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LAND USE, ECONOMY AND ECOLOGY
NEEDS AND PROSPECTS
FOR A CO-EVOLUTIONARY DEVELOPMENT

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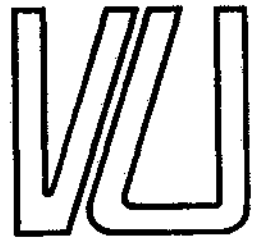

VRIJE UNIVERSITEIT
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LAND USE, ECONOMY AND ECOLOGY:

NEEDS AND PROSPECTS

FOR A CO-EVOLUTIONARY DEVELOPMENT

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1. Prologue

Since the beginning of the 1970s the actual and potential conflicts between the economic system (including production, consumption and technology) and the environment (including both natural and man-made elements) have become a subject matter of intensive research in both the developed and the developing world. And in many countries environmental pollution (notably air pollution, water pollution and noise annoyance) has been coped with fairly successfully. Abatement policies, however, have mostly been oriented towards pollution problems of a concrete - often local or regional - nature, witness the great many regulations that have been edicted in the field of industrial pollution, sewage and the like.

In the past decade our world has been confronted with some striking new phenomena in the interlinkage between the environment and socio-economic activities. One of those is the globalization of environmental impacts. Another is the regionalisation of often hardly visible but quite substantial discrepancies in the utilisation of environmental resources. The global impacts of environmental pollution reflected inter alia in ozonisation, desertification, deforestation and acid rain have come as scientific surprises and are up till now hardly managed in actual policy-making. However, especially since the publication of the report of the Brundtland Commission (1987) an increase of interest in global environmental problems has taken place. In this context the notion of sustainability has become a key concept in prospective global thinking.

In the second place, the great many small-scale and marginal changes that take place with clear regional dimensions have to be mentioned. All these incremental phenomena which look hardly relevant by themselves but have severe environmental impact lead to the need for more coherent planning. In this respect land use becomes nowadays a focal point in the attention of policy-makers and researchers. In many countries, the landscape is to a large extent governed by agricultural land use. Not less than 55 percent of European land use is directly related to agricultural activities (exclusive forestry). However, for the next decades substantal shifts in agricultural land use are expected.

Agriculture has traditionally played a fairly stabilizing role in environmental and land use systems, but since the severe competition and modern technologies have entered this primary sector, land use in many

countries is exhibiting gradually and persistently a 'creeping' pollution, which forms a sharp contrast with an ecologically sustainable economic development. For these reasons, an increasing number of researchers is interested in this form of land use.

In the light of the previous observations, the question is increasingly raised whether in the field of land use a co-evolutionary development of economic conditions and environmental qualities is a feasible option (cf. Norgaard, 1984). Such a co-evolutionary development would imply a simultaneous (and preferably parallel) improvement of both the economic system and the environmental system (or, if one would like to adopt Pareto's principle: a co-evolutionary development would imply an improvement in one of the two systems without affecting the remaining one). Thus co-evolution takes for granted a balance between economic development (all quantitative and qualitative changes in the economy that lead to a positive contribution to welfare) and ecological sustainability (all quantitative and qualitative environmental strategies that serve to improve the quality of an eco-system and have also a positive impact on welfare).

It is noteworthy that the concept of welfare has to be understood here in a broad sense as the (individual or collective) utility derived from the availability or use of scarce commodities, no matter whether such utility attributes can be measured in monetary terms or not (the so-called formal welfare concept; see also Nijkamp and Soeteman, 1988). Consequently, also toxic materials, ionizing radiation, beauty of landscape, traffic safety, wholesome food or availability of shelter may be regarded as arguments of a welfare function.

For instance, in the framework of agricultural land use, the welfare gains from agriculture should not only be measured by income (or production) generated in the agricultural sector, but should also incorporate negative (often non-monetary) impacts on landscape, species diversity or eco-stability (see also Dahlberg, 1986). Clearly, various changes in land use patterns may be due to factors outside the realm of the agricultural system itself (e.g., climatic factors).

