OBS 04: The environmental implications of the 2003 CAP reforms in England

Synthesis report from external observatory projects OBS 01,02,03

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SECTION 1. INTRODUCTION AND APPROACH

1.1 Introduction

1. This summary report covers the findings of a suite of three projects carried out by a partnership between the Countryside and Community Research Unit (CCRU), University of Gloucestershire and the Central Science Laboratory (CSL), York, for the Defra Agricultural Change and Environment Observatory programme, from January to September 2006.

2. The aims of the projects were:

- **OBS 01 Environmental Monitoring Baseline Project**: ‘to develop a framework for environmental monitoring for the Observatory Programme and using this framework provide a baseline environmental monitoring assessment for the first year; to identify gaps in the current range of monitoring programmes and the implications for future monitoring.’

- **OBS 02 Environmental impacts of CAP Reform – Assessment of implications of farm level changes on environmental outcomes**: ‘to provide an up-to-date, enhanced assessment of the potential impacts of CAP reform on the environment by examining recent and anticipated farm change, building upon environmental links identified by previous studies and contemporary evidence.’

- **OBS 03 Quantitative approaches to assessment of farm level changes and implications for the environment**: ‘to provide a systematic review of the scientific evidence base linking agricultural and farm level change to the environment; to produce a framework for the key environmental impacts which highlights requirements for monitoring data/projections of farming activities and practice, and develop illustrative case studies.’

1.2 Approach

**OBS01**

The first part of this study consisted of a review of existing surveys and monitoring programmes with the potential to provide data for the monitoring framework, under the following categories: Drivers, Mechanisms, Processes (Farm Business and Farm Management), and Environmental Impacts. Web and literature searches were carried out to identify monitoring schemes that could be useful in the monitoring of environmental impacts of agricultural practices for the purposes of the Observatory. This review was used as a basis for identifying a selection of indicators for inclusion in the monitoring framework, with links where appropriate to existing policy indicators. A baseline assessment was produced, providing a summary of the current status of each of the indicators, plus time series data indicating recent trends. A gap analysis identified areas where monitoring data were lacking or inadequate, and recommendations were made for further work to maintain and extend the monitoring framework.
**OBS02**

This study gathered information from five sources: formal and informal literature, including the farming media; ongoing research programmes (including close liaison with the Defra observatory team); workshops and targeted interviews with key subject area specialists and practitioners. Evidence was sought on the detailed emerging and anticipated trends in farm change resulting from the implementation of the 2003 CAP reforms in England, and these were evaluated for their environmental implications and significance (in respect of scale, geography and timing). An analysis of gaps in the evidence base, and potential means to address these, was also undertaken. The approach was qualitative and iterative. An initial literature review and data analysis was completed in February, followed by three workshops and four interviews with practitioners to discuss emerging findings and key issues in relation to farm change. The literature review was then updated and expanded to incorporate insights from ongoing research programmes, and in May-June interviews were carried out with selected environmental experts, to produce a detailed and up-to-date assessment of the environmental implications of emerging and anticipated farming changes. Gap analysis spanned both farm change and environmental evidence bases.

**OBS03**

This study aimed to review and assess the available evidence to enable interpretation of the links between policy changes, agricultural change and environmental impacts. Firstly, a review of the evidence base for the environmental effects of agricultural practices was carried out, based on published information and ‘grey literature’, to present a broad overview of the major environmental impacts of farming practices on natural resources (soil, water, air), biodiversity, landscape and the historic environment. This was designed to complement the more qualitative analysis based on workshops and expert interviews that was carried out in OBS 02. The outputs of the evidence review were used to assemble a framework for the interpretation and prediction of the environmental outcomes of CAP reform. The types of modelling tools available to enable evidence–based predictions of environmental impacts of future changes were reviewed, with examples of relevant applications. Finally, two case studies were developed as examples of the use of the framework in providing quantitative analysis of environmental impacts for selected indicators. These were based on two contrasting agricultural regions of the UK: an upland agricultural landscape in Northern England, and a lowland arable landscape in East Anglia.
SECTION 2. CAP REFORM AND ITS ANTICIPATED IMPACTS

2.1 The most recent CAP reforms, in brief

The main change in support resulting from the 2003 CAP reforms in England has been the decoupling of aid to producers in the principal sectors which have benefited from CAP subsidy in the past, namely: beef, arable, sheepmeat and dairy. From 1 January 2005, all former direct payments to producers have been combined into a single payment per hectare of eligible land, based upon a pattern of allocation which is initially based largely upon levels of historic receipts but which over seven years will become transformed gradually into a flat rate per hectare of land, with three rates crudely zoned by productive capability (moorland, other SDA land, and all other land).

In the beef, sheep and arable sectors, the new payment or Single Payment Scheme (SPS) replaces the bulk of support to these sectors, whereas in the dairy sector there is still a significant guaranteed price element in support alongside the SPS, and the contribution of the dairy sector to the SPS budget is relatively small. The dairy sector is also unusual in that its output is limited by production quotas. However, there will be ongoing price cuts and compensation in the form of increased contributions to SPS over the next few years, as the EU dairy regime continues to be reformed.

At the same time, reform of the sugar sector has been agreed in 2006 and this will result in a significant cut in the guaranteed price from 2007, with compensation to producers also rolled into the decoupled SPS, as this proceeds.

As a result of decoupling, land which was previously used for other kinds of farm output and which therefore did not receive CAP direct aids, will in future be eligible for SPS, at a level which will increase gradually over the transition from a historic to a flat-rate area-based payment system (previously ineligible land only receives the ‘area’ element of the new SPS, as this gradually increases to replace the ‘historic’ element). However, some specific types of agricultural land use are excluded from the SPS by EU legislation – these include permanent crops such as modern commercial orchards and vineyards.

In the specific case of horticulture, because decoupling will not apply identically between the EU Member States and thus horticulture producers in some countries will not receive decoupled aids, and because of the differential impact of SPS on growers depending upon whether their land was formerly eligible for arable aids, the total area of land eligible for SPS on which fruit, vegetables and potatoes can be grown has been fixed by reference to a system of specific prior authorisation (so-called ‘FVP’ authorisations). These authorisations can be transferred between producers but their total area is capped. They are intended to prevent a large-scale move of formerly arable land into horticulture, because its SPS payment will be much higher than that being claimed by land previously in horticulture, which would otherwise create significant unfair competition.

Decoupling will mean that henceforth, decisions about what and how much to produce from farmland will not affect support levels under the SPS, so farmers can change their farming systems and practices in response to other market and external signals, in line with demand. However, in order to continue to receive SPS, beneficiaries have to uphold a prescribed list of basic standards as set out in EU legislation (on health, welfare and the environment), and manage their eligible land according to a set of criteria of ‘Good Agricultural and Environmental Condition’ (GAEC), which are designed to ensure that the environment is protected and land retains its productive capability, in the long term. These sets of conditions are
collectively termed ‘cross compliance’ and are divided between a set of ‘statutory management requirements’ (from legislation) and seventeen ‘GAEC’ conditions.

