhaul is widely acknowledged. The aim of the present paper is to contribute to the discussion of this issue.

For this purpose some fundamental aspects of the agricultural production process are treated first, because the kind of effort that is needed to control overproduction and the environmental effects of agriculture depend, to a large extent, on the technical options and boundary conditions.

Subsequently, two opposite perspectives of agricultural development are presented that were originally developed by The Netherlands Scientific Council for Government Policy (WRR) within the framework of its policy-oriented survey of the future (WRR, 1983). These are the perspectives of separation and integration of functions, that differ especially in their view of agriculture in its relation to nature and environment and in how to cope with the problem of overproduction. The perspective of separation of functions is based on the idea that agriculture, as well as nature and environment, are best served by physical separation because then both interests can be optimised in their own right and with their own means. Overproduction in this perspective is mainly controlled by more market-oriented prices. The perspective of integration of functions is based on the idea that agriculture, nature and environment cannot do without each other and that all interests are best served by physical intertwining and integrating of functions. Overproduction in this perspective is mainly controlled by quota systems.

The discussion of the advantages and disadvantages of these opposite perspectives paves the way for the presentation of a broad outline of a common agricultural policy that is characterised by both market orientation and solidarity and may lead to a competitive and sustainable agriculture and a fair reconciliation of conflicting agricultural and environmental goals.

SOME FUNDAMENTAL ASPECTS OF THE PRODUCTION PROCESS

As has been said, the kind of effort that is needed to control overproduction and the environmental effects of agriculture depends, to a large extent, on the technical options and boundary conditions. If the production potential were approached in such a way that more and more effort in terms of labour, capital, energy and raw materials is needed to increase agricultural output, the present problems of overproduction would be of a temporary nature, but the demands on the environment and the natural resources would continue to increase. If, however, there were still considerable leeway for both increase in production and production efficiency so that costs per unit of product are considerably decreased, overproduction would remain a continuous threat. But at the same time there would remain options to manage the demands of agriculture on the environment and natural resources.

Past performance

In analysing the regional agricultural production in the EC of the original nine countries, it was found that the annual yield increases in absolute terms were about the same, independent of the production level (Meester & Strijker, 1985). For wheat, this yield increase has been, up to now, about $70 \text{ kg ha}^{-1} \text{ year}^{-1}$ and, for summer grains, somewhat less. This yield increase was roughly the same for potatoes and sugar beet when expressed in terms of dry matter. Therefore, this growth has neither led to much differentiation among regions nor between crops. However, the scale of the analyses may have obscured emerging problems. For instance, in some parts of The Netherlands, potatoes and sugar beet may suffer from a too-narrow crop rotation and over-mechanisation (Van der Weijden *et al.*, 1984).

This constancy of yield increase over time is also shown in Fig. 1 where the yields of wheat per hectare since the end of the nineteenth century are presented for the United Kingdom and the United States.

A few years after the Second World War a sudden transition from a slow growth of a few $\text{kg ha}^{-1} \text{ year}^{-1}$ to a high growth of around $70 \text{ kg ha}^{-1} \text{ year}^{-1}$ occurred. This large difference is also observed in the rest of the Western world, although, for the European continent, the suddenness of the transition was obscured by the occurrence of the war. For instance, in France, the growth rate before 1940 was only about 10 and, after 1950, about $75 \text{ kg ha}^{-1} \text{ year}^{-1}$. In The Netherlands the rapid increase in rate of production after the war was a consequence of advances in several areas.

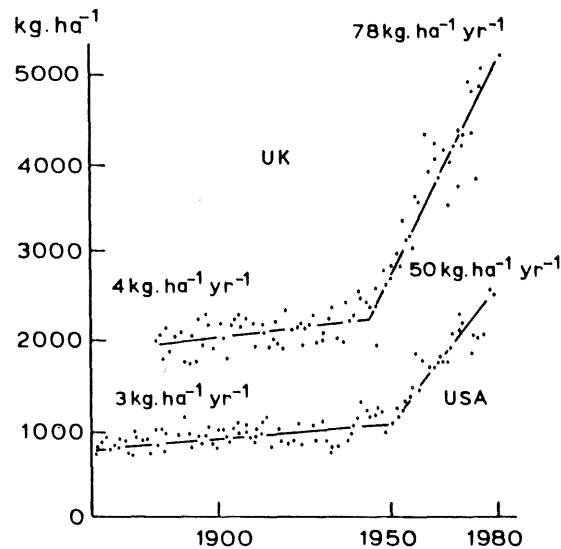


Fig. 1. The trends in the yield of wheat in the United States and the United Kingdom over the last 100 years (FAO data and De Wit, 1981).

Plant breeders introduced the short straw varieties developed by Heine during the Second World War; nitrogen fertilisation techniques were improved by plant nutritionists; herbicides (and later insecticides and fungicides) were introduced by crop protectionists and mechanisation allowed better and more timely operations. Thus the much heralded 'Green Revolution' in some developing countries in the 'sixties, as illustrated in Fig. 2 for Indonesia, was preceded by a 'Green Revolution' in the industrialised countries by only 20 years or so. But this latter revolution in the West has gone largely unnoticed, although the reason was the same: an innovative combination of plant breeding, water management, fertilisers, control of weeds, pests and diseases and mechanisation.

Production potentials

To answer the question for how long and to what level this increase in yield may continue, it should be kept in mind that every location has its own production potential, depending on climate, intrinsic soil properties, reclamation level and crop properties. The quantitative knowledge of the primary production process is advanced to such an extent that this production potential for the main crops can be estimated with some confidence (Van Keulen and Wolf, 1986). This was first done by Buringh *et al.* (1975) on a world scale, some of their results for Europe being summarized in Fig. 3.

