Farm Management and Environmental Issues in the EU

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ABSTRACT

In the framework of general progress towards sustainable development, a review of European Union policy for an environmentally sustainable form of agricultural production is provided. At European level, interest is increasingly focused on integration of environmental aspects into the general policy. Agriculture is recognised as being multifunctional in character, since it plays an important role in protecting rural areas. This has had a direct influence in changing the CAP, which in the past ten years has acquired environmental awareness, and many efforts have been made by Member States to reduce the pressure of agricultural practices on the environment. The results obtained with the application of the CAP) in terms of improvement of the environmental impact of agricultural activities are encouraging. But it is paramount to adopt better evaluation tools, by selecting and adopting specific indicators for the different types of pressure on the environment caused by human activity. The statistical data needed to define of a set of environmental indicators relevant to agriculture are still lacking or are neither homogeneous nor easily accessible. Finally, a methodological approach to a sustainable, environmentally sound farm management is proposed and its main aspects are examined. Also, a possible system of environmental accounting at farm level is suggested.

INTRODUCTION

In the last 15 years it has become clear that in agriculture sustainable development is inconceivable without taking into account the problems concerning environmental protection and land conservation (COM, 1999). Sustainable development has been defined as "*a type of development that manages to respond to the needs of the present generation without putting at risk the availability of resources for future generations, by maintaining the balance between ecological, economical and social factors".*

Clearly, according to this definition development is conceived as a set of factors that must all remain in balance over time. The conservation of non-renewable resources cannot be separated from economic return, which ensures positive social and cultural development. ".

Guidelines for sustainable development have been established since the General Assembly of the United Nations in Rio (1992). The 27 principles of the Rio Declaration on Environment and Development analyse the actions that are related to environmental aspects. The United Nations use Agenda 21 as a tool to emphasise the need to promote sustainable agriculture, in the framework of a rural development programme. The capacity of agricultural regions to absorb the demographic increase must be maintained without neglecting the preservation and the restoration of natural resources, particularly in those areas less suited to agricultural production. Of the numerous spheres of intervention that make up the programme of Agenda 21, the following are particularly relevant :

- The recognition of the multifunctional character of agriculture, which can have a fundamental role for sustainable development.
- The need to plan the use of resources and to further inform and educate farmers. It is particularly important to design cultivation and farm management methods that are related to the specific character of different areas, taking into consideration all existing interactions between agricultural activities and society.
- The awareness that many of the original vegetable and animal genetic resources have been badly utilised, thus exposing them to the risk of extinction. Projects for the recovery, preservation and classification of vegetal and animal germplasm that can be of value for a sustainable agriculture must be launched at national level and supported by specific funding.
- The recommendation to reduce the use of synthetic-chemical substances. This applies to both plant protection - through biological pest control, resistant varieties and low environmental impact cultivation techniques - and to fertilisation - by promoting programmes for sustainable preservation of soil fertility (use of crop rotation, green cover against erosion, increase of organic matter content in the soil).

THE ENVIRONMENT IN THE EU AGRICULTURAL POLICY (1957-2000)

At European level, the concept of sustainable development and the inclusion of environmental issues in the Union’s general and agricultural policies have followed a

similar evolution as other regions of the developed world. The main stages of this process can be resumed as follows:

1957.The foundations for the future development of the environmental policy were already being laid at the inception of the European Economic Community. Article 130 R of the establishing Treaty identifies the following objectives:

- to protect, to promote and to increase the quality of the environment;
- to protect human health;
- to make careful and rational use of non-renewable natural resources;
- to promote measures to solve the existing environmental problems.

1986. Adoption of the Single European Act, which makes reference to Article 130 R of the establishing Treaty recognising the need to integrate the environmental policy into the general one.

1990.The European Council asks for the adoption of an environmental programme based on the principles of sustainable development, caution and preventive action, as well as common responsibility.

1991.The Commission's Reflection Paper on development and the future Common Agricultural Policy recognises the need to promote extensification. The objective being not only to reduce the production surplus, but also to contribute to a model for agricultural production and food quality that is sustainable from the environmental point of view, underlying the dual role played by the farmer as both food producer and caretaker of the countryside.

