

Environmental Management for Agriculture (EMA) and Sustainable Agriculture

By John Tzilivakis and Kathy Lewis

Agriculture and the Environment Research Unit, Department of Environmental Sciences,
University of Hertfordshire, UK (J.Tzilivakis@herts.ac.uk and K.A.Lewis@herts.ac.uk)

To be presented at the second European conference of the European Federation for Information
Technology in Agriculture, Food and the Environment (EFITA).
September 27-30, 1999, University of Bonn, Germany

Abstract

The UK Government sees the adoption of environmental management systems as a potential indicator of sustainable agriculture. This paper describes one such system Environmental Management for Agriculture (EMA) and explores its potential to contribute to sustainable agriculture.

EMA is computer software that has been developed by the Agriculture and the Environment Research Unit (AERU) at the University of Hertfordshire (UH), in collaboration with IACR Rothamsted and ADAS. It provides an environmental audit of all farm activities, a comprehensive library of information on environmental best practice, regulations and legislation, and a set of decision support modules to help identify site-specific best practice. The project started in 1994 with funding from Ministry of Agriculture, Fisheries and Food (MAFF) and extra funding in 1996 came from the Milk Development Council (MDC). An EMA business club has been established with membership from major retailers, industry organisations and individual farmers. Corporate subscription to this club is being used for further development, dissemination and maintenance of EMA, including the development of a web site. The software has been given the label of 'for the public good' by MAFF which means it is available free of charge except for a small administration cost for CD production, postage and packaging. The software has been in use amongst several hundred farmers and advisers in the UK for 2 years and its uptake is on the increase. EMA has also recently won an award in the Governments Science into Practice Awards 1998.

The interest and uptake of EMA by farmers, advisers and others involved in agriculture clearly demonstrates that it has a role to play in modern agricultural management. EMA is becoming a key medium for the transfer of environmental best practice advice and technology. It is perhaps, to a limited degree, filling the niche of a once free advisory service. But what will be its impact in terms of sustainable agriculture. Will it have any significant environmental, social or economic effects? At this relatively early stage we can only speculate on what such effects might be. However, what is apparent is that EMA can place a farmer in a better position to respond to changing pressures. Enhancing the ability of the industry to adapt will help the process of incorporating environmental and social costs into the food production system. In conclusion, it is difficult to assess the contribution of EMA to sustainable agriculture. But what is sustainable agriculture? There are many definitions and components. At a fundamental level it is a process of evolution. Therefore, those that have a better ability to adapt will survive and sustain in the longer term.

Keywords: Agriculture, Environment, Management, Sustainable, Software

Introduction

The potential environmental impacts from agriculture can be diverse. They may be local and site-specific, such as damage to biodiversity, or more international or global in nature, such as emissions of ammonia and greenhouse gases (Skinner et al., 1997; Jarvis & Pain, 1994). Increasing concerns over such impacts have led to both political and consumer pressures for the industry to respond to such issues and improve its environmental performance.

The difficulty is being able to deal with the diversity of issues within the framework of farm management. Figure 1 is a simplified representation of the complexity of the system and the range environmental issues associated with it.