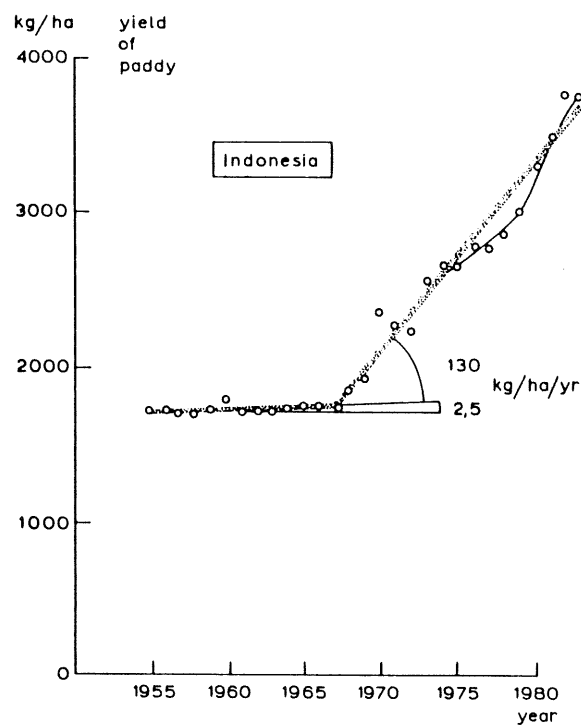


Fig. 2. The trends in the yield of rice (in kg ha^{-1}) in Indonesia (FAO data). The temporary stagnation in the 'seventies is due to an epidemic of stemborer.

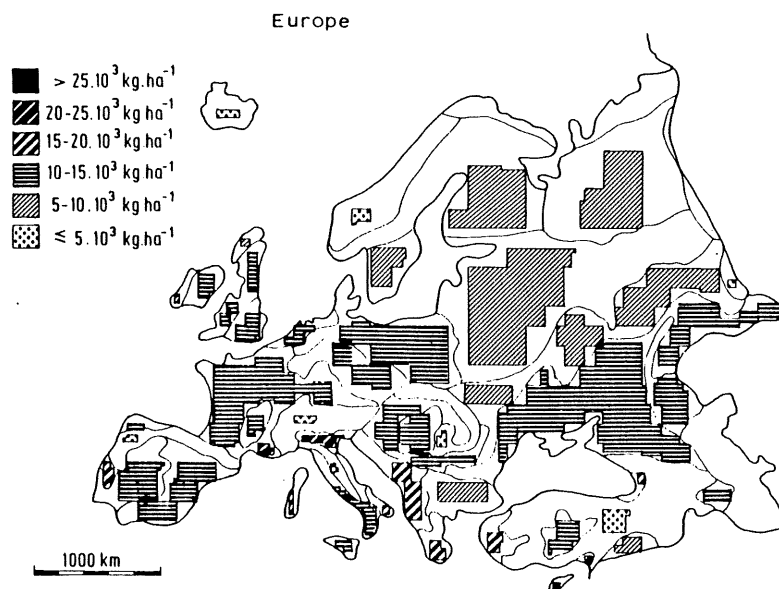


Fig. 3. Production potential in Europe. The areas that can be potentially cultivated in the broad soil and climatic regions are represented by the shaded area and the average potential yield of one or more crops (in kilograms of grain eq per hectare per year) is indicated by the type of shading (De Wit *et al.*, 1979).

For the whole continent, 27 broad climatic and soil regions were distinguished. Water and intrinsic soil constraints were taken into account, but otherwise it was assumed that the soils are reclaimed to the highest feasible level and that neither weeds, pests, nor diseases interfere. More differentiating calculations have been made for several countries, but not, as yet, for the countries of the EC.

A comparison with the present situation shows that a great part of the potentially cultivatable land in Europe is indeed in use as such, but that the potential production still exceeds considerably the actual production. Even in The Netherlands, there are still large possibilities. This means that, practically all over Europe, the rate of production increase per unit of surface could be maintained for a number of years.

The efficiency of production

The increase in yield in the last decades was associated with an increase in labour productivity. Around 1900 the production of 1 ton of wheat in The Netherlands required 300 man hours, whereas in intensive modern agriculture the same amount of wheat requires not more than 1.5 man hours.

The increased inputs that are necessary to bring about these increased yields are sometimes brought under a common denominator on the basis of their energy content, some recent data of Pimentel (1984) being summarised in Table 1. Contrary to earlier data presented by this author, it appears that the fully-mechanised, high-yielding American corn farm is three times more energy efficient than the traditional farm in Mexico, where the work is done by hand or with the help of animal traction and no industrial fertilisers are used.

One may question the usefulness of adding together indiscriminately all sorts of energy ranging from food and firewood for maintaining human labour to fossil gasoline for running a tractor. But comparison on the basis of direct plus indirect use of only fossil energy reveals anyhow that the so-called law of diminishing returns is not very illuminating for this energy total as an input. This is because energy is not a single production factor, but a raw material for the manufacture and operation of production factors that are used in various proportions, depending on the production level and on the state of technology. These increasing returns on energy suggest that technological innovation in agriculture enables a continued yield increase with relatively less inputs per unit product. This may be understood as follows.

The relative costs of fixed operations, such as ploughing and sowing, decrease, of course, with increasing yield. It is too little realised, however, that the number of fixed operations increases with increasing yields at the

TABLE 1
Energy Production and Direct Plus Indirect Use of Energy, Human Labour and Animal Traction Included, in Corn Cultivation under Four Different Conditions, According to Pimentel (1984)

	<i>N</i> use (kg ha ⁻¹)	Yield (kg ha ⁻¹)	Output (10 ⁴ kcal ha ⁻¹)	Input (10 ⁴ kcal ha ⁻¹)	Out/In
<i>Mexico</i>					
Human labour only, no industrial fertilisers	0	1944	690	941	0.73
<i>Mexico</i>					
Human labour, oxen, no industrial fertiliser	0	941	334	460	0.72
<i>USA</i>					
Human labour, horses, industrial fertiliser	152	7000	2450	2670	0.92
<i>USA</i>					
Human labour, machines, industrial fertiliser	152	7000	2450	1150	2.14

expense of the variable operations. For example, to achieve moderate yields it is necessary to adjust the acidity of the soil by liming, but high yields do not require more lime. Similar phenomena hold for other mineral nutrients. This makes many inputs not a variable cost element but a complementary cost element of the decision to grow a crop on a certain place. In this way, the popular notion of variation of inputs in dependence on relative prices, described by continuous partial production functions with diminishing returns, is undermined. This increase of the number of fixed operations at the expense of variable operations also means that the needed amounts can be better controlled in the case of higher yields. Or, to put it in another way: the growth processes near the potential level of production are much better understood and managed than close to the bottom-line, where far too many factors interfere.