The fact that both conventional economic factors and environmental goods may contribute to welfare and also have to be traded off against each other, does of course not imply that as an extreme case one of the two systems might be completely extinguished. Both economic and environmental systems need a certain minimum achievement level (or threshold value) in order to survive. For instance, Ciriacy-Wantrup (1952, p. 253) several decades ago already advocated the use of a minimum bequest value

in strategic environmental policies, in particular the establishment of safe minimum standards of conservation by avoiding critical zones brought on by human activities which make it uneconomical to halt and to reverse depletion. Thus the idea of a co-evolutionary development needs a careful consideration of sustainable threshold levels for both the economic and the environmental system.

In the remaining part of the paper we will examine which new developments may be threatening for a co-evolution of the economy and the ecology in the context of European land use. Special attention will be given here to the agricultural policy of the European Community. Next, we will identify the research needs which have to be fulfilled in order to support and to ensure the idea of an ecologically sustainable agricultural development and land use. In this context we will draw up an extensive research agenda for the scientific community (and their sponsors) in this field.

2. Threats to a Co-evolutionary Development

It would be a mistake to believe that only modern agriculture is detrimental to environmental quality. For instance, the Greek philosopher Plato already complains in his Critias about the landscape changes in Attica which had turned the environment into "...bones of a wasted body....richer and softer parts of the soil having fallen away, and the mere skeleton being left" (cited in Clark, 1986, p. 8). But also in other European countries (e.g. Italy, Spain, England, the Netherlands) soil erosion, as a result of agricultural and forestry activities, has affected the landscape in all time periods between nomadic cultures and modern high-tech agriculture (see Wilkinson, 1973). In spite of a high degree of resilience of environmental systems in general, the absorptive (or carrying) capacity of landscapes (and their related environmental conditions) has been insufficient to stand the changes in agriculture. Nevertheless, until World War II the land use implications of agriculture were relatively modest compared to the postwar dynamics. Postwar agriculture has not only become an industrial activity in many countries, but is even increasingly becoming an automated and informatics driven high-tech sector. This development is also induced by the strong competition at the European level. And consequently, land use is rapidly becoming a focal point of environmental-economic research.

This new position of land use as issue of scientific research is different from that in the past. Apart from the period of physiocrats, when the productive capacity of the natural environment (mainly land) was regarded as the major source of welfare, other periods of history of economic thinking have paid less attention to land as an important production factor. For instance, in classical economics capital and labour, in addition to land, were regarded as the main welfare generators. Furthermore, the classical economists assigned only a minor role to the government being an institution for establishing the framework within which market decisions had to be taken. It is interesting to note that also the classical economists were aware of the possibility of a stagnating economy caused by lack of natural resources.

As a consequence of neo-classical thinking, it was taken for granted in the post-war period that nature is not the source of welfare, but only the welfare constituents produced by labour, capital and land. Clearly, land has not become irrelevant, witness also the following quotation of Randall and Castle (1985, p. 573): "...there seemed no reason to accord land any special treatment that would suggest its role is quite distinct from that of the other factors. Land could safely be subsumed under the broader aggregate of capital,..."

After the neglect of environmental factor in Keynesian economics, we are now facing a situation where the externalities and limits to growth (with regard to both renewable and non-renewable resources) have become a focal point of economic research. The major question is, however, how to avoid a 'tragedy of the commons' (Hardin, 1968) in view of the long-term threats exerted by the (seemingly) inevitable and persistent changes in agricultural land use.

In order to obtain a solid analytical framework for a further investigation of land use developments and for the design of a meaningful research agenda, we will introduce here two concepts, viz. <u>environmental potential</u> and <u>utilisation impact</u>. Environmental potential refers to the ability of environmental systems (including land use) to provide a positive contribution to socio-economic development (and hence to welfare) without affecting environmental goods (or attributes) that would negatively influence ecological sustainability. The notion of utilisation impact describes all changes exerted by the socio-economic systems upon the environmental potential (i.e., the extent to which production and/or consumption affect ecological sustainability). See also figure 1.