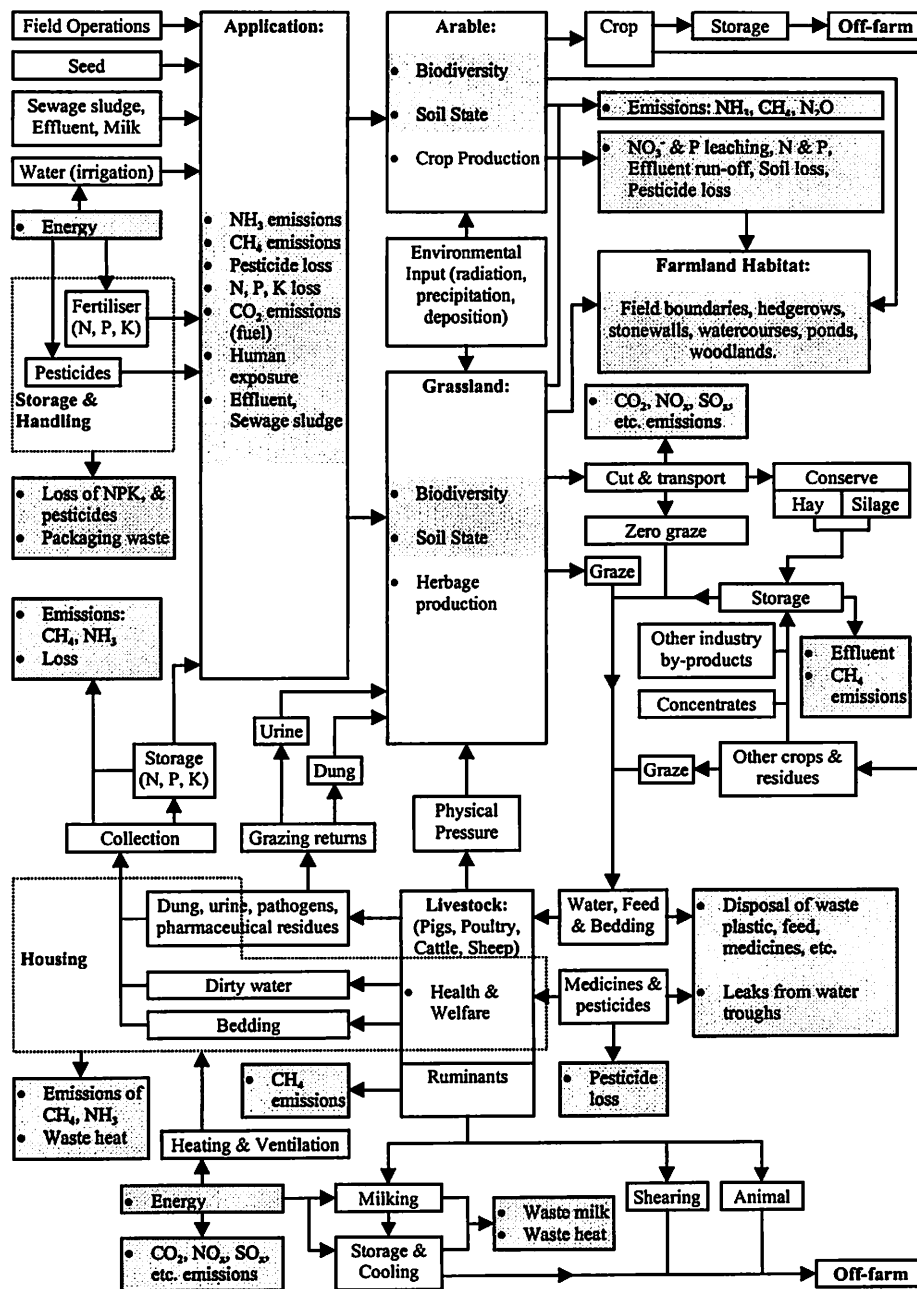


Figure 1. Agriculture and the Environment System Flow Chart

In other industries formal environmental management systems (EMSs) have been developed. These include the Eco-Management and Audit Scheme (EMAS) and the ISO 14000 Series, in particular ISO 14001. There has been a low uptake of these schemes in the agricultural sector. The relatively high cost of their administration within the business has made them unsuitable for the majority for the agricultural businesses in the UK (Newbold *et al.*, 1997). However, many of the fundamental principles and activities can be applied to agriculture. These include having a fundamental objective of continuous improvement, assessing the key environmental effects of the business, ensuring regulatory compliance, identifying objectives and targets for improvement, putting a programme of action in place to meet those objectives and undertaking an annual review/audit of activities to assess performance.