For example, the application of energy-rich nitrogen fertiliser is better controlled in situations where the yield is higher because then less unpredictable losses occur by volatilisation, denitrification, leaching and even immobilisation. This is indeed important, as appears from the work of Van der Meer & Van Uum-van Lohuyzen (1986). As shown in Fig. 4, they found that the recovery of industrial fertilisers by grass under zero-grazing increased considerably during the last 15 years because the water supply level is now better controlled and probably also because the quality of the organic matter in the soil has increased.

Viewed over time, the yield of wheat in The Netherlands increased from

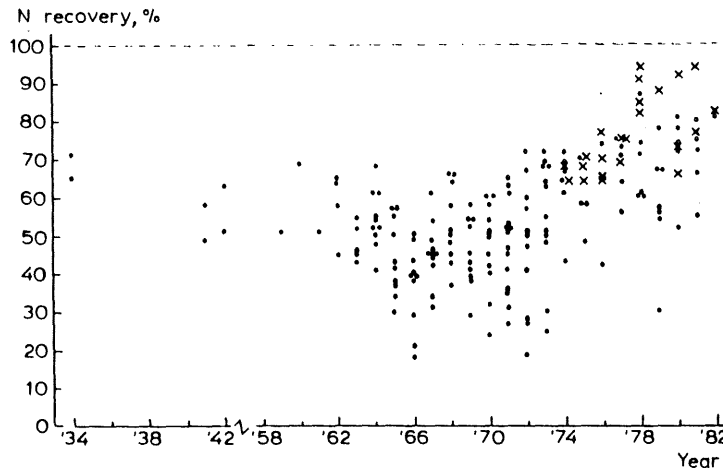


Fig. 4. The recovery of nitrogen fertiliser on grassland under zero-grazing in course of time, according to Van der Meer & Van Ulm van Lohuyzen (1986). (The recovery percentage of nitrogen fertiliser is the increment in the uptake of nitrogen divided by the rate of application of the fertiliser multiplied by 100.)

3500 in 1950 to 5000 kg ha⁻¹ in 1970, whereas the efficiency of the indirect plus direct energy use stayed about the same at 145 kg GJ⁻¹, in spite of the about threefold increase in labour productivity in the same period (De Wit, 1979). Protection against pests and diseases is also a very important prerequisite for high yields. This does not require much energy, but rather the skill and experience to apply appropriate chemical and biological controls. Moreover, in integrated systems of pest control, the limited need for pesticides and fungicides is offset by a decreased need for herbicides in the case of good crop growth. In these integrated systems use of fertilisers and biocides is limited by monitoring the development of crops, pests and diseases and applying appropriate agronomic measures at the appropriate time. This requires well-trained farmers working in close co-operation with support services.

Thus, continuing yield increases until the level that climate, soil, reclamation level and know-how permit leads to a continuing increase of efficiency of all production factors, measured per unit product. The rate of increase of the yield per hectare is therefore not so much determined by economic factors, but by the rate at which new knowledge and insight can be put to use. If it pays to farm a field, it pays more to exploit the technological possibilities to such an extent that the yield potential that is dictated by the existing level of reclamation is approached.

Whether this yield potential should be enhanced by further reclamation is a more complicated problem, because the possibility to increase the productivity of labour and machinery may be as important a consideration.

But also when this is taken into account there are locations where present production potentials and farm prices at the existing level of reclamation and infrastructure are too low to justify further cultivation, whereas at the same time further reclamation and improvement of infrastructure is too costly. These are the marginal soils that, without a policy of support, are bound to lose in a Europe where markets are saturated, prices are under pressure and where there is still considerable leeway for production increases at decreasing economic and ecological costs in regions that are well suited for agriculture.

Some other aspects

Where the primary products are used for livestock farming the situation is analogous. There exists a linear relation between increased production potential of breeds and the increased amount of food that is necessary to realise this potential. At the same time, the maintenance costs of the animal itself and of the mothers that are needed to maintain the herds are hardly influenced by the production potential. Hence the production costs per unit end product decrease with increasing performance of the animals and this the more so because the conversion efficiency is also improving. The rate of increase in production per animal is therefore also not so much determined by prices but by the rate at which new production technologies are developed and implemented.

It can be seen in Table 1 that the energy balance of food crops is positive in the case of high technology farming. Nevertheless, it is not very sensible to use them as a feedstock to produce liquid fuel because the manufacture of alcohol requires, especially in the process of distillation, so much energy that the overall balance is negative. The processing costs are less for oil out of oil-seeds, provided that it is used as such in diesel engines. Cellulose crops like trees and hemp have a positive energy balance because they can be used for heating and underfiring without much further processing. A small wood-fired electricity generator of 100 MW output would need, however, a surface of 40,000 ha of short-rotation trees on excellent land. The area has to be several times larger if the trees are grown on marginal land, as they usually are. This is prohibitively costly. On the other hand, with fast-growing crops of trees, fibres and maybe oil-seeds, a farmer would only need a few hectares to cover his energy needs around the house and thus evade high taxes on energy. But even then, it appears that it is much more profitable in The Netherlands to grow traditional agricultural crops and buy energy in the usual form, which is anyhow much more comfortable to use.

Not only the food processing industries, but also the textile, paper and chemical industries, use large quantities of agricultural products. Apart

from fibres, the main raw materials are cellulose, starch and sugars. Unfortunately, prices are such that, apart from cellulose for the paper industry, further agrification can only be envisaged in Europe when energy prices are much higher than the high prices in 1984. The production of special chemical and pharmaceutical products may have better prospects, but the demand for these does not seem sufficiently large to envisage any appreciable increase in acreage. The same may hold for other highly specialised forms of production, such as seeds and seed potatoes or horticultural products, whether in the open air or in glass-houses.