In brief, the GAEC conditions comprise:

1. General requirements (upkeep of all land)
2. Post-harvest management of land after combinable crops (from harvest to 1 March)
3. Waterlogged soil (restricting use for agricultural operations)
4. Burning of crop residues (preventing)
5. Environmental Impact Assessment (requiring in certain circumstances)
6. Sites of Special Scientific Interest (SSSIs - protection)
7. Scheduled monuments (protection)
8. Public rights of way (maintenance)
9. Overgrazing and unsuitable supplementary feeding on natural and semi-natural grassland (prohibiting)
10. Heather and grass burning (restricting)
11. Control of weeds (management)
12. Eligible land which is not in agricultural production (preventing irreversible loss of capacity)
13. Stone walls (no destruction)
14. Protection of hedgerows and watercourses (basic protection and maintenance)
15. Hedgerows (environmental management conditions)
16. Felling of trees (restricted)
17. Tree Preservation Orders (TPOs – requirement to observe)

The two parts of cross-compliance will be monitored by inspections and enforced by Defra’s Rural Payments Agency (RPA).

2.2 Anticipated impacts and environmental implications

GFA-RACE & IEEP (2004) considered the likely environmental impacts of the changes as both positive and negative. They summarised the anticipated trends as shown in Table 1

Table 1: Summary of anticipated environmental threats and opportunities from decoupling, in England

<table>
<thead>
<tr>
<th>Environmental opportunities</th>
<th>Environmental threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>A reduction in inputs, including artificial fertilisers and pesticides leading to improvements in water quality and biodiversity.</td>
<td>Specialisation and concentration in some sectors, especially cereals and dairying, leading to localised adverse impacts. Could include: increases in water pollution; greenhouse gas emissions; soil erosion, compaction and contamination; and increased levels of ammonia and acidification. There could also be loss and degradation of habitats with further declines in farmland biodiversity; and loss and degradation of landscape features such as hedgerows and damage to archaeological features.</td>
</tr>
<tr>
<td>An increase in fallow land leading to: a reduction in soil erosion, soil compaction and pollution of watercourses; the provision of habitats for farmland biodiversity; and a reduction in damage to archaeological</td>
<td>Reductions in the labour force and an increase in contract farming leading to loss of countryside skills and management practices and loss of local knowledge and stewardship. Less diversity of crop and grazing patterns</td>
</tr>
</tbody>
</table>
features. The extent of these benefits depends on the management of fallow land.

Some increase in heterogeneity of habitats if land is taken out of production or managed for conservation purposes.

resulting in increased homogeneity of habitats with consequences for biodiversity and landscapes.

Increased field sizes and loss of boundary features.

<table>
<thead>
<tr>
<th>Reductions in livestock numbers that will promote a reduction in greenhouse gas emissions; improve air quality and reduce acidification by reducing ammonia emissions; reduce soil erosion, poaching of land and pollution of water courses by nitrates, slurry and sheep dip; reduce grazing pressure on important habitats and improve the condition of SSSIs, especially in the uplands, with benefits for biodiversity; and prevent damage to archaeological features</th>
<th>Undergrazing or cessation of grazing leading to: a decline in condition of some SSSIs and other important wildlife sites; loss of landscape character; and a switch to alternative, possibly more damaging, land uses (eg some recreational activities). A reduction in suckler cow numbers in absolute and relative terms leading to greater difficulties in achieving environmentally sensitive cattle-based grazing regimes on some important habitats and wildlife sites, including SSSIs. Note cattle numbers are likely to fall more steeply than sheep numbers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>An increase in the incentive for farmers to enter land into agri-environment schemes and increased funding helping to: reduce impacts on soil, air and water; improve habitat management and reverse declines in farmland biodiversity; protect and manage landscape features such as hedgerows and protect archaeological remains. Also potentially increased incentive for the development of scrub and woodland subject to the development of supporting rules and adequate funding.</td>
<td>Reduced incentive to enter land into agri-environment schemes and woodland schemes due to insufficient payment rates leading to a theoretical loss of environmental benefits in the future.</td>
</tr>
<tr>
<td>The Single Farm Payment can be transferred or traded. There is uncertainty of the implications for the environment, in the potential transfer and trade of SFP entitlements</td>
<td></td>
</tr>
</tbody>
</table>

Source: derived from text in GFA-RACE and IEEP (2004)
SECTION 3. FARM LEVEL CHANGE IN RESPONSE TO CAP REFORM

3.1. Early evidence of change

The Literature gives more detail on adaptive responses than was available from earlier work. A reduction in the quantity of production in key supported sectors (cereals, beef and sheep) is predicted, with increased pressure to cut variable and fixed costs of production, but no significant change in average income levels by farm type, in the short term. In relation to farm management practices, the following changes have been predicted:

- specialisation of cropping systems, as farms concentrate upon those crops which appear to offer the greatest economic returns in current and future markets – these are predicted to be predominantly wheat and oilseed rape;
- more year-on-year flexibility of land use between arable crops and grass, although the extent of the use of this will depend upon a range of factors including farmer attitude, farm circumstances and enterprise/infrastructure economics;
- a shift towards more low-cost livestock production systems, which could involve both more extensive / less actively managed approaches as well as those involving larger intensive operations.

Cross compliance, because it mainly reinforces existing environmental standards on farms, is not anticipated by practitioners to have a big impact on farm management. This view is consistent with earlier work.

In the short term we identify a contrast between arable, dairy, and sheep and beef sectors, in the nature and rate of adjustments.

Arable

The predominant response to the reforms in the arable sector for the time being, as seen in recent surveys and in the view of practitioners, appears to have been ‘wait and see’ with few farms making radical changes and a resumption of cropping patterns similar to those seen in 2003, before the reforms were agreed (2004 was an unusual year, much more preoccupied with entitlement and uncertainty). This has meant a significant use of fallow land and a marginal decline in the areas sown to a variety of cereal crops, continuing a trend that has been apparent since 2000. However as suggested in earlier work, decoupling, in principle, is thought to open the door to more exploitation of comparative advantage and thus gradual specialisation at the regional and farm level.