These principles have been incorporated into a more informal environmental management system that is specifically geared towards the needs of the agricultural industry. This system is known as Environmental Management for Agriculture (EMA).

Environmental Management for Agriculture (EMA)

EMA is computer software developed by the Agriculture and the Environment Research Unit at the University of Hertfordshire in collaboration with IACR Rothamsted and ADAS. The project started in 1994 with funding from the Ministry of Agriculture, Fisheries and Food (MAFF) and the Milk Development Council (MDC). The software is designed to encourage farmers to adopt environmental best practice. In some respects it can be regarded as a technology transfer tool and its potential in this area was recognised when EMA recently won an award in the Governments Science into Practice Awards 1998. The software has been in use in the industry for 2 years during which time it has been thoroughly tested and validated (Lewis & Tzilivakis, 1998).

Figure 2 summarises the structure of EMA. The software is composed of an Evaluation system that assesses environmental performance and Advisory and Technical systems that provide support for improving performance.

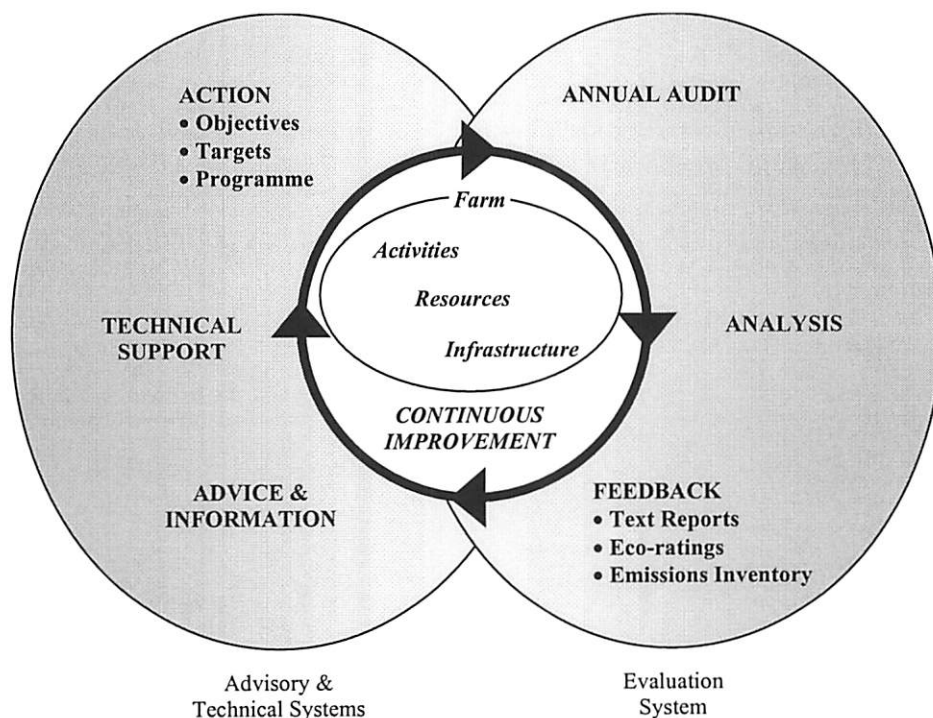


Figure 2. Summary of EMA Structure

The Evaluation system is an auditing system designed to analyse farm practices and compare them to environmental best practice for the farm. The audits are divided into discrete activity areas and in some instances there are sub audits:

- **Fertilisers & Livestock Wastes:** Organic wastes, Fertiliser applications, Odour.
- **Pesticides:** Field crop applications; General Management; Non-crop use (rodenticides, granular & pelleted baits, seed coatings & treatments, sheep dips, other livestock treatments, wood preservatives, fogs, mists & smokes).
- **Soil Sustainability:** General Management; Soil Nutrients & pH; Sewage sludge use; Lime use; Soil Erosion.
- **Livestock Management:** Indoor & Outdoor Pigs; Intensive Poultry – broilers & layers; Cattle; Sheep & Goats; Silage Production.
- **Energy Efficiency**
- **Water Efficiency**
- **Conservation**