1992.The Maastricht Treaty gives priority to sustainable and environmentally friendly growth. The environmental aspect is integrated into the Union's other policies. The 5th Environmental Action Programme (5EAP) identifies the targets to be reached in the agricultural sector by the year 2000 (See Tab. 1).

Tab. 1: MEDIUM TERM TARGETS UP TO THE YEAR 2000 AND ACTIONS NEEDED IN AGRICULTURE

Targets up to 2000	Actions
Standstill or reduction of nitrate levels in groundwater	Strict application of the nitrate directive (91/676)
Reduced incidence of surface waters with a nitrate content exceeding 50 mg/l. or giving rise to eutrophication of lakes and seas	Setting of regional emission standards for new livestock units (ammonia) and silos (silage). Reduction programme for phosphate use
Stabilization or increase of organic material levels in the soil	Allocation of premiums and other compensation payments to be subject to full compliance with environmental legislation
Significant reduction of the use of plant protection products per unit of land under production and conversion of farmers to methods of integrated pest control, at least in all areas of importance for nature conservation	Registration of sales of plant protection products. Registration of use of plant protection products. Control on sale and use of pesticides. Promotion of "Integrated Control" (in particular training activities) (Regulation 2078/92) and promotion of bio-agriculture (Regulation 2092/91 on organic farming)
15% of agricultural area under management contracts	Programmes for agriculture/environment zones with premiums co-financed by EAGGF. Protection of all endangered domestic animal races. Programmes for agriculture/environment (Regulation 2078/92)
Management plans for all rural areas in danger	Re-evaluation of license conditions for irrigration and of state aids for drainage schemes. Training of farmers, promotion of exchange visits between regions with comparable environment management situations
Increase of forest plantation, including on agricultural land	New afforestation and regeneration of existing forest, favouring the most adequate means for the environment (slow growing trees, mixed afforestation)
Improved protection (health and forest-fires)	Further action against forest-fires (Regulation 2158/92)

Source: EEA, 1995: 39 modified

The Common Agricultural Policy (CAP), created in the mid-50s to find solutions for rural development in the post-war years, undergoes extensive restructuring. The reform recognises the farmer's role as provider of environmental services and promotes less intensive cultivation techniques, on the basis of the following key recommendations:

- reduction of market intervention and gradual decrease of prices for agricultural produce;
- direct payments to farmers, independent of the level of production, as a compensation for the lower prices;
- optional set-aside of cultivated land;

- promotion of extensification in livestock farming (cattle and sheep);
- adoption of accompanying measures, including a new "environmental package" (Regulation 2078/92), further promotion of reforestation (Regulation 2080/92), support for organic agriculture and widespread support to reduce intensive farming practices.

1995.The European Environmental Agency (EEA,1995) reviews the 5EAP, acknowledging the results achieved by the European Commission, in particular in the development and implementation of the initiatives recommended by the Action Programme. Although some progress is observed, it is difficult to relate the environmental improvements to specific actions. Even if environmental pressure has been greatly reduced, the improvements are often imperceptible. This is due to the non-linear nature of environmental processes and the still limited scope of specific actions. However, the report emphasises the ongoing need to consider the environmental aspects and to broaden and strengthen the objectives and the approaches employed.

1997.The Amsterdam Treaty modifies the Treaty establishing the European Community (Art. 6), hereby including the environment in all its policies. The Treaty allows Member States to maintain or adopt more severe environmental measures than those at EC level, as long as they are compatible with Community policy and that the Commission is notified.

1998.At the European Council in Cardiff the Commission reaffirms its commitment to improve environmental management.
The Vienna European Council reaffirms the need to include the environment between the decisions on agricultural policy to be adopted for Agenda 2000.

