Centre for Agriculture and Environment

Ministry of Food, agriculture and Fisheries
Danish Institute of Agricultural Sciences

ADAS

Study on Input/Output Accounting Systems on EU agricultural holdings

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Preface

As project manager of this study I would first like to thank Gillian Goodlass and Niels Halberg for being excellent project partners. I also would like to thank the team of the European Commission being involved in this study for their constructive input: Luis Carazo-Jimenez, Michael Hamell from DG environment and Martin Scheele from DG Agriculture.
I also would like to thank the developers of IOA systems for filling in the survey questionnaire. I am especially grateful for the contact persons who kindly provided additional information to make a more in-depth study of ten selected IOA systems possible. Lastly I would like to thank my colleague Frits van der Schans for his final reading of the text.

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1 Introduction

1.1 Background to this study

An important part of the food consumed in Europe is produced on intensive agricultural farms. The intensive nature of such production systems means that food may often be produced at a relatively low price, but this may be at the expense of contributing to environmental pollution (e.g. nitrate, phosphate, eutrophication, pesticides). The economic driving forces mean that intensive agricultural production systems will continue in Europe in forthcoming decades. Therefore it is necessary to tackle environmental problems of intensive production systems by decreasing the pollution of nitrogen, phosphorus, pesticides, CO_2 etc.
Within the group of intensive farms there is a lot of variation in efficiency of production and often related to this in environmental performance. Two examples from the Netherlands, one of the most intensively farmed countries in Europe, show this:

- In 1995/96 in the Netherlands 33% of the dairy farmers with a milk production of more than 11,500 kg per ha had a nitrogen surplus of less than 400 kg N per ha, while on the other hand 33% of the dairy farmers with a milk production of less than 11,500 kg per ha had a nitrogen surplus of more than 400 kg N per ha (Langelaan, 1997).
- In an inquiry among Dutch potato farmers use of fungicides against Phytophthora appeared to vary between 1 and 21 kg active ingredients per ha, with an average of 10 kg per ha. Differences in application were determined for 60-70% by the dose per treatment and for 30-40% by the number of treatments (Janssen, 1996).

Adequate management information is an important prerequisite to help farmers achieve a higher efficiency and to reduce environmental impacts. Management information can be given by Input/Output Accounting (IOA) systems. Therefore it is interesting to compare IOA systems and analyse the role of IOA systems as a management instrument to improve the efficiency of farms and reduce environmental pollution.

In a considerable number of countries nutrient balances have been used at farm level, purely as a management instrument for farmers or as a base for levies on surpluses such as is the case in the Netherlands. Other single issue output accountings systems are on e.g. pesticides and energy. More and more initiatives cover a range of aspects, often for certification or marketing purposes. Several countries such as the UK have developed the concept of Good Agricultural Practice (GAP) into a series of practical guidelines to help agricultural consultants and farmers minimise the risk of polluting soil, water and air while allowing economically viable agriculture to continue (e.g. MAFF, 1998).

Although a variety of IOA systems are already used across Europe, at the moment there is no complete overview of these systems, their scope, details and efficacy. Hence, DG agriculture and DG environment authorised a comprehensive review and critical assessment of IOA experiences.

Input/Output Accounting systems operating in different Member States vary considerably in their emphasis and the breadth of their remit. This depends partly on the nature (supply – e.g. farmers, or demand – e.g. supermarkets) of the forces driving their establishment. IOA systems can be either a narrowly defined auditing method focused on economic criteria (e.g. feed input: meat, milk or eggs output) or a broader remit which also considers the environmental impact of the waste products (including emissions to surface and ground water, soil and air) from the agricultural production system under consideration. The latter, broader approach would also take account of the outputs and fate from livestock waste such as slurry and manure, and possibly even consider the impact of the method of recycling this "waste" on subsequent outputs such as NH_3 volatilisation or nitrate leaching etc.

The CAP already provides a considerable number of instruments seeking to improve or maintain the environmental profile of agriculture, although these are not uniformly implemented across sectors and regions. Although the recently adopted CAP reform reinforces some of these instruments, it is not yet clear whether EU agriculture will be able to reach a position of 'environmental neutrality' in the near future. This is especially true with respect to the most intensive types of farming.

From this perspective, the examination of individual farm practices through Input/Output Accounting deserves further consideration as a possible tool to asses (and potentially raise) the environmental performance of EU farms. In the context of local conditions, the subsequent analysis of accounts may contribute to the establishment of *standard recommended practice* for groups of accounted farms together with *individual best practice* for each accounted holding. The former may contribute to delivering a practical meaning to the Good Agricultural Practice (GAP) concept, while the latter provides a potential means of improving the environmental performance of individual farms.
However for nitrogen it is acknowledged that IOA systems (e.g. PARCOM-guidelines for mineral accounting) appear most useful under high surplus situations as a result of the non-linearity between net input and losses. This is a point endorsed in OSPAR NEUT-document NUT/97/4/2.

1.2 Objective of this study

The objective of the project is to provide Commission services (DG agriculture and DG environment) with a critical assessment of current experiences with Input/Output Accounting at farm level. This report will hopefully contribute to a better understanding of the strengths and weaknesses of IOA systems to make farming in Europe more environmentally friendly.

1.3 Structure of the study

Three project partners have carried out the study in the period between March 2000 and March 2001. The Centre for Agriculture and Environment (CLM) based in the Netherlands coordinated the project in close co-operation with ADAS based in the United Kingdom and DIAS based in Denmark. This report contains four chapters.

In chapter 2 a comprehensive overview of existing IOA systems in Europe is presented. The information is obtained through networks of the three project partners. The developers of IOA systems filled in a questionnaire including questions about design (e.g sectors and environmental subjects covered), management and administration (e.g. indicators produced by the system and required input data) monitoring and evaluation (e.g. effectiveness) and additional information available for further study. A short summary of each system is presented in this report.

In chapter 3 ten IOA systems were selected for further study. Based on a more elaborate questionnaire comprehensive reports were made for each of the ten selected IOA systems. A summary of these reports is presented in this report, as well as a comparison of the ten selected IOA systems.

In chapter 4 an analysis of strengths and weaknesses of IOA systems is presented taking two perspectives: the farmer and society. A number of tables give a good overview of differences between selected IOA systems. The analysis has a qualitative character in the cases where hard data were lacking.

In chapter 5 all IOA systems have been developed in the past decade. Further development of IOA systems is discussed in this chapter. Reasons for introduction of IOA systems are presented as well as suggestions for ways to develop them further.

1.4 References

- Janssen, H. 1996. Oorzaken van verschillen in middelengebruik tussen bedrijven [Causes of difference in pesticide use between farms]. LEI-DLO, The Hague.
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- MAFF, 1998. Code of Good Agricultural Practice for the safe use of pesticides on farms and holdings. UK Ministry of Agriculture Fisheries & Food/Welsh Office Agriculture Department.

2 Survey

2.1 Summary

Of 241 questionnaires sent out to 20 countries 55 completed forms were returned. No information could be obtained about systems in Portugal or the USA. The subject of nutrients was covered by 91% of systems, pesticides 38%, energy 29% and other subjects including wastes 44%. Nearly half of the systems covered more than one subject, the most common single subject system was nutrients. The arable sector was covered most often by the systems (76%), with dairy (62%) and pig (56%) the most prominent of the livestock sectors. The respondents judged that 65% of systems were at least moderately effective in improving the ratio of inputs to outputs. The highest levels of ratio reduction tended to occur with systems which included the livestock sectors or protected horticultural crops. Over half (56%) of farmers had a good opinion of the system, indifferent or bad opinions were more likely to be due to effect on income than the type of system or who managed it. High uptake was more likely in compensated systems. Farm incomes in the arable and dairy sectors were most likely to be improved by systems, negative effects were most likely in the horticultural sector. Government was the main driving force in 38% of the systems, but government was not necessarily the driving force behind the 15% compulsory systems and only one of these was compensated.

2.2 Introduction

Input/Output Accounting systems (IOAs) vary considerably in their emphasis and the breadth of their remit. This depends partly on the nature of the forces driving their establishment. They can be either a narrowly defined auditing method or a have a broader approach covering the environmental impact of waste products (including emissions to surface and ground water, soil or air). The objective of this project is to provide the Commission with a critical assessment of current experiences with Input/Output Accounting at a farm level. This report covers the first step in the project which was to identify all existing IOAs on agricultural holdings in the EU and some interesting examples from non-EU OECD countries and to obtain information about them.

2.3 Methodology

2.3.1 Subject of the search

Input/Output account systems (IOA systems) for nutrients, pesticides and energy at agricultural holdings. The IOA systems of interest were defined as: systems that register inputs of nutrients, pesticides and energy on the farm and relate these to outputs, which allow an assessment of environmental performance and management change.

The IOA systems that were investigated used environmental meaningful units. IOA systems which express inputs and outputs in economic terms only were not investigated.

2.3.2 Geographical coverage of the search

The three consortium-members divided the countries as follows:

ADAS	United Kingdom (England/Wales, Scotland, N Ireland), Republic of Ireland, France, Spain
DIAS-EU	Denmark, Sweden, Finland, Germany, Austria
DIAS-nonEU	Norway, Switzerland, United States of America
CLM	the Netherlands, Belgium, Luxemburg, Portugal, Italy, Greece

2.3.3 Search Procedure

The following procedure was used:

1. For each country (except nonEU-countries) that was assigned to them, ADAS, DIAS, and CLM contacted the agricultural ministry, the farmers union, and the agricultural attaché of their own country, with a request to provide names of organisations and possibly persons that deal with development or implementation of IOA systems.

2. ADAS, DIAS, and CLM explored their own network to draw up lists of contact personnel in all countries to be included in this project. Contacts in countries assigned to other partners were exchanged. Potential resource organisations were as follows:

- Environmental Ministries
- Research organisations
- Market-led IOA systems
- Supermarket chains
- Meat processors
- Cereal trade
- Fruit and vegetable marketing organisations
- Dairy industry and trade
- Farm advisory services

3. For nonEU-countries, DIAS screened OECD reports with the aim of finding contact personnel involved in IOA systems.

4. ADAS, DIAS, and CLM sent the questionnaire and accompanying letters (all in English) to their contact personnel.

5. After the deadline had passed, ADAS, DIAS, and CLM telephoned their contacts, in order to stimulate a response, or request an alternative contact person.

2.3.4 The questionnaire

A tick box style questionnaire was devised (see Appendix 1) to collect information about:

- design and content, including the original driving force behind the system
- management and administration, including the inputs/outputs and relationships
- monitoring and evaluation, including information about effectiveness
- information available for further study.

2.4 Results

2.4.1 Completed questionnaires

The questionnaire and accompanying letters were sent to 241 contact personnel in 204 different organisations as well as to a number of internal contacts in CLM, DIAS and ADAS. By 27 January 2001 a total of 55 completed questionnaires had been received. The respondents were Austria (2), Belgium (3), Denmark (6), England (9), Finland (2), France (3), Germany (5), Greece (1), Italy (2), Luxemburg (1), Netherlands (10), Northern Ireland (1), Norway (1), Republic of Ireland (1), Scotland (3), Spain (2), Sweden (1) and Switzerland (2). No replies were received from Portugal or USA. The systems (grouped on the basis of subject area) are described briefly in Appendix 2.

Nearly half the systems covered more than one subject area. Most (91%) of the 54 questionnaires covered the subject area of nutrients, whilst 38% covered pesticides, 29% energy and 44% other subjects including wastes. Looking at the 30 single subject systems most (26) were nutrient with only 3 pesticide and 1 energy based system. A breakdown by industry sector is given in Table 1. The majority of systems were farm and not commodity based. Many contact personnel reported that commodity based systems for meat and poultry products were not based on input/outputs but on animal welfare and were not therefore appropriate for this survey. However some commodity based IOA systems for produce do exist, usually with an end point of certified produce which has traceable (and environmentally acceptable) inputs of pesticides and fertilisers. Other systems although described as farm based can be used to achieve certified produce which has a 'quality' label and thus a marketing advantage. These systems can originate from research or government in the first instance or directly from producer groups or supermarkets.

Table 1 Percentage of completed questionnaires covering each industry sector

Arable	Horticulture	Beef/ veal	Dairy	Pigs	Poultry	Organic Farming	Other (including protected crops)
76	53	45	62	56	44	49	31

Government was cited as the main driving force in 21 of the systems and as the funder of research in 2 other systems. There were 9 systems described as having multiple driving forces. There were 8 mandatory systems and 4 which although voluntary, were described as compulsory for those wishing to 'qualify' for a certain quality/label status

or join a compensated environment scheme. Only 4 of the mandatory and 2 of the 'qualifier' systems were government driven.
Half the systems had no restrictions on eligibility and where there was a restriction they were ranked as follows: farm area (31%) livestock numbers (24%), soil type (24%), geographic location (20%) livestock density (16%) and other unspecified (15%).

The most common indicators for systems were nutrient balance 53%, pesticide regime 27%, energy balance 22% and nitrate leached 13%. None of the other 19 indicators were used by more than 3 systems and 8 were used by only 1 system. Where specified, nutrient balances covered Nitrogen (N), Phosphorus (P) and Potassium (K) in 13 cases, N and P in 12 cases, N only in 9 and P only in 4 cases. Two systems also covered heavy metals, both of these were Danish.

Farmers were more often involved in collection than processing of data (Table 2). No-one processed data in 1 system. Tools for processing data exist for 67% of systems and 71% have a manual or set of guidelines.

Table 2. Information Handling (No. of systems)

	Data Collection	Data Processing
Farmers/Outside Agency	23	17
Farmers only	22	11
Outside Agency only	10	26

The results are explained to farmers in a specific report (either written and/or verbal) in 65% of systems and in 40% of systems, farmers get information on the performance of other farmers using the system. The most common reference values for comparison and/or interpretation are official limits (49%) followed by: own historic data (38%), average values from a set of farms (29%), experts view of best practice (27%) and finally best results from a set of farms (22%).

The cost per year of administering the system in terms of time was not known in 7% of systems, where it was known it was judged as follows: < 4 hours (22%), 4-16 hours (38%) or >16 hours (33%). Regulation of the system is shown in Table 3.

Table 3. Regulation of Systems (%)

Government	Advisory Service	Other External	None
36	15	22	27

Farmers were compensated for the costs of joining in 17 of the systems, 1 of these was a mandatory system and 3 were 'qualifier' systems.. The effect of the system on farm income is shown in Table 4, overall there was a positive effect on income for about a third of the systems, notably the arable and dairy sectors.

Table 4. Effect of system on farm income by sector (%)

	arable	horticulture	beef/veal	dairy	pigs	poultry	organic farming	other	all sectors
negative	2	10	4	3	3	4	0	10	4
no effect	17	28	20	15	16	21	25	40	21
positive	48	24	32	41	35	21	33	20	34
not known	33	38	44	41	45	54	42	30	41

Six of the systems were still at the research or design stage, 12 were pilot schemes and 35 were in use. The oldest system to be used began in 1975 and the most recent are due to begin in 2001. The smallest system has only 2 farmers in it and the largest over 80,000.

Respondents were asked to judge the effectiveness of their system in terms of its effect on input/output balances, 12 were unable to do so whilst 20 made an attempt to quantify the effect. In 35 systems the respondents thought that its use had led to a reduction in the ratio. Where quantified the range was from 0.5 to 90% reduction with the highest values occurring in systems which included the horticultural protected crops sector (respondents did not identify which sector(s) the reduction referred to). There was no effect in 5 systems and in 3 systems the inputs were increased. Documented evidence on effectiveness was reported to be good or very good for only 20 systems (not all of whom attempted to quantify the effect). One of these 20 (Appendix 2 no.43) was able to differentiate between sectors and identified more benefits in the dairy sector than the arable and pig sectors, but most respondents did not differentiate between sectors. Another means of judging the success is to look at the number of farmers joining the scheme expressed as a percentage of those the respondents expected to join. Just over half the respondents were able to make this judgement. Very few (7) of the systems had more than 75% uptake (Table 5) and 5 of these were compensated systems. The farmers opinion of the systems is shown in Table 6. Only three respondents said that farmers disliked their system and in another instance the opinion was good when results were used for advice, but opinion changed to bad when they were used for taxation purposes. Farmers opinion of the system did not appear to be directly related to the subjects covered, whether a system was mandatory or compensated, or the degree of interpretation received. However there was an indication of a negative relationship with income.

Table 5. Uptake by farmers

% of expected uptake	No. of systems
0-25	11
26-50	7
51-75	5
76-100	7

Table 6. Farmers view of the system

Opinion	No. of systems
Good	31
Indifferent	5
Bad	3
Not known	16

2.5 Discussion

The response to the survey was disappointing with less than a third (31%) of questionnaires sent out receiving any response (including negative ones). There was also some difficulty over the definition of IOA systems and in some instances the consortium was obliged to abide by the respondents view that theirs was not a true IOA system and accept a ‘nil return’. The final 55 questionnaires include some planning tools which, whilst not true IOAs, are the likely pre-cursor to a full IOA system.

Most respondents found it difficult to give quantitative figures on the effectiveness of their system. Systems which were in use or finished were more likely to have relevant data than pilot schemes. Driving force (government or research) was also an important factor in availability of data but the nature of the scheme in terms of mandatory/compensation issues and management factors such as who it was regulated by had no effect. Several respondents said that their system was too new to have any data yet, but one system reported to have documented evidence after only one year. Using a reduced data set of those systems where there appeared to be documentary evidence of the percentage change in the IO ratio a simple regression analysis was made to determine which factors gave the highest reduction. (A value of 0 was allocated to those systems with no effect and an arbitrary -1 to those reported to increase the ratio). The most significant factor was sector and it was possible to attribute 47% of the variation in IO ratio to the livestock sector and a further 28% to the horticultural protected crops sector. The latter effect was due to two systems with 90% reduction in the IO ratio. In the more detailed survey in task 3 the differentiation between sectors will be studied in more depth but the implication from the initial survey is that IOA systems may not have beneficial effects in terms of IO ratios in all sectors.

Information on effectiveness in terms of uptake is limited to 30 systems of which only 3 were mandatory and surprisingly in 2 of these cases uptake was reported as less than 75-100% of the potential. One ‘qualifying’ system reported 75-100% uptake, none of the others gave uptake figures. The factor most likely to increase uptake was compensation, 23% of the systems with <50% uptake were compensated compared with 50% of those with >50% uptake. Using the documented dataset described in the previous paragraph the average reduction in IO ratio was greater (50%) for the 4 systems where no effect or lower income was reported compared with 21% for the 7 systems where income was improved. Bearing in mind the fact that farmers opinion was generally poor or indifferent for systems which caused a reduced income it seems likely that to achieve high uptake of an effective IOA system it will probably be necessary to pay compensation.