A description of the farm including current cropping determines which audits require completion, i.e. if no organic manure is used then the audit for that activity is disabled. Audits can be categorised into two types, quantitative and qualitative, although some are a mixture of the two. Examples of quantitative audits include the types and quantities of fertilisers and pesticides used on each field. Qualitative audits are more of a checklist approach. The user is presented with a series of questions and they are asked to select answers that best describe farm practices, for example selecting from a list of features that best describes the farm's pesticide store. The audits collect data, and then the software compares it to what would be best practice for that farm (the definition of best practice is tailored according to the farm profile, for example best practice may vary with different soil types). The storage of the data also provides a valuable record of farm practices from year to year.

Three mechanisms are used to report environmental performance in the different activity areas. Firstly, there is a text report that highlights where best practice has or has not been achieved and where further advice might be sought, e.g. codes of practice (advisory system), BASIS advisers, etc. Secondly, there is an eco-rating. This is score of environmental performance that operates on a scale from -100 to +100. This scale aims to reflect the potential effect on the environment. Negative scores indicate a negative effect and positive scores a positive effect. For example, when using pesticides the aim is to minimise the negative effects, therefore the score will not be above zero. Whereas other activities, for example wildlife conservation, can have enhance and improve the environment and a positive score is possible. To aid the understanding of the eco-rating the scale is banded as shown in Figure 3.

The scale used for crop applications of pesticides (B in figure 3) is different to the standard scale (A in figure 3) in order to reflect the complexities of the issue. There is an overlap between bands in the centre to take account of the toxicity of the pesticide and way it is used. For example, a highly toxic pesticide will tend to have a poor eco-rating but if it used correctly it is acceptable practice. Likewise a pesticide of low toxicity will tend to have a better eco-rating but if it used incorrectly or poorly it is not acceptable.

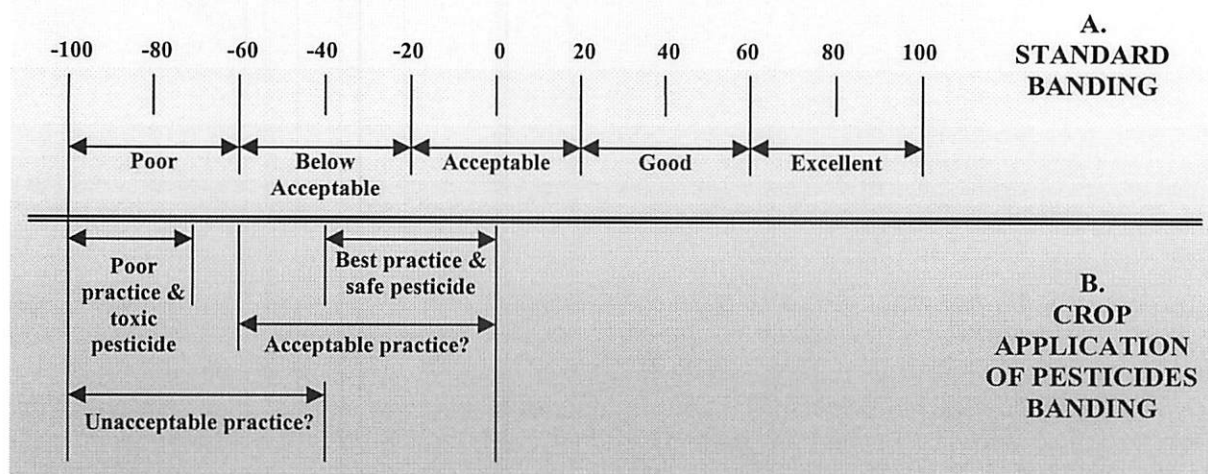


Figure 3. Eco-rating Bandings

The eco-rating scores for the different farm activities can be viewed as a profile. It can then be used to judge changes in the environmental performance of farm activities from year to year.

