DEPARTMENT for ENVIRONMENT, FOOD and RURAL AFFAIRS **CSG 15**

Research and Development

Final Project Report

(Not to be used for LINK projects)

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Project title	Application of sustainable Agriculture Indicators at farm Level for England and Wales
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Executive summary (maximum 2 sides A4)

Sustainability indicators have been developed in response to, amongst other issues, the understanding that sustainability cannot be condensed into a single, simple definition or measurement. DEFRA (as MAFF) published a pilot set of sustainability indicators in early 2000 to provide a means of measuring the economic, social and environmental impacts of agriculture in Great Britain and to help assess the effectiveness of policies and the sustainability of the sector. As policy tools, many of the indicators are highly technical in nature and / or relevant only at regional or national level (e.g. pesticides in groundwater, EU Producer Support Estimate). Few have direct, close links with on-farm management decisions and some are not directly measurable on farm. There is no breakdown of the indicator values for differing farm types or geographical demarcation. As a consequence, any attempt to persuade farmers to take note and respond to messages provided by the indicator trends is likely to fail. However, changes at farm level will be required before improvements at national level can be anticipated.

This project sought to address this issue by describing the National Indicators, using a variety of techniques (including disaggregation, harmonisation, use of surrogate indicators and other measures) at farm level and disseminating this information and other key messages describing the meaning and purpose of the indicators to farmers and growers.

Several means have been used to achieve this and various conclusions relating to the appropriateness of the indicators to the farmer, the integrity of the raw data used for this purpose (rather than its primary intention) and the views and opinions of the industry, have been reached.

- Two national industry workshops have been held to seek the views and inputs of key industry stakeholders. These workshops generated considerable interest and were well attended. The workshops aided the identification of additional indicators which better described farm level risks (e.g. the OECD/CSL indicator describing risks to aquatic species from pesticides) and also helped to 'tease out' the underpinning messages that each indicator sought to convey linking these with farm practices.

A simple software tool for farmers has been developed which collates relevant information in order to identify appropriate indicator values for a specific farm and location and provide a management focus such that farmers are

- provided with information to help them select indicators relevant to their situation, assess their performance and take steps for improvements where required. This is linked back to the national level. Significant problems arose in the development of this package. In the first instance, it was necessary to revisit the original data used to calculate the 35 pilot indicators. The following problems were encountered:
  - *Difficulties in tracking down and obtaining the data.* Staff movements, company reorganisation / closure and inadequate record keeping meant that the acquisition process was very slow and frustrating. In one or two instances the data no longer existed.
  - *Poor data quality and gaps in knowledge.* In many instances the indicators were calculated and extrapolated from poor quality or gappy data leaving trends open to interpretation.
  - *Recalculation problems.* As information on what assumptions where made when the indicators were originally calculated was sketchy and subjective, recalculation did not always produce the same results as those published. A few errors in the original publication also came to light.
  - *Inappropriateness at farm level.* Not all of the indicators were appropriate at farm level or had any meaning when disaggregated. Surrogate indicators were sought or just the underpinning key messages and linked management practices conveyed. With respect to some indicators there was insufficient scope for disaggregation or the data was statistically irrelevant or inaccurate at farm level.
  - *Huge data sets.* In some cases the data sets were very, very large and required a considerable amount of data handling and re-sorting before being potentially useable within a software package such as that being developed. For example, the Environment Agency database on surface water quality monitoring had typically in excess of 500,000 records for each year. The 1995-99 table was over 436Mb in size.
- The project also includes a significant amount of awareness raising activity to promote the concept and objectives of the pilot national and farm level indicators. Several farmer workshops have been held, posters produced and an audio cassette explaining the background and purpose of the national and farm-level indicators has been produced. This cassette is available free on demand.
- A dedicated website has been set up enabling free-flow discussions and information exchange.

Overall this project has proved difficult not only with respect to data issues but also regarding the raising of awareness and interest from farmers and the wider industry. This has probably been due to other priorities. However, there have been a considerable number of enquiries regarding acquisition of the audio cassette and software. Both are available free on demand – with respect to the audio tape whilst we have stocks remaining. However, the audio contents have been converted to a MP3 file and this will be included with the software and placed on various websites for downloading.

Scientific report (maximum 20 sides A4)

1. INTRODUCTION

Sustainability indicators have been developed in response to, amongst other issues, the understanding that sustainability cannot be condensed into a single, simple definition or measurement. DEFRA (as MAFF) published[1] a pilot set of sustainability indicators in early 2000 to provide a means of measuring the economic, social and environmental impacts of agriculture in Great Britain and to help assess the effectiveness of policies and the sustainability of the sector. As policy tools, many of the indicators are highly technical in nature and/or relevant only at regional or national level (e.g. pesticides in groundwater, EU Producer Support Estimate). Very few of them have direct, close links with on-farm management decisions and some are not directly measurable on farm. There is no breakdown of the indicator values for differing farm types nor geographical demarcation. As a consequence, any attempt to persuade farmers to take note and respond to messages provided by the indicator trends is likely to fail. However, changes at farm level will be required before improvements at national level can be anticipated.

This project sought to address this issue by describing the National Indicators, using a variety of techniques (including disaggregation, harmonisation, use of surrogate indicators and other measures) at farm level and disseminating this information and other key messages describing the meaning and purpose of the indicators to farmers and growers.

2. INDUSTRY CONSULTATION EXERCISE

Two industry workshops were held during the project. The meetings were held at DEFRA's Nobel House and around 70 delegates were invited to each.

2.1 Workshop I: 10.30am, Friday 1st June 2001

This first workshop was intended to explain the project objectives to the delegates and to promote general discussion regarding how these could best be delivered using the project framework. Discussions were undertaken first as a single group then split into workshop groups. There were six groups, each group being asked to consider a specific indicator category, review the indicators within that category and address the following issues:

- Soundness of the indicators in providing a target for the agricultural industry
- Ownership of the indicators - to whom do they belong
- Simple and practical ways to encourage ownership of the indicators
- Suggestions for alternative indicators

Focus Group 1
GROUP A Indicators: Agriculture within the Rural Economy and Society
The group concluded that despite the need to track the profitability of the sector and potential impacts on society none of the indicators within this group had any meaning at farm level and were questionable even at regional level. Indeed a few, such as EU Producer Support Estimate, may be too technical for some farmers to understand. However, from a general interest perspective and as a basis for discussion they did have merits. Consumers, government and industry negotiators would also have a particular interest in all of them (except the agricultural assets and liabilities) because in various ways the indicators effected the decisions all these groups needed to make. Hence it was these groups that had ownership of the indicators in group A. Encouraging farmer ownership of these indicators was going to be difficult due to the general lack of interest in sustainability probably arising from the industry's current problems, their direct relevance and the vagueness of the term 'sustainability' - what's in it for the farmer now when he may be out of business anyway by tomorrow.

The following alternative indicators were suggested; however, it was also noted that such data would be difficult to obtain and present in a meaningful manner:
- research and development;
- retraining (CPD), needs to consider issues such as post-16 training within the farming sector. As farming becomes more complex, the need for highly educated farmers will be key to driving the industry forward;
- volume of support and advice available to the industry;

- number of students entering the industry.