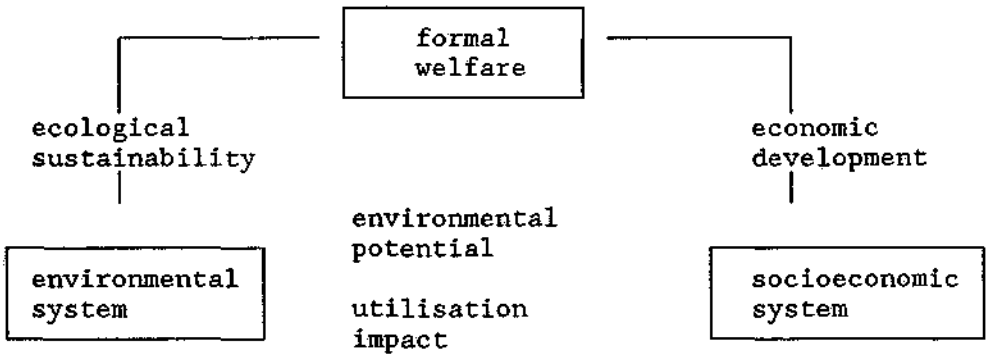

Figure 1. The interaction between potential, impact, sustainability and development

It is evident that in the long run environmental potential and utilisation impact are mutually interwoven phenomena. For instance, a high level of environmental potential is often accompanied by a low level of utilisation impact, and vice versa. It is also noteworthy that environmental potential is essentially a production factor, although it may sometimes be an unpaid factor.

The results of the trade-off between economic development and ecological sustainability are strongly influenced by the existence of (dynamic) boundary conditions within which a co-evolutionary development has to take place. Examples of such conditions are physical limits (e.g., soil condition, climatic or physiographic factors, social limits (e.g., educational systems, cultural attitudes, etc.), technological limits (e.g., genetic manipulation, automated milk control), and economic limits (e.g., market structure).

It is evident that especially at a local or regional scale the possibilities of conflicts between environmental potential and utilisation impacts become manifest, and it is at this level where long-term strategic insights into feasible policy directions are lacking.

Furthermore, it should be noted that from a geographical viewpoint a significant spatial difference may exist between environmental potential and utilisation impact. For example, the regional potential for the production of tapiocca in Thailand leads in Dutch agriculture to an intensive utilisation impact for cattle breeding due to tapiocca imports from Thailand. In other words, the indirect land use of Dutch agriculture is drastically exceeding its current land use in the Netherlands (implying essentially an externalisation of agricultural land use). This observation explains also to some extent that labour productivity and

soil productivity are respectively a factor 3 and 4 higher than the average European level! It is illustrative in this context that the Netherlands is able to generate at a much smaller area almost the same production value as Germany or Great Britain. The rationalisation of Dutch agriculture and its transformation into a high-tech sector can also be illustrated by taking a look at the following figures: on the one hand, a strong and persistent structural decline in agricultural employment, a (slight) reduction in land for agricultural use, and a strong decline in the number of production units (e.g. farms), and on the other hand a rapid growth in agricultural production and agricultural exports. The strong position of Dutch agriculture is to a large extent also due to the dominant place of the Dutch food and livestock industry, which uses approx. 60 percent of Dutch agricultural production (the food and livestock industry delivers in turn 14 percent of its production to agriculture).

Various key forces are of decisive importance for the strong (national and international) position of the Dutch agricultural and food and livestock industry: the advanced organisation of research, education and information, the know how in the area of marketing and logistics, the advanced agricultural technology, the favourable natural circumstances and geographical location, and the high societal and political support for the agricultural sector.

