

AGRI-ENVIRONMENTAL INDICATORS IN THE MANAGEMENT OF FARMS. THE SPANISH CASE

Elisa I. Cano Montero

Clara I. Muñoz Colomina

Elena Urquia Grande

ABSTRACT

The current reform of the EC Agricultural Policy decouples subsidies from production and introduces the new concept of “eco-conditionality” which makes the receipt of subsidies contingent on compliance with a number of environmental standards.

This reform, put in place by the Commission, involves a high risk that the cultivation of some Mediterranean products will be abandoned. Their producers will have to meet the challenge of competitiveness and avail themselves of appropriate mechanisms such as codes of good agricultural practices and the application of efficient management systems.

The existence of a framework of indicators helps to strengthen the financial and management control of farms, something which is indispensable in periods of crisis, while allowing the policy of change to be monitored.

Our research work is based on such indicators, and aims to provide a framework of key performance indicators that will enable producer groups to analyse the technical, economic, and environmental aspects of their farms. We believe that the performance indicators we propose will help farmers to meet and assess requirements concerning the respect and improvement of the environment, and the pursuit of quality, sustainable farming, and competitiveness. Permanent monitoring of these indicators will also enable benchmarking to be carried out among farms and will provide a tool that will promote continuous improvement in the financial and agricultural management of farms.

We believe that this scenario calls for the definition of agri-environmental policies based on cause-action-effect relationships between agriculture and the environment, with a view to achieving a continuous improvement in the system.

Keywords: eco-conditionality, EC Agricultural Policy Reform, indicators, sustainability, continuous improvement, benchmarking.

AGRI-ENVIRONMENTAL INDICATORS IN THE MANAGEMENT OF FARMS. THE SPANISH CASE.

1. Introduction

EC Agricultural Policy, the original goal of which was to guarantee the supply of member states while providing an adequate income for farmers, has had a number of undesirable collateral effects in the shape of production surpluses, an increase in EC agricultural expenditure, and an impact on the environment. This is why EC Agricultural Policy has been reformed a number of times during the four decades it has been in existence. The latest reform to be approved (June 2003), implemented by Council Regulation (EC) 1782/2003, introduces a change in economic policy with the dual concepts of decoupling and single payment per farm. This represents a move away from direct subsidies to production granted to farmers or associations of producers, which are being gradually eliminated and decoupled from production. Most Common Market Organizations (CMO) are to switch to the new system between 2005 and 2006 (with the exception of new member states) while for certain crops there is a transitional period which ends in 2013 at the latest. The reform affects «Mediterranean products» and sugar. Some Mediterranean agricultural sectors, such as cotton and tobacco, are more sensitive to single payment per farm because of the nature of the crops or the nature of the affected regions.

The reform also introduces measures to reduce the impact on the environment in accordance with guidelines set out in the EC Common Agricultural Policy (CAP) concerning social welfare, as can be seen in the proposals included in the Agenda 2000 CAP reform agreement for the period 2000-2006 on the quality and safety of foodstuffs,

protection of the environment and animal welfare, conservation of the landscape and rural areas, multi-functionality, sustainability, and competitiveness. This reform reflects these proposals as, in addition to the concepts of decoupling and single payment, it includes the notion of “eco-conditionality” which makes the receipt of subsidies contingent on compliance with a number of environmental standards. In particular, Council Regulation (EC) 1782/2003 and Commission Regulation (EC) 796/2004 introduce the obligation to adopt environmentally friendly Good Agricultural Practices that allow farmers to bring quality and competitive produce to the free market, with penalties if they should fail to meet the required standards. This is why it is so important for farmers to define a code of Good Agricultural Practices that will also safeguard the environment.

The general strategy of the European Union hinges on the integration of agriculture with the environment based on the cause-action-effect relationship between them. The model currently being proposed is the one adopted by the OCDE: the Pressure-State-Response (PSR) model, developed as part of the *Driving Force-Pressure-State-Impact-Response* (DPSIR) framework and the IRENA project. There is a framework of action for the agricultural sector, in which management tools based on total quality and activity management are vital elements.

Our research work is based on these tools and proposes the adoption of a framework of key performance indicators that will allow agricultural associations to analyse the technical, economic, social and environmental aspects of farms. This is very useful for the managers of associations who need to have summarized, reliable information about problems in farms and environmental trends. These indicators also make it possible to compare and exploit the positive synergies of the farms with the best results on a

regional and national basis, leading to the continuous improvement of the other farms involved, thus leveraging the idea upon which benchmarking is based. We consider that our proposed performance indicators will, on the one hand, help to implement and assess UE strategy with regard to the respect and improvement of the environment, and the pursuit of quality, sustainable farming, and competitiveness, as set out in the CAP and, on the other hand, to clarify the strategic planning of farm holdings. Our research paper takes as its starting point the definition of environmental policies as a result of the application of the DPSIR model (Commission of the European Communities, 2000).

Our paper is divided into three parts: in the first part we provide a brief international overview of the proposals from the OCDE and the European Commission regarding agri-environmental indicators, and of the applications of those proposals in various countries. In the second part we look at producers of a number of Mediterranean agricultural products who are committed to sustainable agriculture and require support tools. In the third and final part we provide a framework of performance indicators to be applied to these farms at a nationwide level which will help them to achieve their sustainability goals.

2. Agri-environmental indicators within the framework of the OCDE.

Agenda 21 in chapter 14 on the promotion of sustainable rural agriculture and development addresses the need to readjust agricultural, environmental, and macro-economic policy at a national and international level. It points to the participation of the population and a better management of inputs so as to maintain soil productivity while respecting the environment as one of the ways to implement that policy. It adds that governments should play an active role in improving and expanding information about agricultural and food early warning systems by carrying out research into the state of

natural resources with regard to the production and planning of foodstuffs and agriculture, in order to assess the impact on those resources and establish analytical methodologies and tools. The last chapter of the Agenda refers to the need for governmental and non-governmental organizations to produce sustainable development indicators at both a national and a regional level.

Among the first proposals for farming indicators, even prior to the recommendations made in Agenda 21, are those based on mathematical models such as the MIMIC (Multiple Indicators / Multiple Causes) model developed by Bollen (1989), Joreskog, and Sorbom (1989) and, subsequently, Esposti and Pierani (2000) which aims to measure the causal relationships between certain variables. The Agenda prompted a huge response in the form of a great many new indicators tailored to present day needs and oriented towards planning support and strategic control (Brown, N.; 1999, Oñate et al., 2000, European Commission, 2000, 2001, Chamberlain, B.; 2004).