Operating at marginal returns (i.e. with very little profit) should drive a polarisation of arable farming, according to some analysis (e.g. Deloitte) with more cropped land maintained by large-scale arable enterprises farming the land on contract, while other businesses gain the added value of niche markets, or rely on diversification, and can therefore sustain the cropping of relatively small acreages\(^1\). However some arable farmers consider their fortunes are the same or better than 1991 and are optimistic about the future. Many expect to adopt new enterprises and make major capital

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\(^1\) The 2006 Farmers’ Voice Survey identified a growing polarisation. The proportion of farmers who take all their income from farming is growing. Similarly the proportion of farmers generating income from sources unconnected to agriculture is also increasing, with small farmers more likely to be in receipt of this.
investments; though at the same time they anticipate making savings in machinery, cultivations and staff. Indeed the 2006 Farmers’ Voice Survey found that one in five respondents have managed to maintain or increase profit levels compared to 4% in 1999 (www.adas.co.uk). This may reflect the fact that support payments have not yet radically changed but is also in line with those studies that suggested that decoupling would have a marginal impact on farm income in the main crop sectors (Moss et al, 2000; Jones 2004a)

Analysis suggests that the decline in the total number of farmers and farm workers will coincide with the enlargement of farm units and simplification in farming systems. A polarisation between those farms which are able to continue farming profitably and are likely to specialise and expand, and those farms which are likely to be better off by reducing or extensifying their farming activity and thus will act accordingly, has been predicted. However according to recent studies of farmers intentions following the reform (University of Coventry and University of Hull, 2006), there is unlikely to be a mass retreat from farming in the short-term; instead farmers intend to ‘wait and see’ or adapt.

According to some analysis (e.g. Jones 2004a), decoupling should have a marginal impact on the main crop sectors (cereals and rapeseed) since the facility to claim voluntary set-aside with respect to pre-existing arable area payments means they were already ‘decoupled’, to a certain extent, before 2005. A predicted modest reduction in production results in a marginal price increase under their decoupling scenarios (relative to the baseline), with impacts greater in the rapeseed sector because this crop has been more dependent on area payments than cereals, in the past.

June and December survey data for 2003-5 indicate a significant increase in fallow land, plus modest growth in rape, linseed and maize, and a modest decline in barley and oats. There is some evidence of a decrease in wheat area. However, this may well be a feature of its shifting position in rotations (with a possible decline in the incentive to grow second wheats), such that farmers have decided on a ‘wait and see’ policy in 2005, which meant deciding not to crop rather than make significant changes. More detail on the occurrence and function of set-aside and fallow land in the 2005 census is given in the Defra Environmental Observatory study report (Defra, 2006a ), which indicates how little the pattern of fallow has changed since 2003, although its classification has shifted from voluntary set aside to fallow as a result of the reforms. As anticipated, dairy farms have tended only to set aside the minimum as required under the regulations, while in the arable heartlands it is clear that fallowing is becoming a more regular element in rotational management. As yet, it is clearly too early to say that there is any real evidence of a contraction in the overall area of land being managed for cropping.

The arable workshop added a few nuances to these patterns. It is clear that uncertainty about entitlements has meant that farmers are delaying making decisions about farm structural changes. An increase in horticultural production is not expected due to limited FVP authorisations, and a lack of suitable land. However, expansion in organic farming is expected, due to demand. Participants anticipated more specialisation into wheat and rape, with some simpler rotations (dropping barley and legumes) amongst the larger growers. Smaller farms might go for mixed cropping and premium prices. No return to mixed farming is predicted although beef fattening may increase, making use of vegetable waste. Land quality will influence cropping decisions. Heavy land which is difficult to work and light land which is low yielding lighter land will not be cropped, but go into temporary fallow and short term set aside instead. Farms will become zoned with cropping efforts concentrated on the more
productive areas of the farm. If the wheat price remains low there will be more fallow and farmers will look to diversify. One option may be that contractors crop only in the years when prices are good. Farmers are likely to put 5-10% of land into ELS conservation management options. Marginal land will be used for this purpose, so reducing the need to intensify cropping on the rest of the farm to maintain the same income. Continuing changes in management arrangements are anticipated, with an increase in contracting and a fall in the number of people taking day-to-day cropping decisions.

**Beef and sheep**

By contrast, the predominant response to the reforms in the beef and sheep sectors seems to have been to see them as a trigger for change. Producers are already beginning to make system changes in response to the expected change in support between now and 2012. Broadly speaking, as discussed more fully below, early changes appear to involve reduced recruitment into beef suckler herds among existing grass-based beef producers and changes in management strategies for common land and rough grazings in the uplands among sheep producers, which would be consistent with planned extensification and/or simplification. In addition, there is some evidence of increased keeping of sheep in lowland areas.

In the LFAs, it is considered that alongside fewer beef cattle, there are also likely to be fewer dairy cattle as dairying continues to decline, and that more hill/upland farms are likely to focus on sheep production only (Cumulus, 2005). These trends are also suggested from farmer intention data reported in Dwyer (2005), indicating that on LFA cattle and sheep farms there is likely to be a one-third reduction in suckler cow numbers and a much smaller reduction in beef finishing cattle. With sheep, it is anticipated that there will be a minor reduction (under 5 per cent) in breeding ewes and a similar increase in the proportion of lambs finished, rather than sold on for fattening on lowland farms.

According to Cumulus (2005), as well as taking on additional land, more farm businesses will seek to broaden their farming systems. In LFAs some hill sheep farmers are already moving into cross-breeding, using additional in-bye land and other lower lying land, in order to obtain higher margins. This is likely to be related to a move away from traditional fell management, with ewes and lambs now being kept on in-bye land until weaning and fell or moorland areas only being used from August onwards.

Some cattle farmers are also diversifying from traditional calf production from suckler cows to rearing on and finishing cattle on more productive land and/or lowland feed lots. These finishing systems are likely to involve housing, supplementary feeding, breed changes and intensification on in-bye land.

The Defra June Survey analysis (Defra, 2006c) found that while the beef herd increased by 3 per cent there was a marked decline in the number of suckler herd replacements compared to a year earlier. This was both in the number of heifers in calf and the number of potential replacements (not yet in calf) aged over 2 years. The report concluded that a significant fall in replacement numbers in 2005 is likely to result in a reduced suckler herd in 2006 and a reduction in the number of cattle available for beef production in 2007.

Analysis of June Survey data 2003-5 by Joint Character Area type indicates that although there was an overall 3% increase in the number of suckler cows in England in the year to June 2005, the pattern is quite varied across the country. The greater reductions tend to be concentrated in the far North East (Northumberland and the Cheviots). Increases appear more concentrated around South Cumbria and Lancashire in the North West and in the South West between Salisbury Plain and the
Devon Redlands – traditional dairying areas, suggesting that the increase may be arising where dairy farms are switching into beef. The Defra study (Defra, 2006c) also found that trends were beginning to emerge according to farm type. The greatest reductions in replacement heifers in calf were found on extensive livestock holdings (cattle & sheep lowland and LFA). The greatest increases in suckler cow numbers occurred on “other” farm types where the main activity of the holding in 2004 was not extensive livestock production. Half of this increase on “other” farm types occurred on holdings classified as farm type “dairy” in 2004.