1999.By adopting the project Agenda 2000 (CCE, 1999) the European Union reforms many of its policies so as to find new solutions. Agenda 2000 is about the agricultural sector and in particular the CAP, which must also include the environment, the quality of production, the revitalisation of rural society, etc.
The CAP reform is adopted in Berlin, as a response to fundamental challenges in the agricultural world:
- to improve the quality of the environment in disadvantaged areas and offer equal opportunities to the inhabitants;

- to leave future generations an environment that has regenerated after a period of heavy impact due to human activities;
- to guarantee the quality of agricultural and food produce by insuring a fair income to farmers;
- to use the financial resources of the European Union efficiently.

All of this takes place in a European Community which is expanding as new members join; has a decreased growth of its financing sources; gives priority to the need to shorten the gap between the various regions in terms of wealth and economic development; and at the same time has an agricultural model rapidly evolving towards environmental rehabilitation.

The agricultural sector, representing 2.3% of EU gross domestic product and 5.3% of occupation (EEA, 2000), undergoes the structural changes introduced by the new CAP. Size and the diversity of farming have been substantially shaped by the changing demand of consumers, the various trends in the rural world, the technological progress and the globalisation of economy: and this will continue in the future. These trends have had both a negative and a positive impact on environmental quality and nature conservation.

A concept which has been developing and has been emphasised in Agenda 2000 is the *multifunctionality* of agriculture as a sector trying to respond to various challenges: to produce food, fibre and energy sources; to protect rural environment and landscape; to contribute to vitality of rural areas and to balanced regional development. From the environmental point of view, these different goals can only be balanced through greater ecological efficiency.

Since 1980, the gross added value in agriculture rose by 25%. This increase is partly due to a growth in productivity, and in part to the greater demand for high added value products. At the same time, the use of fertilisers has been decreasing and is now stabilised with no consequence to yields, which have been maintained, above all, through the adoption of new farming technologies. This evolution suggests that the improvement of ecological efficiency in agriculture is largely related to the increase of productive efficiency, due to the impact of research and Community policies on farmers' behaviour.

However, while the economic efficiency is growing, the quantity of inputs per hectare has remained stable, even increasing in some cases in recent years. This is due to the trend towards a constant reduction in cultivated surfaces and the intensification of

the production (with an increase of added value per hectare). This development is fully in line with the evolution of the CAP: at first, its main aim was price support, whereas from 1992 until the reform of 1999, most resources were allocated to farmer's income support and to compensatory payments, with the agricultural and environmental programmes receiving only a small fraction of the budget. The system of protected production has stimulated intensive farming: in these circumstances, to integrate and implement environmental policies such as reducing nitrogen excess, limiting the use of pesticides and water consumption is a challenge. This partly explains the slow progress in introducing environmental aspects in the agricultural sector.

One action undertaken by many Member States to reduce the pressure on the environment was the adoption of measures according to the Nitrates Directive. Agriculture is one of the main sources for the presence of nitrates and phosphates in water. High nitrate concentration in underground water represents a great risk to human and cattle consumption. Furthermore, it promotes eutrophication in sea and coastal areas, with possible economic damage to tourism and fisheries. In general, the objectives established by specific agri-environmental programmes have not been reached. Perhaps this is because farmers are expected to comply with the minimal environmental rules sanctioned by Community legislation without receiving any additional compensation.

Another important source of environmental pollution is the presence of pesticides or their metabolites in water at surface level and deeper. Agri-environmental programmes offer several courses of action, including the strengthening of low environmental impact management systems (integrated agriculture) or organic cultivation methods. Organic agriculture, regulated since 1991 by specific production rules (Regulation 2092), offers a variety of advantages on the environmental, social and economic level, in comparison with the intensive methods. This type of agriculture doesn't make use of synthetic substances (such as fertilisers and pesticides). It employs a system of sustainable crop rotation and has the advantage of maintaining the physical, chemical and biological fertility of the soil, promoting biodiversity and preserving non-renewable resources such as water, by using energy efficiently. Organic agriculture also guarantees the safety and quality of its food production, made possible by monitoring and certifying the whole production chain, thus meeting consumer demands. Although the "*protection of the environment*" is implicit in organic farming, it is nonetheless necessary to guarantee the respect of environmental criteria through to specific rules, such as those concerning nitrate leaching in ground water.