We go on to look at farming based on the evaluation of different variables (van de Werf and Petit, 2002), which has produced a number of methods including the Farmer Sustainability Index (FSI) (1993), Sustainability of Energy Crops (SEC) (1996), Eco Points (EP) (1996), Life Cycle Analysis for Agriculture (LCAA) (1997), Agro Ecological System Attributes (AESAs) (1997), Operationalizing Sustainability (OS) (1997), Multi Objective Parameters (MOP) (1997) and Environmental Management for Agriculture (EMA) (1998), and Agro Ecological Indicators (AEI) (2000).

In another collection of methods we take things a step forward by look at the present situation of countries and farms (see Table no.1). In these methods governments play an important role as users. We take as our starting point the study of eleven cases in various countries in which the objectives, users, and spatial and temporal scope are all

clearly defined. This allows us to develop a framework of indicators based on the following principles (Payraudeau, et al. 2005):

- A clear concept of the method and its indicators.
- Consistency of indicators with observed values.
- Appropriateness of the indicators and method chosen to the users for which it is intended.

Table 1: Indicator development methods (Payraudeau et al. 2005):

Method	Cases	Objectives	Users	Scope	Timeframe
ERM 1 (Environmental Risk Mapping)	De Koning et al. 1997	Modelling of soil nutrient balance in Ecuador	Researchers and policy makers	National Cells	Year-on-year variation
ERM 2 (Environmental Risk Mapping)	Giupponi et al. 1999	Modelling of the impact of water quality in several scenarios in Italy	Policy makers and local governments	1840 Km ² 4 ha	30 years
LCA 1 (Life Cycle Analysis)	Biewinga and van der Bijl 1996	Evaluation of the ecological and economic suitability of energy crops in Europe	Researchers and policy makers	4 European regions 45300 km ²	Annual
LCA 2 (Life Cycle Analysis)	Geier and Kopke 1998	Evaluation of the conversion of traditional farming to organic farming in rural Germany	Local governments and farming advisors	Farm	Annual
EIA (Environmental Impact Assessment)	Rodrigues et al. 2003	Evaluation of sustainable agriculture subsidized by the NT in Brazil	Policy makers	Farm	Annual
MAS- 1 (Multi-Agent System)	Petit et al. 2001	Evaluation of the amount and quality of water, using socio-economic models in multi-agent systems in France	Stakeholders policy makers and farmers	Farm	10 years
MAS- 2 (Multi-Agent System)	Becu et al 2004	Modelling of the impact of an irrigation system managed under social and agronomic constraints in a multi-agent system in Thailand	Stakeholders policy makers and farmers	327 Farm holdings	10 years
LP-1 (Linear Programming)	Zander and Kachele 1999	Optimization of various production systems at farm holding level using a linear multi-objective programme in Germany	Researchers and local governments and non-political organizations	40 and 32 farm holdings 3 scales	Annual
LP-2 (Linear Programming)	Hengsdijk and van Ittersum 2003	Optimization of production systems to maximize production while minimizing impacts on an	Researchers and local governments	Stratification into units according to climate and soil	31 years

		individual and regional scale in Mali		type	
AEI-1 (Agri-Environmental Indicators)	ECNC 2000	Development of the DSR model at a macro level in Europe	Researchers and policy makers	According to type of indicator	Depends on the indicator
AEI-2 (Agri-Environmental Indicators)	Rasul and Thapa 2004	Evaluation of the sustainability of agriculture using ecological, economic, and social indicators in micro regions in Bangladesh	Researchers and policy makers	110 farms family farm holdings	Annual

In an attempt to integrate all the various proposals at an international level, the OCDE proposes a set of indicators which it calls agri-environmental indicators (see table 2) which should conform to the following characteristics (OECD, 1997a), (FAO, 2003), (Piorr, 2003):

- Policy relevant: that is to say the selected indicators should be demand (issue) rather than supply (information) driven and address the environmental issues facing governments and other stakeholders involved in the agriculture sector.
- Analytically sound; that is to say, they should be measurable.
- Easy to interpret and communicate results to policy makers
- Economically viable; that is to say, that data collection and measuring should not consume an excessive amount of resources.

The OCDE also identifies thirteen basic issues (nutrients, pesticides, water and land use, land conservation, soil and water quality, greenhouse gas emissions, biodiversity, wildlife habitats, agricultural landscape, farm management practices, farm financial resources, and socio-cultural issues) which allow us to define 35 indicators for their short-term development and another 20 for long- to medium-term development given that they require further development and fine-tuning (European Commission, 2000).

The specific framework to incorporate these indicators and reflect the cause and effect relationship between agriculture, resources, and the environment was firstly set out in the OCDE's Driving Force- State- Response (*DSR*) model and subsequently in the model designed by the European Environment Agency's, known as the Driving Force - Pressure - State- Impact - Response (*DPSIR*) model. These models predict the impact of farming practices and the use of natural resources on biodiversity and natural landscapes, and on any government actions that are being carried out. This results in an ongoing process that receives continual feedback from the experience of previous years. In this way, agri-environmental policy decisions can be made with greater insight (Alvarez-Arenas, 2000) and farming strategy in any EU country, whatever its landscape, cultural, or historical diversity, can be aligned with the UE's global strategic policy. This, therefore, is the model we will use when we put forward our proposals for a number of improvements.

In Figure 1 below we can see a graph depicting the *DPSIR* with examples of each component of the acronym which we will be looking at one by one later in our proposal.