A third method of reporting back is an emissions inventory. The EMA software models the loss of pollutants from the farm using the data supplied in some of the audits and the farm profile. Although simplified in some areas, the models are responsive to best practice. Therefore any trends observed in the emissions inventory can be used as a supplementary guide to the environmental performance of the farm. The emissions included in the inventory include nitrate, ammonia, oxides of nitrogen, methane, carbon dioxide, carbon monoxide, sulphur dioxide, pesticides, and amounts of silage effluent, FYM, slurry/excreta produced (Lewis *et al.*, 1999).

The advisory system is a computerised library of documents on environmental best practice. The system is split into a Legislation database, Codes of Practice, Library Information and Environmental Management. The legislation database contains summaries on over 250 pieces of legislation relevant to agriculture and the environment in England and Wales, including European Directives. The Codes of Practice section contains numerous documents including MAFF, Fertiliser Manufacturers Association (FMA) and National Farmers Union (NFU) Codes of Practice (MAFF, 1998 a, b, c, d & e; FMA, 1998a & b; NFU, 1996), Guidance on Sewage Sludge, the FWAG Guide to Environmentally Responsible Farming (FWAG, 1998), the LEAF Guide to ICM, and other miscellaneous guides. The Library Information section contains short texts designed to give a concise introduction to agriculture and the environment issues, e.g. nitrates, pesticides, biodiversity, and water and energy efficiency. The Environmental Management section provides a guide to the formal environmental management systems EMAS and ISO 14000. The advisory system is hyperlinked in a similar manner to the Internet. For example, in the codes of practice various references are made to articles of legislation. These are underlined in the text and clicking on them will display the relevant summary in the legislation database. Such links between the various documents allow the user to explore a line of thought and the search and bookmarking facilities greatly enhance the encyclopaedia of knowledge contained within the advisory system.

The Technical system contains a set of decision support modules. These aim to help the farmer make a more informed decision that will reduce the risk of damaging the environment. The modules include:

- A fertiliser recommendation module that calculates the amount of inorganic fertiliser required given the crop, soil type, soil P, K, Mg, previous crop or soil N analysis, and organic manures applied.

Amounts of inorganic fertiliser required are calculated along with appropriate timing to reduce the risk of nitrate leaching.

- A waste management adviser that offers information on minimisation, recycling and safe disposal on a range of wastes found on farms including plastics, packaging, chemicals and workshop wastes.
- A pesticide informer that identifies all pesticides that are approved to treat a given problem on a given crop. A description of each pesticide is given in the list along with all the label precautions. These are displayed graphically using an icon system when the user clicks on one of the pesticides listed, e.g. a Bee if it poses a hazard to Bees. This allows the user to take account of the potential hazard when choosing pesticides. For example, if Bees are going to be present during application the user may wish avoid those that are hazardous to Bees or if it is to be used near surface waters to avoid those pesticides that are hazardous to aquatic life.
- A soil damage and erosion risk assessor.
- The soil, environmental risk and climate database provides baseline information about the area in which the farm is located. This includes 30 year average climate data, dominant soil type, if there is a principal aquifer underlying the area, groundwater vulnerability, sulphur deposition, erosion risk, nitrate leaching potential, and if any part of the area is in an NVZ.

The software has been in use amongst several hundred farmers and advisers in the UK for 2 years and its uptake is on the increase. The software has been given the label of 'for the public good' by MAFF which means it is available free of charge except for a small administration cost for CD production, postage and packaging. The low cost of the software should maximise its potential for dissemination.