Some States have introduced a tax on pesticides and fertilisers, with questionable results (Pretty, 1998). Agenda 2000 provides for the establishment of Codes of Good Agricultural Practice, to give farmers and technicians guidelines on how to minimise the impact of all farming inputs on the environment.

Regulation EC 2078/92 and Agri-environmental Aspects

In the application of Regulation 2078/92 the objective established by the 5th Action Programme for the environment has been surpassed. The objective was to engage farmers to provide environmental services for at least 15% of the European cultivated surface by the year 2000, whereas a percentage of 20% has been reached. The obligatory implementation of the Regulation on the whole territory of all Member States has stimulated several initiatives, according to the various specific needs, which have accelerated the environmental recovery process of farms. Agri-environmental programmes, encouraging the farmers to try and manage ecologically their holdings, have covered about 20% of the agricultural surface of the EU. Globally, Member States appear to have responded positively. They have managed to promote an approach to programme management based on evaluation, which has made possible to monitor and adopt a good assessment method, thus reducing the gap between objectives and results
The results obtained are globally positive:

- There is evidence of important reductions in the use of nitrogen fertilisers, along with an improvement in the spreading techniques, which has increased the efficacy of N unit. The effects of the "Nitrates Directive" adopted by the Community in 1991 must also be considered (Oenema et al.,1998). It has been an important step towards including environmental issues into agriculture, being based on the principles of "the polluter pays" and "prevention of pollution at the source".
- A positive impact on nature conservation can be observed, in the light of European agriculture's primary role in the protection of biodiversity and landscape. The threats posed by agriculture to biodiversity are twofold: intensification and under-utilisation. The first is subject to constant research, with the aim to remedy to damage caused by growing use of fertilisers, by increasing specialisation, by disappearance of boundaries between cultivated land and natural habitats, such as wet areas, rural woods and hedges, by use of pesticides and by substitution of traditional practices, and by soil compaction. As for under-utilisation, land

abandonment can have a deep impact on natural environment, particularly in marginal areas, where the biodiversity of farming environment is quickly lost with the reforestation, limiting the number of species. In conclusion, the programme has had positive effects from most points of view and especially concerning recovery and conservation of those elements that have been abandoned by agriculture.

- There is evidence of increased employment and income, particularly in marginal areas where agriculture plays a fundamental role in environmental protection.
- The implementation of the regulation has helped to modify the image of agriculture as an activity separated from environmental management, and has also increased farmer awareness of environmental issues.

As for the application of the Regulation, there have been many different approaches: each member State has chosen its own implementation model. Even those countries that had launched an agri-environmental policy before the adoption of Regulation 2078/92 are still at the experimental stage. In this phase, it is particularly important to focus on evaluation and monitoring of what has been done, working at the same time to facilitate the dissemination of positive experiences which can be used in demonstrative and training activities. Even considering negative experiences and failures in the application of the Regulation, the experience gained by the various Member States is enough to guarantee a better implementation of agri-environmental programmes in future.

The Regulation has produced encouraging results for:

- the improvement or preservation of biodiversity in agriculture;
- the dissemination of production methods highly favourable to environmental quality. Organic agriculture, at first adopted by a very limited number of farmers, has been growing rapidly in some regions; even if some problems remain in the distribution and marketing of the products;
- the reduction of arable surfaces in favour of grazing land, which allows mixed forms of farming with longer crop rotation. This permits an improvement of biodiversity (protection of weed flora) and soil quality. There is also the positive effect of the green cover against soil erosion and the possible reduction of nitrogen leaching;
- the improvement of landscape quality, facilitated by an integrated approach aiming towards the conservation of a "*landscape system*", which must also include historical features. It is necessary to allocate funds for landscape protection,

encouraging farmers to continue to maintain those farming practices that no longer have productive relevance but which are a feature of landscape (Mansfelt van et al.,1999).