At an aggregate national level the Defra June Survey shows little change in sheep numbers between 2003 and 2005. However, a more detailed investigation of upland holdings shows that while the total number of sheep and lambs has remained stable (+1%), there are indications that the structure of the flock is beginning to change. The most notable change is a reduction in breeding ewe replacements (-14%). Whilst large increases in other male and female sheep over one year old (+93% & +105% respectively) are apparent it is too early to infer changes to flock structure from these figures as the confidence intervals are very wide and the level tends to fluctuate year on year.

In examining changes in the LFA there is a clear distinction in patterns of observed change in cattle herds, with the North West influenced more strongly by the trend whereby small dairy farms are exiting and going into beef, while in other upland areas the dominant trend is for a decrease in beef herds. Similarly, in examining different arable areas of England, we can see how a combination of natural and social factors affect the trends observed. For example, the growth in pasture used for horse grazing is more marked in areas closer to high densities of urban population in the north than it is in the more sparsely populated arable areas of East Anglia. Also the East Midlands, with its more varied agricultural character and capability, often shows a different degree of response to trends in respect of arable crops than those apparent in the north and east.

The workshops with practitioners suggested the following. Most farmers have opted to continue as before, until they receive the SPS. Some sheep farmers are just starting to cut back on numbers, particularly old breeding ewes and some have already reduced sheep numbers on the fells. There is also some evidence of sheep breeds changing and an increase in off-wintering, resulting in a weakening of the hefting habit. Also, upland beef herds are disappearing. Nevertheless, there is demand for quality beef and increasing interest in traditional breeds, and ‘lifestyle’ beef producers are apparently showing some signs of success. There is a greater need for farmers to reinvest if they want to stay in beef and dairy compared to sheep, because of the more significant waste and hygiene/welfare/housing issues. Beef and sheep farms are changing in a more pro-active way, compared to dairy. Some single suckler3 beef farmers are talking of cutting back. Two trends are envisaged for beef: more intensive, commercial, mainstream beef using arable by-products; and less intensive systems meeting the demand for slow reared, quality meat. There is currently a buoyant organic beef market and direct sales. Current poor prices mean there is a disincentive to move into sheep and the loss of an abattoir in the South West (SW) has upset the market. There is a growth in smallholder or ‘other’ sectors. Newcomers are attracted into farming through more flexible arrangements and for example through targeted initiatives such as ‘Fresh Start’ (in Cornwall), and they often have off-farm income to support them. 50% of land in the SW is being sold to

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2 Upland category (19 JCAs in total) represents all JCAs where the number of farms in LFA is more than double those of the other categories.
3 (i.e. a cow raising a single calf as opposed to a multiple suckler system where a cow raises more than one calf)
non-farmers (figures reported are from recent Savills research), and this brings many new opportunities for existing farmers.

Young people are leaving the hills as farming is harsh and uneconomic and there are difficult succession issues. Agricultural support alone will not be enough to attract them to stay in hill farming. Wider issues need to be addressed, such as local housing. Diversification and reliance on off-farm income is already common in the uplands. This means that increasingly, farm-based labour is being diverted elsewhere and taking farmers away from the hills, so the hill management suffers.

**Dairy**

In the dairy sector, although significant changes are occurring and a concentration of production into fewer and larger farms is evident, this is a continuing trend pre-dating the 2003 reforms. It is clearly influenced by a host of factors – including both policy and market changes – among which the specific impacts of CAP reforms may be relatively minor. As a by-product of this change, a proportion of those marginal dairy farms that are deciding to quit milk production are moving into beef enterprises in the short term (see Lobley et al, 2006).

The ADAS Farmers’ Voice Survey of 2004 (ADAS, 2005a, 2005b) found that in aggregate, farmers intended to further reduce the number of dairy cows by 9%. Farmers in 2005 intended a significantly larger reduction in the numbers of dairy cows, compared to intentions in 2004. Among the various restructuring options, organic conversion is likely to be attractive to a proportion of dairy farms. Recent analysis by Defra (2006b) of June 2005 Survey data for the dairy sector showed a continued decline in cow numbers which more than offset the increase in average milk yields, leading to reduced milk production. Dairy production is becoming concentrated in the West of England, due to cow numbers reducing faster, on average, in the East than in the West. The greatest rate of reduction has been on holdings not classified as “specialist dairy”. On lowland specialist dairy holdings, declines are related more to herd size than region - in general the larger the herd size, the less of a reduction (except for much smaller herd sizes of 10 to 40 cows).

The workshops with practitioners indicated the following. There is currently little evidence of farmers planning to exit the dairy industry as a result of the 2003 reforms. Those giving up are medium sized units, who have the option and the business sense to make changes. They are changing to beef (linked to supermarkets contracts and direct sales) and sheep, or responding to the high demand and good premiums for organic milk. Smaller farmers are stifled by the love of milking and the lack of time to plan changes. As pressures mount, a tipping point will be reached when farmers will exit dairying. There will be a polarisation in land use across the country. Areas of poor land will extensify or be abandoned, while production will intensify on the better land. It is expected that smaller dairy herds will disappear while larger farmers will expand and invest. Access to a milk processor is critical, as well as investment in modern unit facilities.

**General**

In the short term, there is a contrast between arable, dairy and other livestock farm sectors, in the nature and rate of adjustments. Whilst few farms are making radical changes in the arable sector, in the livestock sector the reforms have been seen as a trigger for change but with dairy continuing to change in response to other factors. These emerging patterns of change are being experienced in different ways and at different rates in different parts of the country, such that the implications for the environment will also vary according to local geography, culture and history. This was most clearly shown in the workshops, where emerging responses were differentiated
by land quality (e.g. SDA/DA where DA farms face more immediate needs to adapt, but have more options), infrastructure (transport links and slaughter/processing concentration influencing development of intensive stock production), and cultural outlook (larger farms, younger generation, non-dairy holdings will be swifter to identify new opportunities and adapt). Change is generally more evident in the north and west than in the south-east and east, at present. The relative influence of ‘non-traditional’ sectors and enterprises (e.g. leisure, horses, hobby and lifestyle farming), varies significantly between regions and Joint Character Areas. National survey data indicate significant increases in horses and non-commercial holdings since 2003, which may be related to CAP reform but could also be a statistical effect of registrations.

3.2 Patterns of future anticipated change

This section uses analysis from previous predictions, recent evidence of trends and practitioner observations to suggest patterns of change in the future for the key farming sectors.