Focus Group 2

GROUP B Indicators: Farm Management Systems

This group of indicators were seen as informative, easy to measure and useful at farm level although current data as presented in the DEFRA publication[1] is sketchy. The correlation between farming systems and sustainability was questioned. Most discussion focused on adoption of farm management systems and the use of audits and CoGAPS[2] to define sustainability. There are a plethora of schemes and audits now in operation within UK agriculture, all having different standards and different objectives. How or if any of these were related to sustainability was questionable - it was concluded that it would help if at least one major scheme was policy led. The DEFRA CoGAPS were seen as too 'woolly' and only define the minimum acceptable standard. We need to strive for better.

The following alternative indicators were suggested and in all cases sound data would be readily available:

- EMA[3] (Environmental Management for Agriculture software) sales and distribution;
- assurance scheme registrations;
- relevant Environment Agency prosecutions and pollution incidents;
- wildlife pesticide poisoning incidents.

Focus Group 3

GROUP C Indicators: Input Use – Pesticide Use

There was much disagreement regarding the soundness of these indicators. They were seen by some as highly complicated and in some instances unsound. There was debate regarding whether or not indicators of risk should be used. It was agreed that indicator 14: pesticides in groundwater, is unsuitable as the Environment Agency data is skewed towards the Thames Valley region. However, new monitoring programmes for groundwater quality are now being introduced. The other four indicators need to be refined and/or presented with more detailed information and the group felt they did not form basis for targets.

For example, indicator 15 shows a trend of a decreasing use of pesticide active ingredient. Whilst some of this usage reduction can undoubtedly be attributed to better use, there are many other factors contributing to the decrease. These include newer chemicals needing lower application rates, variations in crops grown (different crops have different pest and disease pressures) etc. Regarding ownership it was considered that although Government initiated these indicators they belong to the whole industry. However, to achieve ownership the indicators must be credible from the outset. Consideration should be given to financial incentives via assurance schemes to help promote sustainability policy objectives.

With respect to Indicator 13 it was generally felt that a breakdown of which pesticides were found to exceed the EU limit in surface water would be much more meaningful at catchment or hydrometric zone level. Farmers within a specific water zones would then have more of an indication as to whether or not their practices were contributing to a local problem i.e. if they used a pesticide being identified locally.

Delegates also discussed other indicators produced by other bodies which may be relevant including the Pesticides Forum Report[4] and the work undertaken by the OECD[5]. It was widely recommended that this be given serious consideration for adoption, especially the OECD/CSL indicator of aquatic species risk which describes the risk arising from applications of active ingredients as related to the total area sprayed.

Focus Group 4

GROUP C Indicators: Input Use – Nutrients and Greenhouse gas emissions

There was general agreement that the pilot indicators were acceptable at policy level only and very questionable at a practical level. Prediction / estimation of the quantities of nutrients being lost from agricultural land is a complex scientific and technical problem. Local interpretation of the indicators is required and simplification is essential. As is the case with all the indicators it is essential that farmers understand what practices contribute to an issue and how they should modify their actions to help reduce a national problem. To achieve ownership, there would need to be a demonstration of the benefits to farmers as well as the supply industry, focusing particularly on financial advantages and likely improvements to farm efficiency. It was agreed that a nationwide education exercise would be required. Rewards for performance to encourage ownership should be considered.

Actions to improve awareness of the sustainability issues underpinning the indicators in this group (social, economic and environmental) had to be practical and preferably built into existing management systems. These systems and the software arising from this project should relate adoption to financial and environmental gains. Nutrient balance sheets were considered to be key to encouraging farmers to use nutrients more efficiently and so improve the nations performance in this area.

The only surrogate indicator suggested was typical quantities of nutrients applied (UK and by crop). This data is already available from the annual Fertiliser Practices Survey, FMA.

Focus Group 5
GROUP C & D Indicators: Energy, Water and Soil
With respect to the energy indicators (23 and 24) the discussions concluded that enterprise benchmarks would be beneficial to the industry and enable better interpretation of the indicators. It was difficult to know what the trends in these indicators actually meant. Farmers who have never carried out an energy audit (either themselves or with a consultant) should be encouraged to do so. Government should ensure steps are taken to encourage the involvement of smaller farms. It was suggested that an indicator reflecting trends in renewable energy use would be useful.

For the water indicators (25), the key issues were seen to be efficient use as well as local availability, and that irrigation and other farm uses should both be considered but separately. Indicators should consider issues of economics of use and the type of water (potable or dirty) and look at the percentage of water re-used on site; although it was recognised that quality data of this sort is difficult and expensive to collate. It was felt that an indicator on non-irrigation water use would be useful.

With respect to the soil indicators (26 and 27). These were not thought of as being very useful at farm level due to difficulties in local interpretation. Issues such as soil structure, useable/non-useable organic matter, soil mapping and carbon lock up might be of value. However, collation of statistically meaningful sampling data would be hugely expensive and provide only limited practical value. Suggestions for alternative and additional indicators included:

- soil loss – consider catchment issues i.e. water course sediment;
- amount of CO_2 produced by farmers;
- heavy metals – develop national targets for reduction.

The focus group felt it important that existing recording systems are tapped into, rather than developing new ones that would increase the administrative burden on farmers. Every effort should be taken to make farmer involvement easy. Farmers need to be given access to benchmarks for their own enterprises.

Focus Group 6
GROUP E Indicators: Conservation value of agricultural land
The focus group considered these indicators to be pragmatic and generally sound at national level but that it would be very useful to disaggregate them at farm level. However, much of the data cannot be regionally disaggregated without loss of accuracy and in many cases the data is not available or would be costly to obtain. Localisation of indicators might require localisation of objectives and targets (i.e. provided by Countryside Character / Natural Areas). There was concern regarding lack of measures of quality (e.g. species diversity, habitat quality). There appears to be considerable emphasis on new habitat creation (e.g. planting of new hedges) instead of maintenance of existing ones.

The focus group felt that there was a danger that these indicators could become targets, when it would be more useful if farmers set targets and objectives themselves. The indicators, especially their farm-level counterparts needed to reflect circumstances on the farm, including non-economic interests. The National Indicators within this group do not belong to farmers but to Government and national environmental lobby groups and businesses. There was doubt as to whether farmers needed these indicators at all, when they might be better served by more practical guidance, advice and targets. There was also concern about the data presented in the DEFRA publication[1] as it was very out of date; however, it was noted that the Countryside Survey 2000[6] would provide a better picture. It was felt that farm indicators should be seen as part of wider local environmental assessments, and not in isolation. There is a need for the indicators to link up with existing stewardship schemes and take account of the usefulness of priority habitats and species as potential indicators.

The focus group proposed the following alternative and additional indicators

- an indicator encompassing all aspects of farm biodiversity - in fields and marginal habitats, resources inherited and those created;
- environmental balance sheet or accounts would be useful;
- an indicator should be developed relating to archaeological issues.

Conclusions from Workshop I

- Everyone is responsible for the indicators – farmers and the wider industry;
- Indicators must be credible, practical and cost effective with respect to data collection;
- The complex interaction between the indicators should be recognised;
- Indicators are not targets – targets should come from farmers themselves;

- It is important to note that the indicators have been developed from existing information;
- Any ownership has to be seen to benefit farmers and the industry.