Systems covering nutrient, pesticide and energy subject areas

No.	Title	Organisation	Country
5	Green Accounts	Landskontoret for Planteavl	Denmark

This is a voluntary system developed by advisers which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is a pilot scheme begun in 1999 and not currently used outside Denmark. Farmers are given a written specific interpretation based on official limits/targets, best results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a surplus and covers NPK and Copper, pesticides are expressed as TFI and active ingredient, energy use is calculated per ha or per livestock unit. Water use is also covered.

No.	Title	Organisation	Country
6	Kvamilla - EMAS	Landskontoret for Planteavl	Denmark

This is a voluntary system developed by advisers which can be used by arable, dairy and pig sectors as well as organic farmers. It is a pilot scheme begun in 1997 and not currently used outside Denmark. Farmers are given a written specific interpretation based on best results from other farms. It is thought to be moderately effective. The nutrient account is expressed as a balance, pesticide and energy use is calculated. Water use is also covered.

No.	Title	Organisation	Country
10	Ethical Account for a Livestock Farm	DIAS	Denmark

This is a voluntary system developed by researchers which can be used by dairy and pig sectors as well as organic farmers. It is a pilot scheme begun in 1994 and not currently used outside Denmark. Farmers are given a written specific interpretation based on official limits/targets, average results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a surplus and covers NPK, copper and zinc, or as efficiency of NP use, pesticides are expressed as TFI and % untreated area, energy use is calculated unit of produce. Soil compaction, nature quality and use of antibiotics are also covered.

No.	Title	Organisation	Country
13	Environmental Management for Agriculture	Univ of Hertfordshire	England

This is a voluntary system funded by government and developed by researchers/advisers which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. The scheme has been in use in the UK since 1997 and there has been some international interest. Farmers are given a written specific interpretation based on expert statements of best practice and their own historic data. It is thought to be very effective. The nutrient (NPK), pesticide and energy use is calculated and expressed as an eco-rating which has a scale +/- 100. Soil sustainability, conservation and biodiversity are also covered.

No.	Title	Organisation	Country
14	Assured Produce	ADAS	England

This is a voluntary system (compulsory if you want to use the label scheme) developed by marketing organisations which can be used by arable and horticultural sectors. The scheme is in use throughout the UK since 1997. Farmers are expected to meet official limits/targets and expert statements of best practice. It is thought to be moderately effective. Farmers who comply with the advice can market their produce with the assured produce quality label.

No.	Title	Organisation	Country
15	Assured Produce (Hortic)	Checkmate International	England

This is a voluntary system (compulsory if you want to use the label scheme) developed by farmers and marketing organisations which can be used by the horticultural sector. It is in use (since 1997) mainly in the UK but also by some growers in the Netherlands. Farmers are given a written specific interpretation based on average values from other farms and their own historic data. There is no information on effectiveness. Farmers who comply with the advice can market their produce with the assured produce quality label.

19	Agro-ecological Indicators	INRA	France

This is a voluntary system developed by researchers which can be used by the arable sector. It is a pilot scheme begun in 1994 currently used in France and Germany. Farmers are given a written verbal interpretation based on expert statements of best practice. It is thought to be moderately effective. The nutrient account is expressed as scale based on modelled losses for N and difference from best practice for P, pesticide use is expressed on a scale which includes risk and rate aspects, energy use is expressed as scale and includes direct and indirect use. Water use is also covered.

23	Criteria for environmentally friendly agriculture	Thuringische Landesanstalt fur Landwirtschaft	Germany

This system was developed by government, farmers, researchers and advisers and can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is a pilot scheme begun in 1994 which is now in use. Farmers are given a written and oral specific interpretation based on expert statements of best practice. Inputs have increased since it was introduced. The nutrient account is expressed as a balance and covers NPK, pesticides are expressed as intensity points, energy balance is calculated per ha. Soil analysis, humus balance and biodiversity are also covered. Farmers are compensated for using the system.

28	Agricultural Environment Label	CLM	Netherlands

This is a voluntary system (compulsory if you want to use the label scheme) initially funded by government and developed by advisers which can be used by arable, horticultural (including protected crops and fruit) and pig sectors. (A dairy system is under development). The system is now in use (since 1995) within the Netherlands. Farmers are given a written specific interpretation based on official limits/targets. It is thought to be very effective. The nutrient account is expressed as a balance and covers N and P, pesticides are expressed active ingredient, energy use is calculated per unit of product. Farmers who comply with the advice can market their produce with the AMK quality label.

32	Environmental Opportunities in Agriculture	SEPA	Scotland

This is a voluntary system funded by government and developed by researchers which can be used by arable, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is a pilot scheme begun in 1999 based on guidelines from England and Wales but not currently used outside Scotland. Farmers are given a written specific interpretation based on best results from other farms. It is thought to be moderately effective. The nutrient, pesticide and energy accounts are expressed as £/ha to the farm. Water use, wastes (eg packaging) and veterinary products are also covered.

50	REPRO software	Inst Ag Eng Bornim	Germany

This is a voluntary system developed by advisers which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is a pilot scheme begun in 1996 and not currently used outside Germany. Farmers are given a written specific interpretation based on official limits/targets, average results from other farms and expert statements of best practice. It is thought to be moderately effective. The nutrient account is expressed as a balance and covers NPK, pesticides use is recorded, energy use is calculated as an output/input ratio and as intensity of input. Humus balance and C-Dynamics are also covered.

52	Tesco Natures Choice	Tesco	England

This is a mandatory system for horticultural growers who wish to sell produce to the super market which developed it. The scheme has been in use since 1991 within the UK and now internationally as well. Farmers are given a written specific interpretation based on official limits/targets, results from other farms and expert best practice. There is no information about effectiveness. Nutrients are expressed as difference from best practices, pesticides are expressed as TFI, energy use is calculated per unit of product. Wastes (eg packaging, vegetable washings), biodiversity and staff health and safety issues are also covered.

Systems covering nutrient and pesticide subject areas

No.	Title	Organisation	Country
22	Finnish system	Helsingfors Universitat	Finland

This is a voluntary system developed by government which can be used for arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. The system has been in use within the EU since 1985. Farmers are not given any interpretation although results are compared with official limits/targets and historic data. It is thought to be moderately effective with respect to the use of N and P. Farmers are compensated for using the system.

27	Albert Hein - controlled crop production	CLM	Netherlands

This is a mandatory system developed for the marketing organisation Albert Hein which can be used by arable, horticultural, protected crops and fruit sectors. It has been in use since 1993. Farmers are given a verbal specific interpretation based on official limits/targets. It is thought to be moderately effective. The nutrient account is expressed as a balance and pesticides are expressed in terms of rate, frequency and active ingredient. Farmers are compensated for using the system.

29	Environmentally aware crop production	CLM	Netherlands

This is a voluntary system developed by farmers which can be used by horticultural, protected crops and fruit sectors. The scheme has been in use since 1996. Farmers are given a general explanation only based on average results from other farms. It is thought to be moderately effective. The nutrient account is expressed as use of N and P, bonus points are given for non use of pesticides. Farmers are compensated for using the system.

34	PLANETOR	Universita di Padova	Italy

This is a voluntary system developed by advisers and researchers which can be used by arable, horticultural, beef/veal, dairy and pig sectors. It is a pilot scheme begun in 1999 based on one developed by Minnesota University in the USA. Farmers are given a written specific interpretation based on official limits/targets and expert statements of best practice. There is no information on its effectiveness. The nutrient account (N and P) is expressed as a relative index based on losses, pesticides are expressed as a relative index based on losses and risk. Soil loss is also covered.

35	Ecopoints	Institute of Organic Farming	Austria

This is a voluntary system developed by government which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. The system has been in use since 1995 in Austria and by some researchers in Germany and France. Farmers are given a written specific interpretation based on official limits/targets, expert statements of best practice and their own historic data. There is no information about its effectiveness. The nutrient and pesticide use is transformed into points for ease of farmer understanding. Farmers are compensated for using the scheme.

42	TIBRE (Targeted Inputs for Better Rural Environment)	Scottish National Heritage	Scotland

This is a voluntary system developed by government which can be used by arable, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use in Scotland since 1994. Farmers are given a written/verbal specific interpretation based on official limits/targets. Farmers are encouraged to use the latest technologies to reduce inputs. There is no information about its effectiveness. The nutrient (NPK) and pesticide use is transformed into an environmental loading. Wastes (eg packaging) are also covered.

Systems covering nutrient and energy subject areas

No.	Title	Organisation	Country
18	IPPC	ADAS	England

This is a mandatory system being developed by government for intensive pig and poultry holdings with large livestock numbers. It is not yet implemented. Farmers will be given a written specific interpretation and guidelines to follow.

37 Herdbook system from Luxemburg (FHL) Federation des Herdbooks Luxembourgeois

This is a voluntary system (compulsory if you want to use the beef label scheme) developed by a farmers co-operative which can be used by arable, beef/veal, dairy and pig sectors as well as organic farmers. The system has been in use since 1992 in Luxemburg and Belgium. Farmers are given a written specific interpretation based on, average and best results from other farms, expert statements of best practice and their own historic data. It is thought to be moderately effective. The nutrient and energy accounts are expressed as a balance and an efficiency. Use of waste bi-products is also covered. Farmers who comply with the advice can market their beef with the FHL quality label. Farmers are compensated for using the system.

Systems covering nutrients only

No.	Title	Organisation	Country
1	Field Stable Balance	Fed. Off. & Res. Centre Agric.	Austria

This is a voluntary system developed by advisers which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is a pilot scheme due to start in 2000. Farmers are given a verbal specific interpretation based on official limits/targets and expert statements of best practice. It is thought that it will be moderately effective. The nutrient account is expressed as a balance and covers NPK. Farmers will be compensated for using the system.

2	Animal Balance	Vlaamse Landmaatschappij	Belgium

This government system is still under development and will be used by beef/veal, dairy, pig and poultry sectors from 2001. Farmers will be given a general explanation based on official limits/targets. The nutrient account (N and P) is based on animal production. Farmers will be compensated for using the system.

3	Soil Balance	Vlaamse Landmaatschappij	Belgium

This is a voluntary system developed by government which can be used by the arable and dairy sectors. It is a pilot scheme due to start in 2000 in Belgium. Farmers will be given a general explanation based on official limits/targets. The nutrient account (N only) is expressed as a surplus and should be less than 90 kg/ha at the end of the growing season. Farmers are compensated for using the system.

4	Farming Balance	Vlaamse Landmaatschappij	Belgium

This is a voluntary system still under development by government which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It is due to start in 2001 in Belgium. Farmers will be given a general explanation. The nutrient account is expressed as a balance and covers N and P. Farmers will be compensated for using the system.

7	Pig system	Landskontoret for Planteavl	Denmark

This is a voluntary system developed by advisers which can be used by pig farmers. It was developed originally (1980) to calculate production efficiency and nutrients were added in 1989. It is used in Denmark, Norway and Sweden. Farmers are given a written specific interpretation based on average and best results from other farms and their own historic data. It is not thought to have had any impact on input/output ratios. The nutrient account (N and P) is expressed on a per pig and per farm basis.

8 Mandatory Nitrogen Account | Landskontoret for Planteavl | Denmark

This is a mandatory system developed by advisers which can be used by arable, horticultural (including protected crops), beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use since 1992 in Denmark. Farmers are given a written/verbal specific interpretation based on official limits/targets. It is thought to be moderately effective. The nutrient account is based on demand and consumption.

11 Ncycle Model | IGER | England

This is a voluntary system developed by researchers which can be used by beef/veal and dairy sectors as well as organic farmers. It is a pilot scheme in use by researchers since 1995 in the UK and internationally. Farmers are not given any interpretation. The nutrient account (N only) is expressed an empirical mass balance.

12 Nitrate Sensitive Areas Scheme | MAFF | England

This is a voluntary system developed by government which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors. The scheme is restricted to certain catchment areas in England and began in 1990, it is now being phased out. Farmers are given a general explanation only based on their own historic data. It has reduced N inputs and nitrate leaching by about 20%. The nutrient account is expressed as N loss from the root zone. Farmers are compensated for joining the scheme.

16 Fate of N&P on MAFF Demo Farms | ADAS | England

This is a voluntary system funded by government and developed by researchers which has been used on arable, dairy, pig and poultry farms. It is at present a research tool used on demonstration farms in England in 2000. Farmers are given a written specific interpretation based average results from other farms and expert statements of best practice. The nutrient account is expressed as a balance and covers N and P.

17 MANNER | ADAS | England

This is a voluntary system developed by government and researchers which can be used by any sector of the industry which applies organic manures. The system has been in use in the UK since 1997. Farmers are given a written specific interpretation based on expert statements of best practice. It is thought to be moderately effective at improving the use of nitrogen in organic manures. The nutrient account is expressed as N availability and N loss from the applied manures.

20 Mineral Balance | Institut de L'Elevage au Rheu | France

This system developed by advisers and researchers is used by arable, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It was a pilot scheme now in use in France. Farmers are given a written/verbal specific interpretation based on average and best results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a surplus and covers NPK.

21 EQUIF (Ferti-mieux) | ANDA | France

This is a voluntary system developed by advisers and researchers which can be used by the arable sector. It has been in use as a test study since 1997 in certain catchments in France. Farmers are given a written specific interpretation based on average results from other farms, expert statements of best practice and their own historic data. It is thought to have reduced inputs by 10%. The nutrient account (N only) is expressed as a balance based on a ratio of inputs and requirements.

24 Farm Level Nutrient Balance (STANK) | SJV | Sweden

This is a voluntary system developed by advisers which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use in Sweden since 1996. Farmers are given a written specific interpretation based on average results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a balance and covers NPK.

25	NutriNorm	DSM Agro	Netherlands

This system developed by advisers can be used by arable, horticultural and dairy sectors as well as organic farmers. It has been in use since 1991 in the Netherlands. Farmers are given a written specific interpretation based on official limits/targets and their own historic data. It is thought to have reduced inputs by 25%. The nutrient account is expressed as a balance and is based on the MINAS methods.

26	MINAS	Dutch Government	Netherlands

This is a mandatory system developed by government which can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use since 1998 in the Netherlands. Farmers are given a written specific interpretation based on official limits/targets, best results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a balance and covers N and P.

31	Cross Border Nutrient Management Scheme	Dept. Agric. Rural Dev.	N. Ireland

This is a voluntary system developed by government which can be used by beef/veal and dairy sectors. It has been in use in Northern Ireland and the Republic of Ireland since 1997. Farmers are given a written/verbal specific interpretation and training based on official limits/targets. It is expected that the scheme will be moderately effective but this will not be known until the final audit is complete. The nutrient account (P only) is expressed as a balance.

33	Whole Farm Nutrient Budget	SAC	Scotland

This is a voluntary system developed by researchers which can be used by arable, beef/veal and dairy sectors as well as organic farmers. It is a pilot scheme begun in 1996 and not currently used outside the UK. Farmers are given a written specific interpretation based on official limits/targets, expert statements of best practice and their own historic data. There is no information on its effectiveness. The nutrient account is expressed as a system balance for N and a soil surface balance for P and K.

36	NURP (Nitrate Reduction Planner)	Res. Stat. Cattle Husbandry	Netherlands

This is a voluntary system developed by government, farmers and water companies which can be used by the dairy sector. It has been in use in the Netherlands since 1996. Farmers are given a verbal specific interpretation based on official limits/targets. It is thought to be moderately effective. The nutrient account is expressed as nitrate concentration in ground water calculated from N use and animal production. Farmers are compensated for using the system

38	Nutrient Balance of Swiss Agriculture	Swiss Government	Switzerland

This is a mandatory system developed by researchers which can be used by arable, horticultural (including protected crops), beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use since 1996 to calculate total NPK balance for Switzerland. There are no individual farmer reports.

39	Nutrient Balance of Swiss Agriculture	Swiss Government	Switzerland

This is a mandatory system developed by advisers which can be used by arable, horticultural (including protected crops), beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use in Sweden since 1996. Farmers are given a written specific interpretation based on average results from other farms and their own historic data. It is thought to be moderately effective. The nutrient account is expressed as a balance and covers NPK.

41	Nutrient Management Planning	Dept. Agriculture, Food and Rural Development	Republic of Ireland

This government system is compulsory for farmers in the Rural Environment Protection Scheme (REPS) and can be used by arable, horticultural, beef/veal, dairy, pig and poultry sectors as well as organic farmers. It has been in use in the Republic since 1994. Farmers are given a written specific interpretation based on official limits/targets. It is thought to be very effective. The nutrient account is expressed as a balance and covers N and P. The system is compensated for farmers in the REPS scheme.

43 Voluntary mineral accounting system 88-98 CLM Netherlands

This is a voluntary system developed by researchers and CLM which can be used by arable, dairy pig and poultry sectors. It was used in the Netherlands between 1988 and 1998 but has now been largely replaced by the MINAS system. Farmers are given a verbal specific interpretation and general information based on average and best results from other farms and their own historic data. For dairying the N surplus was reduced by 8-25% and the P surplus by 0-60%. P surplus was also reduced for arable holdings but for pigs reduction was due to efficiency of production and not to mineral accounting. The nutrient account is expressed as a surplus and covers N and P.

44 MIAR (mineral input registration 1990-95) CLM Netherlands

This is a voluntary system developed by government which can be used by pig and poultry sectors. It was used in the Netherlands between 1990 and 1995. Farmers were given a general explanation based on official limits/targets. Inputs were reduced by 3-4% annually. The nutrient account (P only) is expressed on a per livestock unit basis. Farmers were compensated for joining the scheme and rewarded for reductions.

45 Distribution of P in Forest Soils CSIC Salamanca Spain

This is a government research tool for arable/forestry production which has been in used by researchers in Spain since 1992. Farmers are not given any interpretation. The nutrient account (P only) is expressed as a balance.

46 Optimum P fertiliser rate in arable soils Universidad de Sevilla Spain

This is a recommendation system developed by government, researchers and farmers which can be used by the arable sector. It is still in the under development but has been in used as a research tool in part of Spain since 1997. Farmers are given a written/verbal specific report. It is thought to be moderately effective. The recommendation is for P only. Two research projects on P loss/balance but are as yet insufficiently advanced to be included in the survey.

47 Reduction of Nitrate Pollution in Thessaly Min. Agric., Dept. of Environ. Greece

This is a voluntary system developed by government which can be used by the arable sector. It has been in use in Greece since 1995. Farmers are given a general explanation based on average results from other farms. It is thought to be very effective. The nutrient account is expressed as nitrate leaching, N mineralisation and plant N uptake. Farmers are compensated for joining the scheme.

48 PlantePlan Daldata As Norway

This is a voluntary system developed by researchers which can be used by arable and horticultural sectors. It has been in use in Norway since 1998. Farmers are given a written specific interpretation based on official limits/targets, average results from other farms and expert statements of best practice. It is thought to be very effective. The nutrient account is expressed as a balance.

53 Fertiliser Recommendation after soil testing LUFA Germany

This is a recommendation system developed by LUFA which can be used by the arable sector. It has been in use in the Baden-Wurttemberg district of Germany since 1986. Farmers are not given any interpretation but official limits/targets and the farmers own historic data are used. Inputs have been increased by the system. The nutrient account is expressed as the difference between crop requirement and soil/organic manure supply. Farmers are compensated for joining the scheme.