Agriculture should be responsible for its own continuity and should manage its own affairs in such a way that external effects are minimised. Present agricultural practices are so much geared towards gains in the short term that considerable additional efforts are needed to put its affairs in order.

Water management, and especially drainage, is a key factor to ensure high and stable yields, but it may also have considerable external effects. In some cases, the water-level in surrounding non-agricultural areas is adversely affected, whereas, in other cases, mineral-rich water out of agricultural areas is discharged or seeps into nature reserves that are characterised by their low level of plant nutrients. There are also adverse internal effects of water control and drainage. The need to increase labour productivity too often requires the use of heavy machinery. Its use in late Autumn and early Spring, however, may cause considerable damage to the structure of the soil. This damage may be controlled by deep drainage but this may lead again to water shortage. Hence, short-run economic advantages of increased labour productivity may threaten the continuity of production in the long run. That makes it necessary to strike a balance between the two. Other persistent problems in agriculture are due to the use of too narrow crop rotation schemes, especially for potatoes and sugar beet.

TWO PERSPECTIVES

Against this background of technical possibilities and boundaries two opposite perspectives for agriculture are presented to enable a further discussion of agricultural developments in the European Community. These are perspectives of separation and integration of functions.

Separation of functions

The perspective of separation of functions is based on the idea that agriculture, as well as nature and the environment, are best served by physical separation because then both interests can be served optimally in their own right and with their own means. Overproduction is brought under control

by abolishment of all forms of price supports and market protection. The farmer is not troubled by demands from conservationists and it is possible to create attractive environments without violating agricultural standards. Considerable yield increases are still possible, so that all demands can be met with greater efficiency on a smaller area than at present by a relatively small number of capable farmers and against international competitive prices. Marginal soils are exploited extensively and in such a way that all justifiable demands of nature conservationists are met. External effects like the pollution of water and air are better controlled because of the high efficiency of production, so that it is possible to meet high national and international standards. It is not implied in this perspective that high technology farming in the endowed regions is devoid of any diversity. The cropped areas may be, but this need not apply to boundaries, field divisions, uncropped areas and sides of roads and waterways. There are also excellent examples of nature reserves that were designed and created within the framework of land improvement schemes.

As has been said, the yields continue, then, to increase on all soils that remain in production with an estimated 70 kg grain equivalent $\text{ha}^{-1} \text{ year}^{-1}$ or more and this continuing increase has to be balanced by taking marginal land out of production. At an average yield in the EC of 4000 kg grain equivalent per hectare this amounts to an increase of 1.75% per year. Since marginal soils yield less than the average, about 2.5% of these soils would be forced out of production each year. This amounts to more than 30% of the land up to the year 2000.

Oskam, of the Agricultural University in Wageningen, calculated some other consequences of this market-oriented approach in the dairy sector on behalf of the Policy Oriented Survey of the Future of the WRR (WRR, 1983). He found that the price of milk has to be lowered in the course of some years by some 20% to achieve equilibrium on the EC-dairy market. In The Netherlands this would lead to a decrease of employment of 7000 person-years over and above the 34 000 person-years that would anyhow be lost if the dairy policy of the EC at the beginning of the 'eighties should be continued. These numbers have to be compared to a total employment of 145 000 in the dairy sector. Since other regions in the EC would be less competitive, this market-oriented policy is worth considering from the Dutch point of view.

Within this perspective, the EC has to remain competitive on the international markets. Therefore a development policy remains necessary in the regions that are already agriculturally-endowed to increase the productivity of labour and land by, for instance, land re-allocation and reconstruction. These endowed regions are mainly found in the North-Western part of Europe. There are also regions in Europe, as for instance in Ireland, where

agriculture is as yet underdeveloped, but where limited structural improvements would suffice to change this drastically. This may be so attractive from the national standpoint that some of these possibilities will occur in spite of opposition by conservationists.

The marginal land in Europe forms an excellent starting point for creating ecological refuges and semi-natural reserves, intertwined with areas that are extensively grazed by cattle, sheep and deer and with semi-natural permanent forests with production as one of its functions. It is also suggested that this land could be used for growing agricultural products that are not contributing to the present surplus.

By means of such extensive use of land, hardly any income is generated, so that only a fraction of the present farmers can be gainfully employed on such land. Therefore transitional income subsidies are necessary to support the farmers that are unable to find employment elsewhere because of advanced age or for other reasons. In the long run this does little to keep these marginal areas to such an extent populated that a reasonable infrastructure can be maintained, so that even the weekend-farmer and his family may become discouraged. A full separation of functions is also impossible because there are valuable ecological refuges that can only persist if the countryside is properly farmed. Also nature reserves should not be restricted to marginal soils.

Many of the agriculturally-endowed areas in The Netherlands already have a reasonable infrastructure so that it is doubtful whether the present rate of land improvement of 40 000 ha year⁻¹ should be maintained. The environmental concern in these endowed regions may well focus on the summer grazing of cattle, which contributes substantially to the pollution of the environment with nitrogen compounds out of urine and faeces. This may be brought under control by housing the cattle also during summer and the use of, among other feeds, fresh cut grass as a stable fodder. Proper storage and use of manure, together with the increasing efficiency of nitrogen fertiliser under zero-grazing, may very well reduce the present all-time high fertilisation rate of 400 kg N ha⁻¹ year⁻¹ by at least 50%.