A global analysis of the results obtained through the implementation of Regulation 2078/92 suggests that although the relationship between agriculture and environment in very complex, a correct and efficient management of investments in the agricultural sector requires the selection and utilisation of specific indicators to measure the different kinds of impact on the environment caused by human activities, as well as management methods that use such indicators to monitor the results obtained and reduce the impact of agriculture on the environment.

THE ENVIRONMENTAL INDICATORS

In 1998 the European Councils of Cardiff and Vienna have introduced an innovative instrument for decision-making in agricultural policies, expressing the need of environmental indicators to quantify the complex relationships between human activity and environment and to better aim interventions. In fact, a set of indicators makes it easier to understand the complicated phenomena at the base of the evolution of agricultural systems over time, providing the quantitative figures that are needed to monitor and direct such evolution.

The environment is a composite system with single components interacting in many different ways. Therefore, environmental indicators must give environmental information according to a "holistic", i.e. global, approach. This is even more necessary when these indicators are applied to agriculture, which is in itself a complex system since its activity is based on various positive and negative interactions with the environment. In sound environmental management and sustainable development, these indicators are particularly suited to identify the practices which have an adverse effect or which are not sustainable, therefore suggesting which inputs to reduce or minimise.

Often the information available on the various agricultural activities of a farm (use of fertilisers, pesticides, condition and conservation of biodiversity, etc.) are too generic and global, and do not adequately consider regional diversity. Therefore, they are of no use or are misleading to a policy intent on addressing the problems of the sector in a focussed way at all levels, and at the same time reflecting the differences in economic structures and environmental character. For instance, when global data are employed to evaluate trends in the use of environmentally dangerous substances, such as pesticides or fertilisers, a general decrease in consumption doesn't necessarily mean

that the environmental situation is improving. Some substances may simply have been substituted by others, applied in smaller doses but having a potentially higher toxicity. The fact that average amounts of nitrogen spread on cultivated surfaces has diminished doesn't rule out excessive usage and risks to ground water in specific areas.

To be used for a better monitoring of rural policies and agri-environmental programmes, the indicators must truly reflect specific local conditions, they must be geographically differentiated, and must correspond to the specific criteria of the programmes (Dahl,1995; Segnestam,1999).

In the Fourth International Workshop on Indicators of Sustainable Development, held in Prague in 1998, the representative of EUROSTAT reported on the work on indicators undertaken by the Commission on Sustainable Development. EUROSTAT launched a pilot study on statistical data from the Member States, which researched 46 indicators, 21 of them environmental. From this work it is possible to conclude that to be able to use environmental sustainability indicators there is a lack of available statistical data, even in the most advanced Member States, and their uniformity and accessibility is very limited. A list of core indicators for the agricultural sector has been proposed by the Scientific Advisory Group (SAG): they refer to air pollution (6), climate changes (6), loss of biodiversity (8), marine and coastal environment (5), ozone layer reduction (4), excessive use of resources (4), toxic substance release (4), waste management (3), water pollution (6) (COM, 2000).

. It can be concluded that to be able to develop agri-environmental sustainability indicators in the near future, it will be necessary to overcome several challenges:

- there will have to be specific indicators for specific social, economic and environmental conditions, with a reference to the various contexts where farming activities take place;
- it will be necessary to make an effort to reduce the large number of indicators needed to describe such a complex reality as the relationship between agriculture and environment, limiting them to the few, simple and applicable indicators called for by the politicians;
- it is urgently necessary to fill the existing gap between the data needed to calculate the already defined indicators and those that are really available;
- it will be necessary to observe and monitor with more continuity in space and time the various human activities and the features of the environment so as to be able to manage them: an objective which is still far from reach;

- some environmental or environmental impact processes are still not very well understood, have a random behaviour or are influenced by other factors. It is therefore difficult to choose useful indicators to describe them;
- as always in the case of complex systems, where knowledge of how the single parts works is not enough to understand the behaviour of the system as a whole, suitable indicators will have to be developed using models.