54 Feld-stall Landesanstalt fur pflanzenbau forchheim Germany

This is a mandatory system developed by government which can be used for arable or grassland. It has been in use in the Baden-Wurttemberg district of Germany since 1996. Farmers are given a written specific interpretation based on official limits/targets. Inputs use has been increased by the system. The nutrient account is expressed as a balance.

55 Potato System Co. Re. Pa. Italy

This is a voluntary system developed by farmers which can be used for horticulture. It has been in use as a pilot system in the Genoa district of Italy since 1997. Farmers are given a verbal specific interpretation based on average farm values and their own historic data. The system is thought to be moderately effective but no details about its operation are available.

Systems covering pesticides only

No.	Title	Organisation	Country
9	Pesticide system	Landskontoret for Planteavl	Denmark

This is a mandatory system developed by advisers which can be used by arable and horticultural sectors. It has been in use in Denmark since about 1997. Farmers are not given any interpretation but official limits/targets are used. It is thought to be moderately effective (0.5% reduction in inputs). The pesticide use is expressed as a treatment index.

40 Environmental Yardstick for pesticides CLM Netherlands

This is a voluntary system developed by CLM which can be used by arable, horticultural (including protected crops) and dairy sectors as well as organic farmers. It has been in use in the Netherlands since 1991. Farmers are given a written specific interpretation based on official limits/targets, average and best results from other farms. It is thought to be very effective (90% reduction in inputs). The pesticide use is transformed into environmental impact points. The cost of joining the system may sometimes be compensated by drinking water suppliers.

51 Program for balanced crop production Potato Research Institute Finland

This is a voluntary system (compulsory for those getting compensation for environmentally friendly production) developed by government which can be used by arable and horticultural sectors as well as organic farmers. It has been in use in Finland since 2000. Farmers are given a general explanation based on expert statements of best practice and their own historic data. It is too early to say how effective it is going to be. Pesticide use is recorded. Farmers can get compensated via the environmentally friendly production scheme.

Systems covering energy only

No.	Title	Organisation	Country
30	Energy Yardstick	CLM/De Marke	Netherlands

This is a voluntary system developed by researchers which can be used by the dairy and pig sectors. It has been in use in the Netherlands since 1996. Farmers are given a general explanation based on average and best results from other farms and their own historic data. It is thought to have no effect on inputs. Energy use is expressed directly in terms of production as transformed into carbon dioxide equivalents.

49 Energy Ana__sis Tool on field and farm level Inst.Agr.Eng. Goettingen Univ. Germany

This system being developed by researchers can be used by the arable sector. It has been used for research in Germany since 1996. Farmers are given a written specific interpretation based on average results from other farms and their own historic data. It is thought to be moderately effective. Energy use is expressed as a total, broken down into input groups or farm activity, intensity, net yield and transformed into a productivity indicator.

3 Detailed analysis of ten Input/Output Accounting Systems

3.1 Summary

Increasing concern about environmental issues was the driving force behind development of each of the systems studied. In most cases a major part of the funding to develop the system or run pilot projects came from government. Benefits in terms of increased awareness of problem areas were identified by several systems originators. Anecdotal evidence suggests that farmers are encouraged to make actual changes to their management on the basis of the systems, if they receive detailed help from an adviser associated with the system, or if the system results in a marketing advantage. It seems likely that input output accounting systems could be used to increase awareness and provide evidence of the impact of management changes, they may need to be linked to supporting systems of technical advice.

3.2 Introduction

The 10 IOA systems were chosen to represent a range of those systems which covered all three key subject areas (nutrients, pesticides and energy), together with one specialist system in each subject area and a mainly market based system. In general systems were chosen which had been in operation for some time and were reported to be effective and have good documentation. The aim of the analysis was to describe the systems in detail and provide a factual comparison.

3.3 Description and essesment of each system

The 10 systems chosen are listed in Table 1 using the identification number allocated in the initial survey.

Table 1 System Details

ID	Name	Country of Origin	Countries Used by	Subject
5	Green Accounts	Denmark	Denmark	Nutrients (NPK) Pesticides Energy
10	Ethical Account for Livestock Farms	Denmark	Denmark	Nutrients (NP) Pesticides Energy
13	Environmental Management for Agriculture	UK	Worldwide	Nutrients (NPK) Pesticides Energy
19	Agro-ecological Indicators	France	France + Germany	Nutrients (NP) Pesticides Energy
28	Agricultural Environment Label	Netherlands	Netherlands	Nutrients (NP) Pesticides Energy
50	Repro	Germany	Germany	Nutrients (NPK) Pesticides Energy
37	Herdbooks system (FHL)	Luxemburg	Luxemburg + Belgium	Nutrients (NPK) Energy
24	Farm Level Nutrient Balance (STANK)	Sweden	Sweden	Nutrients (NPK)
40	Environmental Yardstick for pesticides	Netherlands	Netherlands + Belgium	Pesticides
30	Energy Yardstick	Netherlands	Netherlands	Energy

5. Green Accounts

Background

There was generally strong political interest in nutrient and pesticide pollution in Denmark in the 90's. Regulation concerning use of manure and fertilizers was implemented gradually from 1987 and strengthened from 1993. The was ongoing debate in media and between political parties concerning the necessity for further strengthening and the feasibility of introducing fertilizer and pesticide taxes. A parliamentary resolution agreed to let further strengthening of regulation depend on a 10-year follow-up analysis of the first Nutrient action from 1987. By the mid 90´s farmers were already tired of detailed regulation on fertilizer use at a field level (system no. 8 in task 2 report) and did not like the other option of taxes on inputs. Farmers unions claimed that regulation was strong enough already and sufficient to reach environmental goals and that promoting voluntary actions would be better. In this situation there was a big need for farmers organizations to prove that farmers could improve by voluntary actions, but with initiatives that also get involvement from the less motivated farmers (those with low environmental performance and low nutrient efficiency). In an earlier pilot project the central advisory service (farmer driven in DK) at Skejby had developed a resource management tool called Miljø- og ressource styring, (1994-98), which was linked with an ISO 9000 certification scheme, Kvamilla (system no. 6 in task 2 report). The Ministry of Environment's office for agriculture supported the project, which was partly inspired by the ongoing development of the ethical account (system no. 10 in task 2 report). In a meeting between high level representatives from the farmers union and from the Ministry of Environment in 1997 it was decided to support the development of green account for farmers. The idea was that the voluntary principle might be coupled with giving benefits to the best performing farmers (i.e. allowing more LU per ha if nutrient use efficiency was documented better than average etc.). It was thus hoped that in the long term such tools could reduce the regulatory burden on farmers and simplify regulation.

Methodology
The system covers nutrient balances (N, P, K, Cu) at farm, field and herd level, pesticide use, energy use, water use for irrigation (M^3 per ha) and for housing (M^3 per LU). It can be used by all sectors except horticulture (glass house production).

Nutrients Surplus in kg per ha based on sum of inputs (feed, fertilisers, N fixation and deposition, seeds and imported manure) less sum of outputs (animal products, sold crops and exported manure) divided by area of the farm.

Pesticides Amount of active ingredients used per ha and Treatment Frequency Index (TFI) based on sum of amounts used divided by standard approved dosages per ha.

Energy Energy use based on diesel used in MJ divided by area and electricity in MJ used in total.

Results
In pilot phase the interpretation was not systematically planned across the participating advisors. The advisors gave oral explanations but lacked a common reference material. In the next phase it is planned to give written evaluation using as the standard for nutrients a calculation of the expected results if the farm followed a good farming practice. In the longer term it is expected that reference material for different farm types may be developed from analysis of a larger sample of farm results. For pesticides the standard will be the average public goal for maximum pesticide use (TFI) corrected for the portfolio of crops on the farm. This is calculated by the software.

Most of the data required to run the system is part of standard information kept in farm accounts and farmer may run the system for themselves or have an adviser to do it for them. Diesel and electricity use and the amount of feed in Kg's are not normally registered in the economic accounts, and the information has to extracted from the receipts. A printout for each farmer of the amounts of purchased fertilizer in kg N and P per season is now available from the suppliers. The input of N-fixation and deposition is calculated by the program using a standard formula per ha adjusted for fertilizer application or clover content.

The indicators for nutrient surplus and pesticide treatment frequency were almost similar in the two projects (resource management and green account) experiences from farmers' use of them in both projects will be discussed here.

Number of farmers involved in development of the two systems is as follows:
1994-95: Pilot phase of the environmental management system: 12 farms
1995-96: Implementation phase 1: 148 farms
1997-98: Implementation phase 2: 166 farms
On most farms single items were selected to focus on (e.g. nutrient balance or pesticide TFI) and most farms had only results from one year.
1999-00: Green account pilot phase: 35+60 farmers involved.
Actual voluntarily uptake of the Green Account is not possible to evaluate before next year because the system is only now offered for a wider use.

In the Green Account pilot phase very few farms have participated long enough to allow a precise evaluation of effects based on development of indicator values between years. For example the results of nutrient balances from year one will usually not be available before the decisions for the next season in terms of fertiliser use have already been implemented.

Also, the "optimal" pesticide application fluctuates due to differences in weather etc. between growing seasons why a simple comparison between two years on a farm is misleading.

On most farms the indicators and their interpretation were used to generate ideas for improvement on particular areas. Action plans were an integrated part of the concept. Usually, in the resource management project, farmers would chose one or two areas (e.g. Nitrogen surplus or P surplus) to focus on. Together with advisors he would write an action plan for improvement including changes in management and planning (e.g. the use of other feeds or change in fertiliser applications). There is reason to believe that this actually resulted in improved resource use and lower environmental impact, but results can only be seen over several years. It is assumed that generally the farmers incomes have improved, though not considerably, because of a more efficient use of resources. In some instances the increased efficiency has had economic costs associated with e.g. the use of expensive feeds with higher AAT or special fertilizers.

10. Ethical Account for Livestock Farms (Etisk regnskab for husdyrbrug)

Background

The system was developed as a result of a growing political focus in late 80's/early 90's on environmental aspects of intensive farming systems and increasing awareness in the public on animal welfare problems. The initiative was in research, motivated by an assumed need for tools to describe individual farm results in both technical-economic terms and in environmental/animal welfare terms. The basic idea was that farmers would benefit from a decision aid tool that described their farms performance not only in traditional economic terms but in relation to society's increasing interest in environmental impact, animal welfare and product quality. It was assumed that some farmers would be interested in improving their management in some of these areas for several reasons:

They could anticipate future regulation and be ahead

They would be more satisfied themselves knowing that they had done what was economically feasible to accommodate interests of future generations and the livestock

They might save inputs and thus improve on net income.

It was not a priori assumed that the farmers could obtain a market advantage (higher prices) and no promises were given in the project as to the establishment of a label or certification scheme on the basis of the results. The three year (1994-1997) pilot project had 20 farmers and was mainly funded by the Ministry of Food, Agriculture and Fisheries but the pig-sector and dairy sector (farmers organisations) supported the project with allocation of their employees and funding some of the farm studies. A number of local advisors were involved in the process but the central advisory services started a similar project during this project period (see system 5 Green Accounts). The themes of the ethical account were numerous covering different aspects of animal welfare and health, use of medicine and other aspects of product quality and a selection of environmental and resource use issues: Balances of N, P, Cu (on pig farms), use of pesticides and energy, impact on soil compaction and biodiversity.

Methodology

Nutrient Balance Surplus per ha in kg N or P based on sum of inputs less sum of ouputs divided by area of the farm.

Pesticide use Treatment Frequency Index (TFI) based on average use of standard approved dosages (for each pesticide: actual use per field divided by the public approved dosage).

Energy Energy use per kg crop in MJ based on sum of diesel use divided by crop using standard values per field operation. Sum of energy use in MJ per ha in each crop divided by yield. Also energy use per kg milk or per kg pig in MJ based on sum of direct (electricity and diesel) and indirect (concentrates and fodder) divided by yield.

Results
In the development phase the 20 participating farmers were invited to attend workshops to discuss the topics of the ethical accounting system and hear about the indicators. Written and oral explanation of the relevance of each indicator was supplied in each of the three yearly ethical accounts that each family received. Also, a written and oral interpretation by the Scientist/"advisor" based on his judgement of the indicator level compared with the other farms were given and discussed in relation to the farms specific conditions and management practice. There were no public target values or goals formulated at the time of the project. Comparisons were made between years and between farms. In general it was not possible to ascribe any changes on the farms to the I/O A system alone, since farmers were at the same time faced with strengthened public regulation of the use of fertilisers, manure and pesticides. Moreover, differences between crop growth seasons influence the use of pesticides and energy on a particular farm, which might even contradict the farmers' (good) intentions. However, when asked during the interviews after the third year of the pilot scheme, 6 of the 15 dairy farmers and all (5 of 5) pig farmers claimed that they had actually changed management practices within the area of the environmental issues covered by the indicators. Moreover, 5 and 2 respectively of the dairy and pig farmers said they had changed practice regarding the wildlife qualities on their farms.
The telephone interviews in general showed a high interest in the system, increasing over the three years. On average the 20 farmers valued the system 6.9 on a scale of 1-9. Most farmers stressed the whole farm approach as one of the important elements of the system (i.e. the combination of several environmental topics covered together with animal welfare, economics and the farmers own values in a dialogue). Many of the farmers felt that three years in a row of using the system was enough because of the extra work using the system. Also by then they felt they would have had the benefits of the detailed data collection and could manage to improve their environmental management without quantification for a while.

13. Environmental Management for Agriculture

Background
The system covers the whole farm: crop protection (pesticides), crop nutrition (fertilisers and manures), energy efficiency, water use, livestock husbandry and welfare, wildlife conservation and habitats, soil management and waste management. The activities covered by the system are integrated so that environmental trade-offs or pollution swapping are identified. All sectors are covered except ornamentals and glass, fruit will be included in the next revision. It was developed at the University of Hertfordshire in the UK for use by farmers and their advisers to encourage more sustainable practices. Initially it was mainly funded by the Ministry of Agriculture Fisheries and Food (MAFF) who wanted to encourage the uptake of their Codes of Good Agricultural Practice. It is based on the principle that you need to know what you are doing wrong in order to be able to do anything about it. The computerised system helps to measure the environmental performance by evaluating an eco-rating that compares actual farm practice and site-specific details with what is perceived to be the best practice for that site using an expert system together with scoring and ranking techniques. The eco-ratings can be displayed on a positive-negative scale to aid transparency and interpretation. In support of the assessment the system incorporates modules to explore 'what if' scenarios and a hyper text system containing a wealth of

background information. It is recommended that the system be used by those seeking to carry out audit trails for quality assurance schemes, but it is not compulsory.

Methodology
Individual eco-ratings are determined for each activity and then normalised to a common scale. To aid understanding values may be positive or negative. Undesirable or unsustainable activities such as those leading to serious nitrate leaching, water pollution etc. will lead to negative eco-ratings. The zero point reflects a neutral or benign activity. Activities which comply with principles of best practice give positive eco-ratings. The eco-rating scale is set at +/- 100 to aid visualisation and understanding of the rating. The rating is calculated in a different way for quantitative data (field applications of fertilisers or pesticides) than for qualitative data (energy).

Nutrients For fertilisers the differential between actual application rates and recommended rates provides baseline eco-rating. This is then enhanced by scores associated with factors such as application timing, rainfall levels and soil type to establish a measure of environmental impact.

Pesticides For pesticides the baseline eco-rating is derived from the hazard warning labels associated with the product. There are about 90 of these which are ranked according to the severity of the risk and those appropriate to the product are summed to give its baseline eco-rating. Some label precautions may be disregarded if not relevant to the site eg a hazard to fish is not relevant if there is no water or fish on site. The baseline eco-rating is enhanced by considering parameters which influence fate and transport of the pesticides in the environment such as solubility, vapour pressure, soil half-life, octanol water partition coefficient as a measure of bio-accumulation and the organic-carbon partition coefficient used with the GUS equation to reflect soil mobility and the risk of leaching. For each parameter, 5 risk bands are assigned to over come the problem of values varying with environmental conditions such as temperature, pressure and soil type. For each parameter a score is assigned according to the appropriate risk band, these are then summed for each active ingredient. These values are then weighted by the proportion of active ingredient in the product and summed to give a product value. Further enhancements are made by comparing with best practice and regulatory compliance (eg has permitted number of applications, or maximum dose rate been exceeded).

Energy For qualitative assessments each task associated with the activity has several steps and these steps have options. For energy these steps include, in addition to the calculation of the amount direct energy use, an assessment of, for example the degree of insulation. Each option is assigned a score and scores are summed across the steps to get a total for the task. The task may be weighted depending on its relative importance to the activity and adjusted from defaults to reflect local priorities. The scores for all the tasks are summed to get the eco-rating for the activity.

The system includes an emissions inventory for the whole farm based on the different processes eg energy use gives carbon dioxide, carbon monoxide, sulphur dioxide, all oxides of nitrogen and methane: fertiliser use - ammonia, nitrous oxide and nitrate leaching: pesticides use - pesticide loss. The aim is to raise awareness and understanding not to provide a very precise calculation. Where possible emissions are related back to financial losses/gains and so to profitability.

Results

Output from the environmental audit takes the form of text and graphical displays which can be viewed and/or printed out. The graphical display of eco-ratings is designed specifically to aid understanding. Trend analysis is available when farmers have been running the system for some time. Guidance is included in the software with a lot of backup text information, the purchase fee includes telephone helpline both for computer problems and technical help with interpretation if required. For those farmers who have the system run by their adviser this help would come from the adviser. The whole purpose of the system (and the reason MAFF paid for its development) was to increase awareness of problems and to ensure that farmers could track and monitor their performance and compare with best practice. The 'best practice' in the system is provided by scientists (research) and government (legislation, codes of practice). During 1999 1000 copies of the software were sold. The major part of these sales (52%) was to advisers (for whom the software was designed), however 26% of sales were direct to farmers indicating their interest in using the technology to improve their business. Although the system was designed for use in England and Wales 12% of sales have been to Scotland and 7% outside the UK. Since 2000 sales of the software have passed to commercial outlets and no further figures on distribution are available. Other than sales there is no information on the success of the scheme and there has been no assessment of effectiveness, although Norfolk Area Land Management Initiative is investigating its use in their project area which is small and arable based. There is no formal check on farmers results but the system is used (and therefore checked) in audit trail compliance which is a requirement for many markets within the UK. Indeed Farm Assurance Schemes are advising those members wishing to achieve the correct standard to use EMA as a guide. Using EMA counts towards proficiency (instead of proof of book purchase, literature familiarity) for UK advisers on the BASIS scheme. (BASIS is a UK proficiency scheme which ensures that the advisers subscribing to it are competent and up to date). The EMA system is updated regularly and users can upgrade their system by accessing the Internet. Priorities for updating the system are set by a business group which comprises 8 influential agricultural companies and organisations including MAFF. They rely on feedback from the industry including individuals.