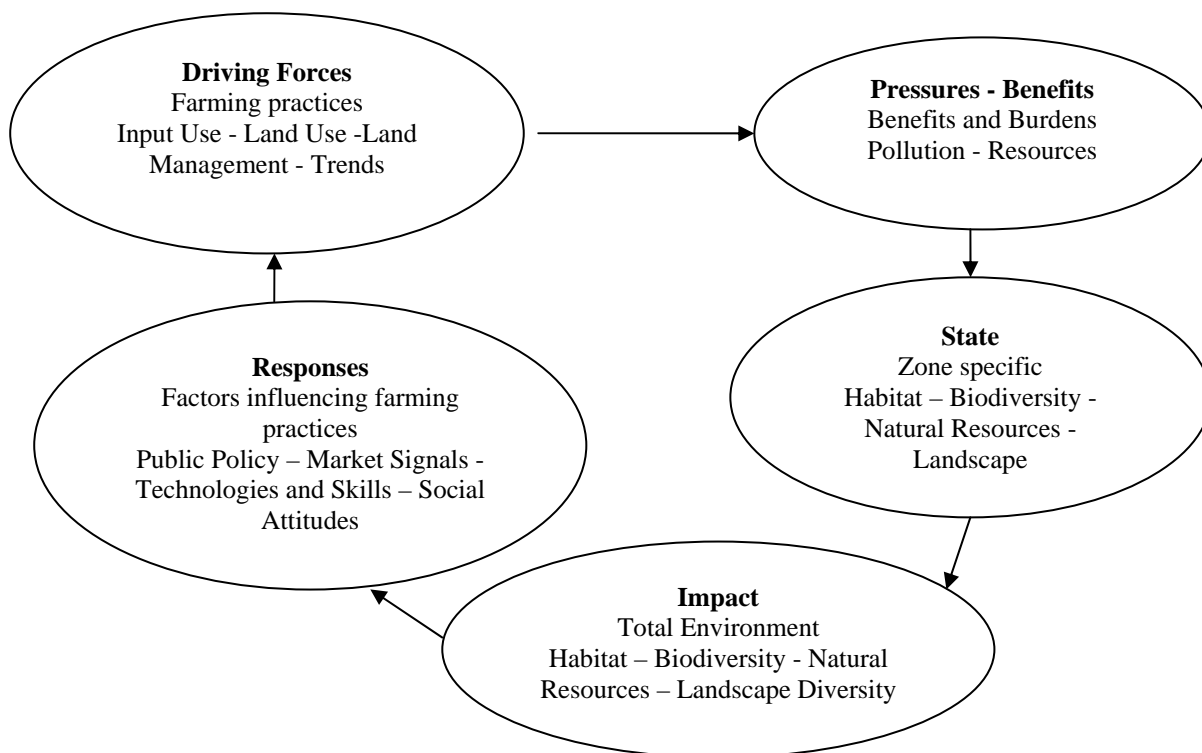


Figure 1: DPSIR model

Source: Document produced by the Commission of the European Community.

Communication from the Commission to the Council and the European Parliament (2000)

To establish the causal relationships between government policies, farming practices, natural resources, and the environment is a complicated, multi-phase process. The DPSIR framework has provided a consensus in the definition and production of the agri-environmental indicators which, in turn, enables the data requested to be standardized and benchmarked.

Later, the IRENA* project (a report on environmental integration indicators in agricultural policy), provides the interaction between agriculture and environment in the European Union (UE-15) based on the DPSIR approach. This project subscribes to and validates the indicators proposed by the European Commission, choosing the 35 most

* This is a joint project of the Directorates General of Agriculture and Rural Development, Environment, Eurostat, and the Joint Research Centre of the European Commission coordinated by the European Environment Agency.

closely related to farm management. The resulting set of indicators is known as the *Core Set of Indicators for Agriculture* (Petersen, J.E; 2004) (see Table 2).

Table 2: Core set of indicators

Source: Petersen, J.E; 2004

DPSIR Ref.	Indicators	* Irena	Group	Objectives	Indicator to measure objectives
RESPONSES	Common policy	1	* b	Area under environmental support to agriculture	Land area with financial support programmes to carry out environmental beneficial activities Number of farmers meeting BPA standards (minimum standards are laid down in Commission Regulation 1750/1999
		2	* b	Regional level good farming practices	Pending
		3	* d	Regional level objectives and degree of success	Pending
		4	* b	Area under natural protection	Area and % of land subject to crop restrictions due to being areas of natural protection
		5	* a	Market signals: Incentive for organic production	Ratio between organic and conventional produce Economic results of organic farm holdings compared with traditional ones Market share of organic farm produce compared to total market for farm produce
	Tech & Skills	6	* a/c	Technologies and skills: training level of day labourers?	Training of day labourers in agro-environmental farming
	Attitude	7	* a/b	Area under organic agriculture	Area under organic agriculture
DRIVING FORCES	Use of input	8	* a	Amount of nitrogen and phosphates in fertilizers used	
		9	* a/c	Consumption of pesticides	
		10	* a	Intensity of water usage	Water usage per 1,000 € of output from irrigated arable land Annual usage of diesel-type energy; information is limited to diesel products as agricultural fuels are easily distinguishable
	Land use	11	* a	Energy usage	Inventory of developments broken down by type and location
		12	* b	Land use: Topological changes	
	Management	13	* a/c	Land use: crop or livestock	
		14	* d	Management	Pending
	Trends	15	* a/c	Intensification/Extensification: is the result of a rise in the production rate per area or work unit	Trend of the % of agricultural land devoted to forage Profitability trends of land under crops by chosen crop Production trend of cereals etc. per work unit Trend of livestock units per hectare of forage
			* a	Specialization/Diversification: improved economic efficiency	Importance and changes in types of agriculture Proportion of revenues for the farmer generated by non-agricultural activities Proportion of revenues for the farmer generated by non-agricultural activities
		16	* a/c	Margination	State and trend of crop density (SGM) and of farmers with or without heirs
PRESSURES	Pollution	17	* a	Surface nutrient balance	Total input of nutrients (organic and mineral fertilizers..) less crop consumption Purchase of fertilizers by countries broken down by N or P Fertilizer for livestock Seed consumption Pilot project to test the reliability of tools that measure CH4 balance in river basins, sewers? and reservoirs
		18	* a	CH 4 emissions	Aggregate figures of CH4, N2O, CO2 emissions in farming , weighted by global potential?
		19	* c	Pollution of farmland by pesticides	Pending formal definition
		20	* c	Water pollution	Pending formal definition
		21	* a/c	Water abstraction on the land / water stress	Total amount of water pumped directly out of the ground by farmers
	Resource overspend	22	* a/b/c	Erosion of arable land leading to < production	Location and estimate of the amount of topsoil lost Covered land and farming practices in risk areas
		23	* a	Change matrix for covered land is vital to monitor development	Change matrix for covered land broken down by size and variety
	Benefits	24	* b	Genetic diversity at 3 levels: species, organisms, and ecosystem	Total number and % in production of principal crops / livestock feed Number of crop varieties at a national level / livestock at risk
		25	* b	Areas of high natural value	Interrelated with indicator 4
		26	* a	Renewable energy sources: Biodiesel & wood	Area and volume of wood and oilseed crop production for producing biodiesel
STATE	Biodiversity	27	* d	Wealth of species as bioindicator for possible farming development	Pending according to information required
		28	* c	Quality of arable land	Farming areas where there is an imbalance between land capacity and its current usage
	Natural Resources	29	* d	Level of nitrates and pesticides in water	Pending
		30	* d	Levels of water on land	Pending
	Landscape	31	* b	State of landscape	Number and diversity of memorable elements seen (pending fine-tuning)
IMPACT	Habitats & Biodiversity	32	* c	Habitats and biodiversity	Density of linear elements and covered land at a farm holding level
		33	* b	GHG emissions	Greenhouse gas emissions by economic sector
	Natural Resources	34	* b	Nitrate pollution	Nitrogen emissions by economic sector
Landscape Diversity		35	* b	Water use	Water consumption by economic sector
				Diversity and globality of agriculture	Global agriculture diversity rates and their evolution over time

3. The case of tobacco in Spain

Some Mediterranean agricultural sectors such as cotton and tobacco are more sensitive to the change to a single payment per farm. In the case of tobacco, in the period 2006-2010 its CMO intends to decouple subsidies from production, which will have a profound effect on the sector and make its future outlook uncertain.