A METHOD FOR THE MANAGEMENT OF AGRI-ECOSYSTEMS

In most European countries agriculture is going through a critical period, but the economic recession has also an indirect and positive effect on the environment. The current challenge is precisely to go back to a high level of economic return while maintaining a low impact of farming activities on the environment. Without a doubt, landscape is one of the main aspects influencing the total perceived quality of a given environment. It can be defined as the visible projection of natural dynamics as well as historical transformations undertaken by man, who has been adapting the environment to his needs. The new sensitivity for the environment can be translated into opportunities and challenges for agriculture. It is necessary to respond with innovative solutions that are " *market-oriented"* and *"environmentally friendly",* aimed at "*improving the quality"* with a systemic approach. The management of rural landscape is a point of conflict in the relationship between agriculture and landscape conservation. Although considered for a long time the exclusive competence of the primary system operators, landscape has lately become the object of widespread interest by the whole community.

In the recent past, the attempt to safeguard non-productive values of the rural context has taken the form of a restrictive approach, which almost always has generated conflict, since it was perceived as contrary to the interests of the farmers. This conflict could be partly overcome with the new strategy, developed in the last few years through the agricultural policy of the EU. It provides some tools for sustainable management of rural areas in an attempt to marry the need to protect the environment with the economic needs of agricultural production.

An example of this is the method developed within the Research Network for EU and Associated Countries on "*Integrated and ecological arable farming systems*". In it almost all European countries that have co-operated in the search for sustainable forms of management and alternative solutions to industrial and intensive farming are been actively represented. The Network has proposed two views of agriculture:

- IFS (Integrated Farming System), where the production process is aimed to the maximum rationalisation of the technologies employed, reducing external inputs and at the same time planning an agricultural development which is not only based on the economic return and production quality, but also on the "*ecosystem factor*" (Vazzana and others, 1997);
- EFS (Ecological Farming System), where income and profit are secondary to the ecological goals. The objectives of protecting the environment, nature and landscape, of recovering and improving the ecosystem, have the same or even more importance than the economic ones.

This methodology aims to offer farmers an easy tool to quantify the evolution towards ecological and sustainable management. The approach is an "holistic" one, referring to a whole system, and it focuses on informing and training the farmer, who is called upon to take centre stage in the process (participating approach). Just as important is consumer information. The consumers are required to understand the advantages, both direct and indirect, of this type of agriculture and to be willing to economically support the producers.

The methodology proposed by this Network is articulated in 5 stages.

- A hierarchy of objectives is established. The economic, social and environmental objectives must direct the farmer towards a management programme aimed at eliminating the drawbacks of intensive farming. Through a simple operation, the ten main objectives to be attained are selected .
- These objectives are then transformed into multi-objective parameters describing specific conditions and features of the system in question. The parameters correspond to the above mentioned sustainability indicators, and can be employed to evaluate the progress made towards the objectives. Many of the 16 parameters used by the method concern the relationships between farming activity and the environment. These parameters are reflected in multifunctional methods, which are able to operate on the basis of more parameters. The main methods are those indicated for an agri-environmental management of the farming system, that is: Multiple Crop Rotation (MCR); Integrated or Ecological Nutrient Management (I/ENM); Ecological Infrastructure Management (EIM); Minimal Soil Cultivation (MSC); Integrated Crop Protection (ICP); Environmental Exposure –based Pesticide Selection (EEPS). MCR is a basic and comprehensive method to preserve soil fertility in biological, physical and chemical terms, and to sustain quality production