2.2 Workshop II: 10.00am, Thursday 10th January 2002

This second workshop was intended to bring delegates up to date on project progress and to seek the industry's input into the development of the software and communication of the messages that underpin the indicators and/or are important for achieving national sustainability objectives. The software shell as developed was demonstrated and was largely supported by the audience with some useful ideas being put forward regarding design and the type of information to be included. These were all subsequently incorporated. LEAF reported back on the four farmer workshops they had held (see later under 'Farmer Awareness Raising Exercises').

Delegates were then divided into four Focus Groups with the following objectives:
- Identification of the key messages underpinning each of the national indicators;
- What were the principle on-farm practices which would influence the indicators;
- What would be the best route for communicating these messages.

Focus Group 1 - Structure of Agriculture Report

1. Agricultural Assets and Liabilities:
   - This first indicator provides a snapshot of the industry;
   - Farmers should be aware of their own assets and liabilities and plan accordingly;
   - The plot at farm level needs to be made more meaningful to the farm, possibly by showing ratios rather than raw data.
2. Age of Farmers:
   - At first glance this implies little change with time, but it could be that the statistics lie and that the form filler is not the active farmer;
   - This type of data could be used to stimulate better forward planning, succession and pensions.
3. Percentage of Holdings That AreTenanted:
   - Could be used to warn farmers of the decline in tenanted farms and impacts on long term security.
4. EU Producer Support Estimate (PSE):
   - With greater detail for farmers this could be used to show changes in support emphasis and total value.
5. Payments to Farmers for Agri-environment Purposes:
   - Farmers should beware of the frequent changes. The indicator needs data on the number of schemes available and their value.
6. Total Income from Farming:
   - With greater detail regarding percentage income by source (diversification, off-farm, leisure etc) this could be valuable to farmers in illustrating the need to offset direct income from farming.
7. Average Earnings of Agricultural Workers:
   - Needs to be compared with the national minimum wage and agricultural minimum wage;
   - Should show farmers the need to beware of increasing hours worked to maintain productivity levels.
8. Agricultural Productivity:
   - For this indicator to be meaningful, it needs to be directly linked with indicators of profitability.
9. Agricultural Employment:
   - The indicator needs updating to show the recent financial situation and so employment problems of the industry;
   - The gradual decline in employment illustrates the gradual decline in the industry.

Generally these indicators are useful in highlighting the state of the industry but need targeting towards specific sectors. Influenced by:
- the farms level of financial and business skills;
- forward planning;
- general resource efficiency, productivity and waste minimisation.

Focus Group 2 - Farm Management System Report

10. Adoption of Alternative Farming Systems:
    - Farmers should have a demonstrable management system in place. Farmers should be pursuing an integrated approach;
    - LEAF is just one example. There are many others;
    - Could be linked to farm assurance schemes and provide access to markets;

- Uptake of an alternative farming system could improve consumer confidence and traceability;
- Helps illustrate the fact that farmers can make a positive contribution towards sustainability.

11. Area Converted to Organic Farming:
    - The plot demonstrates clearly that organic farming is increasing;
    - Farmers should be aware that supply could outstrip demand;
    - Profitability issues could be a problem in the short term.
12. Knowledge of Codes of Good Agricultural Practice:
    - Data not sufficiently sound or meaningful to be useful;
    - Other indicators needed to demonstrate levels of best practice;
    - Water protection needs to be given a high priority.
28. Area of Agricultural Land:
    - It is difficult to identify the relevance of this indicator to an individual farmer;
    - No direct messages are obvious regarding agricultural practices.
29. Changes in Land Use From Agriculture to Hard Development:
    - Shows losses of countryside as a resource;
    - Data out of date and needs updating;
    - If decrease continues it would be difficult to farm less intensively when we must produce food on less land;
    - Consequences for imported food and prices.
30. Planting of Non-food Crops:
    - Farmers need to be aware of the benefits to society and their own business that could be found in non-food crops;
    - Awareness of varieties and crops available;
    - Awareness of national policy objectives.

The group felt that the responsibility for communicating the messages behind these indicators and responding to them lay as much with wider society as farmers.

Focus Group 3 – Inputs and Resources Report

13. Pesticides in Rivers:
    - Shows water contamination is a national problem;
    - Farmers need to take action or should expect prosecution;
    - Impacts on aquatic biodiversity can be substantial;
    - Data needs additional screening to remove active substances which have been revoked or are no longer in use;
    - Data should be displayed at catchment level or according to hydrometric boundaries;
    - Toxicity of pesticides; issues of spray drift minimisation; these are all messages that continuously need reinforcing;
    - Pesticide choice is important especially where surface water is present on the farm.
14. Pesticides in Groundwater:
    - The Environment Agency have put this indicator on hold because the data is predominately that of the Thames Region and so skewed away from national trends. Other monitoring data is not currently available;
    - Risk could be assessed via a mathematical modelling approach but would need great simplification;
    - Key messages still need to be conveyed to farmers about the risk of leaching. This needs to be linked to the vulnerability of aquifers.
15. Quantity of Pesticide Active Ingredients Used:
    - Messages should be targeted towards user groups e.g. farmers, spraying contractors and land managers;
    - Data needs additional screening to remove active substances which have been revoked or are no longer in use;
    - Data should be displayed at catchment level or according to hydrometric boundaries;
    - The Water Framework Directive needs to be placed into context;
    - Messages should be structured towards raising awareness regarding impacts on aquatic species.
16. Spray Area Treated With Pesticides:
    - Data needs to be more crop specific;
    - The rationale needs explaining.
17. Pesticide Residues in Food:
    - Needs to be related to UK food production and harvest intervals;
    - Will be very difficult to do anything meaningful;
    - Need to co-ordinate with work of the Pesticide Forum.
18. Nitrate and Phosphorus Losses from Agriculture:
    - Indicator has been based on modelled NVZ data not farm data so may be giving a false message;
    - Link needs to established the EU Drinking Water Directive;

- Mechanisms for loss reductions need to be established;
- Significance of P losses will probably increase.

19. Phosphate Levels of Agricultural Topsoils:
    - Indicator should be a guide for fertiliser strategies;
    - Farmers should have access to expert advice in this area.
20. Manure Management:
    - Links to water pollution and storage needs should be emphasised;
    - Links to ammonia emissions needs to be explained;
    - Links to nutrient strategies important;
    - Appropriate use of manures can save money;
    - Emphasise need for good practice in messages.
21. Ammonia Emissions from Agriculture:
    - Increase awareness of the environmental issues arising from ammonia losses;
    - Link to fertiliser strategy and nuisance;
    - Inform of national targets for emission reductions;
22. Emissions of Methane and Nitrous Oxide from Agriculture:
    - Explain source and potential environmental impacts;
    - Global warming potentials probably not meaningful to a farmer.
23. Direct Energy Consumption by Farms:
    - Encourage energy audits;
    - Emphasise cost reductions when wastage reduced;
    - Emphasise need for good practice & energy efficiency;
    - Explain environmental impacts.
24. Trends in Indirect Energy Inputs to Agriculture:
    - Explain what indirect energy is and the potential environmental impacts.
25. Use of Water for Irrigation:
    - Emphasise cost reductions when wastage reduced;
    - Emphasise need for good practice & water efficiency;
    - Link to crop type;
    - Need for irrigation plans.
26. Organic Matter Content of Agricultural Topsoils:
    - Trends show a decrease in soil organic matter and soil fertility. The potential problems of this need to be emphasised
    - Soil as a resource needs to be conveyed;
    - Link to manure management.
27. Accumulation of Heavy Metals in Agricultural Topsoils:
    - This needs to be linked to the importance of an integrated approach to soil management;
    - The need for an assessment of farm issues associated with long-term accumulation issues;
    - Possible links with sewage sludge use and/or other soil conditioners;
    - Emphasis needed to promote local soil analysis and regional monitoring in problem areas.