A key issue is the need to provide support and updates. This is being handled by establishing an EMA club with membership from major retailers, industry organisations and individual farmers. Corporate subscription to this club is being used for further development, dissemination and maintenance of EMA, including the development of a web site (<http://www.herts.ac.uk/natsci/Env/aeru/emahome.htm>) to provide a facility for users to download EMA updates. Additional funding has been obtained to further develop the environmental assessment of pesticides within EMA so that it is more risk based compared to its current hazard oriented approach. Funding has also been obtained to develop an organic farming module that will assess the economic and environmental implications of converting from conventional to organic farming over a seven year period. It is also hoped that at some point in the future fruit and other horticultural crops will be incorporated into EMA. This may also include extending the system to growers in South Africa and Chile.

EMA and Sustainable Agriculture

EMA is still at early stage in terms of dissemination into the industry. However, it is clear from the level of uptake and interest that EMA has an important role to play. In particular the issues covered by EMA overlap considerably with those being considered in the debate on sustainable agriculture. Therefore it is of interest to explore how EMA might contribute to developing sustainable agriculture. Assessing this contribution is not easy. Webster (1997) recognises that there are great difficulties in determining what agricultural systems are sustainable. There has been a lack of consensus defining sustainable agriculture in practical or functional terms. However, there is no lack of definitions, Pretty & Howes (1993) listed 75 definitions for sustainable agriculture. The only consensus is that sustainable agriculture should meet the needs of the current population without comprising the needs of future generations (Bowers, 1995). But this does not provide clear objectives for the development of sustainable farming systems.

The lack of clearly defined objectives for sustainable agriculture inherently comes out of the complexity of the systems involved. From an environmental perspective there are multiple environmental

objectives that need to be considered. These include biodiversity, greenhouse gas emissions and climate change, nutrient emissions and impacts on ground and surface water such as eutrophication, the use of pesticides, air pollution including ammonia emissions and the impact of its deposition in ecosystems, waste, water pollution from slurries, manure and silage, and soil sustainability. EMA aims to help the farmer address all these issues and in particular it aims to take account of site sensitivities and features. The damage tolerance and ability of environmental receptors to recover will determine the levels of pressure that can be sustained. This ability can be termed as resilience and Martin (1988) and Conway (1987) both recognise it as an important property of sustainable agroecosystems. However, they also recognise that sustainable agroecosystems must also be stable, productive and equitable. This brings economic and social dimensions into consideration.

Farms need to be financially viable whilst also protecting the environment. There is little to be gained from putting farms out of business in pursuit of environmental protection, unless there is a policy of turning land over entirely for environmental purposes. Impacts upon the rural economy must also be taken into consideration (Webster, 1997). Additionally, the industry as a whole must produce food that is affordable. A farm that protects the environment but produces food that no one can afford is no more sustainable than a farm that produces cheap food but at the expense of environmental damage. The social dimension also introduces elements of value, quality and priorities. These include food quality and safety, cost, animal welfare, and health and safety. There are also differing social priorities on environmental protection be it water quality, air quality, biodiversity or landscape.

Marsh (1997) describes farming systems as the meeting point of natural, economic and social systems, each of which has its own dynamics. Sustainability appears to be a search for a utopian balance between environment, society and economy. However, the dynamic nature of these systems means that the heart of sustainable agriculture will need to be evolutionary. It must be able to respond to threats and opportunities. To reduce environmental damage where necessary whilst performing its economic and social functions.

The adoption of environmental management systems is seen as a potential indicator of sustainable agriculture by the UK Government (MAFF, 1998f). However, it does not indicate either the impact of the farm on the environment or its sustainability. The fact that a farm is trying to manage its environmental impact does not mean that there are not any negative impacts or that its performance is improving. However, it does provide an indication of the response of the industry to tackling the issue. In relation to this, using EMA does not directly make a farm sustainable. However, as described above, sustainable agriculture will need to be evolutionary. EMA can act as a catalyst in this evolution in a number of ways including:

- It can make the farmer more of aware of environmental issues.
- It provides an assessment of environmental performance and allows this performance to be monitored.
- It provides support and advice on managing environmental impacts and provides tools for identifying and adopting best practice.
- It provides a medium for the transfer of new information and knowledge. As we learn more about the interactions and impact of agriculture on the environment these need to be translated into best practice and transferred into the industry.