The European tobacco sector produced 344,327 t of tobacco from 132.336 ha under tobacco at the time of the 2004 harvest (Spanish Tobacco Growers, 2006), mostly from small holdings (between 5 and 10 ha). The European Union leads the world in imports of raw tobacco and is the fifth largest producer (FAO, 2004) with Greece, Italy, Spain and France being the main producing countries. Tobacco growing employs 453,887 people in some of the lowest income per capita areas such as Mezzogiorno in Italy, northern Greece, and Extremadura in Spain (European Commission, 2003). Tobacco farms are generally grouped into mercantile associations; at the time of the 2004 harvest, France had 3,900 tobacco producers, grouped into 9 cooperatives (Anitta, 2004). In Spain nearly all tobacco growers are organized into 10 producer groups, as can be seen in the following table:

Table 3: APAS (Agricultural Producer Groups)

APA	TOTAL 2003		
	PRODUCTION (kg)	QUOTAS	GROWERS
SAT ASOC. AGRUPADAS TAB	11,559,051	1,876	1,714
IBERTABACO S.C.	8,319,644	1,028	989
SAT TABACOS DE TALAYUELA	5,974,005	158	151
COTABACO	4,166,270	283	259
TABACOS DE CÁCERES, S.C.	3,069,838	449	431
GRUTABA	3,172,751	289	274
TABACOS GRANADA	3,084,942	911	902
COUAGA	1,056,255	259	240
TABACHAVANA	218,412	70	70
TABACOS BIERZO	138,451	54	54
CONTR. INDIVIDUAL	2,364	12	11
TOTAL	40,761,983	5,389	5,095

Source: MAPA, 2003

The reform which is already being implemented in Spain means that 40% of subsidies are already decoupled from production, and subsidies will be completely decoupled between 2010 and 2013, with 50% for the grower and 50% for funding rural development measures. The model of reform chosen by the Commission carries a strong risk that growers will abandon the crop. Decoupled subsidies encourage growers to stop producing and this will have a very direct effect on certain areas of European countries such as Macedonia, Thessaly, and Thrace in Greece; Abruzzo, Basilicata, Campania, Umbria, Apulia, and Veneto in Italy; Alsace, Aquitaine, Dauphiné, Nord, Midi-Pyrenees, Poitou, Loire Valley in France, or Extremadura and Andalusia in Spain.

In Spain, the effects are already being seen: in fact for the 2006 harvest, tobacco contracts are down by 16%. We are in a period of great uncertainty; growers have just four years in which to redirect their investment. In the light of this situation, those growers wishing to stay in the sector or change product need to look carefully at the potential of their assets and make adjustments to the financial management of their present farms. The first step is to analyse and control costs, which will enable growers to offer quality products at a low price and in a way that is compatible with the protection of health and the farming environment, and with sustainable agriculture. In this scenario, we believe that a framework of indicators can help monitor the change policy adopted by the various countries by supporting and facilitating its control, management, and evaluation. The tobacco farming sector is making an effort to follow the guidelines of the Member States with regard to preserving the environment and contributing towards a sustainable agriculture with quality products. Countries such as France and Italy are already working towards the continuity of the tobacco crop; they

believe the answer lies in inter-professional associations that leverage Good Agricultural Practices, the rational use of resources, and product competitiveness. In Spain, work is also underway in the same direction; we are seeing the influence of Associations for Integrated Treatments in Agriculture (ATRIAs) and Good Agricultural Practices more and more in cooperatives[†]. The Inter-professional Tobacco Organization (OITAB) has also been set up to strive towards the promotion of quality in production and a better use of resources by means of training, research, and the monitoring of the production process.

Meanwhile revenues are showing a clear downward trend. Up until now the EU subsidy was an essential component of the final price received by the growers, which in Spain amounted to between 80% and 90% of revenues, while the remainder was made up by the processing companies. This would seem to indicate that the continuity of the production of crops in crisis such as tobacco will largely depend on the control of costs, the application of Good Agricultural Practices, and inter-professional associations that can manage, standardize, and defend the interests of the sector.

All the above calls for a market oriented quality management system, one which is of a multidimensional and dynamic nature in the sense of being able to adapt to the medium and provide tools that promote continuous improvement (Oakland, 1989). Costs need to be rationalized at every stage of a production process based on environmentally friendly practices, and farms and cooperatives should be encouraged to group together in order to capture positive synergies and offer a certified quality product able to compete successfully in the market.

[†] As can be seen in the recent publication of the “Basic technical guidelines to improve the quality and competitiveness of Spanish Virginia tobacco” which speaks of the need for a quality standard and the application of GAP (Good Agricultural Practices)

4. Proposal for key farming performance indicators based on the DPSIR approach for benchmarking in Spain.

Within the framework of EC Agricultural Policy, the concept of sustainable agriculture is currently immersed in a strategic transformation process aimed at meeting the needs of society, improving decision adoption processes (Agenda 21), and being more competitive. Consequently, there is a need to measure the efficiency of farm resource management at both a strategic and operational level. We believe that the use of key farming performance indicators would go some way to addressing that need and would facilitate the decision making process (Chamberlain, B.2004), (Rodríguez, R., 1999). After reviewing the framework of OCDE and EC agri-environmental indicators, and since the set of indicators proposed by the European Commission only defines management indicators, we propose going a step further by taking the DPSIR model as a reference. This model adds and develops further key performance indicators which, when complemented by five basic drivers of farming practices – financial capital, natural resources, social capital, physical capital, and human resources (Bebbington, 1999) – can act as a thermometer of a farm's performance, both per se and in relation to the environment. The idea is to provide clear information about physical, economical, and financial trends in this area, firstly to the managers of the farming associations and then to agri-environmental policy makers at both a regional and national level, so as to fuel opinion and debate about the principal problems, their causes, and the measures adopted to address them.