It was generally thought that it was important to explain the rationale behind the indicators and set the context (e.g. national, EU, global). The main message should be geared towards encouraging farmers to plan their fertiliser and crop protection strategies and to use nutrient balances. Appropriate and optimised use of all inputs was considered the main route for achieving national policy objectives for sustainable agriculture.

Focus Group 4 – Conservation and Biodiversity Report

31. Area of Agricultural Land under Commitment to Environmental Conservation:
    - Farmers need to be encouraged to join these schemes;
    - Farmers need to be aware that they could be paid for something they are already doing or considering doing;
    - Emphasise advice availability.
32. Characteristics Features of Farmland:
    - Currently a measure of quantity not quality. It is quality that is more important;
    - Location may be important – not all features are suitable or possible on all farms;
    - Emphasise advice availability.
33. Area of Cereal Field Margins Under Environmental Management:
    - Link to Habitat Action Plans;
    - Emphasise that they are relatively easy to do;
    - Provide information in software regarding the availability of funding;

34. Area of Semi-natural Grassland:
    - This is a rare and valuable habitat – farmers should be proud of it but it requires sound nurturing;
    - Their value needs greater recognition.
35. Populations of Key Farmland Birds:
    - Currently the best available on-farm measure of conservation value;
    - Habitat value is important but food source and availability is of equal significance.

Main messages should be focused on advice and payments available for supporting these habitats. Farmers should shout more about their achievements. General discussions at the workshop focused on the quality of the data the indicators were based on and the need to update many of the indicators on a frequent basis. Messages should be kept broad, clear and concise.

3. REVISITING THE ORIGINAL DATA

The first step was to collate as much of the data that was originally used to develop the pilot indicators as possible, in order to identify how the indicators had been calculated, what assumptions had been made and what means of disaggregation may be possible. Data collation was slow and not as successful as was desired.

Identifying who currently had data ownership, precisely what data had been used and what assumptions had been made in the calculation of the indicator and its temporal trends proved difficult. Organisations were generally very reluctant to release of data to the research team. They stated concerns about how the data would be used and its statistical interpretation, despite our assurances that we would discuss approaches with them. In addition, they were concerned about the time and costs associated with administering the data and formatting it, albeit that this must have been done previously to calculate the indicators in the first place. Copyright was another obstacle which required much discussion to overcome. The main issues arising were:

- *Difficulties in tracking down and obtaining the data.* Staff movements, company reorganisation/closure and inadequate record keeping meant that the acquisition process was very slow and frustrating. In one or two instances the data no longer existed.
- *Poor data quality and gaps in knowledge.* In many instances the indicators were calculated and extrapolated from poor quality or gappy data leaving trends open to interpretation.
- *Recalculation problems.* As information on what assumptions where made when the indicators were originally calculated was sketchy and subjective, recalculation did not always produce the same results as those published.
- *Inappropriateness at farm level.* Not all of the indicators were appropriate at farm level or had any meaning when disaggregated. Surrogate indicators were sought or just the underpinning key messages and linked management practices conveyed. With respect to some indicators there was insufficient scope for disaggregation or the data was statistically irrelevant or inaccurate at farm level.
- *Huge data sets.* In some cases the data sets were very, very large and required a considerable amount of data handling and re-sorting before being potentially useable within a software package such as that being developed.

A more specific description of the problems we encountered has been given below.

13 Pesticides in rivers

- The Environment Agency data set is enormous (500MB database, containing 500,000 monitoring records for each year between 1995 and 1999) and so data handling was time consuming;
- New software had to be written to decode and search the database (removing anomalous sites and chemicals);
- Each sample point had a grid reference which then had to be allocated to one of the 59 hydrometric zones/catchments in England and Wales (grid referencing was occasionally inconsistent between EA regions);
- Once allocated to a catchment the number of samples and number of sampling sites within a catchment were used to give some indication on the level of sampling in relation to the size of the catchment;
- When a catchment is selected the monitoring data for all the pesticides has to be calculated and split into the 3 bands: % of samples, below 100 ppb, 100-500 ppb and over 500 ppb.

15 Quantity of pesticide active ingredients used

16 Spray area treated with pesticides

- Data taken from Pesticide Usage Surveys;
- Temporal frequency of survey is variable and not annual, thus there had to be some interpolation between each survey year to gain an estimate for the years in-between.

21 Ammonia emissions from agriculture

- The data came from the inventory of ammonia emissions from agriculture;

- The data is only available for a national picture, it cannot be broken down by geographical area or farm type;
- However, the national total figure can be broken down into source (cattle, sheep, pigs, poultry, conserved grass and tillage crops), by activity (outdoor livestock, land spreading, housing, storage and fertiliser), or both.

25 Use of water for irrigation

- This data came from a survey of irrigation use;
- The survey data contained data on water use by the crop using the water or the source of where the water came from causing consistency problems;
- The data can also be broken down by county.

19 Phosphorus levels of agricultural topsoils
26 Organic matter content of agricultural topsoils
27 Accumulation of heavy metals in agricultural topsoils

- The data for these three indicators came from the National Soil Inventory;
- Unfortunately, the data supplied only contained data for 1979-81 when the first samples where taken across the UK. It did not contain the partial re-sample taken in 1995. Thus no trend data is available (which is quite important for these indicators);
- The data can be broken down by county (although NSRI expressed some reservations about the statistical relevancy of this breakdown - they thought that the data should not be broken down beyond the national level - we disagree, if it's valid for the national level, then its valid for the county level providing statistical spread is sympathetic to the national distribution).

The next step was to analyse and interpret the data to try and recalculate the National Indicators. This again was a struggle. Problems have arisen with trying to identify how the original values were calculated, what assumptions were made, what data was included or omitted, how were incomplete data-sets handled etc. None of the organisations who had ownership of the data seemed to have recorded the process and in some instances this vital information has been lost as staff involved in the initial indicators work were no longer employed within the organisation.

Identifying means of disaggregation was the final stage of data analysis. In some cases there has been no scope for disaggregation for a number of reasons such as the indicator having no meaning at that level, the absence of data altogether or the statistical relevancy of it. In these cases a surrogate indicator or other means of conveying the underpinning messages needed to be identified. The means of disaggregation and use of other indicators as surrogates or as additions are detailed in the next section.

4. THE INDICATORS AT FARM LEVEL

For each indicator presented in the DEFRA report[1] the project attempted to breakdown the national value such that it was more meaningful at farm level. How this was achieved and the degree to which is was successful varied with each indicator.

In the software, the national data for each indicator can be displayed graphically, together with text displays relating to:
(i) background information explaining the meaning of the indicator, how it was calculated, any assumptions made and the source of the data or reference;
(ii) key messages. This links the indicator to management practices i.e. those practices which have the potential to influence the level of environmental risk or which may improve performance in that area;
(iii) links to associated indicators;
(iv) help in using the software, in understanding the exact nature of the input data and in interpreting the outputs.
The user is given the opportunity to enter descriptive data pertaining to his or her farm at a basic and/or more detailed level. Where this is provided other facilities become available, for example to calculate farm values for the indicator or to carry out simple risk assessments.