Given the saturation tendencies at the demand side and the ongoing productivity size, it is foreseeable that in the near future agricultural land will be taken out of current productive use. Tentative estimates for the Netherlands for the next 20 years amount even to approx. 25 percent of agricultural land, which might be given an other destination. This might no doubt lead to a revolutionary change in Dutch agricultural land use, but very much will depend on the agricultural policy at the level of the European Community. Therefore, we will briefly describe some elements of the Community policy and tendencies in the field of agriculture. This Community policy aims at the following objectives:

- increase in agricultural productivity;
- maintenance of agricultural income at an acceptable level;
- stabilisation of markets for agricultural products;
- safeguarding of the supply of agricultural goods;
- ensuring a reasonable price level for consumers.

It is noteworthy that environmental objectives are not explicitly mentioned in the agricultural policy of the Common Market. So it seems

that (rather limited) internal problems in the agricultural sector are regarded as far more important than the above mentioned sustainability issues. Thus it is clear that at the present level of Community policies a co-evolutionary development of land use, economy and ecology do not score very high. Despite the political shortsightedness in Brussels, it is a favourable circumstance that in individual countries agricultural policy is increasingly oriented toward environmental management. For instance, in the Netherlands the insight has grown that agriculture, for its own sake and survival, is dependent on ecological sustainability, so that agricultural has to take full account of environmental considerations. The European Community, however, seems to be more preoccupied with the economics of overproduction generated by its own subsidy policy than with the ecology of overproduction.

In general, the following four key forces may be expected to play a key role for environmental quality in the context of agricultural land use: scale increase and concentration of agricultural production units, modernisation and intensification (caused by modern technology), uniformity trends (clearly exemplified by agribusiness complexes), and emancipation (leading to a recognition of the agricultural sector as a modern advanced industry). Clearly, these key forces have severe environmental impacts, such as lack of diversity in landscapes, soil degradation (e.g., erosion, exhaustion), and degradation of water quality.

Thus it is clear that in a modern agricultural sector various intensive conflicts may emerge between environmental potential and utilisation impact, a situation which may be reinforced by the current Community policies. Therefore, it may be interesting to have a brief closer look at these policies. In general, three types of agricultural policy may be distinguished, viz. a market conformity, a quote system and area management.

A policy of market conformity has one clear advantage: it takes away the current budgetary problems of the Community by favouring competition (instead of protection) in agriculture. As a consequence, the price level of various agricultural products would fall and, especially in an open market after the year 1992, various marginal and sub-marginal agricultural activities would be bound to vanish. However, it is not entirely certain whether such a policy would be favourable from an environmental viewpoint. Some land might be taken out of production (which may seemingly be beneficial for the environment), but as long as no insight into alternative uses of vacant land does exist, it is difficult

to conclude a priori that this policy is environment-friendly. In addition, the land kept in production might even be cultivated in a more intensive manner, so that again the environmental impacts may be dubious. Thus a balance between ecological sustainability and market conformity is by no means guaranteed.

The second policy option of a quota system is not always favouring efficiency, although a strict quota system may make various agricultural areas redundant. The remaining production units, however, will try to minimize costs within the quota's set, so that a more intensive agricultural use of the remaining land is foreseeable. Unless compensatory measures for the protection of environmental quality would be taken, a quota system is not a priori favouring a co-evolutionary development. It has to be added, however, that in the mean time in a country like the Netherlands various policy measures are considered that do ensure a better ecological sustainability of redundant agricultural areas.

Finally, a policy of area management may serve to control both overproduction and to stimulate environment-friendly agriculture. Area management would require a broader set than just purely agricultural objectives, inter alia also recreational and environmental objectives. But then area management might for instance imply that certain designated areas are earmarked for alternative uses, e.g. conventional agriculture, recreation, nature parks, etc. However, it is also clear that unless area management would also apply to agricultural land kept in use, the same disadvantages as sketched above might emerge, so that again a balance between environmental potential and utilisation impact is not a priori ensured. Nevertheless, up till now only a few experiments in this field have been undertaken, so that further analysis of foreseeable consequences is no doubt warranted.