Within this perspective, marginal regions are developing on the light, sandy soils in the Eastern part of The Netherlands. These soils were severely overexploited in the 19th century, but this was redressed by the early introduction of, especially, phosphate fertilisers. Therefore, the small, mixed farms in these regions could survive reasonably well in the first half of this century. However, since World War II, these enterprises proved too small to keep up with the increase of labour productivity in general. This has been the main reason for the transition to intensive livestock farming. These farmers feel themselves now attacked in the rear by the severe but unavoidable measures to control the manure problem. Regional policies to mitigate

the problems should be directed to the creation of employment outside agriculture. However, even under a more promising economic outlook than at present this has proved to be difficult. Another marginal area in the North-Eastern part of The Netherlands consists of worn-out peat soils. There potatoes are often grown every other year, but this requires so many chemicals to control soil-borne diseases that not only flora and fauna are threatened but also the quality of the groundwater.

Integration of functions

The perspective of integration of functions is based on the idea that agriculture, on the one hand, and conservation of nature, on the other, cannot do without each other and that both interests are best served by spatial intertwining and integration of their functions. This perspective was, again on behalf of the Scientific Council (WRR), worked out by a group at the Department for Environmental Biology of Leiden University (1984) under the title of 'Integrated agriculture' (Van der Weijden *et al.*, 1984; Van der Wal *et al.*, 1985). In this perspective, the important role of agriculture within the EC is fully recognised, whereas, at the same time, the societal causes of the problems in agriculture and of the deterioration of nature and the environment are emphasised. It is stated that, in present day agriculture, too much emphasis is put on increasing labour productivity at the expense of the productivity of the soil, energy and other basic resources. At the same time, it is stated that conservationists have held on far too long to the idea of the old cultural landscapes and to the myth that everything was much more beautiful around 1900.

Economically, great importance is attached to the creation of employment opportunities and mitigation of income differences and increased self-sufficiency in Europe. This is also emphasised because economic dependencies on a world scale are not seen as mutually beneficial but lop-sided to the advantage of the economies of the industrialised world. Higher import levies on grain (substitutes) for animal fodder and lower export refunds for agricultural products are envisaged to reduce the burden of the EC budget, to increase self-sufficiency in Europe, to limit (indirect) energy consumption, to encourage re-use of organic waste and to reduce regional overproduction of manure.

It is considered of vital importance to keep labour costs down by reduction of taxes and of social levies on labour, by income subsidies for small farmers or by some negative income tax scheme. The necessary budgetary compensation could be found by extra levies on energy and raw materials. The use of the latter would then be reduced while the use of labour would be encouraged. Things would not go as far as machines being replaced

again by the people they once replaced, but expert work as accurate observation, planning, caring for crops and livestock, etc. would certainly be promoted. Such techniques have been already developed on research institutes and experimental farms, but too many of them gather dust on the shelves because relative prices are what they are. The changes of relative prices that are envisaged should make it feasible again to adapt agricultural practices to small differences in soil and topography, to exploit the advantages of more sophisticated crop rotation schemes, to exploit hedgerows for firewood, to use lighter machines and to farm, in general, with more care. In combination with subsidiary payments, this opens possibilities for the re-introduction of functional natural elements at the farm level.

However important the price mechanism is, it alone cannot solve the problems of overproduction, decreasing employment and threat to the environment through segregation. Therefore, the change of course in the EC policy in the direction of the quota system should be continued. It should then be taken into account that large farmers on good soils have more alternative possibilities to make an income than farmers in marginal areas. Besides providing food and employment opportunities without raping the earth, agriculture has several other functions, such as the creation of attractive landscapes and ecological refuges and the re-use of industrial and domestic waste. These subsidiary functions should be paid for as far as possible as well. In this way renewed attention could be given to the promotion of functional natural elements in the landscape, even to the extent that natural reserves could be seen as a last resort. Payment of subsidiary functions, together with a preferential allotment of quota to farms in marginal areas, should keep farming there a viable enterprise.

Drastic policy measures are needed to promote developments in the desired direction. To assist in their development the Institute for Agricultural Economy (LEI), in co-operation with the Department for Environmental Biology of Leyden University and on behalf of the Scientific Council, developed a linear programming model of the agricultural sector in The Netherlands. This is not a behavioural economic model that claims to predict social and economic changes induced by policy measures, but a tool to investigate possible consequences of mutations in the technical and economic boundary conditions of the agricultural production process.

This model (WRR, 1983; Bakker, 1986) distinguishes twelve agricultural regions, sixteen crops and nine animal husbandry systems that are functionally and spatially intertwined by a transport module. Migration of agricultural labour from one region to another is restricted. The costs per unit product are specified for labour, procurement of services, commercial fertilisers, energy and animal feeds, depreciation of buildings and machines and other capital, except the soil. For the intervention products, levies were

introduced for amounts above the market saturation level, whereas price elasticities were estimated for the EC as a whole for the free market products.

It suffices here to discuss the option of doubling the cost of energy in such a way that this manifests itself also in the prices of all other means of production in proportion to the energy costs of their production. The most important of these are industrial fertilisers and imported concentrates. It appears, then, that the acreage of arable land with wheat, potatoes, maize for silage, and sugar- and fodderbeet would be doubled. These crops are all used for fodder, so that the self-sufficiency becomes almost 100%. There is no importation of concentrates any more. The number of dairy cows is reduced by 20% so that overproduction in this sector would be a thing of the past. All intensive livestock branches are reduced so that there is practically no more overproduction of manure. The use of energy in its direct form is hardly affected, but in its indirect form it is reduced by practically 50%, because of the reduced import of concentrates.

But now the bad news. There would be a considerable loss in employment: 8% in agriculture itself and another 13% in the associated industries. The sector income would be reduced also with 8%. For a fair comparison, it should be taken into account that the present situation cannot be sustained in the long run, so that sometime and somewhere these losses have to be accepted. Also, in this case, the burdens of the policy are again put on the shoulders of the small farmers in marginal regions so that they cannot survive in their profession without preferential treatment. Although the use of fertilisers would be considerably reduced in the economic environment that is envisaged, in case of industrial nitrogen it is still close to 200 kg N ha^{-1} . It may be that adapted techniques could reduce this amount still further, but it will remain considerably above 100 kg N ha^{-1} and this is still far too high to enable reconciliation with the demands of conservationists.