19. Agro-ecological Indicators

Background

The work was launched in 1993 and is based on the personal initiative of a researcher of INRA Colmar (Dr. Girardin). After a bibliographic work on sustainable agriculture and integrated agriculture he concluded that there was a urgent need of operational tools for assessing the environmental impact. He made the choice to develop a set of agro-ecological indicators taking into account the main environmental issues linked to cultivation practices (choice of crops, soil fertility and nutrient management, pesticides, etc.). A local organisation, the "Association pour la Relance Agronomique en Alsace (ARAA)" was interested to take part in the project and made it possible to get the following financial support: the EU Interreg programme, the Land Baden Württemberg (Germany) and the Alsace region (France) as part of the ITADA programme, the "Agriculture tomorrow" programme of the French Research Ministry. The system was implemented as a pilot phase in 1994. Approximately 50 farmers are or have been involved in the pilot. In order to increase the number of users, it is planned to develop a computerized version of the indicators. In a first stage, a software for the pesticides indicators is being developed and is going to be marketed in the next months. This software will be translated in German and Spanish. This project is being run in collaboration with a small French software company, I-Cône. In a further stage, the software for all indicators or at least the main will be developed. For the development in

Germany, the collaboration with a German partner, the IfUL (Institut für Umweltgerechte Landbewirtschaftung) based in Müllheim (Baden Württemberg) will be reinforced in a further ITADA project. The original system covered nutrients (Nitrogen and Phosphorus), pesticides, energy, irrigation, organic matter, crop diversity, crop sequence. The themes soil cover and ecological structures were added later on. Initially the system only covered arable crops but it is being extended to dairy/beef sector (forage production aspects of the system), organic farming and viticulture.

Methodology

Nutrient use The nitrogen indicator uses a simple model to assess the risk of nitrogen losses (by leaching and volatilization) or benefits of risk mitigation. The aggregation consists of adding up the losses. These quantitative data are transformed in minus and or plus marks in order to obtain an indicator ranging between 0 and 10. The calculation of the phosphorus indicator is based on the fertilizer rate in relation to the recommended fertilizer rate with a correction for the fertilizer type and for specific measures implemented by farmers to improve the fertilization efficiency.

Pesticides

For a single application, the calculation of the pesticides indicator is based on four modules assessing respectively the risk linked to the amount of active ingredient applied and the impact on groundwater, surface water and air. In a second step, an overall indicator is calculated. Three types of input variables are used:

- pesticides properties linked to exposure or to ecotoxicological effect;
- site-specific conditions (e.g. runoff risk);
- characteristics of the pesticide application (e.g. rate of application).

A fuzzy expert system is used to aggregate all these heterogeneous variables into indicator modules and to subsequently aggregate these modules into a synthetic indicator. Output values for each module as well as for the overall indicator are expressed on a qualitative scale between 0 (maximum risk) and 10 (no risk). For a programme of pesticides applications, an AEI indicator is obtained by summing the overall indicator values of each single application and by calibrating it according to the requirements of IPM strategies.

Energy The energy indicator is based on an ready reckoner which converts the energetic consumption into a mark between 0 and 10, where 7 is based on the integrated agriculture reference. Four inputs were used in the calculation:
Direct energy use - machinery and irrigation systems. For direct energy use (electricity or diesel fuel) models of energy use by machinery and irrigation systems were developed. Indirect energy use - pesticides and fertilisers. A calculation factor (energy coefficient) was developed for each active substance of pesticides and each sort of fertiliser.

Results

The system is still being run as a pilot scheme and of the first group (17 farms) 9 are still involved, the numbers are changing from year to year but generally increasing, currently about 50. Until recently all calculations were done by researchers or advisers because software was not generally available. The performance of the farm is not compared to the performance of other farms. However, there is an expert statement of best practice and problem areas identified and discussed. Some assessment of the effectiveness of the system has been carried out and in one example it was found that to get most improvement in farmers management, there is a need of intensive extension work. Where the method was applied to a group of farms in a superficial way (visited twice a year and a meeting with all of them was organized) there was less benefit than with a single farm which received more individual attention. The impact of the system on farm income is not well documented. However in one study it was assessed that the additional cost to improve the whole indicators (except for crop diversity and sequence indicators) was 56.1Euro. In another study on a group of 13 farms, no correlation was found between values of the indicators and the gross margin for one year. In this case, it seems that no additional cost are needed. Two surveys of farmers, who used the method, revealed that agro-ecological indicators were perceived as a new source of information on farming systems management and as a common base for exchanges within a group of farmers. From the point of view of the farmers, the indicators are also useful to make a dialogue among themselves easier, to facilitate the comparison between different ways of managing farming systems and also to justify their approach in regard to the society. However it would not be an acceptable tool if sued to set taxes or gant subsidies. The output of the indicators are well understood whereas the calculation method is in many cases too complicated. Of the original 17 farmers about 7 use the system in their day to day management.

28. Agricultural Environment Label (AgroMilieukeur)

Background

This system covers nutrients, pesticides and energy and was developed by the Centre for Agriculture and Environment (CLM) in the Netherlands as a result of growing environmental concerns. It was envisaged that consumers would be willing to pay for agricultural products produced under a high environmental standard. Development of the criteria began in 1992 and the first Environmental Label for potatoes, wheat and onions was introduced in 1995. Farmers, consumer and environmental organisations, potato growers and representatives of the Ministry of Agriculture, Nature management and Fisheries were all involved. Management of the scheme has now been transferred to Stichting Milieukeur who license farms to use the environmental label called Milieukeur (abbreviated as MK): MK Potato, MK Wheat, MK Onion. Stichting Milieukeur was already managing this label for different non-food products such as writing blocks and toilet paper. The system has since been expanded to cover vegetables, glasshouse production, fruit, mushrooms, pig meat and dairy products. In the future it is hoped to harmonise the system with a system which will be introduced by the government called 'Incentive Sustainable Agriculture (SDL Stimulans Duurzame Landbouw)'. The goal of the SDL system is to evaluate farms on themes which are important for society (like environment, welfare and animal health). If a farmer complies with certain levels on these themes, he will be eligible for governmental subsidies.

Methodology

Nutrient balance The mineral balance is not administered specifically for the system: in future it will be mandatory for all farms to make mineral balances under MINAS. The balances can be calculated by the farmer and checked by an accountant, or the accountant can calculate the balance on the basis of the farmers' administration. The balances are send to a governmental institute 'Bureau Agricultural Levies (Bureau Heffingen)'. When the mineral losses are higher than the norm, the farmer has to pay a levy. The financial penalty does not have to be paid when the mineral losses are at or below the norm. The height of the levies is prohibitive.

The calculation of the nutrient balance:
(input of N and P by animals, feed, fertiliser (including leguminose crops) and manure minus output of N and P by crops, animals, milk, meat and manure) / number of hectares

Crop protection The input is calculated in order to minimise the use of pesticides. The standard for the use of pesticide is a maximum total use (input) in one season, in kg active ingredients per hectare.

Energy use The farmer is obliged to calculate the direct energy use on the farm per 100 kg of milk. This is a way to make the farmer aware of the direct energy use such as electricity, gas, or diesel. However there is no restriction on the amount of energy a farmer is allowed to use and he can make allowances for the private use of energy. This administration is done by the farmer.

Results
The fact that the system is managed by Stichting Milieukeur means that there is good information about who is using the system. Farmers can compare their results with industry standards although this aspect is better developed in the arable and pig sectors. The effectiveness of the system is often calculated by independent organisations and is regarded as very effective. For example the goals and performance of Milieukeur farming with regard to its impact on nature and the environment was assessed in the framework of ecological sustainability. In 1998 it was recommended to Stichting Milieukeur to consult their participating farmers and interested organisations about the introduction of guidelines for ammonia emissions, resource management, heavy metal surpluses, energy consumption, nature management and water management. The effect of the system on farm income has been assessed for potato growers. In 1995, after one season growing Milieukeur potatoes, most growers did not clearly recognise the various costs involved. Some growers found that the extra costs and risk on farm income were less than supposed (9% of growers) whilst others (17%) found the costs unacceptable high. Strongly marked by 46% of growers were the unacceptable cost involved with the standard for N-balance, whilst the costs for monitoring and control were regarded as less than supposed by 30% of growers and more than expected by 48% of growers. The total effect of the system on farm income is satisfactory according to the potato growers and they are willing to continue.

50. Repro (Material and energy balancing in agricultural concerns/businesses)

Background
The REPRO model was developed against a background of increasing concern about the impact of agriculture both directly and indirectly on the environment. The REPRO model includes humus, nutrient, feed and energy balances. It is balanced at various system levels. The most important spatial system boundary is the agricultural business, the most important temporal system boundary is financial or management year. Livestock farming, crop cultivation and soil/land use are analysed as subsystems down to the crop rotation and field level. Important preliminary work in the development of the model was the working out of a methodology for quantifying agricultural material flows/circulation, the development of humus balance methods and the derivation of indicators regarding structure, humus and nutrient housekeeping.

Methodology
System boundaries and formulation The REPRO formulation confines itself to the analysis and evaluation of material and energy fluxes, dependent upon the business structure, management/farming intensity and procedural arrangements. This simplication is made on the assumption that, with it, essential environmental impacts will be directly or indirectly encompassed. The aim is to build up an adequately exact picture of the business system with as few indicators as possible. A pre-requisite for scenario calculations is the linking of the business branches via the material flows. Changes in the business system must become visible as changed balances.

Model coefficients/algorithms The coefficients and balancing methods are derived principally experimentally from long term trials with reference to location. In the place of constant coefficients, variable coefficients, applicable to the circumstances are used. The transferability is tested by practical application and model calculations.

Evaluation The balancing results are evaluated using location dependant agro-environmental indicators. The indicators include energy output/input ratio, energy intensity, humus balance, nutrient balance, nitrate leaching and carbon dynamics. A quantitative identification of the potential for environmental damage is thereby enabled. Desirable ranges for cultivated areas, livestock density, N balances and energy use are provided.

nutrient balancing done following method of Hulsbergen, etc.:

energy balancing done following method of Kalk and Diepenbrock:

humus and nitrogen balance coefficients were derived principally from field experiments: Hulsbergen and Biermann

Results
The software has been used since 1996 in a pilot scheme with 50 farmers. It is reported to have had a beneficial effect on farm incomes in the arable, dairy, pig and organic sectors but no figures are available. It is reported to have been moderately effective in changing the indicators but no figures are available.

Herdbooks System (FHL)

Background
In 1992 the Luxemburg government asked all farming organisations to develop new schemes for sustainable agriculture. The Herdbooks Federation (FHL) looked at what was required and came up with a concept to judge the sustainability of agriculture systems with nutrient and energy balances and the soil fertility. Their aim was to get farmers to understand the environmental problems by showing easy to understand graphics of inputs, outputs and balances. An important aspect of the system is that FHL advisers work directly with the individual farmers both in collecting the information and in giving advice based on the report. The system is also used in Belgium for a few interested farmers. The system covers nutrients (NPK) and energy (direct and indirect). Since 2000 humus balances have also been calculated for 8 pilot farms. The economical situation of the farms is also considered. In theory the system can be used by any sector of the industry although in practice in Luxemburg the nature of the farming (mixed arable and livestock) means that the main sectors covered are arable, cattle (dairy and beef), pigs and organic farming. The majority of users of the system are those wanting to be part of the beef labeling scheme for whom it is compulsory. The other main users are part of a project (co-financed by the government) which is looking at ways to improve the efficiency of agriculture production methods. These farmers have to pay to join the system.

Methodology
Farm gate balance - all inputs are compared with all outputs, the difference is the balance. Surpluses and efficiency are calculated for both nutrients (N P and K) and energy (total and fossil). The use of bi-products is also assessed (for example brewers grains for animal feed or sewage sludge for fertiliser). The FHL advisers do the calculations and explain results to the farmers.

Information is collected on farm by FHL advisers. The data necessary for calculation of the output indicators are part of standard farm accounts (required for tax purposes) in Luxemburg. For some items such as electricity use it may be necessary to convert the tax information which is in terms of money spent into the amount of electricity this would buy. The data collected is what was actually bought or sold on the farm, there are no default data. Portable computers are used so the FHL adviser can collect data and give an outline report on the farm which can then be explained and discussed face to face. Later a written report is produced (7 pages long) with the nutrient and energy balances, together with advice on how to make improvements. The latter could involve taking soil samples for analysis to help with fertiliser use for example. The inputs are based on total farm purchases. However on a few pilot farms a new field level balance is being investigated. This looks at individual field fertiliser rates and yields and will be used to check the fertiliser recommendation system with a view to making improvements if possible.

Results

Farmers are helped to judge whether their figures for inputs, outputs and balances are high or low by graphical comparison with the worst 25%, average and best 25% of other farms. Reference values include average and best values from sets of farms, expert statements of best practice and farmers own historic data. Individual farmers results are confidential but it is possible for FHL to make comparisons between farms based on groupings such as location or farming system. For the co-financed part of the system FHL have to make a report to the government. For the beef label scheme the report is made to the supermarkets and there is an annual conference with a presentation to the press of the results. For those wanting to join the beef label scheme the system is compulsory but the farmers get free advice with this scheme and associated marketing advantages. The supermarket bear the costs for the calculation. The co-financed project with the government costs every farm 12500,-LUF/year.

Farmers were involved in the original design and some are still involved on the committee which runs the Herdbook. The farmers suggest what should be included and environmental pressure can influence decisions for example the recent work to include a CO_2 balance.

FHL have found it difficult to judge the impact of the system. Improvements are possible on some farms but not all. Fertiliser is about 75% of the input to the nitrogen balance, the risks to yield of reducing this are high and costs relatively low so not much pressure on farmers to change. Feedstuffs are a big part of the energy balance so small reductions make a big improvement in surpluses and as feed stuffs are expensive there is more incentive for farmers to make a change. FHL report that using the Herdbook system is a good way to make the farmers aware of the problems, and the graphical display helps them to see where they could have an impact. Those involved in the beef label scheme get marketing benefits

24. Farm Level Nutrient Balance (STANK)

Background

The system was developed as a result of an initiative by publicly employed advisors in Lensstyrelsen (regional offices under state control). The method was inspired by research and started in 1996, it was motivated by the political interest in agricultural nutrient loss (there was a government program and an action plan for reduction of nutrient losses from 1985). From mid 80's to 1995 around 19000 farms with more than 10 livestock units used a precursor to the system which was an advisory service concerning nutrient planning where balances are included. The STANK system covers nutrient balances (NPK) at a farm level and herd level including feed imports and can be used by all sectors of the industry except glass house production. Using the system has been a condition for obtaining one of the environmental agricultural supports in 1998-99 (REKO- resource saving conventional farming). Some companies have given price premiums for farmers using the system (Danisco, Skåne Mejerier, Svenskt Sigill) but with no specific demands or limits for surplus. It has been used only with educational or marketing intentions. From 2001 a project, Greppa Näringen, will start in three counties, Skåne, Halland and Blekinge, where more care are taken to use a specific standard procedure (including data quality checks) for a high number of farms (estimated but still voluntary participation but linked to financial support for specific advisory service). The data will be collected to form a database. A detailed description of the software will be prepared in beginning of year 2001. The intention is to describe both the references for background values and the calculation process.

Methodology

Nutrients Surplus in kg per ha of N P and K based on sum of inputs (feed, fertilizers, N-fixation and -deposition, seeds, imported manure) less sum of outputs (animal products, sold crops, exported manure) divided by area of the farm

Results

The system is run for the farmer by his adviser as part of fertiliser planning (this advisory service is supported by specific funds used by public and private institutions for environmentally adapted use of plant nutrients). Since 1995 the number of farmers using the system has been around 1500 each year judged from number of plans made by advisors. The results are used as a basis for discussing potential alternatives on the farm and possibilities for reducing the surplus and losses on a voluntary basis. At present no standard values for interpretation exist but it is planned that the calculation and use of values for comparison will be made more systematic. An analysis of 1300 farm results will be used to instruct the advisors in order to make them better prepared to evaluate the individual farms results.

An evaluation of the extension program on plant nutrients was done by ”Statistics Sweden” in 1999. It shows that 30 % of the farmers have been attended courses or have received advisory visits during 1996-1999. More than 90% said they had used the training. Around 85% have changed their handling of plant nutrients and 92% say that the advice they have received at the training have influenced the changes.

In the process of preparing for the program ”Greppa Näringen” a questionnaire was sent to 700 farmers and 339 farmers gave answers. More than 200 had received advice for environmental utilisation of plant nutrients and 75% were satisfied with the service. Out of the farmers in the ”REKO”-program 50 % said that the two-day course they received had led to changes on their farms. Around 50% of the farmers said that they needed better understanding of the measurements to be taken to reduce the losses of plant nutrients. The effect on the use of fertilisers has not been specifically evaluated. But it is known that the use of phosphorous has been reduced drastically. Partly this is a result of other costs and the lower price of grain but the extension service has definitely had some impact on the changes. Statistics Sweden has done a general nutrient balance for the major regions of the country. This is done at certain intervals and will be used to evaluate the effect of the extension programs.

At present the IOA system is seen as a tool for the advisor. Advice can often be given to a farmer without putting to much emphasis on the balance. The approach so far has been based on a voluntary system in order to educate farmers and help them to find locally adapted solutions at farm level and has been reasonably well received.

A mandatory and ”taxing” system is expected to change the view of the farmers. Progress will be monitored and in 2005 there will be a new discussion on mandatory approaches.

40. Environmental Yardstick for pesticides

Background

In 1990 the government introduced a new crop protection policy that was entirely focused on reducing the amount of pesticides in kg active substance. Although there was no policy that was giving attention to the differences in toxicity of pesticides, the Ministry of Agriculture, Nature management and Fisheries supported the initiative of the Centre of Agriculture and Environment (CLM) to develop an Environmental Yardstick for pesticides. The CLM started to develop the yardstick to give farmers a tool to compare the environmental effects of pesticides, notably on water organisms, soil organisms and leaching to groundwater. In the initial phase the CLM cooperated with a large number of organisations in a steering group: different departments of the Ministry of Agriculture, Ministry of Environment, Governmental Institutes (IKC, Plantenziektenkundige Dienst), Research Institute (RIVM), farmers organisation (Federation of horticulture study groups, arable grower). A working group of ten arable and horticultural growers contributed to the design. Also involved were researchers from the Staring Centre and the Experimental Station for Horticulture under Glass. The environmental yardstick was developed in 1991-1992 and tested with twenty groups of farmers in 1993 (total of 185 participating farmers). In 1994 the yardstick was introduced in practice. Information material has been distributed among farmers, farmers' organisations and technical advisers. At the moment the yardstick is used on a large scale in the Netherlands. The environmental yardstick is also used to monitor environmental performance, to set standards for labelling purposes and it is used as a tool for policy evaluation.