Over the next 3 to 5 years, sheep are likely to become more common in lowland areas and less common on the open moorland of uplands - particularly if, as suggested by practitioners, hill farmers decide that it is more cost-effective to concentrate their production on better and more accessible land and thus progressively abandon moorland management. These expectations are broadly in line with previous predictions (Hall et al, 2002 etc.) but this study has added to our understanding of the key factors in decision-making, in this sector, and elaborated likely upland changes in more detail.

Beef cattle are likely to become less numerous overall, but this implies marked declines in the uplands, increases at least temporarily in traditional dairying areas (as less efficient dairy businesses use beef as an exit route), and extensification into the more marginal parts of current mixed and arable farming areas. Cattle may also disappear from the least productive parts of existing lowland semi-natural grazed habitats such as heathlands and marshlands, unless they can be sustained here on purely environmental management (as opposed to viable production) rationales. This appears most likely if they are able to enter the higher tier Environmental Stewardship scheme and that, in turn, will depend upon scheme resources and targeting over this critical period. Again, the overall trend is consistent with previous studies, but the additional regional and sub-regional trends identified in this study enable more careful environmental appraisal of their implications and potential policy responses.

Dairy farms are likely to continue on their current trend of becoming less numerous, larger scale businesses, distributed less evenly across the country. They are likely to decline in upland and arable areas and concentrate in lowland situations where grass growth and maize forage production are favoured climatically and culturally over all-arable systems. However, these trends appear only weakly affected by the CAP reforms. It is still too early to establish the degree to which cross compliance and GAEC conditions, in conjunction with implementation of the EU Water Framework Directive in the UK, will affect this basic pattern.

In more productive arable areas, it seems likely that larger scale, block cropping of wheat and rape and simplified rotational systems - in which fallows play a significant role replacing second wheats, barley and other cereals - will become more dominant. Sugar beet production will contract. The National Farm Research Unit and Andersons (Food East News, 2003) predicted a large decline (25%) in area sown to crops by 2007, with a corresponding increase in the size of arable units. They
suggest that those exiting the industry would be small farmers on grade 4-5 land not capable of producing 3.25t/acre (8t/ha). However the more recent evidence suggests that structural changes could take longer than this to work through the system and may not be so dramatic. Greater use of contractors is anticipated, also a tendency towards more contract farming. Andersons predict that grassland and permanent pasture areas will increase slowly, on arable farms. If land of low fertility becomes available it may be used for extensive livestock.

Literature predicts lower input use from the changes, but the statistics don’t yet show this – the area of pesticide applications increased between 2000 and 2004. Input figures are not yet known for fertilisers but a decline is likely due to gradually increased set aside/fallow area, while application rates may stay the same on cropped land. More use of reduced tillage and other low-cost management techniques are likely (see www.smi.org and 2005 Farming Practice Survey).

In less productive arable areas, the likely trends appear as follows.

- Persistent fallow land is likely to be an important short to medium term phenomenon and patches of less accessible/productive land will fall into disuse.
- Some land is likely to go to built development – particularly where new housing on green field sites is already favoured, under other government policies (e.g. south and east England);
- Some land will be diverted to novel or niche crops, and particularly into renewable energy production using annual crops (rape is particularly favoured but sugar and wheat could also feature, while short rotation coppice seems less likely), and
- Some arable farms may become more mixed enterprises, particularly if associated with farm diversification into leisure, adding value/direct sales, and/or organic farming, where livestock production offers the potential to enhance the value or scope of the diversified activity, despite its relatively low returns\(^4\).
- Other areas may see minor shifts into different outputs including wine, fruit and vegetables in the coming 5 to 7 years (the latter depends critically upon the future status of the FVP authorisation procedures, and the relative profitability of domestic product versus imports, which is in turn affected by transport costs). In localised areas where currently there is a mix of livestock (often dairying) and cropping, one possibility will be for maize or cereals to replace temporary grass as the main source for silage production, and for this to be supplemented by production of high-protein fodder, to support increases in relatively intensive livestock enterprises (beef finishing, outdoor pigs).

In all areas, the influence of non-commercial and/or non-agricultural farmland management will strengthen as a result of the reforms (eg lifestyle farming, or environmentally-motivated landownership and management), as will the scale of land used for horses and recreational pastimes. This continues an existing trend but the implications of the reform are for a relative acceleration of the trend as farming revenue declines with decoupling, in the short to medium term (3-5 years). Where land leaves productive agriculture for leisure or lifestyle use, the related impact upon land values and the structure of holdings is often such that the reversal of this process becomes highly unlikely.

\(^4\) The recent 2006 Farmer Voice Survey (adas.co.uk) confirms the importance of diversification with one in ten farmers receiving >30% of their income from a diversified enterprise, although the proportion of farmers undertaking diversified activities has remained relatively constant since 1999.
There is also the potential for significant areas of land to be taken out of production and managed in accordance with the rules of the Single Payment Scheme (GAEC 12), on a 'minimal-cost' basis. In arable areas this may well occur as a continuing practice on the smallest and least productive sites but elsewhere there is likely to be a variable annual pattern, with different land leaving and entering production each year. In effect, this would mean a continuation of the recent phenomenon of significant areas of fallow land being present in arable areas, but the total extent of this area should increase slowly over the next 5 years or so. In livestock areas, 'GAEC12' land is perhaps more likely to be long-term and involve the most awkward and least productive areas of land – e.g. rushy pastures, overgrown heather where there is no grouse interest, gorse and bracken stands. This kind of land could amount to an increasingly significant proportion of farmland in some parts of the country, including upland and lowland heath areas, and common land. However, both its spatial pattern and extent will depend upon individual landownership and tenure. It will be influenced by the relative quality and scale of landholdings as well as by other factors such as the family labour force and/or succession plans, and will therefore present a very varied pattern of development, across the country.

Figures 1-3 illustrate the broad patterns of change that we anticipate in respect of the three main ‘farming zones’ in England.
Figure 1– possible system changes – lowland livestock

Various kinds of cropping: wheat, vegetables

Dairy

Organic

Equine (livery)

Beef

Sheep

Beef and Sheep

Larger, more specialised

Figure 2– possible system changes – LFA farms

Localised scrub / woodland

Upland sheep (breeding and finishing)

Equine (livery)

or Land
Leaves
Farming

leisure, nature woodlands

Beef

Upland Dairy

Beef and Sheep

Larger, much more Extensive, more Old stock/wethers (primarily landscape management)

Figure 3– possible system changes – arable & horticulture

Sugar

Set-aside/fallow

Larger, more specialised, wheat, rape dominant

Grazing/mixed (organic, intensive beef, outdoor pigs, equine / livery)

Bio-energy, novel crops, pharmaceuticals

Horticulture (only if FVP system relaxed)

woodland

leisure

nature parks

housing

or Land Leaves Farming

leisure, nature woodlands
One additional area of impact to consider is that of the most explicitly environmental elements in the 2003 reforms – i.e. the effects of firstly, cross compliance and GAEC rules, and secondly, its likely effects upon the uptake of the new agri-environment scheme and movement from existing schemes to the new scheme. Generally it would be expected that the introduction of the new cross compliance and GAEC rules should bring about a gradual improvement in basic environmental management standards on farms, regardless of how they are changing. However, this will depend upon how clearly standards are defined and how well they are enforced, as well as how compatible they are with other trends in farming practice. Good information and advice are likely to be an important element in securing benefits from these developments, and it is likely to be some years before such benefits can be demonstrated. Similar points apply to ELS uptake as it spreads across more productive areas of lowland England.