At present, energy is not considered such a scarce commodity that products are likely to be taxed according to their added energy values and certainly not at the level that is assumed here. But less drastic steps appear not to control the overproduction of agricultural products and manure, so that strong environmental measures and quotas appear indispensable within this perspective of integration of functions.

MARKET ORIENTATION AND SOLIDARITY

The most pressing problem for the EC is the rising costs of the common agricultural policy which threatens to crowd out any other activity of this organisation. In order to keep the problems within bounds, a budget ceiling

has been set, the intervention prices are being constrained, or even decreased, and a super-levy on milk has been introduced. The latter is a system of allotment of production. Up to 1984, these were only operative in one form or another for sugar beet, wine and olives. For wheat, mechanisms of 'co-responsibility' are being considered. These would require wheat growers to contribute financially to the costs of export. This relieves the EC budget, but does little to constrain the increase of production. Payment according to quality is also contemplated. In practice, this is a disguised form of price reduction, since the climate in North-West Europe does not favour the growth of wheat that is suitable for baking high quality bread. Protection of European agriculture by a considerable increase of import duties on imported (substitutes) and vegetable oils and fats is advocated in France, but it is in general presumed that this would put the EC into a collision course with the USA and other exporters of these agricultural products. The decrease of intervention prices is in accordance with the perspective of separation of functions and the extension of quota systems much more in accordance with the perspective of integration of functions.

Such a mix of instruments is at present necessary to execute an incremental policy that needs by now the support of twelve Western European governments who have different interests to serve and operate out of different ideologies. However, incremental changes may also eventually lead to a consistent common agricultural policy. Such a policy has to serve three central aims to be workable and acceptable by all member states. These are:

- the maintenance of a balance between production and demand
- the mitigation of geographical differences in incomes and possibilities for development
- the continuity of agriculture in the marginal regions to maintain the integrity of the landscape and the natural environment

As has been explained, a simple policy of price decrease would lead to the containment of production by the abandonment of land in marginal regions. This is politically unacceptable and would force the countries with considerable areas of marginal land to a renationalisation of their agricultural policy. Because there is no other option than further integration for the industrial policy of the European Community, this would lead to an unacceptable isolation of the agricultural sector. Moreover, the member states would outbid each other as undersellers on the international markets and this would help nobody.

Extension of the system of production allotment seems more attractive because it requires, for the time being, only a gradual adaptation of the historical policies. In the long run, however, this system does not function, either. Production allotments do not prevent the production increase per

unit area, so that the allotted quantities are going to be cultivated on less and less land. The remaining acreage then becomes available for non-restricted crops. Because these are also grown most economically in the central regions, this leads, with some delay, to a situation where marginal lands are being deserted in spite of the allotments that are granted. Important economic, social and environmental goals are therefore not attained by this policy. Another important argument against a permanent system of production allotments is that it can be executed only by national governments and leads therefore also to a renationalisation of the agricultural policy.

Both the policy of production allotments and the policy of price decrease may bring about a balance of production and demand, but neither permanently serves the aims of mitigating geographical differences and maintaining the continuity of agriculture in marginal regions. To serve these aims, structural measures are needed that require a transfer of public money from the better-endowed regions to the outlying and marginal regions of the Community. The main burden for adjustment of production and demand is then shifted to these better-endowed regions. And that is how it ought to be because these regions are situated at the centres of economic activity in Europe, profit the most from the common market and are better suited to technical adaptation and change.

These arguments support a common agricultural policy that is, in comparison with recent proposals of the EC Commission (1985), characterised by more market orientation in the central regions on the one hand and more support for the marginal regions on the other. Such a policy has been worked out in the advice of the Scientific Council (WRR) to the Dutch Government and is presented here only in broad outline with emphasis on technical and environmental aspects. This is done by discussing first the policy measures that are envisaged for the less-favoured regions, then those for the better-endowed regions and then the problems of change that are invoked by these measures.

The less-favoured areas

The less-favoured areas of the nine member states in the EC are found in NW Ireland, throughout Scotland, the North-east of Wales, in SE Germany, around Luxembourg, in France in the Vosges, the Central Massif, the Pyrenees, the Jura and the Alps, and in Italy along its central axis. There are also large areas in the newly admitted states of Greece, Spain and Portugal and, of course, many more smaller pockets throughout all EC countries.

The problems in these regions are not new and in the 1985 Green Paper

of the Commission of the EC several basic types of aid-systems are discussed: pre-pension schemes, schemes with a structural policy element or with a social orientation and buying-out schemes with environmental objectives. Pre-pension schemes and other schemes with a social orientation are only a last resort for individual farmers and their households. Although necessary to avoid intolerable social pressures, in view of the problems that are coming up, they are incomplete in the structural sense.

The basic idea behind the structural schemes of the Green Paper is that there are also, in marginal regions, farms which made important investment efforts in the past and could be fully viable in the future, but they will meet economic difficulties for some time in the case of a strict price policy. These farms could be aided by temporary support in the form of a flat-rate allowance per unit of production, depending on circumstances. The more successful such a scheme is, the larger the problems are going to be in the central regions, but a better distribution of productive capacities may be worth this price.

The opposite of these structural schemes are buying-out schemes. The land will then often be made available to public organisations for the creation of ecological refuges, semi-natural reserves, leisure parks and afforestation. The need for refuges, reserves and leisure parks is limited and afforestation schemes require large initial investments which may bear some fruit only in the long run, although this does not seem likely on marginal land. These types of land-use do not create much work, but at places the tourist trade may be stimulated. Extensive pastoral use has also the disadvantage that little labour income is created. Along with forestry, it seems therefore only an attractive occupation for weekend-farmers or farm families which have other sources of income. Their number is on the increase, especially in regions such as South-East Germany with a rather dispersed and foot-loose industry.