The 35 national indicators (and extra surrogate indicators) provide a substantial amount of information of variable relevance. Many of these indicators are not directly applicable to the farm level and those that are will vary in their importance. Thus there is a need to prioritise and focus attention towards those indicators that are of most relevance to a particular farm. Firstly, the full list can be reduced to those indicators that are off direct relevance to the farm level situation. Then, depending upon the type and depth of information provided by the user it may be possible to give others a very low priority based on the farm profile, e.g. if no irrigation takes place on the farm, the irrigation indicator (no. 25) is not relevant to that farm. Then the farm values for a specific farm can be calculated to prioritise the remaining list. The calculated farm values are compared to national, regional or farm type specific indicator values. Where the farm value is

significantly different from the indicator value (good or bad) this indicator is highlighted. Thus the end user should end up with a list of indicators that are most relevant to the farm level, with a number of those indicators highlighted as being of most interest due the farm value being significantly different. Thus drawing attention to those indicators where the farm 'performance' is good or poor.

Details of how indicators have been modified for farm level analysis are given below.

AGRICULTURE WITHIN THE RURAL ECONOMY AND SOCIETY:

1 Agricultural Assets and Liabilities:

10 years data is now available for the years between 1991/92 and 2000/01, disaggregated on the basis of country (England or Wales), farm type and tenure (owner-occupied, tenanted, mixed or all). Start up displays the basic national plot showing the value of assets and liabilities, as three ratios rather than in real terms. The three ratios are: (a) total assets as a % of external liabilities (b) current assets as a % of current liabilities and (c) liquid assets as % current liabilities. The ratio being more appropriate at farm level than the raw data as it facilitates easier comparison.
More appropriate farm level data can be displayed disaggregated by and available for plotting by:

- Country (England and Wales);
- Farm type (e.g. dairy, cereal, vegetable, fruit, mixed, livestock by type etc.);
- Tenure (owner – occupied, tenanted or mixed).

A more detailed level of analysis can be carried out if the user has supplied asset and liability data from farm accounts and this figure for any number of years displayed as a text report and as overlaid figures on the main plots. Analysis of the three farm-data ratios over time is used to provide warnings of possible negative financial trends.

2 Age of Farmers:

Basic national and disaggregated plots for 1990 to 1997 show the age distribution of farmers in three age brackets (a) under 45, (b) 45-65 and (c) over 65 for all farm types and countries. Data can also be plotted by county or farm type (e.g. dairy, cereal, vegetable, fruit, mixed, livestock by type etc.).

3 Percentage of Holdings that are Tenanted:

Basic plots show the proportion of total area tenanted for the years 1997 to 2000. Data is disaggregated and available for plotting by tenure (owner occupied, rented or mixed tenure), county and by farm type (e.g. dairy, cereal, vegetable, fruit, mixed, livestock by type etc.)

4 EU Producer Support Estimate (PSE):

The national data shows the net % PSE - a measure of support as a percentage of gross farm receipts for the years 1986 to 1999. Disaggregated data by a wide range of commodities and by the type of support in ECUs can also be displayed.

5 Payments to Farmers for Agri-environment Purposes:

The national data shows expenditure as a percentage of total public expenditure. The disaggregated plots show the same data but broken down by scheme type (e.g. habitat scheme, countryside stewardship, organic, moorland etc.) over time between 1993 and 2001 and showing the total spend, spend as a proportion of CAP grant and subsidy expenditure.

6 Total Income from Farming:

The data available covers the years from 1989/90 to 2000/01. The published national data shows two plots, total income from farming per whole time person equivalent, and total income from farming. The disaggregated plots show net farm income by country, sector, farm size, tenure and off-farm income by sector.

7 Average Earnings of Agricultural Workers:

The data available covers the years from 1965 to 2000. The published national data shows agricultural wages for England and Wales as a proportion of average manual workers earnings. The disaggregated plots show average annual weekly earnings and the average annual hours worked for regularly hired full-time men. Also displayed are data for the national minimum hourly wage and the minimum farm wage. Data can also be plotted by country (England and Wales) and worker type adjusted by the Retail Price Index. For the year 2000, data can be broken down by full/part-time, male/female and type of worker.

8 Agricultural Productivity:

National data for the years 1973 to 1998 can be displayed. Problems occurred identifying exactly how these figures had been calculated by MAFF. However, new and additional data has allowed us to show how output has changed over the

past eight years disaggregated by crop, livestock or other produce. The software can also show how inputs have changed over the same period (subdivided by type) and changes in labour inputs over the same period.

9 Agricultural Employment:

The plot shows data for the years from 1984 to 2000. Data is available detailing the number of workers falling into each of a number of categories (full time/part time employment, male/female/casual etc.). Data is disaggregated and available for plotting by country (England and Wales), county (years 1997 - 2000 only), DEFRA region and by worker gender. Comparative data for the EU as a whole is also available.

FARM MANAGEMENT SYSTEMS

10 Adoption of Farm Management Systems:

The published information in the DEFRA report[1] regarding this indicator shows only data pertaining to membership of LEAF and the number of completed LEAF audits returned in that year. The LEAF audit is just one indicator related to the number of farms adopting 'alternative farm management systems'. Data, updated for the years 1999 to 2001, is shown as national data. No further disaggregation has been possible or indeed would be meaningful to farmers.

(10a) Environmental Management for Agriculture:

In addition to the LEAF audit similar data for sales of the DEFRA funded EMA (Environmental Management for Agriculture) system[3] have been included in the software to further demonstrate uptake of environmentally sound approaches to farming. National sales data is shown with the opportunity to disaggregate this data by UK region and user group (farmers, advisors, policy groups, education and others).

Data for farm assurance scheme membership would also have been a valuable source of information but information was not available to the research team.

11 Area Converted to Organic Farming:

The basic national plot which is shown on start up shows the area of land converted to organic farming from 1993 to 2001. The software can also display data for the number of holdings practising organic farming in the same time period and the land area data broken down by country and into three categories showing the degree to which conversion has been completed i.e. area in first year of conversion, second year of conversion and that which is fully converted as well as total figures. Data was provided by DEFRA. A detailed snapshot for 2000 by country is also available.

12 Knowledge of Codes of Good Agricultural Practice:

Discussions with industry and farmers, appeared to show that this indicator was not of great value. The plot within the DEFRA publication[1] does not illustrate any trends with time but just a snapshot of the status of knowledge of the codes in 1995 determined from survey data. The purpose of the Codes of Good Agricultural Practice[2] is to increase the uptake of best practice, minimising negative impacts on the environment, and the purpose of this indicator was to measure good practice uptake; therefore, two surrogate indicators have been used in the software to support Indicator 12. These are:

(12a) Number of Pesticide Poisoning Incidents:

Data is taken from the Wildlife Incidents Investigation Scheme reports[7] from between 1995 and 2000. It has been assumed here that incidents of accidental poisoning should decrease as the uptake of best practice increases. Data can be disaggregated by country or species group. A snapshot for the year 2000 is also provided that shows data disaggregated by country and species group simultaneously. Another shows classification of the cause of the incidents for 2000.