In respect of agri-environment schemes in marginal areas, the predictions are that farms will increasingly diverge between those who choose an explicit environmental route for future management, in which case they will apply for HLS and perhaps also OHLS and achieve more benefits than currently (whether or not they are already in ESA or CSS schemes), and those who decide instead to focus on enhanced profitability through conventional production, in which case the only scheme they might join is ELS and their farming may be concentrated upon their better land while the rest is managed under GAEC 12. Currently many areas have significant ESA and CSS uptake and there is a large proportion of land covered by ESA. There is concern that when these farmers with ESA agreements have to switch schemes they may decide to go for the less demanding ELS rather than the HLS which requires a higher standard of environmental management. If this is the case the benefits, particularly where small parcels of farmland were in higher ESA tiers, will be lost. Decisions made by farmers about Environmental Stewardship, which will vary between and within farms, and across local areas, will therefore have divergent environmental impacts. This is discussed further in the report by Cumulus et al. 2005.
SECTION 4. ENVIRONMENTAL IMPLICATIONS

4.1 Key environmental issues and impact of agricultural practices

The patterns of emerging and anticipated farm change identified above give rise to a wide range of environmental implications in respect of government and Defra’s environmental priorities. Effects on the environment are considered in terms of impacts on soil, water, air, biodiversity, landscape and the historic environment.

A healthy soil is an essential requisite for sustainable food production. Key aspects of concern in relation to soil include compaction, erosion, organic matter, microbiology, pH and pollution by heavy metals and veterinary medicines. Of these, significant changes in levels of compaction and erosion, and possibly organic matter, are considered particularly likely as a result of CAP reform, through changes in the balance of crops grown and in methods of livestock production.

Pollution of water by nitrates, phosphates, and pesticides is a major area of policy concern and the focus of a number of regulations such as the EU Drinking Water, Nitrates, and Water Framework Directives. Pollution by sediment, veterinary medicines and pathogens are also problems, where they occur. Acidification, nitrate pollution, eutrophication, sedimentation and pesticide pollution can all affect aquatic organisms. All these issues could potentially be affected by changes resulting from CAP reform. Changes in types of crop and livestock, cropping practices, and the degree of intensity of livestock production, are likely to be particularly important in affecting the potential for water pollution.

Key air pollutants arising from agriculture are ammonia, nitrous oxide, methane and particulates. Pesticides and odour may also cause local problems. Ammonia can cause eutrophication of nutrient-poor habitats, and also contribute to acidification. Nitrous oxide (N\textsubscript{2}O) is a potent greenhouse gas, which also depletes ozone in the stratosphere. Methane (CH\textsubscript{4}) is also a greenhouse gas. Approximately 80% of ammonia, 64% of nitrous oxide and 40% of methane emissions in the UK emanate from agriculture. Ammonia and methane are mainly derived from livestock, and changes in numbers and management practices resulting from CAP reform will lead to changes in emission levels. However, nitrous oxide arises from a variety of sources and net impacts on losses to air are more difficult to predict.

Over the past forty years there have been major declines in biodiversity on farmland (as well as in other habitats). Policy responses to these declines have included a Government commitment to reverse the declines in farmland birds by 2020, and a range of Biodiversity Action Plan targets to be met through action by a combination of Government and non-Government bodies. Biodiversity declines on farmland have been attributed to the effects of intensification (resulting in higher inputs of fertilisers, organic wastes and pesticides), larger fields, more autumn sowing of crops, polarisation of arable and livestock enterprises, simpler crop rotations, a switch from hay to silage, and higher stocking rates, which has led to overgrazing particularly in the uplands. Future agricultural changes affecting these trends will influence plant and animal population trajectories, though such effects are likely to be mitigated to a greater extent than previously as a result of increased uptake of agri-environment schemes.

Landscape is an important environmental and cultural asset. The Government recently signed and ratified the European Landscape Convention of the Council of Europe (2000), which commits it to promoting the protection, management and
enhancement of landscapes across the country, and integrating landscape considerations into all relevant policies. It is likely that major changes in landscapes will arise from CAP reform, albeit relatively slowly, as the balance and nature of livestock and cropping enterprises alters. In some areas there will be increasing homogeneity and loss of distinctiveness due to either larger scale intensive management in productive areas or, conversely, increased extensification and near-abandonment in marginal areas. The landscape will also be profoundly affected as land leaves productive agriculture for leisure and other uses. The maintenance of landscape features may also decline in these circumstances although again, increased agri-environment scheme uptake may mitigate some trends.

The **historic landscape** is an important and non-renewable cultural resource. Five attributes are considered to have particular importance: archaeological sites, historic buildings, designed landscapes, field patterns and boundaries, and ancient trees. Although impacts will occur, it is probable that the effects of CAP reform on changes to historic landscapes will be less significant than for other areas of concern, although neglect of boundaries could be an issue.

In OBS 03, a wide ranging review of the evidence base for the environmental effects of agricultural practices was presented, based on published information and ‘grey literature’, to complement the analysis of likely changes in agricultural structures and practices presented in the interim report of OBS 02. Table 2, based on this review, summarises the environmental impacts of farming practices on these environmental attributes, describes potential mitigation options to offset negative impacts, and indicates the principle changes predicted to result from CAP reform.
Table 2: Summary of environmental impacts of farming practices, potential mitigation and effects of CAP reform.