with a minimum or no input. I/ENM works preserving chemical soil fertility by tuning inputs of nutrients to outputs, to achieve and maintain agronomically desired and ecologically acceptable reserves. Inputs of inorganic fertilisers are strongly reduced in INM and are fully replaced in ENM by recycling nutrients from organic residues and by biological nitrogen fixation. MSC is a method additional to MCR to sustain production by preparing seedbed, controlling weed competition, incorporating crop residues and restoring physical soil fertility reduced by compaction from machines. Soil cultivation should be minimal to increase energy efficiency, maintain organic matter annual balance and soil cover against soil erosion. EIM provides habitats and corridors for predators and parasites needed to control harmful organisms, establishing the area with linear elements (field margins, hedges, ditches, stone walls, etc.) and non-linear elements (groups of trees or single tree, ponds, etc.), thus rendering the farm habitable for wild flora and fauna and enjoyable for people and protecting the landscape. ICP is a method to achieve an efficient control of remaining harmful species, with minimal use of selected pesticides while meeting EEP norms. EEPS is a method to reduce the overall pressure on the environment by pesticides: in order to prevent short term and long term adverse effects on all species throughout the biosphere, pesticides with reduced persistence, volatility and mobility are selected.

- In the third phase, the parameters are linked to the methods. These are defined in their essential components and are sorted by their importance in achieving the established objectives.
- Then the prototype is verified and improved on the field, identifying the agri-ecological profile of the farm and giving specific consideration to the surroundings and the size of plots, the duration and type of rotation, the neighbouring crops and the percentage of ecological infrastructures.
- The last phase concerns the dissemination of the prototype in actual farms that are working towards a more environmentally sensitive approach. Once the system is created, step by step monitoring will be necessary to make sure that the actions produce positive results. This control is made possible by monitoring the values of the selected parameters-indicators, which must not diverge excessively from the established threshold reference values. Thus the progress towards sustainability of farming systems can be controlled and modified through these indicators which permit the measurement of progress or failure of the management system.

This method, developed in experimental and pilot farms throughout Europe (Vereijken, 1994; 1999), has already been applied for some years in actual farms in Italy as well. It has proved reliable and easy to use, on condition that the farmer takes part in the decision-making. An important objective that has been achieved is the development and testing of indicator parameters that are useful to describe changes produced upon a single farm by integrating environmental variables into the productive ones (Vazzana et al.,1997).

The Rural Development Plan (Regulation EC 1257/1999) could offer the opportunity to strengthen this model for farm management, by promoting virtuous behaviours by the farmers and other rural actors through incentives and technical norms. With a correct management of the single farms, as well as other measures, agriculture and forestry can have a leverage effect in improving the quality of an area in three ways: positively contributing to the solution of environmental problems due to non-farming causes; reducing the negative impact caused by some farming practices or by their concentration in space; acting as an instrument for the implementing policies aimed to enhance the landscape (Mansfelt van et al.,1999) through incentives instead of restrictive measures.

The adoption of agri-environmental measures increases the compatibility of farming practices with the ecosystem of the various parts of a given area. In particular, this means to protect biodiversity, to reduce pollution of rivers and lakes, to limit erosion, to safeguard soil fertility, to support farming that has already reached a minimum impact on environment (organic agriculture), and also to preserve the landscape, more and more threatened by simplification of field layouts and by abandonment of farming in marginal areas.

ENVIRONMENTAL ACCOUNTING

The problem of growing competition between alternative uses of resources is one of the most critical points of sustainable development in agriculture. To make the relationship between economy and environment more transparent also in the agricultural sector, it is necessary to include an *environmental accounting* aspect in the business accounting of a farm. This means considering the additional cost of the transformation of the production along ecological lines; as well as the costs due to the loss of resources or to the necessary measures to prevent pollution, especially in the medium and long term. From this point of view, the natural resources should be considered as part of the business capital and as a factor limiting the production, to be taken into account just like

any other component of the production process (Brand, 1998). The objective of the environmental accounting is to certify the farms of a given area in environmental terms.

A method of environmental accounting has been developed in the Agricultural Faculty in Florence and it is presently the object of a PhD research in co-operation with the Farm Management Group of the Department of Social Sciences– Wageningen University (NL) (Pacini et al., 2000).