(12b) Number of Agricultural Pollution Incidents:

Data is taken from the Environment Agency (EA) report from the year 2000[8], and shows (a) all substantiated incidents by category (b) substantiated incidents by category and region and (c) incidents bu media affected (e.g. water, air & land). Data can be disaggregated by EA region and agricultural source. Data for the years 1994 to 2000 is available.

INPUT USE

13 Pesticides in Rivers:

In order to make the data more pertinent at farm level, it has been broken down by hydrometric region. It had been suggested that this should be done at catchment level but as there are many hundreds of small catchments it proved too demanding on resources. Further analysis of the data to aid its interpretation is also available. For each pesticide active substance found in the hydrometric region, information is provided on its spatial intensity (i.e. the number of sampling sites in relation to the size of the hydrometric region) and the sampling intensity. The raw data could report 100% of samples exceeding threshold limits but in some cases this was due to just a very small (possibly just 1) number of samples being taken providing misleading information. The additional data allows the user to determine the amount of confidence they can have in the data and its relationship to water quality.

Available plots include the national data, data for specific catchments, data for specific pesticides in specific catchment and statistical analaysis of each.
For the generation of farm relevant information catchment and pesticide specific exceedences are compared with those pesticides often used on specific crops. Where a match is identified the user is alerted.

(13a) Aquatic Risk Indicator:

Discussions at the industry workshop held early in the project and with the Pesticide Forum suggested that it would be useful to include an indicator of risk to aquatic species in addition to the basic Indicator 13. Work done on behalf of the DETR[9], developed an indicator that shows the risk to three aquatic species (fish, daphnia and algae) from pesticides over time (1977 – 1996), in relation to the area of crops treated. Risk is divided into several categories from unacceptable to acceptable and clearly shows the reduction in risk that has been seen since the introduction of aquatic buffer zones. This is clearly a valuable indicator particularly because it is directly linked to regulatory assessments. Initially it was hoped that from the PUSG[10] data and ecotoxicological data and fate parameters already available in the EMA software[3], that it would be possible to calculate the plots for crop groups (arable, vegetable, forage and grass) directly in the software. However, this proved impractical as even a very fast computer was taking many minutes to complete the calculations. Consequently, the published graph was reproduced and included and options given to the user to assess which risk category individual applications they might have made or may make, would fall into.

14 Pesticides in Groundwater:

This has proved a very problematic indicator. The Environment Agency data available for this indicator is currently significantly skewed towards the Thames Valley area where intensive monitoring is already carried out. Historic monitoring data for other areas is not available although monitoring programmes are now being introduced. Consequently, disaggregation of the data was not possible. It was also difficult to identify a meaningful surrogate indicator. There was however, the potential to adopt the groundwater modelling routines developed by Cranfield University in collaboration with the University of Hertfordshire for the Pesticide Risk Research Project[11] funded by DEFRA. This uses the MACRO (V4.1) model[12] to predict concentrations of pesticides leaching to 1-m depth over a 1-year period, which are then taken as a protective surrogate for concentrations in groundwater as in current regulatory practice. These predictions are held in look-up tables to avoid having to embed the model itself into the system. For a site-specific prediction the system requires application date and postcode, and groundwater vulnerability data is stored for reference in an embedded database. Rather than request large amounts of data from the user (e.g. crop growth stage) data for a range of parameters are used and maximum and minum values presented to the user. Risk band is based on the worst case scenario.

15 Quantity of Pesticide Active Ingredients used:

The published plot for this indicator in the DEFRA Indicators report shows pesticide usage for Great Britain (from the PUSG[10]) as tonnes of active ingredient applied to arable and horticultural crops. In addition to this, the software system can display usage by crop group (arable, fruit – soft & top, vegetables, grass & forage), and the data can be further sub-divided into specific crops within the crop groups. At farm level, quantities used are compared with national amounts used by crop group.

16 Spray Area treated with Pesticides:

The approach taken for this indicator is similar to that taken for Indicator 15. Data from the PUSG[10] can be displayed by total usages, by crop group and by specific crop.

17 Pesticide Residues in Food:

Currently the national indicator shows number of samples taken and the number of exceedences above the MRL. This data shows total number of samples and exceedences found during the whole survey and not just those relating to UK grown produce. As a consequence, it is not a reliable indicator of best practice or compliance with harvest intervals by UK farmers. The reports from which this data has been extracted do provide data on the specific product and the country of origin; therefore, as well as the national picture, the software provides the option to show just data for UK crops, and this can be further broken down by produce and sample type. Quarterly data for the last 3 years is shown.

18 Nitrate and Phosphorus Losses from Agriculture:

The DEFRA indicators report shows two plots giving example data for losses of nutrients from Nitrate Vulnerable Zones. This provides a snapshot of just a small area of the UK where farming practices are controlled to minimise loses of nutrients by leaching and runoff. As a consequence, this data could be mis-interpeted. Suitable and reliable data for the whole of England and Wales is not available. Consequently, three surrogate indicators have also been included:

(18a) annual average concentrations of nitrates and orthophosphates in surface waters:

For these two surrogate indicators, the data has been taken from the DETR Digest of Environmental Statistics[13]. Whilst it does relate to the quality of surface waters in the UK and a proportion of it will undoubtedly be attributable to agricultural sources, reliable data which may indicate exactly how much is not available. Nevertheless, as the data has been

disaggregated by region it does show areas where surface waters polluted with nitrates and phosphates are an issue and so where farmers should be extra vigilant. Graphical options include nitrates and orthophosphates in surface waters of GB and by region.

(18b) fertiliser nutrient application rates & total nutrient use:
This surrogate indicator shows how usage of all mineral fertilisers has gradually declined. Two options for display are given, (i) rates of N, P and K as kg/ha between 1952 and 2000 for England and Wales[14], and (ii) UK consumption of fertiliser nutrients between 1996 and 2001[14]. The latter option can be sub-divided further by crop type. This surrogate indicator also links to Indicator 19. The inclusion of this data has the approval of the Fertiliser Manufactures Association.

19 Phosphate Levels of Agricultural Topsoils:
It was drawn to our attention mid-way through the project (by DEFRA) that the data published in the indicators report was incorrect. This data has been recalculated from source data for 1979 only and disaggregated by region. The 1985 data set used in the original calculations was a sub-sample of the raw data set. NSRI (as SSLRC) holders of the data would not release information relating to why only a sub-set of data had been used for the indicator and so we were unable to reliably use this data. This is also linked to the included surrogate Indicator 18b. Farm values may be compared with regional information.

20 Manure Management:
The DEFRA Indicators report[1] shows the results of a survey of manure management practices taken in 1997. Historical and reliable data for trends over time is not available.
(20a) Land receiving manures:
A surrogate indicator is also available which show the average % area (by the crop type) which received organic manures over the last decade (inclusion has the approval of the FMA). The main messages behind the indicator relate to its potential for polluting watercourses and the general perception that manures are a waste product rather than a resource.
(20b) Pollution incidents caused by the agricultural use of organic manures:
This surrogate indicator uses Environment Agency data of Pollution Incidents caused by Organic Manures in England and Wales 2000. Regional data is also available

21 Ammonia Emissions from Agriculture:
The published plot for this indicator in the DEFRA report shows the estimated total ammonia emissions derived from UK agriculture. Data more appropriate at farm level is shown by source (cattle, pigs, poultry, tillage crops etc), by activity (grazing livestock, land spreading fertilisers etc.) or both. A simple spreadsheet facility is also provided for users to estimate their own farms emissions of ammonia and calculate this as % contribution towards national and regional values on an activity basis.