<table>
<thead>
<tr>
<th>Natural resources</th>
<th>Impact</th>
<th>Associated farming practices/mechanism</th>
<th>Mitigation</th>
<th>Predicted changes as a result of CAP reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Compaction</td>
<td>Use of heavy machinery, timing of harvest, trampling by high densities of stock (esp. cattle).</td>
<td>Reduced ground-pressure traffic systems, harvesting technique, crop layout. Mobile troughs, housing livestock over winter.</td>
<td>Increase due to larger more intensive dairy farms, variable pattern in arable areas - some increase with block cropping, some decrease due to more fallow/less risky crop types</td>
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<td></td>
<td>Erosion</td>
<td>Large field size, hedge removal, smooth seedbeds, compaction (see above), crop type, late harvesting, too many sheep on peaty upland soils (esp. by watercourses). Stocking rate. Outdoor pigs.</td>
<td>Use of cover crops, fallow land overwinter, contour cultivation, non-inversion tillage. Targeted grazing, mobile troughs, feed rack positioning, shepherding, buffer zones.</td>
<td>Increase due to more maize in dairy areas, decreases from more fallow, lower stocking in hills and cross compliance effects from GAEC soil plans</td>
</tr>
<tr>
<td>Soil organic matter (SOM) content</td>
<td>Conventional farming can lead to reduced SOM</td>
<td>Farming type: organic farming improves SOM and reduces loss. Crop type: energy crops may build up SOM.</td>
<td>Highly variable according to location and farm type</td>
<td></td>
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<tr>
<td>Microbiology</td>
<td>Application of slurry and sewage sludge containing antibiotics.</td>
<td>Organic farming systems are beneficial.</td>
<td>Damage from more horse keeping, more concentrated large dairy farms, benefits from shifts out of beef into sheep in some areas</td>
<td></td>
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<tr>
<td>pH</td>
<td>Inorganic fertilizers acidify the soil. Stocking rates.</td>
<td>Liming. Lower stocking rates.</td>
<td>Benefits from more extensive practices in many areas, but this also suggests reduced liming. Where stocking intensifies on upland in-bye, expect more liming here, too. Anticipate more acid grassland/vegetation on open moors</td>
<td></td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>Sewage sludge applied to land. Feed.</td>
<td>Energy crops may be used to decontaminate land.</td>
<td>Could see more of both of these - not a direct result of CAP reform, though: more driven by other factors</td>
<td></td>
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<tr>
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<tr>
<td>Water continued</td>
<td>Phosphate pollution</td>
<td>Application of inorganic fertilizer, and also slurry and manure. Timing of application. Soil erosion will hugely increase phosphate transfer and thus pollution risk. Feed. Waste.</td>
<td>Slurry injection and incorporation of manure, precision farming. Cover crop. All measures to reduce soil erosion. Energy crops have low P demand. Reduce P in feed. Organic farming. Reduce soil compaction (see above). Addition of phytase (pigs and poultry).</td>
<td>Similar pattern to that described for soil erosion. Also, any increase in outdoor pigs likely to have negative impacts</td>
</tr>
<tr>
<td>Veterinary medicine and pathogens.</td>
<td>Application of slurry/manure to land, defecation, wash-off from the skin/coat, sheep dipping, spreading spent dip to land. Pathogens from application of slurry, manure, or sewage sludge to land and losses from livestock unit farmyards, direct defecation, the stocking density, the duration and method of slurry storage, the method of slurry application. The mixing of spent sheep dip with slurry. Soil compaction (see above).</td>
<td>Target medicine treatment, prevent access to water courses. Pathogens reduced by active composting, longer storage of slurry. Maintain a low moisture content (poultry litter). Avoid slurry application to wet and/or frozen ground, application technique, prevent access to water courses.</td>
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<tr>
<td>Pesticide pollution</td>
<td>Spraying/application - timing and method, mixing and loading, quantity of pesticide applied, accuracy, crop type, artificial drainage. Sheep pesticides from dipping and arable and root crops are particular issues.</td>
<td>Pesticide handling system, sprayer cleaning (location of cleaning), agronomic assessment, precision farming, maintaining the sprayer, buffer zones and wind breaks, low drift nozzles, organic farming. Phasing out of most damaging substances.</td>
<td>Arable areas likely to see some changes - balance of cost/benefit depends upon precise patterns of crop change. Less spring barley more wheat bad for fungicides, more peas bad, more fallow good but more glyphosate may be used as fallow management, which could then become a greater problem. Dairy to beef shifts and upland extensification generally good, but more sheep in some areas could increase sheep dip problems/ issues</td>
<td></td>
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<tr>
<td>Sediment</td>
<td>see erosion and phosphorus (above)</td>
<td></td>
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<tr>
<td>Water levels</td>
<td>Irrigation, crop type.</td>
<td>Accurately calculating water requirements. Re-use of water, rain collection.</td>
<td>FVP prevents significant vegetable increases, so CAP unlikely to have direct effect in this way. Minor and highly variable impacts likely.</td>
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<tr>
<td>Water continued</td>
<td>Organisms, fish and amphibians.</td>
<td>Acidification and Eutrophication (caused by run-off, ploughing, drainage). Nitrate pollution (particularly for amphibians).</td>
<td>Integrate organic and inorganic fertilisers.</td>
<td>Similar to comments on nitrogen and phosphorus</td>
</tr>
<tr>
<td>Air</td>
<td>Ammonia</td>
<td>Primarily cattle, poultry and pigs. Manure/slurry management including spreading and storage, housing. Broadcast spreading leads to particularly high losses. Timing of application.</td>
<td>Direct injection, incorporation of manure. Minimising moisture content (poultry). Reducing the N content in feed, organic farming, increased use of straw, covering above-ground storage of manure/slurry. Shelter belts.</td>
<td>Fewer housed cattle/reduced stock numbers in many areas should bring benefits. Localised increased problems where intensive dairy and intensive beef develop/concentrate</td>
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<td></td>
<td>Nitrous oxide</td>
<td>Fertiliser, crop type, soil compaction. Defecation in pastures, indirect sources, animal waste in housing or storage, application to land and burning of dung. Livestock type.</td>
<td>Use of urea in place of ammonium nitrate, use of organic manure, drainage. Reduce N in feed, reduce stocking density.</td>
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<td></td>
<td>Methane</td>
<td>High intensity and high mineral nitrogen inputs. Storage method of animal waste, soil compaction, livestock density.</td>
<td>Organic farming systems are beneficial. Anaerobic digestion of waste to produce fuel. Sheep produce less methane than calves.</td>
<td>Lower stock numbers should be beneficial</td>
</tr>
<tr>
<td></td>
<td>Particulates</td>
<td>Soil erosion, Lime, Fertiliser, Pesticides, Poultry litter for manure, Cereal drying, Milling, Diesel &amp; oil, crop type (pollen). Feed (Hay PM &gt; silage), Feeding system, Manure system, Type of bedding (Good quality = low PM), Application of bedding, Temperature, Humidity – moulds, Activity of animals, Ventilation, Incinerators (carcasses).</td>
<td></td>
<td>Decreased wind erosion likely due to less cropping and GAEC soil plans, possibly benefits from reduced machinery use to save costs.</td>
</tr>