These indicators will allow agricultural groups to analyse the degree of economic sustainability of their farms and the use of factors that affect the environment, in such a way as to be able to monitor all the farms in a group individually or as part of the group,

and also monitor the performance of all the groups. This requires indicators to be consensually agreed, properly referenced, and consolidated over a period of time (Menge, 2003).

By working jointly with standardized indicators we can achieve national and international benchmarking and capture positive synergies which, in turn, will bring about a continuous improvement in the management quality of farms and their products while bringing farming in line with agri-environmental policies.

The information obtained is used to measure productive efficiency in terms of revenues, costs, and results. It also provides us with details about the application of the inputs that are most directly related to the environment, such as the consumption of energy, nutrients or phytosanitary products, while providing information about the producers' level of training, the amount of land funded by the European Union, and the extent to which Good Agricultural Practices (GAP) have been applied.

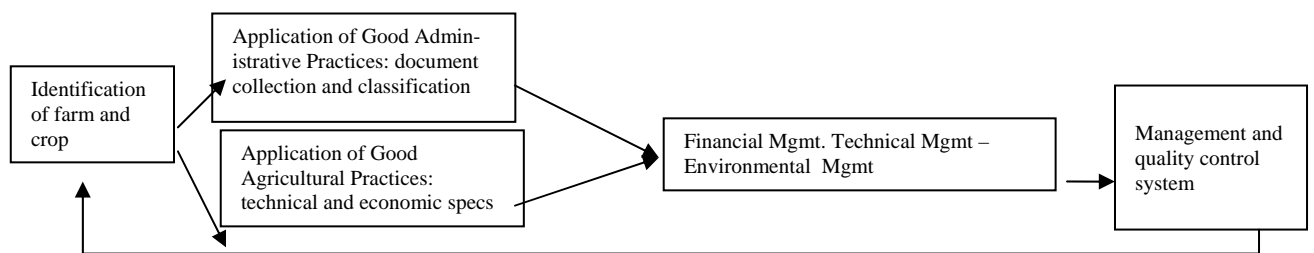
The study that gave rise to these indicators was based on a sample of 23 tobacco farms in the River Tiétar valley in Extremadura (Spain), during the 2003 and 2004 harvests. The crop involved was a monoculture of a single variety of tobacco – Virginia. The size of the farms ranged between 5 and 50 ha with a production quota of between 16,720 kg and 180,000 kg. Information was gathered by personal interviews with tobacco growers and farm technicians. Knowledge of the value chain provided us with the information we need to obtain our key indicators which allowed us to evaluate the performance of each activity, the use of inputs, and the farming practices used, as well as correcting the variables that need to be changed to make the farm more efficient. The model that is best suited to farms, and therefore to the needs of growers in search of continuity and quality, is one that combines the philosophy of activity-based cost management (under

GAP) with excellence of quality. Another requirement is for a model that can address failings in quality management. As Johnson, Kaplan and Cooper said (1996), competitive enterprises require management systems that can efficiently interpret the productive combination.

In order to be able to apply GAP and provide some results, both for individual farms and for those forming part of agricultural associations, first we need to design an information system to retrieve and summarize each farmer’s documentation. Each farm should have a log or recording system on which to keep a record of technical information. It should be maintained following accounting principles (it should be complete, systematic, and regular) and it should be maintained on a permanent basis in order to provide a constant monitoring of all crops grown and all farming activities undertaken at each location (Figure 2) together with the resources applied in each activity. Feedback should be constant.

Figure 2: Monitoring of farm

opera



tions

The proposed framework requires a degree of flexibility to adapt to current strategic planning and to take into account the relevant variables affecting a farm; i.e. long or short term, national or local, economic, social, and ecological levels. (Smaling and

Dixon, 2006). Therefore, before we can define these indicators, we need to know the strategic goals of the farms as dictated by EU general strategy and the convergence of theory and practice. In this way we can close the gap that exists between the information obtained and the actual situation (Wirén-Lehr, 2000).

In terms of their technical and economic content, most of these indicators are aligned with the DPSIR model for the purposes of relating farming practices and inputs with the environment and the corresponding political actions undertaken. More specifically, indicators have been developed for the *Driving Force, Pressure, and Response* sections of the model. With regard to the *Driving Force* section, we aim to identify the causes that put pressure on the environment within a given timeframe from the viewpoint of the financial management of a farm. These causes are broken down into land use, input use (amount of nutrients, phytosanitary products, energy, etc. consumed), and financial management. We consider that the goal of farms should be to achieve productive efficiency through the relationship between costs, revenues, and results. In this section we see that the excessive consumption of inputs, inappropriate cultural practices, or the poor utilization of infrastructure in general, are far from harmless to the economic performance of a farm; on the contrary, they impact on this and other areas of the DPSIR model. That is to say, overly high costs or the inappropriate application of inputs have an immediate effect in the short term. We are referring, among other things, to the reduction of the production per unit of surface area and poor quality products, all of which is reflected in the profit and loss account. Such negative effects also have medium- and long-term repercussions on the environment (habitats, landscape, pollution...etc.). The quantification of these effects over time is one of the most important aspects of UE policy aimed at protecting fauna, flora, and the landscape and

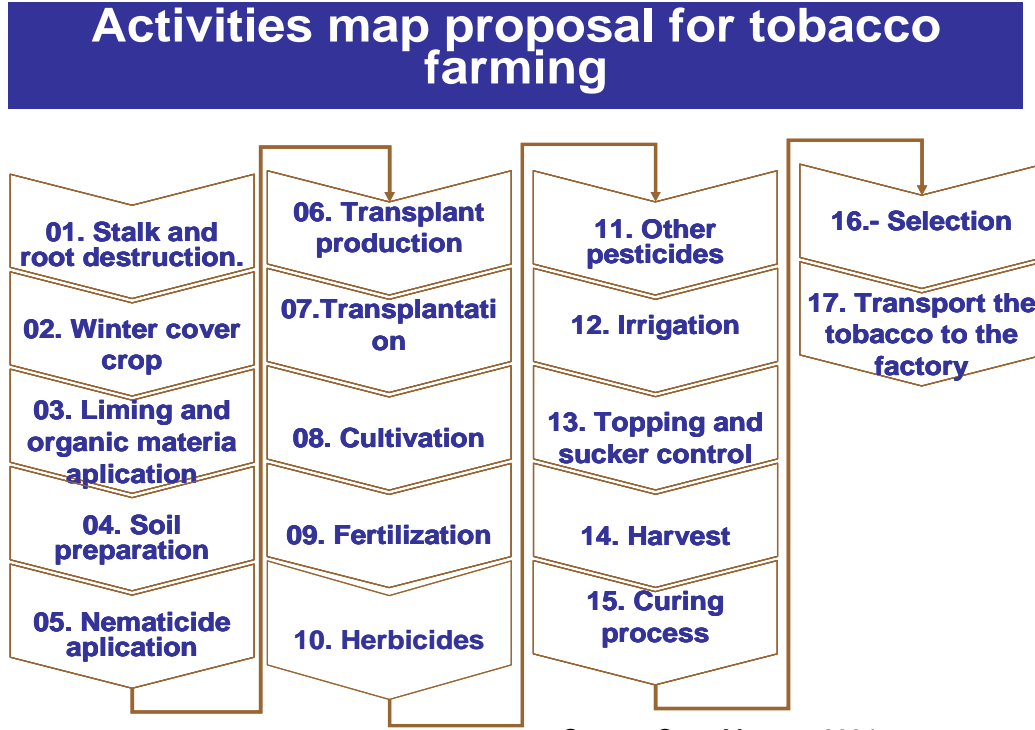
making their protection compatible with farm production. This is why there is constant research into ways of measuring the effect of poor practices and replacing them by practices that will promote sustainable agri-environmental development and pave the way for a virtuous circle.