22 Emissions of Methane and Nitrous Oxide from Agriculture:
With respect to Indicator 22, the DEFRA report shows emissions of methane and nitrous oxide in terms of global warming potential. This plot has been retained, however, a more detailed explanation of the meaning of Global Warming Potential has been provided, and with respect to nitrous oxide a snapshot of emissions in kg of N/ha on a county basis and by source is also provided. Methane emissions can be broken down by source category (i.e. enteric fermentation, livestock wastes and non-livestock sources) for the years 1970 to 1996. A simple spreadsheet facility is also provided for users to estimate their own farm emissions of methane and nitrous oxide and this placed into context with typical farm use.

23 Direct Energy Consumption by Farms:
Direct farm energy consumption by fuel type for the years 1978 to 1997 is provided in the Indicators report. Data showing the amount of electricity generated by biomass between 1992 and 2001 is also available. The software also provides the facility for farm data to be entered, converted (using energy equivalent factors) into energy use data and placed into context by comparing it with typical usage data, thus allowing the farmer to see how well his own data compares. Emissions of carbon dioxide, methane and nitrous oxide are estimated using emission factors.

24 Trends in Indirect Energy Inputs to Agriculture:
An approach similar to that taken with Indicator 23 has been taken here. A simple spreadsheet gives indirect energy consumption relating to farm inputs and also calcuates the amount of carbon dioxide emitted.

RESOURCE USE

25 Use of Water for Irrigation:
The Indicators report[1] shows trends in the volume of water used for irrigation and the estimated total capacity of water storage on farms between 1982 and 1995. As well as this plot, the software disaggregates this data by county, by crop

type and by water source (e.g. ponds, rivers, borehole, etc.). On-farm usage and available storage capacity can be compared with regional data.

26 Organic Matter Content of Agricultural Topsoils:

National Soil Survey data for the period 1979-81 as one data set and for 1995 as a second data set, is shown in the Indicators report . Access to this data was restricted by SSLRC, consequently we have only been able to disaggregate a single data set (1979-81) on a county basis. Data is shown as three categories %OM < 3.6%, %OM 3.6-7., %OM > 7%.

27 Accumulation of Heavy Metals in Agricultural Topsoils:

The indicators report[1] shows two years data for a range of heavy metals across England and Wales. The software also shows data disaggregated on a county basis.

28 Area of Agricultural Land:

The area of agricultural land by use (rough grazing, permanent grassland, arable and other) for the years 1950 to 2000 can be displayed. Data for the later years can be further disaggregated by holding size, by area of crops grown and livestock numbers. Regional data is also available as a snapshot for the year 2000.

29 Change in Land Use from Agriculture to Hard Development:

Changes in land use from agricultural to residential uses for the years 1985 to 1999 can be displayed and disaggregated further by region.

30 Planting of Non-food Crops:

The indicators report shows trends between 1993 and 1998, for the total area planted with non-food crops, specifically hemp, flax, linseed and oilseed rape. The software disaggregates this data on a county basis, showing data as a snapshot for the year 2000. Data for other years was difficult to obtain due to its potential for being tracked back to a particular farm.

CONSERVATION VALUE OF AGRICULTURAL LAND

31 Area of Agricultural Land Under Commitment to Environmental Conservation:

For the years 1987 to 1995, data can be broken down and displayed by county. The only exception to this is data for the Woodland scheme is only available by region. Data is also available for specific schemes.

32 Characteristic Features of Farmland:

As well as displaying the national picture the software can display the same data broken down by county and displayed in a variety of units (km, km/ha and km compared with national data) in order to place the data more in the farm context. Farm data can also be shown on the graph if this is supplied by the user and compared with national and regional figures.

33 Area of Cereal Field Margins Under Environmental Management:

In addition to the national picture, the software graph shows length (km) of arable margins per county per year between 1996 and 1998.

34 Area of Semi-natural Grassland:

As well as displaying the national picture the software can display the same data broken down by county, by a variety of different grass and moorland types (calcareous, unmanaged, moorland, non-improved, upland, purple moor grass) using the definition as provided by the Countryside Information Survey[6].

35 Populations of Key Farmland Birds:

The indicators report shows trends for three groups of birds (farmlands, woodland and rare native species) between the years 1970 and 1998. Data has been extended to include the years up to 2000 and data has been broken down by region.

5. SOFTWARE DESIGN

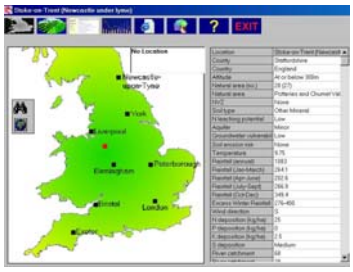
The software (Farm*Smart*)has been designed to provide a simple but interesting means of navigating and exploring the pilot indicators. Figure 1a shows a captured image of the opening screen. The menu down the left-hand side provides direct access to the case studies (showing how the siftware can be used and how indicators vary with location and farm type), a video presentation of how to use the software, access to the audio files on ‘Which way to sustainability?’, and

background information on the software. An icon menu visible across the top of the screen allows the user to navigate around the software facilities. These facilities include an eco-map, indicator navigator, indicator prioritisation routines, report generator and help system

Before exploring the indicators the user needs to supply some basic farm data (location, farm type and tenure). This is used to determine which disaggregated data is most appropriate for the user. There is also the option to supply more detailed data on the farm covering economic issues, input and resource use, management practices and conservation, which is subsequently used for calculating the more detailed farm level data. A third option of data input is via the eco-map shown in Figure 1b. Clicking on this map or typing in a postcode will automatically locate the farm into a county, region and catchment and display localised environmental data such as groundwater vulnerability, erosion risk, locations of NVZs, English Nature's Natural area status, climate data (30 yr. averages) and deposition data etc. The eco-map also provides a direct link to the localised case studies.

Once the farm data is entered then the list of indicators can be browsed as shown in figure 1c.

(1a) Front software screen

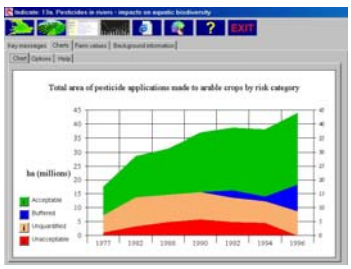


(1b) Eco-map & localised data

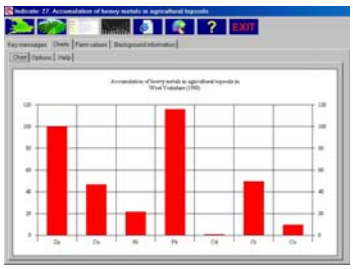
(1c) Indicator access point

Indicators can be selected from a list or by indicator type from a second menu on the left-hand side. Selecting a specific indicator provides access to:

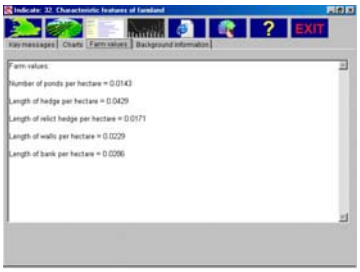
- Charts. Including various plotting options for the national and disaggregated data (see Section 4) (e.g. figures 1d and 1e).
- Key messages – text explaining the messages behind the indicators and links to management practices;
- Background information – an explanation of the data source/reference, how the indicator has been calculated and why it is important;
- Farm values – a text/tabular report giving any calculated farm data (e.g. figure 1f).
- Other facilities here include:
  - Indicator specific reports for the farm;
  - Spreadsheets and tools for calculating farm data;
  - General help on using the software – hints and tips, key to information icons, links to other associated indicators.
  - An explanation of the exact nature of the input data requested.
  - Help on interpreting the display graphs and calculated farm data.