The conclusion may be drawn that the three above mentioned policy options offer interesting possibilities for a co-evolutionary development, but that so far a definite answer cannot yet be given at the European scene. This also leads us to the necessity to formulate relevant research community. This will be done in section 4. However, in section 3 we will first deal with environmental impacts of agricultural land use as seen from the eyes of a micro decision-maker who as a farmer has to take complicated decisions with far reaching consequences in an

uncertain environment. This approach will be stylized here by developing three scenario-type of reflections.

3. A Microscopic View on the Perspectives and Behaviour of Farmers

In the previous section we have adopted a macroscopic view on agricultural land use, ecological sustainability and production efficiency, seen from the perspective of anonymous market forces or abstract environmental interests. In the present section we will pay more specific attention to the motives and perspectives of farmers, who are in fact at the micro level the carriers of the ideas and motives described above. However, their individual decisions are strongly co-determined by competitive forces, changes in megatrends, and public policies. Thus the final outcome of their decision process rests on an interplay between micro priorities and external key forces. In order to analyse some possible outcomes of this process and also to formulate (the basis for) relevant research questions in this field, we will use here a stylized typology of farmers which we present here as scenario-type of exercises.

The following 3 types of farmers will respectively be treated: the ecological farmer, the traditional farmer and the modern farmer. Each of these farmers is supposed to have different perceptions and views regarding his agricultural activities and the impacts of external forces. In light of these views and perceptions, each of these farmers is supposed to take decisions regarding land use, production and area management. In the next sub-subsections an 'ideal-typical' description of these farmers will be given.

3.1. The ecological farmer

The ecological farmer places harmony with the ecology central, in other words: he is a typical representative of a co-evolutionary development who has deliberately chosen for ecological sustainability of agricultural land use.

The ecological farmer does in principle not use capital intensive or raw materials intensive production technologies and avoids the use of pesticides and related environment-unfriendly toxic materials. His agricultural management is based on a relatively low input utilisation (except for labour) and hence relatively low costs. The revenues emerging from environment-friendly goods produced for special market segments

are relatively high. Besides, subsidies for nature conservation and landscape manuscript form an additional source of income for the ecological farmer. Since harmony with nature is a central objective for this farmer, he tries to minimize the damage to landscape and the ecological environment. Hence space-extensive and integrated farming modes are logical consequences, which may additionally be justified because of their foreseeable favourable impact on overproduction. Market distortions (in the form of, sometimes hidden, subsidies) form a contrast with ecological sustainability. The ecological farmer is more in favour of a strict environmental policy (reflected inter. alia in a strict application of the 'polluter pays' principle). But if a market regulation would have to take place, then he would prefer a quota system to a market conform system or a system of area management. Market conformity would imply more price competition which might make ecological farming almost prohibitive, as prices of modern farming, in contrast to those of ecological farming, do usually not incorporate ecological externalities. Area management is not a meaningful option either, as his space-extensive way of farming means already a high claim on scarce land.

3.2. The traditional farmer

The traditional farmer represents the standard agricultural style of farming. Up to certain limits he is prepared to use pesticides, but his production mode is still relatively capital-extensive. He may be regarded as an intermediate entrepreneus between the ecological and the modern high-tech farmer. However, he is unable to gain the sustainable production mode of ecological farming and the large-scale and specialized mass production of modern farming. Although the conventional farmer may share various objectives the ecological farmer, his motives and reaction pattern may be different. His major concern is with the overproduction, as this may affect his income directly or indirectly. His supply has a low price elasticity, as his production level is strongly linked to the prevailing production system and the technology and social pattern adopted within this system (e.g., a dislike of loans). In this perception, a more market-oriented development would not lead to a decline in production, given the above mentioned inertia. The same applies to a policy of area management which might imply an alienation from his traditional land and which might bring his income below a subsistence level. Consequently, he is more in favour of a selective quota

system, as this is the only way to protect him against price competion of his modern fellow-farmers. In contrast to an ecological farmer, who will be induced to seek for extensification of agriculture land (in view of his environmental objective), the traditional one may also consider intensification of agriculture in order to cope with competition of modern farmers.