In the past half century the agricultural industry has been in a constant state of flux, change and reform. So far it has been able to respond and adapt to meet the demands placed upon it, proving that it has the ability to evolve. However, that ability is dependent on having the knowledge to do so. EMA can help

deliver that knowledge and enhance that ability of the industry to respond to the issues it faces now and in the future.

References

- Bowers, J. (1993) Sustainability, agriculture and agricultural policy. *Environment and Planning A* 27, 1231-1243
- Conway, G. R. (1987) The Properties of Agroecosystems. *Agricultural Systems* 24, 95-117
- FMA (1998a) *Code of Practice for the Prevention of Water Pollution from the Storage and Handling of Solid Fertilisers*. Produced in consultation with the Environment Agency England, Environment Agency Wales, Scottish Environment Protection Agency Environment and Heritage Service Northern Ireland.
- FMA (1998b) *Code of Practice for the Prevention of Water Pollution from the Storage and Handling of Fluid Fertilisers*. Produced in consultation with the Environment Agency England, Environment Agency Wales, Scottish Environment Protection Agency Environment and Heritage Service Northern Ireland.
- FWAG (1998) *Handbook for Environmentally Responsible Farming*. FWAG
- Jarvis, S. C. & Pain, B. F. (1994) Greenhouse gas emissions from intensive livestock systems: their estimation and technologies for reduction. *Climatic Change* 27, 27-38
- Lewis, K. A. & Tzilivakis, J. (1998) Evaluating a technique to measure environmental performance within agriculture – Case studies. *Eco-Management and Auditing* 5(3), 126-135
- Lewis, K. A., Newbold, M. J. & Tzilivakis J. (1999) Developing an Emissions inventory from Farm Data. *Journal of Environmental Management*. (In press)
- MAFF (1998a) *Code of Good Agricultural Practice for the Protection of Air* PB0618
- MAFF (1998b) *Code of Good Agricultural Practice for the Protection of Soil* PB0617
- MAFF (1998c) *Code of Good Agricultural Practice for the Protection of Water* PB0585
- MAFF (1998d) *Summary document for the codes of good agricultural practice for the protection of water, air and soil* PB4029
- MAFF (1998e) *Code of practice for the safe use of pesticides on farms and holdings* PB3528
- MAFF (1998f) *Development of a set of indicators for sustainable agriculture in the United Kingdom. A Consultation Document*. Ministry of Agriculture, Fisheries and Food 22 June 1998
- Marsh, J. S. (1997) The policy approach to sustainable farming systems in the EU. *Agriculture, Ecosystems and Environment* 64, 103-114
- Martin, G. G. (1988) Productivity, Stability, Sustainability, Equitability and Autonomy as Properties of Agroecosystem Assessment. *Agricultural Systems* 26, 291-316
- Newbold, J., Lewis, K. A., Tzilivakis, J. Skinner, J. A., Finch, J, Kaho, T. & Bardon, K. (1997) The options for informal environmental management: The agricultural industry highlighted. *Eco-Management and Auditing* Vol. 4:1, 22-27
- NFU (1996) *A Framework Code of Practice for Dairy Farms*. Compiled by the NFU Livestock Department with support and endorsement from the Milk Development Council. September 1996
- Pretty, J. N. & Howes, R. (1993) *Sustainable Agriculture in Britain: recent Achievements and New Policy Challenges*. Research Series Volume 2, Number 1, International Institute for Environment and Development, London.
- Skinner, J. A., Lewis, K. A., Bardon, K. S., Tucker, P., Catt, J. A. & Chambers, B. J. (1997) An overview of the environmental impact of agriculture in the UK. *Journal of Environmental Management* 49, 111-128
- Webster, J. P. G. (1997) Assessing the economic consequences of sustainability in agriculture. *Agriculture, Ecosystems and Environment* 64, 95-102