Methodology

Pesticides The environmental impact of pesticides in the yardstick is expressed in environmental impact points (EIP). All 230 approved active substances in the Netherlands are included in the Yardstick. The more EIP a pesticide gets, the higher its impact on the environment. The EIP are based on the predicted environmental concentration (PEC) in a certain compartment and the environmental standard set by the Dutch government for that specific compartment. If the PEC equals the environmental standard, the score on the yardstick is 100 EIP. In formula:

score yardstick = PEC/environmental standard * 100 EIP

The EIP are assigned for a standard application of 1 kg active ingredient per ha. If a different dose rate is used, the number of EIP must be multiplied by the actual dose rate. The EIP of a formulated product are calculated by multiplying the active ingredient content of the product with the environmental impact points for the active ingredient.

The environmental yardstick assigns separate environmental impact points for the three compartments and effects which are considered:

a) risk of contamination of groundwater by leaching;
b) risk to water organisms;
c) risk to soil organisms.

Results

On a farm level the yardstick is used as management tool by farmers and advisers in order to be able to select a pesticide with the lowest environmental impact. For this purpose a working book was developed for farmers and advisers. This book includes an explanation of the yardstick, a list with the environmental impact points for all pesticides registered in Dutch agriculture and forms to calculate and assess the environmental impact of pesticides and spraying schemes. The safety code of the pesticides is included in the working book as well. Furthermore the information is available on diskette which includes a computer calculation program. The yardstick is also available on the internet. Apart from being a management tool for farmers the yardstick can have three other functions:

1.a performance tool, monitoring the performance of farmers or to reward farmers for environmental results. In groundwater protection areas water companies use the yardstick as a tool to reward farmers for achieving environmental results. In this case for lowering the risk for groundwater contamination. Farmers in the area who only apply pesticides with EIP below 100 (drinking water standard) for groundwater are rewarded for their effort

2. As a standard for labelling. The yardstick is used to set standards for agro-environmental labels like Milieukeur (Bouwman et al. 1993). Farmers that cultivate products for this label are only allowed to use pesticides with EIP below 100 for water organisms, soil organisms and groundwater.

3. As a policy tool to evaluate pesticide policies by local or national authorities. For this purpose the quantity of each pesticide used (or sold) in a certain region is multiplied by its environmental impact points and then added up. This indicates in what region or crop the environmental effects are most serious or which environmental compartment is most seriously jeopardised. Policy makers can use this information to focus extra policy measures.

Evaluation of the environmental impact of pesticide use in the Netherlands over the period 1984-1993 showed a large impact of pesticides on water organisms despite a decrease in volume used (Reus et al. 1995). Analysis with the yardstick made clear that a large environmental improvement of 95% can be reached if the use of a small number of pesticides (about 17 active ingredients) is severely restricted (Reus & Faasen 1995).

The yardstick was also combined with a database on pesticide use (ISBEST) to identify the pesticides and crops with the highest environmental impact in the region of Noord-Brabant (Merkelbach & Wiskerke 1998). The use of this instrument made it possible to identify MITC, lindane, and propoxur as pesticides with a high environmental impact in the region. Pesticide use in the cultivation of strawberry, maize and potato were responsible for the largest environmental impact.

The numbers using the system are increasing steadily (84% of farmers in 1994), it is very user friendly already. However, based on the Yardstick simple coloured environmental impact cards were developed for separate crops in which all pesticides are ordered in accordance to their risk to the environment. This card will give farmers easy access to information on the environmental risk of pesticides. This is being used by farmers as a simple decision making tool before spraying. The cards were distributed for free to all subscribers of the weekly agricultural magazine ‘Oogst’ (Harvest).

30. Energy Yardstick

Background

The idea of an Energy Yardstick was born at the experimental farm for sustainable agriculture “De Marke” which was carrying out comparative research on management systems. The Centre for Agriculture and Environment (CLM) was one of the initiators of the Marke and was actively involved in its development. In 1993 CLM took the initiative with financial support from the Ministry of Housing, Physical Planning and Environment (VROM), the Ministry of Agriculture, Nature management and Fisheries (LNV) and the Dutch Enterprise for Energy and Environment (NOVEM) that has been initiating and financing and energy saving projects for the government.

The environmental policy context of the development of the Energy Yardstick was formed by:

Energy efficiency target;
Political discussion about the introduction of an energy tax;
Increasing public awareness for energy saving.

The energy efficiency target was: to reduce direct energy use per unit product with 26% in the year 2000 compared to 1989. The energy yardstick was perceived as a potential instrument to reach this target in combination with a ‘gentlemans’ agreement (convenant) on energy saving in animal husbandry. This agreement was never signed by the farmers. The main reason was the tendency to increased direct energy use at farm level because of environmental policies on ammonia emission leading to increased manure treatment (drying) and mechanical air purification.

The energy yardstick was developed together with the farm advisory body (DLV) that provided the link to the farmers. Seven study groups were formed in different regions of the Netherlands: three for dairy production, two for pig production and two for poultry production. Each group comprised on average of ten farmers. The two subjects of the Energy Yardstick are energy use and greenhouse gases (CO_2, CH_4 and N_2O) and it was developed for the dairy and pig sectors. Development work on an Energy Yardstick for the poultry sector was not completed because of financial constraints and lack of interest from poultry farmers.

Methodology

The methodology of the Energy yardstick is illustrated in the Table 2. The items in Part A vary per sector and thus the Energy Yardstick for dairy husbandry is different from that for pig husbandry. The items in Part A demand an administrative effort from farmers to produce the input data. These data may have different units such as kWh, liter, cubic meter, number, kg, or Euro. In Part B the input data are calculated into energy use units or emission units. In Part C the different modules are totaled and the balance is made with relevant output data such as kg milk, kg growth of pig meat, average number of sows present.

Table 2: Building blocks of the energy book keeping

Module	Part A: farm based information	Part B: Calculations with standard numbers	Part C: Results
Direct energy use and CO_2 emission	Registration of meter readings	Energy use per item	MJ or GJ Kg CO_2
Indirect energy use And CO_2 emission	Mineral book keeping Book keeping Administration	Energy use per item	MJ or GJ Kg CO_2
CO_2 emission by mineralization of peat	Peat soil area Drainage	CO_2 emission of the soil	Kg CO_2
CH_4 emission by feed fermentation in cows	Livestock numbers, diet, feed ration	CH_4 emission cattle	Kg CH_4 Kg CO_2 eq.
N_2O emission by soil processes	Area, soil type, drainage, fertilization, grazing	N_2O emission of the soil	Kg N_2O Kg CO_2 eq.
Totals			MJ/GJ per farm MJ per hectare MJ per kg milk GJ per kg meat growth kg CO_2-eq.

Results

In the pilot phase the results were discussed in study groups in which ten farmers and a farm advisor participated. The whole study group programme for the EY Dairy consisted of eight meetings of 2.5 hours. The results for individual farms were included in an overview of the whole group for comparison and discussion. There was no formal system to support farmers working with the energy yardstick. This was mainly because energy use and greenhouse gas emission at a farm level does not have a high priority for farmers, farm advisory services and the government.

At the end of the two year pilot study farmers were asked for their views of the system, 31% of the airy farmers and 35% of the pig farmers were planning to continue using it. Their reasons for doing so were as follows:

To compare the performance over time (per year): 39% of dairy and 57% of pig farmers
To assist with management decisions: 31% of dairy and 26% of pig farmers
To compare performance with other farmers: 38% of dairy and 28% of pig farmers

All the farmers were interested in the calculation of direct energy use (100%). Only 62% of the dairy farmers and 20% of the pig farmers were interested in the calculation of indirect energy use. Measuring the emission of greenhouse gases has a very low priority: only 23% of the dairy farmers and 14% of the pig farmers would continue to calculate CO_2 emission from energy use. The calculation of the emission of CH_4 and N_2O will not be continued.

In general the tendency is for pig farmers to be uninterested in using the Energy Yardstick Pigs because their main energy input is concentrate. They are focused on reducing the feed used per kg growth anyway and do not need the Energy Yardstick to

motivate them to do this. Pig farmers also think they can change relatively little in their management to improve their performance on energy use.
The dairy farmers have more potential to improve their performance on energy use through changes in management. However, they are likely to give a higher priority to optimisation of mineral use in their management decisions. The Energy Yardstick is still used in research projects, especially in sustainable farming systems research.

3.4 Comparison between sheets

3.4.1 Purpose and content

The main differences in purpose and content is shown in Table 3. Although the main funder/driving force varied slightly between the systems each had environmental pressure as the underlying reason for development. In addition to the key subject are-as five systems covered additional subjects (water use 5,13,28; soil compaction 10; soil conservation 13, 50; biodiversity/ habitat conservation 10,13,28; animal welfare 10, 28; and waste disposal 13,28). Although the Ethical Account (10) majored on pigs and dairy it could be used by mixed farms with cash crop production and the indicators applied to these crops too.

Table 3 Purpose and Content

	5	10	13	19	28	50	37	24	40	30
Funding/driving force										
government	x	x	x		x	x	x		x	x
farmers	x	x			x	x	x			
extension	x		x					x		
research		x	x	x		x		x	x	x
market requirements					x					
Subjects										
Nutrients	x	x	x	x	x	x	x	x		
Pesticides	x	x	x	x	x	x[1]			x	
Energy	x	x	x	x	x	x	x			x
Other	x	x	x		x	x				
Sector										
arable	x		x	x	x	x	x	x	x	
horticulture	x		x		x	x		x	X	
beef/veal	x		x			x	x	x		
dairy	x	x	x		x	x	x	x	x	x
pigs	x	x	x		x	x	x	x		x
poultry	x		x			x		x		
organic farming	x	x	x			x	x	x	x	
fruit					x					
protected crops					x					
Restrictions										
Geographic location				x					x	
none	x	x	x		x	x	x	x		x

5 = Green Accounts
10 = Ethical Account for Livestock Farms
13 = Environmental Management for Agriculture
19 = Agro-ecological Indicators
28 = Agricultural Environment Label
50 = Repro
37 = Herdbooks system (FHL)
24 = Farm Level Nutrient Balance (STANK)
40 = Environmental Yardstick for pesticides
30 = Energy Yardstick

[1] Although described as covering all three subjects in the initial survey the limited data available from the detailed questionnaire suggests that pesticides are not yet fully covered.

The more detailed survey revealed that there had been some misunderstandings in the initial questionnaire where restrictions on use were incorrectly identified. Only systems 19 and 40 had any restrictions. The restriction to geographic area in 19 is because of the locality in which the research is being done (The Rhine plain) it could be adapted to other regions with similar climate. Similarly for 40 which was developed for temperate climate and flat terrain.

The development and usage of the systems is shown in Table 4. The detailed questionnaire revealed some differences from the initial survey in terms of dates and farmer numbers.

None of the systems is compensated at the moment, but system 24 is an essential input for those wishing to claim one of the environmental supports in 1998/99. Others may become compensated, eg 5 has been put forward to the Commission as part of a revised scheme for environmentally friendly agriculture and so may be compensated in future. If this occurs the system will be audited by external regulators. The organisation who manage 28 have been trying to get compensation for farmers either through added value for the produce or through taxation.

Defaults were used for N fixation and deposition in systems 5, 10, 24; for indirect energy calculations in systems 10, 19; for rainfall in system 13; for mineralisation in systems 19; for parameters such minerals in animals or crops in systems 28, 24; for pesticides with no environmental data in system 40.

Table 4 Development stage and usage

	5	10	13	19	28	50	37	24	40	30
Operational Stage										
Research/design										
Pilot	x	x		x		x				
In use			x		x		x	x	x	x
Other										
Start date	1999[1]	1994[2]	1997	1994	1995	1996	1992	1996[5]	1991[6]	1996[8]
No. of farmers using	95	20	*5000*[3]	*50*	153 [4]	*50*	240	1500	*4000*	50
Mandatory	n	n	n	n	y (label)	n	y (label)	n (?)	n	n
Compensation	n	n	n	n	n	n	n	n (?)	n	n
Auditing										
external regulatory body	n	n	n	n	y	y	n	n	y	y
Input Data										
available from farm accounts	x	x	x		some	nd	x	x	? [7]	x
actual data	x	x	x	x	x	nd	x	x	x	x
budgeted data						nd		x		
field level	x	x	x	x	x	nd			x	
farm level	x	x			x	nd	x	x	x	x
defaults used	x	x	x	x	x	nd		x	x	

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40 = Environmental Yardstick for pesticides
30 = Energy Yardstick
nd = not documented *italic=estimate*

[1] previous version (No 6 in initial survey) began in 1994/5
[2] pilot phase completed in 1997, some aspects incorporated into system 5.
[3] assumes that each copy sold to an adviser is used for 10 farmer clients
[4] based on arable farmer numbers in 1997 (for the other sectors information is in ha).
[5] an earlier (manual) version existed
[6] developed in 1991/92, tested in 1993/94 and used in practice since 1994
[7] farmers who deliver products under certified labels keep this information, the government may make it mandatory for all to keep them in the future
[8] there was a development phase from 1994-96

The information used in calculation of the IO accounts is shown in Table 5, these have been grouped into management type information which may be used in more than one subject area and those which are subject specific. Essential information is indicated with ‘x’ and optional with ‘o’. Some systems (eg 28 and 30) may not require all the information for each sector.

Table 5. Methodology o=optional

	5	10	13	19	28	50	37	24	40	30
Management Information										
Fertiliser use	x	x	x	x	x	x	x	x		x
Manure use	x	x	x	x	x		x	x		x
Livestock	x	x	x		x	x	x	x		x
Feedstuff	x	x	x		x		x	x		x
Seed	x	x				x	x	x		
Milk	x	x			x		x	x		x
Eggs							x	x		
Crop types	x	(x)	x	x	x	x	o	x	x	x
Soil type/analysis			x	x	x	o	o	x	x	x
Irrigation/water use	x	x	x	x	x		x			x
Rainfall			x	x		o				
Machinery use		x	x	x		o	x		x	
Farm or field size	x	x	x	x	x			x	x	
Economics						o				
Nutrients										
Nitrogen	x	x	x	x	x	x	x	x		
Phosphate	x	x	x	x	x	x	x	x		
Potash	x		x			x	x	x		
Other nutrient	x	x								
Deposition	x	x			x			x		
N fixation	x	x			x			x		
Soil N supply			o	x	x					
Mineralisation				x						
Gaseous losses			x	x		x		x		
Drainage losses			x	x		x				
Soil surface balance								x?		
Farm gate balance	x	x	x				x			

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Continue Table 5. Methodology	5	10	13	19	28	50	37	24	40	30
Energy										
Direct	x	x	x	x	x	x	x			x
Indirect		x		x		?	x			x
Pesticides										
Rate	x	x	x	x	x	x	x		x	
Type	x	x	x	x	x	x			x	
treatment frequency	x	x	x	x	x				x	
active ingredient		x	x	x	x				x	
environment risk (including aquatic organisms)			x	x	x				x	
user health risk			x	x						
Veterinary Products										
Type		x	x		x		x			
treatment frequency		x	x		x					
environment risk			x							
user health risk			x							

All except system 30 gave farmers a specific explanation (see Table 6) and this was usually written, although for 5, 19 and 28 some advisers may give a verbal explanation only. Comparisons with own historic data or average farm values were the most common. Only systems 10 and 19 had any information on reproducibility and variation of the indicators between seasons.

Table 6 Use of Results

	5	10	13	19	28	50	37	24	40	30
specific explanation	x	x	x	x	x	x	x	x	x	
written explanation	x	x	x	x	x	x	x	x	x	
comparisons between farms	x	x		x [1]	x		x	x	x	x
comparison with expert best practice			x	x		x	x			
comparison with historic data	x	x	x				x	x		x
comparison with official limits	x				x	x			x	
comparison with average farm values		x				x	x [2]	x	x	x
comparison with best farm values	x						x		x	x
reproducibility of indicators tested		x								
variation of indicators tested		x		?						?

[1] for individual indicators comparison between farms is possible but there are no global farm comparisons

[2] FHL also provide comparison with worst values

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Changes to systems may arise through addition of new inputs or indicators or alteration in the way indicators are calculated. Both of these processes can be influenced by farmer feedback during use. All the systems for which there is information have made some changes (Table 7).

The time to set up data handling in the first instance may take longer in the first year than subsequently (about double for system 5) and longer where software was not fully operational (19).

Table 7 Evaluation and Monitoring

	5	10	13	19	28	50	37	24	40	30
Changes made										
Inputs	y	n	y	y	y	nd	y	y	y	y
Outputs	n	n	y	n	y	nd	n	n	n	n
Indicators	y	y	y	y	y	nd	n	n	n	y
No of farmers	y	n	y	y	y	nd	y	y	y	n
Farmer Involvement										
initial development	y	n	n	y	y	nd	y	n	y	y
changes	y	n	y	y	y	nd	y	n	n	y
farmer opinion of system known	y	y	n	y	y	nd	y	y	y	y
farmer marketing benefits	nd	nd	y	n	y	nd	y	n	y	n
Costs/time consumption										
data handling (hours)	5-8	8	nd	4-16	24 [1]	>16	2-3	4-16[2]	4-16	1
book keeping (hours)	1	2	nd	nd	[1]	nd	0	nd	nd	nd
Effectiveness										
outputs increased	n	n	nd	nd	n	nd	n	n	n	n
inputs reduced	y	y	nd	nd	y	nd	y	y	y	y
indicator improved	y	n	nd	nd	y	nd	y	n	y	y
farm income increased	nd	nd	nd	n	nd	nd	y/n	nd	y/n	Y

nd = not documented
[1] estimated at 2 hours per month to cover all aspects
[2] farmers can opt for different levels of detail

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In the initial survey farm income was thought to have increased in systems 5, 10 (dairy sector), 13, 28 (poultry sector), 50 (arable, dairy, pig and organic sectors), 24 (dairy and pig sector) and decreased in systems 28 (arable and horticulture) but no hard data was available. For system 19 there is some evidence of an additional cost for one farmer group but no costs to another, whilst for system 37 effects vary with season zero for 1992-1995 but generally positive effect on income in other years. For system 40 a survey of 106 farms showed it was there was no effect or an improvement in half the cases and a loss of income in half the cases. System 30 has shown benefits in terms of reduced costs for electricity and dry concentrates but these were to some extent offset by increased costs for fodder etc.

3.5 Conclusions

The amount of information required to run the systems varied considerably even between systems which were ostensibly using the same indicators. Some systems (eg 28 AgroMilieukeur) split into 'sub-systems' which had different data requirements based on sector. Those systems which dealt with only one subject (eg 30 Energy Yardstick) tended to go into greater detail than those which covered several sectors or subjects. Although respondents to the initial questionnaire claimed that their systems were effective and stated that documentation was available, when asked to supply this information for the detailed survey very little hard evidence was forthcoming. However from user comments it appears that those systems where there is detailed/regular personal discussion of results are most likely to be successful, and that increased awareness by farmers of the problems addressed by the indicators is very valuable.