3.3. The modern farmer

The modern farmer is characterized by a high-tech, capital intensive production system, which is comparable with a modern enterprise. Consequently, a high rate of input, a high productivity, mass production and relatively low prices are the main features. Negative aspects are the relatively uniform but never exceptionally high quality of these goods and the high social (i.e., environmental) costs involved. In this high tech regime a quota system would exert a negative impact on the production efficiency, although a quota system might force him to make a transition toward an extremely land intensive production system (in order to benefit from scale economies). However, a modern farmer would prefer a system of market conformity, as this provides him with a maximum potential for a technologically advanced agricultural management. Environmental sustainability can in his view be achieved through environmental standards, provided these do not affect his (international) competitive position. Otherwise, he will regard the environment as his natural enemy rather than as his friend. In his perception, area management is the worst policy option. Altogether, environmental concern is not an essential objective in agriculture, and can be taken into consideration through new technologies.

3.4 Epilogue

The above mentioned three stylized concepts of micro behaviour and attitudes of farmers have also implications at the international (European Community) platform. Countries dominated by a conventional agricultural sector may be inclined to prefer a quota system (or any other of non price oriented measure), while countries with a modern agricultural sector will be in favour of market oriented policies. Should modern farming become the winning option, then a further geographical product specialisation based on comparative cost principles is foreseeable. Consequently, the perspectives for a co-evolutionary

development in which economic efficiency arguments are in balance with ecological sustainability arguments are by no means favourable, even though the precise limits to sustainability cannot be specified. Thus much more insight into the trade-off between the environmental potential and the utilisation impact of agricultural land use within the limits of sustainable development would be necessary. These limits may no doubt be relaxed through modern technology, but explicit consideration of environmental objectives (or environmental constraints) cannot automatically be ensured through the market system. Hence there is a scope for environmental agricultural policy, but the extent to which this is complementary to a market solution is up till now unknown. Consequently, in the field of agricultural land use we face a research area with a rich potential. The next section will be devoted to a more detailed discussion of relevant research questions in this field.

4. A Research Agenda on Co-evolutionary Development in Agricultural Land Use

On the basis of all observations and reflections in the previous section we will present here an outline of a comprehensive research agenda on co-evolutionary development in agricultural land use. We will present three broad core research areas, followed by a more detailed description of relevant research issues in each of these core research areas. These core research areas pertain respectively to (1) impacts of (changes in) environmental conditions (notably land use) on socio-economic development, (2) impacts of (changes in) agricultural land use on ecological sustainability, and (3) impacts of agricultural policies on long-term land use (and related environmental conditions).

4.1 Environmental changes, land use and economic development

This core research area focuses attention on the long-term impacts of the environmental potential on (productive) utilisation forms (notably land use). Within this core research area two major research themes can be formulated, which need urgently attention from the research community.

The first theme concerns the socio-economic importance of the multi-functionality of land for long-term (productive and consumptive) utilisation forms and can be formulated as follows:

Identification of environmental elements which have an important long-term environmental potential for the socio-economic functioning of land-related utilisation forms (including the assessment of the socio-economic relevance of this environmental potential).

This theme should also address the question of gauging the environmental potential in such a way that a trade-off can be made between different forms of land use (e.g., agriculture, infrastructure, recreation etc) from the viewpoint of ecological sustainability. Such different activities may imply from a socio-economic perspective a spatial competition, but from an environmental perspective a qualitative competition between different utilisation forms. Given its importance and the lack of knowledge in this field, the above mentioned research theme offers a rich field for further scientific investigations.

The second theme in the first core research area focuses attention on the long-term strategic significance of changing environmental potentials for land use, and may be presented as follows:

The analysis of the long-term consequences of changes in environmental potentials for land use.