(1d) Indicator 13a



(1e) Indicator 27 (specific county)



(1f) Farm level report

All the information, data and charts for any of the indicators can be reproduced in the form of an HTML report. Prioritisation routines sort the indicators according to farm type and where obvious discrepencies with regional data are identified. Information on all indicators is placed into one page in a more 'glossy' format with appropriate images, diagrams and also appropriate links to relevant web sites. This HTML report can also be printed out on to paper and/or saved.

6. DISAGGREGATED RESULTS

Various examples of how the indicators vary regional and how the indicators can be used to explore regional issues and how farm level practices may be contributing to these can be found in the Case Study Reports (1 to 3) available in Appendix B of this report.

7. CASE STUDIES USING THE SOFTWARE

Various 'theoretical farm' descriptions have been developed relating to various regions on the eco-map (see figure 1b) for a variety of farming systems and enterprises. Seven scenarios have been developed, including: arable farms in Essex and Nottinghamshire, a livestock farm in Lancashire, a mixed arable & dairy unit in Cornwall and a fruit farm in the Weald of Kent. Appropriate indicator values, as close to farm level as possible have been calculated using the software with these being presented to the user as:

- Direct comparisons with national and regional values; and/or as
- the % contribution towards the national or regional value.

The case studies can be explored via the software (data files included) and hard-copy information sheets can be downloaded from the website. The latter is available in Appendix C of this report.

8. FARMER AWARENESS RAISING EXERCISES

Several exercises have been under taken regarding project promotion, farmer and industry awareness raising and to encourage ownership of and motivation towards the indicators. This has included:

- the use of LEAF farmers as ambassadors and a series of farmer workshops;
- production of an audio cassette and its distribution;
- the establishment of a project website used to inform on project progress and events;
- the production of a newsletter, and publicity and press material.

Farmer workshops and LEAF farmers:

LEAF, as a project collaborator, held a series of focus discussion meetings with LEAF farmers to gauge farmers' opinions on the pilot indicators and to encourage their uptake and awareness. Four meetings were held in West Sussex, Gloucestershire, the Wirral and South Yorkshire with an average of 12 farmers attending each meeting. There was a range of farm business sizes and types, with representation from all sectors.

Much of the discussion at all venues reflected on the severe financial difficulties many in the industry were facing. In particular the demise of the family farm, concern over imports, cheap food, lack of understanding of the severe pressures many in the industry are facing and the fact that you cannot be sustainable without making a profit. In the end no one is benefiting. That aside there was a strong commitment to producing quality food and caring for the environment and it was felt that perhaps there could be other more suitable indicators to demonstrate the contribution of farming to the environment and society as a whole. It was widely felt that farmers needed to better appreciate the potential for financial advantage by adopting the indicators and implementing all the management issues related to them. However, as there are so many of them (i.e. 35) and the possibility of additional ones being adopted, it would be useful if some sort of prioritisation was placed on them.

There was a general consensus from all farmers that all the indicators were worthwhile and could be used constructively to demonstrate farmers' sustainability. However, there was concern over the interpretation of the indicators and it was felt that some of the indicators could be misleading in terms of farmers' progression towards sustainability. One issue raised by many of the farmers was that it would help if some of the indicators showed how the UK was performing as compared to Europe and more globally. There was also concern that the information was out of date, was expensive to collect regularly and so the true picture was distorted or simply incorrect. Many farmers expressed concerns regarding the possibility of targets being developed to progress indicator trends particularly because the data underpinning them is not seen as strong or appropriate at farm level.

It was also noted that some indicators should be developed which focus on the good things agriculture contributes to society and the environment. The focus currently provides a very negative picture.

Development of an audio cassette tape

An audio cassette (see Figure 2) has been developed which provides general background on the indicators and advises farmers on their importance and interpretation linking this to management decisions. The tape entitled *'Which Way to Sustainability?'* is around thirty minutes in length and aims to provide farmers with a brief overview of the indicators, what they are and what they mean at a practical level. It includes interviews with four farmers in order to provide a useful context in which the indicators are interpreted with respect to actual working farms. The aim was to produce a quick and easy to use product that could be listened to in cars and tractors out in the field.

2000 cassettes were produced and have been disseminated free of charge to farmers and other interested organisations on demand. The contents of the audio cassette will also be included, as an MP3 file, on a free internet downloadable package and as part of the EMA-2003 software system[3].

Figure 2: The front of the audio cassette tape *'Which Way to Sustainability?'*

Development of the project website:

A website dedicated to the project was launched in the Spring of 2001. This includes general background information, an electronic and interactive version of the DEFRA (as MAFF) Pilot Indicators publication known as the 'Indicator Explorer', press releases, links to other associated websites and contact details. There is also provision of a forum on which discussions arising from the Industry Workshops could be disseminated. An email address and mailing list was also established.
URL: http://www.herts.ac.uk/natsci/Env/aeru/indicators/index.htm
Email: Farm.Indicators@herts.ac.uk

Project newsletter, publicity and press material:

- A newsletter was released via LEAF in September 2001. This contained information on the outcomes of the first industry workshop, details of the planned farmers meetings and project progress plus details of the launched website.
- A number of press releases have been made via LEAF on behalf of this project.
- A poster campaign has also been undertaken. The poster is A1 colour in size and has been used at various agricultural and farmer events. An image is shown below as Figure 3.


Figure 3: The indicator project poster

1. CONCLUSIONS and RECOMMENDATIONS

This report has outlined the work done within this project. A final version of this report will be produced later in the year. The project has attempted to raise the general awareness of the National Pilot set of Sustainability Indicators on-farm by various means with some success. It is anticipated that the release of the software in late 2002 will further this objective.

Overall it has been concluded that the baseline data supporting the pilot indicators is not strong nor in many cases statistically reliable. This has generated misgivings within the industry although this is not evident at farm level. It is generally recommended that fewer indicators be adopted with resources concentrated towards the collection of quality data to underpin them and keep them updated.

The software provides a simple means for farmers and others to explore the indicators in depth, to look at associated data and the underpinning key messages. The software also links each indicator, where appropriate, with management practices which may help to improve performance.

10. REFERENCES

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Appendix A

Indicators for farmers – the top 10 recommended based on usefullness to the farmer and data quality/availablity:

1 Agricultural assets and liabilities (software indicator no 1)
2 Agricultural productivity (software indicator no 8)
3 Number of agricultrual pollution incidents (software indicator no 12b)
4 Pesticides in rivers by catchment (software indicator no 13)
5 Spray area treated with pesticides (software indicator no 16)
6 Annual average concetrations of nitrates and phosphates in surface waters (software indicator no 18a)
7 Pollution incidents caused by organic manures (software indicator no 20b)
8 Emissions of methane and nitrous oxide by agriculture (software indicator no 22)
9 Organic matter content of agricultural soils (software indicator no 26)
10 Populations of key farm birds – regional and by type (software indicator no 35).