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4 Overall analyses of Input/Output Accounting systems

4.1 Summary

More than 40 IOA systems representing very different approaches have been developed and applied on farms in European countries with the aim of improving environmental performance. Major differences regard especially two characteristics: The no topics covered (single or multiple) and the way indicators are presented. In many systems the indicators used are presented as calculations of input related to output and are derived from accounts based data. Other systems present indicators that are transformed to a standard scale and often these indicators are based on a combination of practise and account data compared with norms for Good Agricultural Practices.

Moreover, the systems differ in their origin and driving force: Only a few systems have been developed for mandatory use or for labelling and formal auditioning. Most systems have been developed for the use by advisory services on a voluntary basis.

A number of very different systems seem to have been successful. Effectiveness is defined here as the combination of a system with high (potential) impact on the participating farmers in combination with high uptake in terms of the no of farmers willing to use the system. Generally documentation of effects and uptake is poor and more investigations into this are needed.

It seems that many systems have not passed the pilot phase, even though some of them did get a positive evaluation by the farmers. In several examples the effort of researchers to develop a scientifically valid concept was not matched by efforts to secure the uptake by advisors or other institutions afterwards. The right institutional setting and political context seems to be more important than the character of the indicators used for the question of farmer uptake. But that does not mean that the choice of indicators is not important from another point of view.

In none of the reviewed systems were the use of confidence intervals or variation coefficients an established part of the procedure. Only few reports exist that analyse the variation between farms or between years on specific farms in order to decide to which degree differences are due to systematically different management practices.

4.2 Introduction

The following will present an analysis of the perspectives of the reviewed systems from different points of view, primarily the farmers and the societal/environmental evaluation of the used indicators and concepts. The analysis is limited to the information gathered on the systems in this study and will focus on voluntary systems not linked specifically to mandatory agri-environmental regulation (though some of the systems may be used as documentation of compliance with agri-environmental schemes or with product labelling). Thus, the focus of the study is not regulation measures but the efficacy of IOA systems for motivating and facilitating farmers to increase their environmental performance. An evaluation of the effects of initiatives under the 2078/92 EU agri-environmental regulation is presented by Fay (1999).

4.3 Types of IOA-systems and indicators used

4.3.1 IOA systems for different use

Based on the overview of the different systems presented in task 2 it is possible to distinguish between the following overall concepts:

1. Mandatory systems (systems for public regulation and control)
   The broad review in task 2 identified a few mandatory systems, especially in the area of nutrient use including the manure supply. Both the Danish mandatory fertiliser account (8) and the Irish Nutrient Management Planning (41) requires farmers to register fertiliser and manure N supply and compare it with standard values for crop requirement. No registration of actual yield or output of nutrients is demanded, thus the systems are not fully IOA systems in a technical sense. The Dutch MINAS demands an input output balance (though not including nitrogen fixation) on farm level to compare with maximum values for N and P-surplus per ha. None of the mandatory systems were chosen for further analysis in task 3.

2. Farm management systems for voluntary use comprise the following types:

2.1. Production efficiency tools.
   In some countries tools to plan and evaluate the input use and production are used by many farmers, especially within animal production. The pig production efficiency tool (7) help the farmer to evaluate - among others - the feed use per kg live-weight gain and to compare the protein supply with norms. Such tools may be efficient for environmental improvement in cases where the goals of increasing efficiency of input use (feed or fertiliser) go hand in hand with a reduced loss of nutrients. But usually they do not include an environmental performance evaluation per se. An exception is the Swedish fertilisation planning tool (24) that allows a complete calculation of farm gate and field level balances as part of the software STANK.

2.2. Green accounts.
   These are systems specifically developed for Input/Output Accounting using actual data for input and output on farm and enterprise level (including but not exclusively certification schemes with auditing).

2.3. Other systems for environmental auditing of individual farms.
   These systems may use management information but not necessarily figures for the exact input output relation. A range of these systems exists that use a variety of indicators with different level of detail to evaluate either the planning or the actual management of the farmer. A few examples have been included in this analysis.

Comparing these general types of systems it becomes evident that

- The mandatory systems build on rather simple and controllable data and often indicators do not describe the system accurately probably because auditing and enforcement was given higher priority than the benefit of information for the farmer,
- Voluntary systems rely on the farmers' motivation and capacity to supply and later digest rather detailed information often in close collaboration with local advisors. Moreover, a large variation and ingenuity exists in the range of indicators used and

often the calculation includes scaling and transformations based on (subjective) expert statements. Therefore, they may not seem attractive from a regulatory perspective, except if the fact that they are voluntary inspires farmers to improve their environmental performance.

It is this large variation in voluntary systems that will be in focus in the following analysis with the aim of evaluating which concepts -if any- seems promising from both farmers' and society's point of view.

4.4 Types of indicators used in IOA systems

Table 1 shows the different types of indicators used in the reviewed systems for the assessment of Nitrogen use and the potential losses. Most IOA systems use nutrient balances based on account data but very little information exists regarding how the indicator values (the size of the surplus on a given farm) were actually evaluated. In systems no 8, 13 and 21 the actual fertiliser use was compared with standard fertiliser requirements which off course automatically included a reference value. In no 13 this result was moreover transformed using factors indicating risks of N losses and scaled into a so-called Eco-rating so that the farmer received a value between -100 and +100 for his nutrient management. Thus, the indicator was mix of account information regarding input and assumptions regarding output. A similar approach was developed in system 19 but here the modelled loss of Nitrogen (in combination with evaluation of the farmers efforts to reduce losses) was used as the basis for transformation into the 0-10 point scale.

In table 2 a review is given of the indicators used to cover the topic of energy use. Most systems have used the energy efficiency indicator (though with different names) including both the direct and the indirect energy actually used in the given year. Information from two systems indicates that farmers have low interest in the indirect energy as such. The energy efficiency was calculated using the amount of produce in kg. One system related the energy use to the energy in the items produced. This may be more correct for an ideal societal perspective. But this probably does not give the individual farmer extra relevant information as long as he will not consider to close down his enterprise and produce something different (e.g. beans in stead of pork). No information regarding the farmers' reaction to this was given. In system no. 30 the emission of green house gasses attached to the energy use were also included but with low interest for farmers.

Also for the energy use topic the systems numbers 13 and 19 use rather complicated transformations of the data to a uniform scale in order to allow a more easy evaluation of the individual farmer's results. The pro's and con's of this approach is discussed in section 6.1.

In general the information of farmers' reactions to the indicators is so limited that it was not possible to select the most promising on this basis. In the following section the farmers reactions to each system as a whole (including the indicators) is described.

Table 4.1. Indicators of Nitrogen use and loss

	N-balances	N-efficiency	Input vs requiremts.	Emission risk	Eco-rating
Indicators	N-surplus, kg per ha, farm level	N use efficiency, %	Over-/under consumption, kg N, field level Manure N utili-sation factor, %	Points on scale, 0-10	the eco-rating is the indicator scale +/-100
Calculation	(input-output)/ha	(Input/output)*100%	Std. Crop reqmts-(fertili-ser+manure N supply*std. utilisation factor), Manure N supply*100/ (Std. Crop reqmts-fertiliser)	- (Sum of modelled losses in kg N /30) + (sum of mitigation efforts in kg N/30)	INT(size(scaling factor(std fert rate - actual fert rate)/actual fert rate) + other factors see below
Data needed	All actual input, fields and stable Actual production N content inventory	All actual input, fields and stable Actual production N content inventory	Actual input fertiliser and manure by crop, Std. N content, Crops grown, Std. Crop N req.	Fertiliser use, kg N ha-1, Crop type, soil type,	Std. Crop N req. Actual input, timing, rainfall,soil type
Examples, system no.	5,10,24,28,37,50	10	8, 21	19 AEI	13 EMA
Evaluation, reference used	Range of farms, (28: public levels as for MINAS)	Range of farms with similar production	No surplus, Minimum level of manure N util.%	Scale 0-10, 7 represents integrated farming	Good agricultual practice = standard good practice
Farmers reactions	Generally positive (nos...) (when not compulsory)	Interested but surprised (10)	Do not like detailed, rule-based regulation		?in original questionnaire they said it was good but there is no real proof of this just hearsay

Table 4.2. Indicators of energy use

	Energy use	Energy efficiency	CO2 Emission	Energy saving management	Net energy yield
Indicators	MJ ha-1	MJ kg-1 product	Kg CO2 kg-1 product	eco rating +/- 100 scale also emissions	GJ ha-1
Calculation	Sum MJ input /ha	(MJ input/MJ output)100%		MJ energy consumed	GJ output - GJ input
Data needed	Direct energy use , actual (5) or modelled (19) Indirect energy (19)	Actual direct and indirect energy use, MJ Energy equivalents Actual output, kg	Actual direct and indirect energy use, MJ Energy and CO2 equivalents Actual output, kg	Actual direct energy use	Actual direct and indirect energy use, MJ Energy in products
Examples, system no.	5, 19	10,(28),30,49,50	30	13 EMA	49
Evaluation, reference used	Range of farms Integrated farming	Range of farms, 28:maximum level defined by?	Range of farms	best practice	?
Farmers reactions		Not interested in indirect energy use	Low interest	?	?
Efficiency		Direct energy use reduced			

The IOA systems seen from the farmers/advisors point of view
In general farmers in several countries with a variety of production forms in a different sectors have demonstrated interest in the agri-environmental indicators if they are presented in a non-condemning way.

The evaluation of IOA systems from farmers and advisors position will be based on:

- Information on the farmers reactions to the systems (where available).
- Objective characteristics as time/price of supplying the information, the linkage to support schemes or and the uptake of the different systems.

4.4.1 Farmers evaluations according to interviews

Only sparse documentation exists concerning the farmers view on the systems. Table 3 shows some characteristics of selected systems and results from interviews with farmers using specific IOA systems. Generally farmers participating in the testing phase of the IOA systems have expressed interest and satisfaction with the information they receive in the form of the indicators[1]. This goes for the quantification of their use of pesticides and the increased knowledge of the (differences in) toxicity towards non-target organisms. Farmers also mentioned the nutrient balances as new and surprising information that it was possible to react upon (no. 10, 24 and 28). However, for some reason the majority of farmers using no. 28 found only the P balance useful and did not find the N balance relevant or too costly to improve to the target value. In general, most of the farmers answer that they have changed their management due to the systems. This goes also for energy use, but in both no. 10 and 30 it is the experience that farmers find it difficult to relate to the indirect energy. This topic seems to be too abstract and is better addressed by the efficient use of feed and fertiliser as some farmers state it.

The two systems no. 10 and 24 use absolute values for the nutrient surplus per ha and efficiencies for energy use per kg. Thus, the farmers expressed a need for better reference material to facilitate evaluation of the results for example by comparison with other farms. The reference material used was based on public goals or the average or best practise of a number of other farms. But this was not available in elaborated form at the time of the development of the systems since the indicators were new and data on a large number of farms therefore did not exist. Both for no. 24 and for no. 5 (the Danish green account) it is expected that good data sets for comparisons between similar farms will be available in near future. This would facilitate a use of the indicators for energy use and nutrient surplus comparable with the way farmers use more traditional production efficiency indicators as milk yield, feed efficiency or net margin per unit produced. For the pesticide treatment frequency (TFI) it is expected by the system developers that public goals for the reduction of TFI in different crops may be used as a reference point for the farmers.

[1] It should of course be kept in mind that the farmers involved in the development of a system (pilot farms) often have had close contact with the developers, have received good service and free advice and have not paid the real price of using the system. They may also feel that they have influenced the final version of the system, giving them a sense of responsibility. For these reasons they may be less willing to reveal any criticism that they might have towards the system. As demonstrated some farmers actually did criticise parts of the systems so the mentioned reservations are probably not always important..

Table 4.3: Information on the farmers uptake and evaluation of I/O A systems (only documented evaluations included, 1).

Farmers view regarding:	10 Ethical account	19, AEI	24, STANK	28, Agro-Milieukeur	30, Energy Yardstick	37, FHL	40, Pesticide Yardstick
No. farmers using system	20 (pilot)	50	1500	153	120	240	4000
No. farmers in evaluation	20	17	2-400	<153	<120	<240	185
Relevance and usefulness of indicators	OK: motiva-tions accepted for all, though energy indi-cator difficult to understand	All understand message but not calculations	50% found nutrient balances interesting and relevant	OK: Pesticide, P-balance, waste relevant Not OK: N-balance, field-margins	Direct energy use interesting but indirect too abstract and irrelevant	Farmers positive	Good, usefull, increased knowledge on toxicity
Costs/work required	High, mostly by experts	4-16 hours, no comments	Rely on advisor, Cheap for farmer	48% find costs too high, not compensated	2-3 hours, acceptable	2-3 too fill in, free if part of label else 12.000 LUF year ???	?
Economic effects	Small	Small	?	Generally acceptable 46%: Too high costs to reach N loss goals	?	Marketing benefits , saved costs: Average 100.000 LUF	Half of 106 farmers had lower costs, half had higher or equal costs
Possibility to improve environmental performance	OK for Nutrients, energy, pesticides, Cu	?	85 % say they changed nutrient management	OK:Pesticidessoil disinfect. P surplus, field margins Not N surplus	OK: direct use energy dairy Not OK: direct for pig prod. , Indirect energy	OK: energy use via reduction feed use	Use less toxic pesticides, include in management
Other problems	Lack reference values, Negative if mandatory	Negative if mandatory	Lack reference values Negative if mandatory				Negative if mandatory, fear change to regulation

1) Among the ten systems reviewed in task 3 no. 5 green account was still in pilot phase with 100 farmers and no. 13 EMA was used by more than 1000 farmers. There were however no documentation on farmers evaluations of the systems.

Unfortunately no information was found concerning farmers view on the two systems using the elaborated eco-ratings (13, 19). Since these systems use indicators different from the real IOA systems (see table 1 and 2) one may have expected farmers to be more satisfied with information and at least not complaining over the lack of reference material. However, this is still to be proven and the opposite may be suggested: Due to the complicated scaling inter-farm comparisons of the ratings are not possible (according to the answers from the experts). Therefore, farmers will lack the possibilities to compare their results with colleagues, which is a strong request from farmers using the other systems.

4.4.2 Costs and benefits of using the IOA systems

The possibility for the systems to help to reduce farmers cost was reported to be positive in many cases in the first survey (18 systems indicated positive effects on farm income for the arable sector and 10 for the pig sector). However, documentation of economic consequences appeared to be scarce in the in-depth analysis of selected systems. The economic effects of using the ER no. 10, the AEI no 19 and the pesticide yardstick (40) were small or neutral. This was also reported from the AEL (28) but here farmers found that the costs of reaching the N target were too high. Also, nearly half of the 153 farmers using AEL found that it was a problem for their long term interest that the relatively high costs of using the system was not compensated by higher prices or premiums.

The costs of using the systems were mostly related to data handling and calculations, which was done either by the farmers themselves or by experts or advisors. Only ten of the 55 systems reviewed initially reported administration costs to be lower than 4 hours. For at least 40 of these systems advisors or other externals were (could be) involved in the data processing while 25 systems could be handled by the farmers themselves. Many systems are still in the pilot or development phase, which may be why large support for data handling is given. In 15 of the 55 systems reviewed initially government compensated the costs of the data handling. Systems no. 27, 29 and 35 all with around 1000 reported users have been compensated.

Farmers have demonstrated commitment to use the information offered by IOA systems to improve their management given it is possible with no or limited economic loss. For a number of IOA systems developers have reported economic benefits due to savings in the use of inputs. But documentation of this has not been easy to find (Indeed, if economic savings linked with environmental improvements had a great potential farmers would probably have found out without using the IOA systems). However, from the relatively limited number of interviews economic savings seems not to be the primary motivation for the farmers to improve environmental management. This is supported by the fact that reduced use of i.e. diesel, electricity and pesticides seldom represents large reductions in cost while especially the reduced pesticide use may introduce risks of higher losses. The farmers' motives for using IOA Systems are probably often related to self-esteem and attempts to avoid stronger forms of public regulation. Therefore, the motivation for using IOA systems on a voluntary basis seems also to depend on the degree of existing public regulation using other means than the IOA system.

4.4.3 Uptake of systems

Sixteen of the 55 systems reviewed in task 2 are reported to be used by 1000 farmers or more. Four of these systems are mandatory, 3 are traditional production efficiency tools and another 2 are not separate IOA systems of the type discussed here. There were seven IOA systems reported to have high uptake on a voluntary basis, most of which focus on nutrients.

Three of the 10 systems analysed in task 3 have had a relatively high uptake and may in this respect be seen as successful systems: No. 24 is often delivered as part of an advisors visit to plan the next season's fertiliser use which around 1500 farmers receive every year. It is however not clear how many of these in reality pay attention to the nutrient balances. The system is not used for mandatory regulation or control and it seems to be flexible in its demand for account data.

No. 13 EMA also has a high uptake and probably more than 1000 farmers have used it alone or with an advisor although no clear figures are available. EMA is sold as a computer package for farmers to use themselves but of the 1000 sales recorded in 1999 only 26% were direct to farmers and 52% were to consultants. No information is available regarding the farmers' opinion on the system. Nor is it known whether they actually use the system to calculate and evaluate eco-ratings or only the hypertext background information.
Nr. 40 Pesticide Yardstick has been used by more than 4000 farmers and is found to be very useful for the farmers. Farmers find that the system increases their knowledge on pesticides toxicity in a way that they can include in management. The primary effect is that they shift to less toxic pesticides and with small or no extra costs.
The two latter systems build on a rather extensive set of assumptions and rules for the calculation of the indicators but this do apparently not worry the users.
The three systems with high uptake - despite their differences - share the characteristic that they have been widely accepted by advisors who brought the systems to farmers and helped introduce the ideas behind the indicators. All three systems are integrated in software that facilitates relatively easy on-the-spot calculations using a combination of data available from the farmers' field-notes and default values. But the systems differ in the degree advisors are involved in the use on the farms. STANK is primarily used in connection with advisors' (free or cheap) visits on the farms while less than a quarter of EMA reports on farms are probably made by farmers themselves.
The pesticide yardstick is included in several different advisory service tools but is reported to be used also by some farmers independently of advisors.

Another common feature is that the systems cover environmental issues which are in public focus in their countries of origin but which are not at the same time strongly regulated on the individual farm. Farmers using the STANK and the pesticide Yardstick answered - not surprisingly - that it would influence their interest in the systems if they became mandatory to use.

Many system in the task 2 review were under development so it was too early to judge their success in terms of uptake. Some systems did not make it beyond the pilot phase, for example no. 10 and 30. Important reasons were in both cases lack of interest from the advisory services and that the systems were not integrated into readily useable computer packages. The ethical account (10) may have been too ambitious in its interdisciplinary whole farm approach for the advisory service though the farmers priced this aspect several times over the three pilot years involved.

It can be concluded that farmers' uptake does not depend on the type of system or the indicators used. In stead the number of farmers using a system depends on the institutional frame: Who brings the system to the farmer, is it connected to other type of tactical or operational planning (e.g. fertilisation planning) or integrated in computer packages that minimise data entry, is it part of an environmental support scheme or linked labelling/certification, is it supplied free of cost etc.