In the *Pressure* section, the positive/negative effects of cultural practices in the medium term are measured (Blanco, 2001, Rodríguez, 2001, Payraudeau, 2005). Among the positive effects is the prevention of soil loss caused by erosion (contour farming, utilization of cover crops, etc.) or the prevention of the proliferation of parasites (crop rotation, diversification, etc.) with the consequent elimination of the damage caused by phytosanitary products. Among the negative effects are the water and/or air pollution, soil saturation and salinity... These effects, both positive and negative, are reflected in the environment: in the quality of the water, air, soil, biodiversity, and in the ecosystem. In short, the development of sustainable agriculture depends on the effective control of the negative effects.

In the *Responses* section, we identify the political actions undertaken at a regional, national, or the European Union (EU) level with regard to the funding of agricultural development, research into growing methods, technology, etc., and we assess the degree of compliance with GAP.

In order to be able to create indicators with this profile it was necessary to study the productive processes of farms, in our case tobacco farms, so as to be able to identify the activities (Figure 3) involved in their operation in the context of farming practices adopted within the framework of the DPSIR model (see Table 4).

Figure 3: MAP OF FARMING ACTIVITIES AND PRACTICES



Source: Cano Montero 2004

	DPSIR Ref.	STRATEGIC OBJECTIVES	GAP	INDICATORS
DRIVING FORCE	LAND USE	prevent the development of pathogens	destruction of remains of previous harvest	machine hours to destroy remains/ha
		prevent soil erosion	cover crop	machine hours to sow cover crop /ha
		loosen and aerate the soil	available techniques for leaving the soil in optimal conditions	machine hours to prepare soil/ha
		improve the composition and structure of the soil	application of organic and liming amendments	Kg amendments/ha
	INPUT USE	complement soil nutrients	physio-chemical analysis of the soil, selection of fertilizers, control of fertilizer specifications	units (N, P ₂ O ₅ , K ₂ O, etc.)/ha
		control damage to crops	if biological methods are not sufficient, apply phytosanitary products only when necessary (economic damage threshold), use of protective equipment, storage of products in appropriate places	units (phytosanitary products)/ha
		provide the soil with the optimal amount of water	inspect irrigation system, use clean water, adjust irrigation to soil texture, cover plant needs	m ³ water/ha
		equip workers for carrying out farm work	control of labour by activities, identify mechanized and manual labour; identify family and hired labour	Temporary AWU/ha; permanent AWU/ha AWU; family/ha; AWU/activity; AWU/ha; AWU/harvest
	MGMT: COSTS	rationalize the consumption of fuel or electricity based energy	performance of necessary checks and adjustments	units of fuel/ha. Type of energy/machinery
		rationalize use of assets according to the needs of the farm holding	monitoring of assets	Hm/ha, hm/activity
		economic valuation of the inputs and economic valuation of the activities	record of documentation (invoices, taxes, etc.)	€/kw/ha, €/inputs/ha, €/ha, €/activity, €/harvest, €/production
		MGMT: REVENUES	revenues from the sale of farm produce	€/ha, €/kg
	MGMT: RESULTS	know profit per product and per farmer	record of sale contracts, and knowledge of their content analysis of results and how they are achieved, continuous improvement	direct profit/ha, direct profit/kg, direct profit/family AWU, direct profit/permanent AWU
	RESPONSE	COMMON POLICY	know the extent of farmland funded by agri-environmental subsidies	record of documentation concerning the used and funded surface area
extent of GAP application			record of farming practices used by growers and supervised by the agricultural advisor	degree of GAP compliance/farm; degree of GAP compliance/farming association
ATTITUDE SKILLS		professionalization of farming	courses, demonstrations, advice	training hours/operative
		introduction of ecological farming		ha of ecological production/ha total farm
PRES SURE	POLLUTION	improve the environment	control of the use of fertilizers, phytosanitary products and other inputs	purchase of inputs per farm

The indicators developed in the *Driving Force* section need to be explained in greater depth, since in order to information about costs we require a management control system capable of classifying, valuing, and allocating costs to activities, so as to be able to assess the efficiency of those activities and of the farm in general. This system should also allow us to identify and evaluate the specific amounts and uses of various inputs involved in each farming activity (phytosanitary products, fertilizers, plants, electricity, fuel, machinery, and time employed) or in the key activities, so as to be able to measure both the degree of application of codes of good practices in terms of the rational use of inputs, and the economic effect of that use.

Information about revenues obtained from farm production and their associated costs (Elad, C.; 2004) allows us to obtain results indicators. These will enable us to analyse the various margins (margins per farm, per hectare, per work unit, on sales, etc.,).

The indicators developed in the DPSIR framework are to be integrated in the improvement plan. Here the cooperative or association plays an important role by providing the farmer with advice and issuing reports on the results of farms, thereby contributing to the improved performance of farms and the quality of products at a regional level.

Well used, this battery of indicators will serve as a continuous improvement tool that will impact on farming practices and the rational use of natural resources. The possibility of comparing the indicators will allow us to exploit the positive synergies of the farms with the best results, which will benefit both farm performance and the environment, in accordance with benchmarking theory (Daniel, E. Porter, M. E.; 2003), (Fritz, H. et al.; 2002), (RIRDC, 2001) and (Ronan, G. and Cleary, G.; 2000). This

approach can be extended to farms belonging to producer groups, at both a regional and national level.