To ease the surplus burden, it should be further investigated how the farmer can be enticed to grow agricultural crops that are not contributing to this surplus. Possible candidates are oil and protein crops, but, because of the absence of external protection, price support for these crops could also become a heavy burden on the EC budget. Other candidates are fruit crops, but apart from nuts, most of the demand in the EC is already satisfied. Hemp, Jerusalem artichoke (Topinambour), field-grown vegetables and pharmaceutical crops are also mentioned. But it is often little realised that soils that are marginal for surplus crops are, in general, also marginal for other crops. This is even more so for crops that produce raw materials for industry, since these require high yields per unit area to make the bulk-handling worthwhile.

There is a market for special products that distinguish themselves for all

practical purposes from similar products only by either their origin or the way they are grown. Their lack of distinguishing measurable properties means that both farmers and consumers have to be protected against malpractices. Examples include wine, meat, eggs, cheese and all kinds of 'natural' foods. These latter products are especially attractive because it is, by definition, impossible to grow them in a high technology environment. Unfortunately, they are relatively expensive to produce and cater, therefore, only to the limited demand of some of the affluent.

Obviously, there are no general solutions that enable the formulation of a centralised EC support scheme for the cultivation of crops in marginal areas that do not contribute to the surplus. On the other hand, there are so many suggestions and so many different social, economic and environmental conditions that all possibilities cannot be identified and reviewed by one central authority. Therefore, ways and means should be found to support initiatives at the regional level out of the EC budget. Apart from direct financial support in the form of deficiency payments for specific acreage use, one may consider more indirect supports in the form of research and extension and the development of producers' associations, market organisations and transport facilities.

Damage to the natural environment is intrinsic to productive farming. This being said, it is generally agreed that continued farming of traditional farming country is a necessary condition to maintain its environmental value. Some conservationists believe that a prosperous rural life is even a sufficient condition, but too many examples show that this is overly optimistic. Hence, there are good reasons for directing public support to marginal regions in such a way that environmental goals are served as well. The limited experience in The Netherlands with the 'Relations Act' could be of use here. This law was introduced in the 'seventies to achieve eventually a situation where 5% of the land is farmed in such a manner that environmental goals are also served. In most schemes of this kind, the farmer is paid for the execution of measures that are supposed to maintain the landscape and the ecological refuge functions of the farm. These directives often push the farmer in the direction of traditional farming systems, because these are supposed to be friendly to the environment. This may have been the case in the past, but so many irreversible changes have occurred, even in marginal areas, that this is not necessarily so at present. Some regions have been affected by drainage, some by enrichment with minerals and all of them are affected by the consequences of air pollution. And even if traditional methods are friendly to the environment, they may be very unfriendly to the farmer who has to execute this often heavy and tedious work.

Another approach which is much more in line with the ideas of integrated

agriculture is to define and quantify the ultimate aims that are envisaged and to remunerate the farmer according to his success in reaching them. If hedgerows or hill pastures are worthy elements in the landscape and worthy ecological refuges, it is reasonable to pay the farmer according to quantity and quality. If diversity is a worthy ecological goal, why should the farmer not be paid for the number of species or habitats he is able to create? The 'Relations Act' and the compensation payments in the EC program for hill farming may be bent in this direction and in Great Britain there are promising examples of multiple-purpose farms.

It may be going too far to pay the farmer for not contaminating the aquifer he is living on with nitrate or his surroundings with biocides. But, to deal with a prohibition on the use of agricultural chemicals that is difficult to enforce and therefore problematic, it would be far more challenging to develop farm management systems that fine-tune their use and to put these at the disposal of farmers with the necessary expert help. There are good examples of such management systems, but the development of them should not be restricted to applications in the central agricultural regions.

The various measures that have been discussed here may mitigate the problems of the marginal regions that are created by a more market-oriented policy, but do not eliminate them. Before concluding, therefore, that this more market-oriented policy will be politically unacceptable, it should be realised that the economic function of agriculture in these regions is, in any case, rapidly eroding. The central problem is summarised in the fact that 30% of the workers in these marginal regions are agriculturally engaged, whereas, in the more favoured regions, this is less than 10%. Any policy that is directed at maintaining the present production structure and employment in agriculture leads towards the creation and maintenance of agricultural production surpluses, for which the economic prospects are weak, because they depend on the lasting willingness of the more prosperous regions of the EC to finance such a policy. It is therefore necessary to consider the problems of these marginal regions in a wider context by aiming at a social and economic structure that can replace the agricultural structure to a large extent. Programs for improvement of the infrastructure to bring in industries and services, for the regional creation of non-farm jobs, for education and for the promotion of mobility, are then more likely avenues to alleviate the threatening problems. These are the first responsibility of the national governments; but, within the framework of its industrial policy, the EC has to accept its share of the burden. Attempts by the European Community to solve the problem of the outlying and marginal regions only within the framework of its agricultural and social policy are bound to fail.

The better-endowed regions

The better-endowed agricultural regions in the EC are mainly found in Denmark, The Netherlands and Flanders, the East of England, the North-West and middle of Germany, the Basin of Paris and further down south in the valley of the Po and other rivers and then scattered throughout the continent in relatively small pockets. There are also regions where agriculture is not developed, but where, by means of relatively simple ameliorations, large gains in productivity may be achieved. These areas are mainly found in the south and middle of Ireland, in the south of England, in Schleswig-Holstein, and in the north of Greece and Spain.

Since the production decrease in the marginal regions is mitigated, a considerable reduction of the production in these central regions is needed to reach a situation where exports are so much reduced that the EC budget is not overburdened. This may be achieved by a gradual, but considerable, reduction in intervention prices. Such price decreases will place farmers incomes under considerable pressure, but this can be justified with the argument that these prices are mainly adapted to the costs that are incurred on smaller farms in more marginal situations. This pressure on income leads in due course to a drastic reduction of the price and the rent of the land. This clears the way for the other land uses that are necessary to achieve a better market equilibrium. Since the production per unit area in these central regions is about double the production in marginal regions, the area that is involved is about half. But even then it may concern around 15% of the present cultivated area in the year 2000.