4.5 The systems evaluated from societal/environmentalist point of view

The degree of uptake and the farmers' willingness to include the indicators in their management was discussed in the previous section. While the degree of farmer uptake of a system obviously also is relevant for a societal evaluation of a systems efficiency it cannot stand alone because, a system with high uptake do not necessarily change the individual farms' environmental performance significantly. This may be the case if the indicators used do not in reality reflect a potential or actual impact on the environment, or if the reference material does not demand changes on farms or if the concept is not followed by proposals for change. The same may be true for labelling schemes without threshold values.
In this context effectiveness of IOA systems could therefore be defined as:
The degree to which farmers are facilitated to actually exploit the possibilities for environmental improvement at low or no costs and beyond the limit regulated by existing public law and regulation. Effectiveness is then a combination of

- the systems uptake in no. of farmers,
- the degree to which farmers using the system increase their awareness of environmental issues and
- the degree of changes they make on their farms.

The first factor is described in section 4. The second factor depends on the degree of awareness raising created by the system. The third factor is off course important but not so easy to document.

4.5.1 Awareness raising and changed attitudes

The IOA system may be the information that motivates the farmer to a changed attitude. A shown in section 4 many farmers find that they have got new insight from the indicators and find the information interesting if it is linked to their management. Experiences from many of the pilot systems indicate that farmers generally understand the indicators, are interested and many of them and believe they have changed their management. One benefit of IOA systems is probably that it makes it legitimate for advisors to address environmental issues while also discussing production economics. This may be one of the reasons why only system linked to existing advisory services seems to make it beyond the pilot phase.

Relation to management

There is a large variation in the farmers interests in the agri-environmental indicators and the willingness to use them in management expressed in the interviews. One may suspect that this has to do with their individual attitude towards the environmental issues behind the indicators, see for example No. 28 in tabel 3. But another important factor may be the difference in farmers' use of quantitative information in their general farm management (Ohlmér, 1998). Answers from 250 organic farmers showed that the farmers interest in an environmental decision aid tool depended more on how much they already used quantified production results for management than on their agreement with the environmental objectives Denmark (Noe and Halberg, 2000). In other words, farmers who in their daily management rely mostly on own experiences and personal exchange of ideas between colleagues were not so interested in IOA systems even if they agree on their purpose.

If this is a general finding, it is probably very important to offer farmers different IOA systems with more or less focus on quantified information vis-à-vis practice oriented information (i.e. how good they are to apply methods of good agricultural practice).

It is obvious that awareness is not enough and that the IOA system needs to motivate farmers before changes will happen. Therefore, some conditions need to be met to implement changes in farm management. These include the economic conditions and labelling, reference material and scaling of indicators and the degree of existing regulation.

Economic conditions

In section 4 it was mentioned that the potential economic benefits for farmers probably are small except when the system is combined with Labels or agricultural support schemes. Moreover, it is unlikely that farmers will accept net margin losses without at least a potential compensation in the form of price premiums or environmental support schemes. Therefore, the question of attitude also links to the general question of the possibilities for the farmers to reduce their environmental impact (or resource use) without reducing their net margin or income. Only few of the researched systems have good documentation on this, but other sources might give indications of the potential for improvement of environmental efficiency: Analyses of the difference in indicator levels between farms with the same production, modelling of changed management on typical farms. The analysis of the indicator levels on the ethical account farms shows that comparable farms have significantly different levels of nutrient surplus and energy use. This supports the idea that farmers may have different production strategies that all may be economically rational but differ in their environmental efficiency. Therefore, the variation between comparable groups of farms may be used as reference points for the improvement of individual farms given the farmer is motivated. The interest in information concerning the variation and best results among comparable farms expressed by several of the farms in different systems supports this.
For other types of changes as energy savings, new investments may be needed, that are not economically sound for the farmer without support.

IOA systems in relation to market and labelling

The FHL scheme seems to be successful in terms of the support from farmers and because it has managed to secure farmers price premiums. But there is actually no guarantee that the farmers improve their environmental performance seen from a consumer perspective. There are no demands for example yearly improvements or maximum levels of nutrient surplus or energy use attached to the system. It is not clear if farmers by their own motivation in reality improve their environmental performance when participating in the FHL system.

The Dutch system: no 28 asks for compliance with thresholds that are above the average practice, and thus farmers who want to join the label have to make an effort. Moreover the threshold levels change over time. There is external auditing by an independent control organisation SGS Agro Control. The control procedure for MilieuKeur strawberries is three times per season (at the start, during the season and an administrative control, at the end) and an unannounced visit at a certain number of farms as well as leave or product controls (laboratory tests).

There are supermarket organisations that demand a certain minimum standard on a number of quality aspects without paying for it or without putting it under a label. There are minimum standards to be met in relation to hygiene and food safety but increasingly environmental conditions need to be met as well. This is also called licence to produce. If those conditions are not met, the products can not be sold. IOA systems can have a role to support the on farm evaluation on environmental issues.

The reference material and scalling of indicators

Even systems with high uptake do not necessarily change the individual farms' environmental performance significantly. This may be the case if the reference material does not demand changes on farms.

Farmers demanded more clear reference material to evaluate their own performance. Some types of indicators not only build on a scientific relation but also include normative judgements concerning the right levels of impact from a farm. This especially goes for indicators based on ratings (-100 to + 100; EMA, no. 13) or indices within limits (0-10; AEI, 19). The calculation of indexes and eco-ratings almost always involve a value judgement, i.e. what is the normal/standard values, how many points should a certain result give etc.? (for example the AEI system claims that integrated farming should be given the value 7 on their 1-10 scale. But exactly how is the practice of an integrated farm and why not the value 9?). The scale is based on assumptions concerning the limits, i.e. the best and worst situations that can be expected, and the translation formula. As the individual farm’s results are shown directly on a scale, it seems as if such indicators are easier to interpret for the farmer or consumer. However, this is a result of the value-based translation from the absolute value to the index or rating scale. Threshold values should therefore be clear and based on sound argumentation, especially if they include a value judgements this needs to be stated clearly.

There may be advantages of systems where individual farm results are transformed onto a uniform scale, so-called eco-ratings or eco-points to facilitate a more easy interpretation. However, investigations of the advantages of this compared with the disadvantages of including normative valuations and weightings in the indicators are lacking. There seems to be no investigations of farmers' use of such indices and what they may learn or how they may use them in their management. Therefore it remains to be proven that such scaled indices could be a solution to the problem of interpretation that the other types of indicators have. Moreover, given scaled indices are chosen as indicators a concept needs to be developed where the transformations and weightings are chosen in agreement between stakeholders.

IOA systems in relation to existing regulation

The degree to which mandatory regulation overlap with voluntary approaches needs to be addressed in order to secure success. The evaluation of the degree of successfulness depends on the context. If the system is supported as a government strategy in stead of regulation and the starting point of most farms' environmental performance is low it may be easier to see a positive effect of using the system. This may be one explanation of the apparent success for the Dutch pesticide yardstick. In other circumstances, where public regulation already demands a relatively high minimum standard, it may be difficult to prove a positive effect of the (extra) voluntary efforts that the IOA system promotes. Likewise, the farmers’ uptake may be influenced by the degree of public regulation on the same issues. This seems to be the case when comparing the uptake and apparent success of the nutrient balances (STANK) in Sweden and the Green ac-

count in DK (though presently only in its first year after pilot phase). As discussed in T3 the Swedish system has been seen by the government as one of the main tools to improve the nutrient efficiency of farms. In Denmark, by contrast, a strong rule-based regulation with high demands for documentation on all farms have made it difficult to promote voluntary IOA systems and to judge their impact as related to the mandatory initiatives. Whether such rule-based regulation is more or less cost-efficient than voluntary IOA systems is not the issue of this study.
When asked about their opinion on the use of the systems for mandatory regulation farmers (and system developers) not surprisingly answered that this would reduce the interest and functionality. Likewise, the few systems used for labelling did not in reality demand actual changes on the farms nor external auditing of results. Therefore, the knowledge of how voluntary systems may satisfy the public interests in environmental improvements on a broad range of farms is still lacking.

4.5.2 Documented changes in environmental performance

Among the 55 systems reviewed in task 2, 35 reported that the participating farmers had improved their environmental performance.
Tabel 4 shows the results found in the detailed review of the ten systems. Effects of the systems' use on specific farms have only been published for five of the applications. The two Dutch systems (no. 28 and 40) report high reductions in pesticide use and toxic load respectively. This is primarily a result of farmers using pesticides with lower toxicity towards specific non-target organisms. The ethical account resulted in a changed attitude to the use of pesticides according to some of the few conventional farmers involved. But this did not show in the treatment frequency index over the three years probably because of different pest levels and changes in crops from one year to another.

Regarding nutrients Agri-milieukeur (28) reported a 44% reduction in Nitrogen surplus per ha, but it is unclear over which time span this was found. In the three-year pilot phase of the Ethical account (10) it was not possible to observe a significant trend across the 20 farms. This was maybe not surprising since the farms had already made adjustments due to the mandatory fertiliser accounts introduced in Denmark. Moreover, the results from the first year was not presented to the farmers before most of the decisions for the next growth season were already taken. It was considered too early to judge whether the Green Account have had any effect on the nutrient balances on the pilot farms.
On a more general level the STANK system reported that P surplus has been reduced in Swedish farms but this cannot be attributed to STANK alone. No evaluation of the effect on the farms using STANK has been made.

The Energy yardstick resulted in 6-7 % decreases in direct and indirect energy use per kg milk and in 17% reduction in indirect energy use per kg pig gain. The FHL system (37) reports some reductions in energy use in meat production mostly due to reduced use of concentrates.
There was no clear trend in energy use on the farms in the ethical account, partly due to the lag period resulting from the account based data management. The pig farmers had a very high feed efficiency so they did not find it possible to reduce the indirect energy use much this way. This was also the explanation for the low interest in the indirect energy use on the pig farms in the Energy Yardstick.

Table 4.4 Documented effects of using I/O A systems on specific farms

Topic \ system	10 Ethical account	28, Agro-Milieukeur	30, Energy Yardstick	37, FHL	40, Pesticide Yardstick
No. of farms	20	?	Ca. 100	?	106 ??
Nutrients N-surplus, kg ha-1 P-surplus, kg ha-1	No trend in three years	 Reduction 44%	--	 ?	--
Cu-surplus, kg ha-1	Reduction on two of five farms third year	--	--	--	--
Energy use, Direct , MJ kg-1	No trend in three years	--	Reduction 6% milk Reduction 17% pig gain	Some reductions	--
Indirect, MJ kg-1	No trend in three years	--	Reduction 7% milk Reduction 3% pig gain	Some reductions	--
Pesticides AI: active ingredients EIP: Environmental impact points	Changed management practice but effect blurred by climate and differences in crops grown	 Reduction 75 % AI Reduction 90% EIP	--	--	70-90% reduction in toxic load score

?: results not known, --: Topic not included in system

It has proven difficult to find much documentation on the results of the systems. However, this may not be interpreted as a lack of effects, but the fact that it is very difficult to prove the relation between the use of such systems and the environmental performance of private farms. The time factor mentioned above probably is one explanation for this. However, the IOA system may be the information that motivates the farmer to a changed attitude, which is what many farmers claimed, had happened, see previous section.

The time factor

Many of the changes in management on a farm may only be detected over several years. The ethical account resulted in a changed attitude to the use of pesticides according to some of the few conventional farmers involved. But this did not show in the treatment frequency index over the three years probably because of different pest levels and changes in crops from one year to another. The effects on single farms should also be seen over a longer time period because larger changes in for example nutrient surplus or pesticide treatment frequency often requires both increased practical experience for the farmer and changes in crop rotations.

4.6 Evaluation of the indicators from a scientific point of view

As demonstrated in section 3.2 and tables 1and 2 different indicators have been used in IOA systems. This review of the existing systems cannot give conclusive evidence regarding which type is the best from the farmers' point of view. But there are important characteristics of the indicators that determine their suitability from an environmental viewpoint:

- The possibility to interpret and compare the indicator values,
- The relation between the indicator and the farmer’s management.

4.6.1 The possibility to interpret and compare the indicator values

The development and use of reference material to facilitate an evaluation of the results on individual farms is important as discussed in section 4. Such reference values may be in the form of

- Politically set target values (for example for TFI, as it will be the case in a new pesticide account for Danish farmers promoted by the government),
- Modelled results if a farm follow standards for GAP (as for nitrogen surplus in no. 5 Green account and as in EMA no. 13). The first two methods are using explicit or implicit value statements concerning what are acceptable compromises between production and environmental interests. Thus, this is outside the scientific reasoning and it should be made very clear how such standards have evolved, where they come from etc.
- The farm's results in previous years (for example in no. 19, AEI and in Pesticide Yardstick, no.40). This method is probably used more or less by all systems and assumes that differences between years can be explained to a large degree by changes in the farmers' management. This is discussed in section 2.
- Best practice from a set of comparable farms (this is for example the idea of no. 10 and no. 24 STANK). Here the variation between existing farms is used based on the idea that these may represent the possibilities within a spectrum of economically attractive production methods. This can off course be a conservative stan-

dard. But in the available documentation there was a large variation between farms, why at least a large proportion of farmers may have a fix-point for improvement using this type of reference values. This method is also fairly neutral in the way that it does not tell farmers what would be an acceptable environmental impact.

A special case to consider here is the use of scaled indicators. In systems like no. 13 and 19 the farmers' results are interpreted by transforming into closed scales that represent different levels of environmental performance. This may give the impression that there is a limit to how good or bad a performance a farmer can have. And there are built in assumptions of what are reasonable levels of environmental impact. Moreover, the user may get the impression that there is a uniform and 1:1 relationship between changes on the farm and in environmental performance. If a farmer for example improves from -40 to -20 is then his environmental impact only half of the year before? It is unclear how these underlying value statements are actually addressed when introducing the system to the farmers. As a minimum they should be explained and the origin of the target values for best practice should be made clear. Moreover, it is necessary to clearly state whether the normative evaluations implicit in the transformations are developed by the researchers alone or debated between other stakeholders such as farmers and politicians.

4.6.2 The relation between the indicator and the management of the farmer

This question regards how precisely the indicator levels are and must be measured on the individual farms. In other words, how large a difference should there be between the indicator results in two years before it is safe to conclude that it reflects a difference in management? This again may be divided into different problems: A. The error attached to the indicator calculation on a farm. B. Defining the right systems boundary and C. The importance of factors outside the farmer's control on the changes in indicator values from one year to another. These problems are relevant for most of the indicator types but may be reflected differently for scaled indicators (eco-ratings) than for absolute values.

4.6.2.1 The error attached to the indicator calculation on a farm

When quantitative account based indicators are used it is necessary to collect precise information, so that differences around 10% or more between years on one farm may be interpreted as changed management.

There will always be an error attached to the indicator value due to the estimation of the factors that are involved in its calculation. If the indicators in the IOA systems are meant to give information on differences between farms or differences between years on a given farm it is necessary to have ideas of the size of the statistical variation on the indicator estimates. In the case of Nutrient surplus calculations this regards among others the feed import or the calculation of N-fixation. If for example a farm has a calculated N-surplus of 150 kg per ha in one year and 170 the other, is it then reasonable to look for a agronomic explanation (e.g. more feed used per produced pig) or could the difference be just a coincidence due to stochastic variation (e.g. in the estimated fodder use or the N content in the fodder or..). Similarly, if a farmer increases his eco-rating from 5 to 6 on a 10 point scale, could it then be a consequence of measuring errors?

The questions regarding the sources of variation and the size of coincidental changes that are not attributable to management apply to most of the indicators used. But there is almost no information available on this for the reviewed systems. Experiences from the ethical account suggested that a 5-10% error should be allowed in nutrient balances and energy use. But when the difference between two years was larger than 10% it could usually be explained by the farmers' changed management.

In none of the researched systems were the use of confidence intervals or variation coefficients an established part of the procedure. Thus no explicit evaluation of the precision of the estimated indicator values was made. The primary cause for this is probably that it is not an easy task to do. But it nevertheless remains an important topic to develop parallel to the wider implementation of IOA systems. Obviously there is a balance to be found between demands for precision and demands for practicability. However more research is needed to define the right levels of details for the purpose of using indicators in different (voluntary vs. mandatory/audited) IOA systems.

4.6.2.2 Defining the right systems boundary

It is important to include in an IOA all the enterprises of a farm where important interdependencies exist.
In some systems the nitrogen balance is calculated on the field level using standard values for manure import and/or yields (sometimes translated into so-called "crop request"). This seems to be too simple to catch the actual variation in nutrient supply and nutrient export from fields, especially if they receive large amounts of animal manure. As discussed by Sveinsson et al, (1998) a uniform and coherent concept for nutrient balances including farm and herd level balances should therefore be developed for the use in European IOA systems. An extra advantage of this is that the internal turnover between crops and herd may be checked against the overall farm balance.

An almost analogues case is the calculation of energy use. As mentioned there has apparently been little success in the introduction of energy indicators that include indirect energy. However, to only include the use of diesel and electricity in the energy calculation can be deceptive, since there may be a substitution between these types of energy use. If for example a farmer decides to grow less roughage for his cows and thus imports more feed the direct energy use will be reduced. But the total energy use per kg milk may rise if one includes the (indirect) energy used to produce and transport the extra feed imported.

The point of both examples is, that without a complete system description behind the indicator, it is not possible to focus on the factors that are most important to change in order to improve the environmental performance of a farm. For example, on many mixed livestock and crop producing farms the largest potential for nutrient efficiency improvement may be found in optimising the feed import more than the fertiliser import. Therefore, a nutrient indicator that only includes the field level and uses standards for manure N content is often insufficient.

4.6.2.3 The importance of factors outside the farmer's control

Factors outside the farmers control obviously impact on the indicator result each year. The efficiency in the use of nutrients or the need for energy or pesticides may differ from year to year due to climatic differences.

Also the level of infectious diseases in livestock or the pest levels in the crops may impact on the production level at a given level of resource use. Different conditions between two years may cause the farmer to use more pesticides even if his goal is to reduce it. Likewise the feed efficiency may drop if the livestock is sicker one year compared with the year before (e.g. serious diarrhoea in a pigpen). It was not possible to find any documentation regarding how big an impact such factors may have on the indicator levels and how this was included in the interpretation of the results in the IOA systems. These are questions that need to be researched more.

The practicability of systems and indicators depends on proving that the indicators chosen are significantly influenced by the individual farmer's choice of strategy. Otherwise, there is a risk that the advisors and farmers are wasting time and energy on registrations without importance. And that -in the worst case- efforts are put on the wrong issues.