At a regional level the process of comparing indicators incorporating financial and non-financial data provides us with an internal benchmarking system with the potential to become a performance standard for agricultural holdings.

At a national level, comparison is more difficult due to a lack of transparency and the growing complexity of agricultural chains, but this task will become easier once a standardized set of indicators has been developed.

An added value of benchmarking is a set of management performance indicators known as Best Value indicators (Ronan, G. and Taylor, P.; 2003) characterized by the following attributes:

- consistency: so as to be able to make comparisons over time
- ability to summarize and present information in a convenient form
- existence of a minimum-maximum range for the indicator values
- improved diagnostic methods for existing problems
- input variations and, therefore, output variations can be managed and optimized

Thus, benchmarking has become an important support tool in the quest for improved competitiveness and performance. To be able to find differences with other farms of a similar nature and then find the causes behind them is a major contribution to a sustainable and competitive agriculture.

There is no point in using benchmarking unless you take into account the point at which strategic farm planning interfaces with environmental, economic, and social issues. If it is well used, benchmarking can help us to locate the source of problems quickly and present the most significant indicators.

Finally, it should be stressed that the application of the DPSIR model requires the active participation of farmers, policy makers and governments. This in turn requires an organizational change to take place; that is, it requires farms to move towards their integration in producer groups under the direction of inter-professional agricultural organizations who, in liaison with the various social agents involved, will help design and implement whatever strategies may be required.

The key performance indicator framework that we propose should go a long way to striking a balance between economic imperatives on the one hand, and environmental impacts and social concerns on the other. To achieve this balance we need to weigh our performance indicators against these impacts and concerns in a cost-benefit analysis.

Finally, our proposed framework of indicators should be useful, flexible, and easy to understand so as to provide farmers with easy access to our methodologies of analysis, evaluation, and comparison. Thus, by means of comparison (benchmarking), either using figures from other years or by comparing with farms with similar characteristics, our proposed tool will be able to detect problem hotspots and therefore facilitate the decision making process, while helping the government to implement a set of Good Agricultural Practices for the sector to adhere to. The framework of indicators should be flexible enough to adapt to the strategic planning of each individual farm and overcome three constraints that arise at an international level. Firstly, there is a spatial constraint, since the ability to develop and measure indicators at an international level

cannot be extrapolated to data obtained from agricultural smallholdings. Secondly, there is the problem of overcoming time constraints; that is, the problem of finding causal relationships between variations in the effects of agriculture on the environment in the short, medium, and long term. Finally, we need to overcome the limitation of causal relationships to economic, social, and environmental issues and look for causes beyond.

6. CONCLUSIONS

The present concept of agriculture is destined to change, driven by the opening up of the economy, new environmental requirements, and the demands of competitiveness. Social, health, and environmental legislation in Europe and the application of Good Agricultural Practices are advantages in terms of delivering a quality crop but are causing the price of agricultural products (tobacco, cotton) to lose competitiveness in relation to other countries. Not to forget the fact that, once assigned production quotas are exceeded, farms receive no EU subsidies. Faced with the situation of uncertainty prompted by the partial or total elimination of subsidies, and with no room for manoeuvre, the only option that farms have to survive is to form cooperatives, rationalize each phase of the productive process, control costs, and leverage new tools.

Given the nature of most Spanish farms today, it is vital for farms to form producer groups and use management tools (still in its infancy in Spain in this sector) that will enable them to adopt Good Agricultural Practices and, therefore, to control and reduce their costs, increase farming efficiency, and improve the quality of products. The producer associations should be the main drivers of this conversion of farmers to a business culture, while the farmer needs to take a more active role in the management of his farm. Our proposal will provide these producer groups with another management,

evaluation, and feedback tool to use in their role as advisors and drivers of continuous improvement of farm holdings.

We took the DPSIR model as our reference because it is the model that best establishes the relationships involved in the sustainability of agriculture, from the basic drivers to the use of natural resources and environmental impacts. This model was also proposed by the UE to monitor the move towards the modernization or better overall performance of farms.

In Spain, there is still no real link between European policies (legislation, tax effects, etc.) and the cultural-historical motivation and education of farmers. Therefore, it is no easy task to monitor this change towards sustainable agriculture, combined with the strategic planning of farms. Our proposal aims to facilitate the shift towards an alignment of strategies and so we were careful not to overload our tool with too many indicators that would make it cumbersome to manage, focusing instead on striving towards a set of Best Value Indicators that would help establish thresholds beyond which alarm bells would ring.

As a challenge for the future we are working towards a framework of indicators based on the causal relationships between indicators that will meet the requirements of usefulness, flexibility, and ease of understanding, thereby opening the door for farmers to access a methodology based on analysis, evaluation, and comparison. More than anything we are trying to take a further step forward in the introduction of business management techniques to the agricultural sector and to correct any imbalances that those techniques may have been causing in the past. For this to become a reality, farmers, policy makers, and governments need to accept these indicators; the ultimate success or failure of this proposal is in their hands.

GLOSSARY OF ACRONYMS USED:

ABC: Activity Based Costing

AEI: Agri-Environmental Indicators

APAS: *Agrupación de Productores Agrarios* (Agricultural Producer Group)

ATRIAS: *Agrupaciones de Tratamientos Integrados en Agricultura* (Associations for Integrated Treatments in Agriculture)

GAP: Good Agricultural Practices

DPISR: Driving Force-Pressure-State-Impact-Response

FAO: Food and Agriculture Organization of the United Nations

FSI: Farmer Sustainability Index

LCA: Life Cycle Analysis

OECD: Organization for Economic Cooperation and Development

CMO: Common Market Organizations

OITAB: *Organización Interprofesional del Tabaco* (Interprofessional Tobacco Organization)

CAP: Common Agricultural Policy

UAA: Utilized Agricultural Area

SEC: Sustainability of Energy Crops

UDE: *Unidad de Dimensión Económica* (Economic Dimension Unit)

AWU: Annual Work Unit

BIBLIOGRAPHY

Blanco, I., 2001. *Control de plagas y enfermedades del tabaco. Enciclopedia Básica del cultivo del tabaco*. Cultivadores de Tabaco de España.

Blanco, I., Cano, E.I., 2005. *Guía técnica básica para mejorar la calidad y la competitividad del tabaco Virginia español*. Cultivadores de Tabaco de España. Madrid.

Brown, N., 1999. Towards sustainable agriculture. A pilot set of indicators. www.maff.gov.uk

Bebbington, A., 1999. Capital and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. *World Develop.* 27, 2021-2044.