Some of the soils may become sufficiently cheap to be planted by trees. These grow here much better than in the marginal regions where they are planted too often at present. These forests could well be combined with leisure parks that are also better situated in these central regions than in the more outlying marginal areas. In view of the positive experiences with creating new natural reserves on good agricultural land, part of the soils will also be used for this purpose. The number and kind of ecological refuges will also increase by a more liberal use of roads and other ligulate elements in the landscape for this purpose and field divisions, odd corners and ditch borders on the farm. In this way the trend towards further ecological desertification may be turned down. There is no reason to restrict the ideas of integrating agricultural and environmental functions to marginal regions. However, the trend to larger farm enterprises and to less employment in agriculture will intensify, as was shown for the dairy sector in the treatment of the perspective of separation of functions. This increase in farm size is environmentally acceptable, because there is no evidence for the

popular notion that small-sized farms are particularly friendly for the environment.

At the crop level integration of agronomic measures is needed to achieve high efficiency in the use of labour, biocide and energy. At the farm-level more possibilities for a wider crop rotation and co-operation between farms should be created to minimise negative effects of intensification and specialisation, and to diversify production. At regional, national and super-national levels measures should be taken that stimulate the farmers to engage in such activities.

The necessary decrease of the production potential does not lead to abandonment of soils and to permanently barren fields but to various types of fallowing. Otherwise, situations would be created where it is impossible to maintain the acreage of profitable crops like potatoes, sugar beet and onions and to meet, at the same time, important crop rotational demands. At least in The Netherlands this problem should not be underestimated. The present narrow rotations here give so many problems with pests and diseases that the use of biocides exceeds the carrying capacity of the environment. Fallows have to be cultivated anyhow with green manures to avoid erosion, to maintain soil structure and to control the growth of weeds. But it is then a small step to experiment with other crops, be it only to cut costs as far as possible. Energy out of biomass for use on the farm may then be worth considering because then the taxes on the regular supply are avoided. Animal fodders, protein crops like peas and beans and oil-seeds as far as they fit into the crop rotation, and perhaps industrial crops, are other candidates, as has already been suggested. This development will make it still more difficult to grow these crops competitively in marginal regions.

Problems of change

It will probably remain a central aim of the common market to prevent the exposure of the European farmer to the caprices of the prices on the world-market, so that, in a more market-oriented approach, a system of import levies and export subsidies also has to be maintained at the border of the European Community. If this is done at price levels that both balance each other on the average, a viable agriculture is maintained in the European Community while the budget is maintained under control. Nevertheless, this means a considerable reduction of the price of the supported commodities. To ensure that the farmers in the central regions can adapt to this new situation and that the policy measures that are needed for the marginal regions can be implemented, these price decreases have to be extended over a period of at least 10 years. Such a gradual decrease means, however, that

the present schemes of production allotments such as the quota for sugar and the super-levy on milk have to be continued for some time and a solution has to be found to control the increasing overproduction of wheat. In the case of milk, a gradual decrease of both the quota and the intervention prices may pave the way to replace the super-levy system after a few years by a temporary income support with a social orientation. In the case of small grains in general and wheat in particular, the transition to lower prices may be sufficiently cushioned by means of some co-responsibility levy. By restricting this levy to actual sellers, the establishment of mixed farm enterprises in the central regions could be stimulated. This would be at the expense of the more marginal regions where the livestock enterprises are now situated, but there are good environmental reasons to justify this. Another possibility, inspired by American set-aside schemes, is to reduce the height of the co-responsibility levy to the extent that the farmer is fallowing his land.

It should also be realised that any policy of adapting the supply better to the demand can be frustrated by further reclamation and land improvement schemes that are prompted by national interests. Where these projects are wholly or partly financed by the national governments, they should be reported to the EC Commission, which could then control the plans in accordance with its own policy. This would be a radical shift from the present situation, where national governments act on their own discretion. For other sectors of the economy, however, the member states are not permitted to take actions that distort the competition among them and there are no valid arguments to treat the agricultural sector in any different way. It does not seem likely that the EC Commission would look kindly upon reclamation of the last Zuyderzee polder in The Netherlands out of public funds, if this would lead to a substantial increase of the acreage of agricultural land. This holds also for continuation of drainage plans in France. Because of equity reasons, publicly supported improvement schemes may be permitted in the new EC-countries and in Ireland which also joined the EC too late to develop its potential sufficiently. This remedy would be worse than underdevelopment, if it should lead to farm enterprises that are not viable at the lower prices that are envisaged.

As for marginal regions, initiatives to adapt agriculture to new circumstances and demands can only be generated locally, because the social, economic and environmental conditions are far too diverse for central planning and action. This gives national governments the opportunity to meet genuine political demands for regional autonomy which are manifested in all member countries. The EC can then intertwine its financial support with those of the national governments, provided that the planned activities strengthen the development of the marginal regions in the desired direction.

The separate discussion of less favoured and better-endowed regions may suggest the existence of transition zones which require their own policies. This is not the case, because there is a gradual change in the policy measures that are suggested for both regions. Apart from objective differences, the prices are the same throughout the EC and the control of the EC Commission on structural improvements also holds for all regions. The only difference is that if a region is better endowed, less EC funds will be used for development supports, environmental enumerations, industrialisation and social measures.

A problem that deserves some separate consideration is the financing of the measures that are needed in the marginal regions to enable a more market-oriented policy in the European Community as a whole. At the moment, the agricultural producers in the marginal regions are still able to make some living, because of the existence of a hidden support via artificially high prices. This involves roughly the following amount. The acreage of marginal agricultural land in the EC may be set at 30%, but its production is so low that this acreage does not contribute more than 10% of the value of the agricultural production (Meester & Strijker, 1985). Estimating the price reduction, on average, at 15% in the case of a more market-oriented policy, the hidden transfer of income amounts to 1.5% of the total production value. This is very small compared with the 15% of the total production value that is at present needed to keep the common agricultural policy afloat and that would be partially set free by a more market-oriented policy. The tenfold difference between these two amounts illustrates how much of the present budget is drained away by measures that are needed to eliminate overproduction and how little this contributes to the improvement of living standards in the marginal regions of Europe.

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