This theme is a good example of the need for risk analysis in land use and environmental policy. Incorrect estimates of land use impacts may lead to irreversible - and in any case expensive - policy decisions, as seen from the viewpoint of the environment. For instance, a rise in the sea level may have enormous effects on the saltification process of agriculture in low lands, which may mean a threat to a co-evolutionary development. On the other hand, one may also observe positive trends towards co-evolution, for instance, the importance of a favourable local environment as a location factor for export-oriented firms. It is evident that this second theme has to be investigated as a complement to

the first one. But both themes emphasize the strategic role of environmental potentials as a core element of environmental and land use policies.

4.2 Agricultural land use and ecological sustainability

The dynamics in (agricultural) land use makes straightforward extrapolation techniques inadequate as long-term impact tools. The current overproduction and the changing attitudes (at the level of both policy-makers and farmers) make it highly likely that alternative development patterns will emerge in the future, a major reason being the fact that a further environmental degradation will lead to excessively high costs for agriculture itself, even though precise estimates are not yet available. Since in the long run the interests of agriculture and the environment will likely run parallel, there is much scope for research into co-evolutionary developments. In the light of the previous observations we are now able to formulate four research themes within this second core research area.

The first theme concerns environmental technology assessment and can be formulated as follows:

Research into hardly foreseeable consequences ('surprises') of agricultural-technological developments for long-term land use patterns and environmental conditions.

Given the rapid changes in agricultural technologies (exemplified inter alia by the emergence of agribusiness complexes), shocks and perturbations in land use patterns and related environmental conditions are likely to emerge. An example of interesting changes can be found in Sweden, where experiments are taking place to use vacant agricultural land for bio-energy production.

A second - complementary - theme refers to the question of steering the direction of new agricultural technologies towards ecologically sustainable agriculture, and can be described as follows:

Analysis of incentives needed for orienting agricultural technologies towards sustainable land use from the viewpoint of nature and environment.

When technology could be better planned from the viewpoint of sustainability, it might become a potential friend - rather than an enemy - of the environment. But this would require a closer involvement of environmental interests in R&D efforts. Apart from the use of market incentives, it might also be worthwhile to explore the possibilities of a (compulsory) environmental technology impact assessment prior to the implementation and commercial use of new technologies in agriculture. In any case, a minimum prerequisite would be to examine environmental impacts of new agricultural technologies in an early phase of R&D efforts, as in a later stage adjustment costs might rise formidably (i.e., a preventive environmental policy).

Another theme refers to possibilities of mobilizing international policies for co-evolutionary development, and can be formulated as follows:

Investigation of strategic possibilities for incorporating both agricultural and environmental interests simultaneously in international (notably Common Market) policies.

This theme would require an integrated long term environmental economic view on ecological sustainability in agricultural land use, seen from the perspective coping with overproduction on the basis of co-evolutionary development. Especially beyond the year 1992 there will be a need for a more strategic European policy in this complex field. In view of its own interests, it would be necessary for the agricultural sector to design a meaningful strategy that - from both a local or national and a European viewpoint - would contribute to a consequence of environmental and agricultural land use objectives. Up till now however, this is a highly underestimated research field.

A final theme concerns the attitudes of consumers of agricultural products, as this group ultimately decides whether certain agricultural goods will have a future or not. This theme can be described as follows:

Research into viable policies and actions for favouring qualitative adjustments in consumption needs and patterns concerning agricultural products.

The question whether the agricultural sector will be able to anticipate quantitative and qualitative changes in behavioural patterns of consumers regarding the production mode and the choice of product of the agricultural sector is an intriguing one. Clearly, environment-friendly products will have a higher price, so that a trade-off analysis is a necessary research issue here. However, in addition to insight into viable behavioural changes, it is also necessary to focus attention on bottlenecks in sales channels and marketing strategies in the field of adjusted agricultural goods. In other words, the entire issue of ecological agriculture is at stake here.

4.3 Agricultural policy, land use and the environment

The land use and environmental consequences of agriculture are receiving increasing attention, but their policy dimensions are still underestimated. As mentioned above, viable policy strategies regarding overproduction and new technologies have not yet been accepted, although the current budget deficits of the European Community will undoubtedly impose new policy directions. In the present subsection we will discuss four important research issues in this core research area. In sections 2 and 3, three policy options have been discussed, and each of these will briefly be formulated in terms of research issues.