Becu, n., Perez, P., Walker, A., Barreteau, O., Le Page, C., 2004. Agent based simulation of a small catchment water management in northern Thailand: description of the CATCHSCAPE model. *Ecol. Model.* 170 (2-3), 319-331.

Biewinga, E.E., van der Bijl, G., 1996. Sustainability of Energy Crops in Europe: A Methodology developed and Applied. Centre for Agriculture and Environment, Utrecht, The Netherlands, p. 209.

Bollen, K.A., 1989. *Structural Equations with latent variables*. Wiley, New York.

Buchs, W., 2003. Biotic indicators for biodiversity and sustainable agriculture-introduction and background. *Agriculture Ecosystems and Environment* no. 98, 1-16.

Chamberlain, B., 2004. Farm Management Indicators for the Environment: a New Zealand perspective with emphasis on developing receptive receiving environments to maximize the usefulness of indicators. New Zealand, 8-12 March 2004.

Commission of the European Communities, 2000. Communication from the commission to the council and the European Parliament. Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Brussels, 26.01.2000.

Commission of the European Communities, 2001. Communication from the Commission to the Council and the European Parliament. Statistical Information needed for Indicators to monitor the Integration of Environmental concerns into the Common Agricultural Policy. Brussels, 20.03.2001.

De Koning, G.H.J., van der Kop, P.J., Fresco, L.O., 1997. Estimates of sub-national nutrient balances as sustainability indicators for agro- ecosystems in Ecuador. *Agric. Ecosyst. Environ.* 65 (2), 127-139.

- Elad, CH., 2003. Fair Value Accounting in the Agricultural Sector: Some Implications for International Accounting Harmonization. *European Accounting Review*, vol.13 no. 4, 621-641, 2004.
- Esposti, R., Pierani P., 2000. Modelling technical change in Italian agriculture: a latent variable approach. *Agricultural Economics* 22, 261-270.
- FAO, 2003. Statistics Analysis Service, Statistics Division Food and Agriculture Organization of the United Nations. Rome. November, 2003.
- Geier, U., Köpke, U., 1998. Comparison of conventional and organic farming by process-life cycle assessment. A case study of agriculture in Hamburg. In: *Proceedings of the International Conference on Life Cycle Assessment in Agriculture, Agro-industry and Forestry*, Brussels, Belgium, 31-38.
- Giupponi, C., Eiselt, B., Ghetti, P.F., 1999. A multicriteria approach for mapping risks of agricultural pollution for water resources: the Venice Lagoon watershed case study. *Journal of Environment Management*. 56 (4), 259-269.
- Hengsdijk, H., van Ittersum, M.K., 2003. Formalizing agro-ecological engineering for future-oriented land use studies. *European Journal Agron.* 19 (4), 549-562.
- Jöreskog, K.G, Sörbom, D., 1989. LISREL 7: User's Reference Guide. Scientific Software Inc., Mooresville, USA.
- Menge, M., 2003. Experiences with the application, recordation and valuation of agri-environmental indicators in agricultural practice. *Agriculture, Ecosystems and Environment* 98, 443-451.
- Oakland, J.S., 1989. Total quality management. The route to improving performance. Butterworth- Heinemann Ltd., Oxford.
- OECD, 1997. Environmental Indicators for Agriculture, vol.1: Concepts and Framework. Publications Service, OECD, Paris.
- Oñate, J., Andersen, E., Peco, B., Primdahl, J., 2000. Agri-environmental schemes and the European agricultural landscapes: the role of indicators as valuing tools for evaluation". *Landscape Ecology*. Vol.15, no. 3, 271-280, April 2000.
- Parris K., 1999. OECD Agri-environmental indicators: Work in Progress, extracts from the OCDE publication: Measuring the environmental impacts of Agriculture: The York Workshop, 58-61.

- Payraudeau, S., van der Werf, H.M.G., 2005. Environmental impact assessment for a farming region: a review of methods. *Agriculture Ecosystems and Environment* no. 107, 1-19.
- Petersen, J.E., 2004. Development of farm management indicators in the European Union: Work under the EU's Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy. OECD 8-12 March, 2004.
- Petit, O., Corcos, B., O'Connor, M., 2001. Appropriation Sociale du problème de gestion durable de la nappe de Beauce. Programme Inter-institutionnel de Recherches et d'Etudes en Economie de l'Environnement (PIREE) du Ministère de l'Aménagement du Territoire et de l'Environnement. Université de Versailles-Saint Quentin en Yvelines, Guyancourt, France , p. 90.
- Piorr, H-P., 2003. Environmental policy, agri-environmental indicators and landscape indicators. *Agriculture Ecosystems and Environment* no. 98, 17-33.
- Rasul, G., Thapa, G.B., 2004. Sustainability of ecological and conventional agricultural system in Bangladesh: an assessment based on environmental, economic and social perspectives. *Agricultural Systems* 79 (3), 327-351.
- RIRDC, 2001. Rural benchmarking programs – A review short report 74. <http://www.rirdc.gov.au/Review>
- Rodrigues, G.S., Champanhola, C., Kitamura, P.C., 2003. An environmental impact assessment system for agricultural R&D. *Environment Impact Assessment*. Rev. 23 (2), 219-244.
- Rodríguez, J.A., 2001. Consideraciones medioambientales en el cultivo del tabaco en España. *Cultivadores de Tabaco de España*.
- Rodríguez, R., 1999. El diseño del cuadro de mando integral en empresas agrarias. *Revista Iberoamericana de Contabilidad de Gestión*.
- Ronan, G., Taylor, P., 2003. Benchmarking in Agriculture: Measuring competitiveness indicators. Paper for presentation to the Agricultural Productivity Index Symposium of the Asian Productivity Organisation, Bangkok, Thailand 15-17 December 2003.
- Ronan, G., Cleary, G., 2000. Best practice benchmarking in Australian agriculture: issues and challenges. www.agribusiness.asn.au/Review/Perspectives/2000hadbolt.htm

Smaling, E.M.A., Dixon, J., 2006. Adding a soil fertility dimension to the global farming systems approach, with cases from Africa. *Agriculture Ecosystems and Environment* no. 116, 15-26.

Van der Werf, H.M.G., Petit, J., 2002. Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of 12 indicator-based methods. *Agriculture Ecosystems and Environment* 93, 131-145.

Wiren –Lehr, S., 2001. Sustainability in agriculture - an evaluation of principal goal oriented concepts to close the gap between theory and practice. *Agriculture Ecosystems and Environment* no. 84, 115-129.

Zander, P., Kächele, H., 1999. Modelling multiple objectives of land use for sustainable development. *Agricultural Systems* 59 (3) 311-325.