Unlike ordinary systems of agricultural book keeping, a balance sheet of each single plot, grid and point element makes it possible to assess the environmental impact of various concentrations in farming practices. On the other hand, this method makes it possible to reclassify accounted items for more specifically economic purposes, such as preparing crop balance sheets. Thus, the concept of the *"extended production process"* is introduced. This is defined as a series of operations carried out on the same surface unit of a farm (plot, grid elements, point elements), all of which contribute to obtaining one main product and all related by-products. The "*main product"* is the principal source of income for the farmer, the "*related, or by-products"* are all other products or services resulting from each extended production process.

Unlike the production processes of mainstream economic-agricultural theory, the extended production process is based on a wider definition of the product. It also includes *indirect* products, which are not material, but which offer advantages to the community (for instance, conserving biodiversity, improving the esthetical quality of the landscape, protecting soils against erosion, maintaining the quality of surface and deep water). Identifying indirect products and their relation to farming operations makes it possible to propose a suitably adapted balance sheet which includes as active items both direct and indirect products, and as passive items both the direct and indirect ("externalities") costs for their production. In many cases, this balance sheet is based on information collected by assessing the environmental capital.

The data are collected by means of a questionnaire to assess the environmental capital of a farm. Its agri-ecosystem is divided into environmental systems and sub-systems selected on the basis of sensitive elements identified in the various geographical areas of the region. The information collated through the questionnaire is then used to establish agri-environmental indicators showing the condition and changes in the environmental capital of the agri-ecosystems concerned. The data bases produced as a result of the questionnaire, the set of environmental indicators and the methods of processing them are then put into the Information System of Environmental Accounting.

The interaction between agriculture and environment is complex; their integration depends on how complex the farming processes are (including both harmful and advantageous), on to what extent they interact with the area and on the diversity of local conditions and production systems. The most suitable model and the one which complies best with the need for a systematic method, views agriculture as both an active (polluting) and passive (polluted) subject, which needs to re-establish its balance and role depending on the particular area concerned.

As a minimum requirement, the farmer must respect the general environment, without expecting any compensation. This means that all farmers must observe the laws restricting the use of pesticides, of fertilisers, the utilisation of water resources, and, where necessary, follow national or regional guidelines on good agricultural practices. For example, they must comply with the Code of Good Agriculture Practice of Nitrates Directive (Directive 91/676) (Rosso Grossman,1999).

However, when producers are required by society to pursue environmental objectives beyond "good agricultural practice", incurring costs or income loss as a result, society must provide compensation for this environmental service. This approach is based on the "polluter pays" principle, according to which farmers must bear the cost of compliance with standards and laws up to the reference level of "good agricultural practice", which is reflected on the property rights. But in rural areas the environmental objectives are often more ambitious than the "good agricultural practices" and in those cases they can only be attained by providing for adequate compensation for the farmers. Therefore it is appropriate to pay farmers so that they protect the environment using their own resources or production factors, on condition that the service they provide goes beyond good agricultural practice.

Partial balance sheets (based on a single plot, grid element, etc.) will put into evidence only those indicators that are strictly related with the activity concerned. In other words, there will be indicators of the environmental capital which, since they refer to the specific context of the farm (indicators for farming diversity, for waste management, for animal biodiversity, etc.); will only appear at the level of the balance sheet of a single farm.

The method that makes it possible to relate *economic parameters* to *agri-environmental indicators* is based on the hypothesis that farm practices (farm management behaviour) can be considered as environmental services provided by the farmer to the community. They are evaluated as variations of the PLV derived from the economic accounting, according to the principle discussed above. On the one hand there

are farm behaviours (i.e. maintenance of grid elements) whose cost, calculated through the analysis of economic data, can be translated in terms of advantages provided by the farmer to the community. On the other hand, there are farm behaviours (i.e. management of biodiversity or nutrients) which are not directly translatable in terms of economic benefit. In this case, it is necessary to apply a systemic approach for evaluating the impact of such farm management behaviours on the environment in terms of PLV increase, measuring them against the agri-environmental indicators.

The increase in PLV can be considered as an indication of the capacity of a farm to provide environmental services. Therefore this method makes it possible to identify an "environmentally friendly production", which will have bigger or smaller values of economic PLV according to the environmental behaviour of the farm.

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