However, in some systems attempts were made to explain differences between years on the individual farms in terms of management. A common procedure practiced seems to be the following: The differences between years were assumed to be caused by improved management practice. This was then tested via an evaluation of the changes in the different items of the balance calculations. Thus, if the sum of changes in the items under the farmers control (e.g. import of fodder or use of fertilizer) to a large extend equaled the overall balance change it was concluded that the difference between years was due to management. If not, an attempt was made to 1. Check again for errors in input use, status/stocks or concentrations (e.g. amount of nutrients in manure import/export), and 2. To find explanations in the uncontrollable factors such as unexpected low yields in crops.
This pragmatic way of helping the farmer to interpret the changes from one year to another should be recommended as a standard practise for the use of IOA systems. But it does not entirely compensate for the lack of statistically based confidence intervals.

4.7 Conclusions

It seems to be possible to introduce IOA systems in most agricultural sectors and for a variety of different topics.

- Nitrogen and phosphorus is almost always included and a general concept using nutrient balances is gaining acceptance though small differences exist between systems.
- Energy is most often included by calculation of the energy use per kg product or per ha. Farmers have generally not accepted the idea of including indirect energy. However, it may give misleading results only to include indirect energy in the indicator why new developments are needed in order to find a suitable way to address this topic.
- Pesticides seems to be a good topic to address in the form of IOA systems but the effects in terms of reductions in amounts AI or TFI is hard to demonstrate over short time. However a no of new indicators have been developed that combine amounts with toxicity allowing farmers to chose pesticides that are less damaging to non-target organisms. Some work has been done at EU level in order to standardise this development but still the methods used in the systems were very different and not easy to compare or evaluate.

The above mentioned topics are suitable for almost all types of farms and enterprises. A common feature is that it is the farm that is evaluated with a possible breakdown of nutrients and energy to enterprises within the farm (cowherd, pigpen, individual crops etc.) to facilitate changes of management at the right place in the system.
It is a general problem for most systems using non-scaled quantitative indicators that there is a lack of reference values for farmers to compare their results with. This needs to be solved by for example analysis of a larger no of farms. In a few systems more complicated indicators in combination with graphical illustrations are used in order to facilitate a faster and more easy interpretation of the individual farms results. Though this represents an improvement compared with classical tables this advantage is at the cost of both clarity in calculation methods and the possibility to compare different farms' results.

The importance of measuring errors and coincidental changes for the indicator values needs to be better assessed.

The effect and uptake of an IOA seems to depend on the political context and the level of environmental performance already established by mandatory regulation. In cases where no strong public regulation exist in advance the effects of IOA systems have been of the following magnitude:

- Reductions in direct energy use: 10-20 pct. (but only small reductions in indirect energy use)
- Reductions in fertiliser use and nutrient surplus: 20-40 pct.
- Reductions in pesticide toxicity: 50 pct. (but no good info on amount of active ingredients).

These effects seem possible to combine with high uptake. It is probably important for a high uptake to take place that

- the systems are brought to farmers as part of advisory services,
- the data used are fairly easy to get or is already used in farm accounts,
- the use of the IOA system may substitute for the farmer the demands from other regulation (whether existing or potential).

Besides this the possibility of economic advantages will of course promote a system but this seems not be crucial.

In general there seems to be a potential for the development of the use of IOA systems to facilitate voluntary improvement in environmental performance on topics that are not already strongly regulated by mandatory regulation. But more studies are needed to ensure that farmers in reality change their behaviour and to develop the use of reference values.

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5 The way forward for Input/Output Accounting systems in EU agriculture

5.1 Introduction

Based on the results from the evaluation of existing IOA systems a set of preconditions will be given for the future development and implementation of such management tools for farmers and advisors. Due to the generally low degree of documentation found during the review, the recommendations should be seen as a starting point for future work.

5.2 Why promote the use of IOA systems in agriculture

Environmental or green accounting in agriculture may serve different purposes such as documentation of compliance with either mandatory regulation or rules under a labelling scheme, and a tool for voluntary (self-) evaluation and improvement of single farms. It is the latter case (voluntary self-evaluation) that will be considered here since very little information regarding the first two options exists.

The following reasons to use IOA systems in agriculture are mostly complementary, but some may be contradictory. Contradictions may occur especially when IOA systems are used as a mandatory policy tool. In a mandatory system farmers may want to cheat to present a too positive picture of indicator values. Especially when financial rewards or punishment are linked to those indicator values.

Farmers tool:
- To increase environmental awareness;
- To facilitate voluntary (self-) evaluation of farm management;
- To create motivation for changes in management (attitude change);
- To provide an incentive for environmental innovation of farmers;
- To improve environmental performance of single farms ;
- To improve economic performance of single farms.

Policy tool:
- To document and evaluate compliance with mandatory environmental policy;
- To document compliance with standards of quality ensurance or labelling schemes;
- To link economic incentives (subsidies, fiscal incentives) to farmers doing better than average (20% best farmers);
- To enlarge the policy mix, with an instrument that is cheaper than enforcement of obligatory rules.

Voluntary use of IOA systems by farmers has the potential to motivate and facilitate an improved use of resources and a reduction of negative environmental impact. Efficiency of such systems depends on a combination of high uptake among farmers and a high effect on farms using the system. Combined with the proper reference values the indicators used may increase the farmer's motivation for environmental improvement.

5.3 How to develop the use of IOA systems in agriculture

The following is a list of checkpoints for the further development of IOA systems.

Continue research on IOA systems to improve its effectiveness (and sometimes prove)

The effect of the use of the IOA tool on the motivated farms is poorly documented by probably depends on:

- the present level of environmental efficiency on the farms;
- the skills and attitudes of the advisors bringing the systems to farmers;
- the existence of good reference values from similar farms;
- the degree of economic risks associated with the proposed changes;
- the degree to which the indicator levels are influenced by factors outside farmers control or change coincidentally.

There are three categories of IOA systems: IOA systems based on descriptions of good practice (e.g. codes of GAP), IOA systems based on accounts, and account based IOA systems that include GAP aspects or normative values in the scaling of the indicators. Codes of Good Agricultural Practice (GAP) are established in Rural Development Plans throughout the European Union. IOA systems based on GAP can be a tool for farmers to document their compliance with the GAP codes, but they will not provide an incentive to better GAP, because the description of good practice is fixed. Account based IOA systems provide a better incentive to increase environmental performance beyond GAP, because farmers are challenged to improve the indicator values. Assuming the norms of GAP will change over time, the IOA systems should play a role to stimulate environmental innovation, and not to keep the farmers at an average environmental performance. It is likely that environmental innovation at the 20% best farms will later raise the average environmental performance of similar farms. The IOA systems should help to push the codes of GAP upward and not to accommodate GAP.
In the short term there may be a role for account based IOA systems including GAP aspects or normative values in the scaling of the indicators. But in the medium term the validity of these combined IOA systems is doubtful, because it may not enough push codes of GAP upward.

Link IOA systems to European and national Regulation

Codes of GAP are not linked to direct payments to farmers under the Market Regulations (e.g. for cereals, sheep and beef) which make up the bulk of funds of the Common Agricultural Policy.
In the framework of the Rural Development Regulation (1257/99) it is defined that payments to farmers can only be made if farmers comply with codes of GAP or with existing environmental legislation. Agri-environmental support is paid to farmers committing themselves to go beyond codes of GAP (which serves as baseline) and in return for income foregone and extra cost incurred. IOA systems based on GAP can be used as a monitoring tool for GAP, and thus are a tool to justify payments for services at GAP-level. Account based IOA systems may be used to justify payments for services above GAP-level under the condition the services are defined in terms of environmental performance (and not as farm practices).

In principle measures under the Rural Development Regulation apply to all sectors including the pig, poultry and horticulture sectors. This implies that all farmers (regardless of the sector) that apply for payments under the Rural Development Regulation should comply with codes of GAP or with existing environmental legislation. IOA systems are a tool for farmers to get up to the environmental standard and to proof compliance with the standard to the government administration that is monitoring eligibility for Rural Development payments.

In the Agenda 2000 reforms Member States have decided to integrate environmental concerns more in agricultural policy. Member States shall take the measures they consider to be appropriate in view of the situation of the agricultural land use or the production concerned and which reflect the potential environmental effects. In the Horizontal Regulation 1259/99 a menu of options is presented to link environmental concerns to direct payments under the Market Regulations. A more precise requirement to proceed to an environmental analysis of the sectors has just been approved in form of the implementing rules of this regulation. The menu of options include the possibility for Member States to link environmental conditions to direct payments (cross compliance) or to modulate direct payments to a maximum of 20% and to use the funds for a limited number of measures under the Rural Development Regulation. Those measures are agri-environment, early retirement, afforestation of agricultural land and less favoured areas payments. The funds (obtained by modulation and cross compliance) can only be spent if national co-financing is made available by the Member States.

IOA systems could be used as a farm evaluation tool to monitor if farms comply with existing environmental legislation, codes of GAP (e.g. cross compliance criteria) or environmental targets beyond GAP (e.g. criteria in agri-environment schemes). The latter could be defined in measures paid with funds obtained from cross compliance, modulation and national co-financing. With GAP-based IOA systems farm practices can be evaluated, with account based IOA systems it can be evaluated if the environmental targets are achieved.

Increased uptake may be possible if farmers were able to exempt compliance with the general rules by documenting better than average environmental performance (as an example farmers with documented high efficiency in nutrient use could be allowed to have more animals than the general limit in stocking rate).

Integrate IOA systems in the toolbox of farm advisory services

Among the systems reported suitable for farmers own use almost all the systems with high uptake seems in reality to be used more by advisors. Moreover, it seems that farmers are willing to pay a certain limited fee for this service but most examples of success have been subsidised. It is therefore recommended that IOA systems are delivered by advisors. There seems therefore to be a need for including knowledge of modern methods of extension in the development of IOA systems. This may include efforts to make IOA systems publicly available on the internet.

5.4 How to develop indicators suitable for IOA systems

The wide variation in indicators used so far present a potential to select a group of well-functioning indicators for specific purposes.
The demands to good indicators include:

- Clearly linked to environmental interests;
- Acceptance by farmers and by other stakeholders;
- Transparency in calculation methods;
- Readily access to data on farms and reasonable costs;
- Possibility for the farmer to impact on the indicator result;
- Differences between comparable farms exist that are caused by management;
- Reference values may be established.

Unfortunately the documentation of how indicators fulfil several of these criteria is lacking for many systems. However, the indicators proposed in table 5.1 seem to be suitable for facilitating farmers' voluntary evaluation and search for improvement as part of production planning. The suitability for use in audited IOA systems where threshold values must be met due to public regulation or labelling schemes needs to be investigated.

For nitrogen and phosphorus a consensus is visible around a common method for calculating balances and efficiencies on farm and enterprise level. The methods documented in manual for STANK and other systems may function as a starting point but attempts should be made to standardise the remaining differences of default values that are not a cause of geographical differences. Moreover, reference values to evaluate the results on individual farms should be developed. For harmonisation of the indicators of specific nitrogen losses based on modelling and farmers praxis consensus is not close.

Indicators for energy use may include indirect energy or not. Tests have shown that farmers generally have found indirect energy to be too abstract and not motivating. However, due to the substitutability of direct for indirect energy comparing results between years and between farms based on direct energy do not make sense.

Pesticide use may be described relatively simple by an index of the number of standard treatments carried out on the land. However, a number of approaches exist where information regarding the toxicity of different pesticides is used to scale the pesticide use indicator (e.g. number 40: Environmental Yardstick for pesticides).
IOA systems can be applied to almost all sectors. However, nutrient balances needs to be developed for use in specialised livestock farms with no or only small areas of land.

Many of the chosen indicators are relatively demanding in terms of data availability. Therefore they may be too costly to use in regions where farmers do not need to keep detailed accounts of input use and production levels for taxation or other purposes. This aspect needs to be investigated more on European scale.

Besides the topics dealt with in this study (minerals, pesticides and energy) a number of other issues exist that should be investigated. The impact of farming on soil quality is an important issue because it relates very much to Nitrogen use of plants and Nitrogen-loss. Surplus of heavy metals (dips and growth promoters in animal feed) is another important environmental issue.

Table 5.1 Indicators recommended on the basis of the reviewed systems with documentation of effect and/or uptake [1)]

Topic	Nutrient use		Energy use		Pesticide use	
Indicator	Surplus N and P, kg ha^{-1}	Efficiency, % output *$input^{-1}$	Direct energy , MJ or MJ ha^{-1}	Total energy Use, MJ kg^{-1} product	Treatment frequency index	Environmental impact points: PEC[3)] divided by detrimental threshold levels
Sectors and farm types	Crops, pigs, dairy, poultry, horticulture, mixed farms	Crops, pigs, dairy, poultry, horticulture	Cash crops, Pigs, poultry	Crops, pigs, dairy, horticulture, mixed farms	Crops, mixed farms	Crops, Mixed farms
Reference values	Best practice, comp. Farms, own historic results	Best practice comp. Farms or enterprises, Own historic results	Own historic results, Best practice comp. Farms	own historic results Best practice comp. farms	Public target values for different crops, own historic results	Environmental standards, Own historic data
Time/price[2)]	2-4 hours	15 minutes	30 minutes	2-4 hours	30 minutes	2 hours
Other demands or assumptions	General production and account data readily available	Builds on N, P surplus		General production and account data readily available	Field data available	Field data available, Special software necessary
Comments	Simple but still difficulties with N-fixation and export manure	Ibid.	Only focusing on direct energy may be problematic	Calculation and explanation of indirect energy use problematic		Origin of PEC and environmental standards important

1) Other indicators than the mentioned may prove valuable after further investigations. For an extended list of indicators used in IOA systems see tables in part 4.
2) Only the time used for calculating indicator values on a particular farm given the conditions below. The time indicated below does not include time to discuss improvements on a particular farm.
3) PEC= predicted environmental concentration.

Annex 1 Questionnaire

Title of Input Output Accounting System:

Contact name and address   Tel. No. Fax No. email

Design and Content

1a. Country of Origin	
1b Countries where used	

2. Who is the driving force behind the system? tick one box

Government	☐	Advisors	☐
Farmers	☐	Research	☐
Market	☐	Other	☐

3. Is the system mandatory? | Yes | No |

4. What subjects are covered by the system? tick as many boxes as apply

Nutrients	☐
Pesticides	☐
Energy	☐
Other	☐

5. Which sectors of the industry are covered by the system? tick as many boxes as apply

Arable	☐	Pigs	☐
Horticulture[1]	☐	Poultry	☐
Beef/Veal	☐	Organic farming	☐
Dairy	☐	Other	☐

[1] Includes vegetables grown in the open air, it excludes vegetables grown under glass or polythene

6. Is the system farm or commodity based? tick one box

Farm	Commodity

7. Are there any restrictions on who is allowed to join the system? tick as many boxes as apply

Farm area	Livestock density
Geographic Location	Soil Type
Livestock Nos	Other
Livestock density	None

8. Can the system be used by groups of farms together[2]?	Yes	No

[2] eg can surpluses be transferred from farms with excess to those with deficit

Management and Administration

1. List the indicators produced by the system

Indicator (eg energy use, nutrient balance)	Unit (eg MJ per kg milk, kg/ha)

2. List the inputs required for the indicators

Input (eg livestock numbers)	Unit(eg LU)	Input	Unit

3. List the outputs required for the indicators

Output/product (eg milk)	Unit(eg lt)	Output	Unit

4. By whom is the information collected? tick as many boxes as apply

Farmers themselves ☐ Outside agency ☐

5. By whom is the information processed? tick as many boxes as apply

Farmers themselves ☐ Outside agency ☐

6. Does any tool for processing data/presenting indicators exist for this system? (if yes, please enclose copy or reference)

yes	no

7 Does a manual or set of guidelines exist for the system ? (if yes, please enclose copy or reference)

yes	no

8. How is the input/output relationship (balance) calculated? Please explain it in key-words (Enclose copy of reference documents, if available)

9. How is the output and the results explained to the farmer? tick one box

- Farm specific written interpretation
- Farm specific verbal interpretation
- General explanation only
- No interpretation

10. Does the farmer get information on performance by other farms in the system, apart from information on his/her own holding? tick one box

yes	no

11. If interpretation is made what are used as reference values? tick up to 3 boxes

- Official limits/targets
- Average values from a set of farms
- Best results from a set of farms
- 'Expert' statements of best practice
- Farmers own historic data

12. What are the administration costs[3] in man hours per year of using the system on a farm scale? Tick one box

- < 4 hours
- 4-16 hours
- >16 hours

[3] including an external accountant if required

Monitoring and Evaluation

1. Which regulatory body is the system audited by? tick one box

- Government
- Advisory service
- Other external
- None

2. Is the system compensated?

Yes	No

3. What has been the effect of the system on farm income? tick one box per applying sector

	Negative	No effect	Positive	Not known
Arable				
Horticulture				
Beef/Veal				
Dairy				
Pigs				
Poultry				
Organic farming				
Other				

4. At what operational stage is the system? tick one box

Research/design

Pilot

In use

Other

5. When was the system started? 19....

6. How many farmers use the system? Tick if this no. is an estimate only

7. Since the system was introduced have their been changes in:- tick all boxes that apply

Inputs

Outputs

No. of farmers using the system

8. Do you think this system has been effective in reducing inputs? tick one box

Input use has increased

No effect

Moderate (estimate percentage)

Very effective (estimate percentage)

9. What is the farmers view of the system? tick one box

Good

Indifferent

Bad

Not known

10. What is the actual participation of farmers vis-à-vis expected uptake (in % of expected uptake) tick one box

0-25%

26-50%

51-75%

76-100%

11. Is the methodology of the system described in a formal report? Yes No

Information available for further study

1. If the IOA-system described above is selected for further analysis how would you judge the availability of hard data? tick one box for each item

Item	no hard data	little	moderate	good	very good
Administration costs					
Effectiveness					
Farm income					
Acceptance of farmers					

Annex 2 Needs for further improvement and knowledge building concerning IOA systems

Needs for further improvement and knowledge building concerning IOA systems

The present analysis of the efficiency of IOA systems has pointed to the following needs for increased knowledge:

Choice of overall concept
Voluntary vs. mandatory systems
What are the different demands for data quality?
Is it possible to have a voluntary system with threshold values for labelling schemes?

Relation to political context and regulation
How can IOA systems substitute or enhance mandatory regulation?
What is the importance of existing regulation for the uptake of systems?

Test of uptake and effect on farms
What types of systems have the larger potential for improving farmers' performance in different situations?
Is a close link to advisory services a must for high efficiency

Harmonise indicators, reference values and threshold values among countries
Develop a European research network on IOA systems

Choice of indicators
Do farmers prefer qualitative or quantitative indicators?
How may these types of indicators be included in the production planning?
Test of variation and relation to management on individual farms
Farmers understanding of different types of indicators
Establishment and use of reference values, -what is motivating for farmers?
Availability of data in different countries in relation to demands for quantitative data
Knowledge of the causes of variation between comparable farming systems

Selection of more indicators for other topics to be covered: Impact on soil quality, water use efficiency, waste management, use of medicine, impact on landscape and wildlife of conservation value.