The first research issue is related to a policy strategy based on a quota system, and can be presented in the following way:

Impact analysis of a more strict quota system in the field of physical planning, land use and the environment.

It is evident that a quota system may lead to a decline in over-production while maintaining the current price level, but it has to be added that substitution effects may take place in the direction of products which are not included in the quota system (see also our discussion of stylized farmer's behaviour in section 3). Whether or not a more extensive or a more intensive land use will emerge, will depend inter alia on the revenues of alternative agricultural products, the environmental policy of the government, the prevailing technology, new sectoral developments (e.g., mass production in agribusiness complexes), scarcity of land for alternative uses (e.g., recreation), socio-cultural traditions, and tradeability of quota. In any case, considerable changes in agricultural land use area will most likely take place, but their environmental repercussions are difficult to assess and deserve much more research.

The second theme deals with the current tendency toward deregulation, and can be described as follows:

Impact analysis of more market conform agricultural policies in the field of physical planning, land use and the environment.

Market conformity implies more competition and will no doubt lead to a price decline of hitherto protected goods. In addition, a decline in agricultural land is highly plausible, but there are still many open questions regarding the impacts on agricultural incomes, the agricultural product mix, the relative price level of goods, the degree of extensification or intensification, the contribution to ecologically sustainable agriculture, the possibilities of a region-specific agricultural land use policy, and the substitution effects with respect to alternative used. In summary, the conditions and the extent to which market conformity will contribute to co-evolution is as yet undetermined.

The third research issue focuses attention on alternative destinations for land, and implies the following research endeavour:

Impact analysis of alternative uses of vacant agricultural land in view of ecological sustainability.

It is noteworthy that a re-orientation on agricultural land use is a necessity, as is reflected in the current discussion on area management. Although the latter option is strongly advocated by the environmentalist movement, it is still an unresolved question whether area management is a policy in itself or just complementary to other policies. In this context, a whole set of research questions appears to emanate, such as the extent to which area management should be optional or improved, the financial consequences and economic feasibility, the concerns on this strategy at a European level, the direction of alternative uses of agricultural land, and the long-term contribution to ecological sustainability (see also the discussion of the viability on this option presented in the ideal-typical description of farmer's behaviour in section 3).

Finally, further research is needed regarding co-evolutionary policy strategies. This leads to the following research issue:

Analysis of creative and feasible policy strategies for a fair distribution of the social (including multigenerational) costs of environmental degradation in view of a sustainable agriculture.

New insights into the environmental potential regarding long-term sustainable land use require an effective policy, which avoids a transfer of externalities to future generations. In the light of the 'polluter pays' principle, social costs of environmental degradation may not be charged to the next generation (cf. also Rawl's principle of economic justice). Yet it still has to be decided who has to pay (e.g., the intermediate industry, the agricultural sector itself, the individual farmer, the consumer, the region where production takes place etc.). Especially in case of a region-specific environmental land use policy, uniform charges are not very helpful. Thus it is evident that

intensive research efforts are needed to design financial schemes that ensure an ecologically sustainable agriculture.

5. Concluding Remarks

The agricultural sector appears to take a central position in the current discussion on ecologically sustainable economic development, as land use is one of the driving mechanisms through which co-evolutionary development is realized. A harmonious pathway of both agriculture and ecology is however not a self-evident development which will easily come into being. However, there is not only a potential conflict exerted by agricultural land use upon ecological sustainability, but there is also much scope for sustainable agricultural policies, as in the long-term a favourable environmental quality is a necessity for the survival of modern agriculture. Hence, from a strategic viewpoint it is evident that this long-term parallel evolution of interests has to be emphasized. The present study has made an attempt at delineating a framework for research policy in this field, which emphasizes the important idea of co-evolutionary development of both agricultural land use and environmental conditions by advocating the use of three strategic core research areas (and related research issues) in the field of ecologically, sustainable agricultural land use.

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