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<td></td>
<td>Pesticides</td>
<td>Spray drift, application technique (also see above).</td>
<td>See above (water pesticide pollution). Orchards and vineyards that use air-blast sprayers will have a proportionally greater contribution to air pollution than other crops.</td>
<td>See above. Potential increase in vineyards could cause localised increases (but minimal areas involved)</td>
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<tr>
<td><strong>Biodiversity</strong></td>
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<td>Important: inappropriate to set standardised impacts/mitigation measures for all species</td>
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<tr>
<td>Invertebrates</td>
<td>Assemblage</td>
<td>Crop type, spraying regime, ground cover, husbandry practices, cultivation, timing of sowing. Arable monocultures and use of inorganic fertilizers favour Hemiptera such as aphids. Degradation of field margins and use of herbicides have a negative impact on Hemiptera. Grazing intensity, silage cutting. Pasture improvement coupled with high stocking level reduces butterfly diversity.</td>
<td>Presence of ground cover promotes communities, planting of trees, beetle banks. Energy crops may be beneficial. Conservation headlands. Providing a variety of crops and avoiding concentrations of one crop type. Organic farming can increase species richness and activity. Reduce stocking density. Regular grass cutting good for some hymenoptera. Application of manure or slurry increases earthworm numbers.</td>
<td>Increase in arable monocultures favouring increase in certain species, but reducing diversity. Less spring barley more wheat will increase use of fungicides impacting on some invertebrates. More precise targeting of pesticides will be beneficial. Increase in set-aside on marginal arable areas will provide ground cover and habitats for invertebrates. Conversion of cereals to energy crops on less productive arable land.</td>
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<td></td>
<td>Dispersal</td>
<td>Crop type, crop density, hedgerow (may both facilitate and restrict).</td>
<td>The planting of trees, conservation margins and pollen and nectar mixtures (for bees).</td>
<td>Increased for some species where arable block cropping. Benefits from increased set-aside on marginal areas.</td>
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<td></td>
<td>Survival</td>
<td>Use of agrochemicals - pesticides and herbicides (direct and indirect impacts), tillage (particularly soil dwelling invertebrates), and spray drift. Acidification and Eutrophication of water bodies. Ploughing and re-seeding old pastures with rye-grass Lolium swards (butterflies). Veterinary medicines in manure. Insecticides, veterinary medicines in dung (especially avermectin).</td>
<td>Organic farming, uncultivated habitat overwinter (especially natural enemies), timing of application of agrochemicals. Manure non-injection application (reduces impacts of veterinary medicines).</td>
<td>More targeting of pesticides and increase in minimum tillage to reduce costs will provide benefits. Reduction in water quality from dairy intensification will reduce survival. Increase in set-aside on marginal land will provide benefits.</td>
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<tr>
<td>Birds</td>
<td>Survival</td>
<td>Indirect impacts of pesticides. Also see food sources. Indirect impacts of avermectin.</td>
<td>Selective pesticide use. Minimise use of avermectin at critical times of year, such as during the breeding season or when chicks begin to forage.</td>
<td>More targeting of pesticides will benefit invertebrate food source (see above). Increase in minimum tillage will improve crop residue and weed seed availability thus improving food supply. Increase in set-aside on marginal land benefits birds by providing nesting and feeding ground.</td>
</tr>
<tr>
<td>Food sources</td>
<td>Crop type, soil cultivation practice and timing (winter-sown versus spring-sown). Shift from fodder crops such as turnips to the growth of forage maize. GM affects seeds. Pesticides and timing of spray. Herbicides. Improved seed cleaning. Hedgerow removal or abandonment of hedge management, filling or clearing of ditches and other intensification. Modern, efficient, combine harvesters reduce waste for food. The conversion of rough grazing, the switch from hay to silage and the loss of temporary grassland in rotation. Keeping animals indoors in winter and elimination of rickyards, tidiness and hygiene around farmyards.</td>
<td>Reduction in autumn tillage to ensure winter stubble available (although some birds like wood pigeon benefit from winter crops). The value of stubble for birds may be increased if: (i) herbicide programmes on preceding crops are reduced, (ii) the use of pre-harvest glyphosate is restricted, (iii) barley (especially spring barley) is promoted over wheat and linseed, (iv) stubble is not cultivated. For foraging, a large number of ground-feeding birds prefer sparse or heterogeneous crop structure. Selective pesticide use. Conservation Headlands, grass buffer strips and uncropped buffer strips. Beetle banks and set-aside. Mosaics of short and long vegetation (spatial and temporal variability), low intensity grazing. Shorter swards</td>
<td>More targeting of pesticides will benefit invertebrate food source (see above). Increase in minimum tillage will improve crop residue and weed seed availability thus improving food supply, although less spring barley more wheat will reduce winter stubble availability and food availability. Increased arable monoculture will reduce diversity of food sources. Some benefits from more set-aside on marginal land, some potential benefits from more organic farming and horse keeping.</td>
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<tr>
<td>Birds continued</td>
<td>Shelter</td>
<td>Tillage, crop type. Inorganic nitrogen fertilizer: Grass grows too densely/high for some species. Rapid growth in spring stimulated by nitrogen allows early and more frequent cutting, so that birds do not have time to complete breeding before cutting destroys nest. Short, uniform swards are poor for shelter and protection from predators.</td>
<td>SRC could provide cover. Conversion tillage better cover for ground nesting birds.</td>
<td>Some benefits where more land is fallowed if winter cover exists. Increase in minimum tillage will improve cover for nesting. Livestock extensification will reduce trampling and improve cover for ground nesting birds.</td>
</tr>
<tr>
<td>Breeding</td>
<td>Breeding</td>
<td>Miscanthus and other dense crops unsuitable for some ground nesting birds, but suitable for others. Reduction in the presence of winter stubble. Earlier harvesting limits breeding season of late nesting species.</td>
<td>Conversion tillage better cover for ground nesting birds.</td>
<td>Increase in minimum tillage will improve cover for ground nesting birds. Less spring barley more wheat will reduce winter stubble cover.</td>
</tr>
<tr>
<td>Mammals</td>
<td>Abundance</td>
<td>Increased field size, decreased crop diversity, increase in pesticide treated area and number of sprays applied to each crop. Method of pesticide application. Molluscides and rodenticides are biggest threat. Widespread drainage and canalisation of rivers, pollution and filling in of ponds.</td>
<td>Increased energy crops (relatively undisturbed habitat). Lower toxicity of pesticides and reduced applications. Wildlife strips around intensively grazed fields, conservation headlands on arable fields and uncut margins to arable fields. Sown grass mixtures</td>
<td>Variable pattern in arable areas - decrease due to arable monocultures, but increase due to more set-aside and fallow on marginal land. Better targeting of pesticides will be beneficial.</td>
</tr>
<tr>
<td>Food sources</td>
<td>Food sources</td>
<td>Repeated cultivation of land reduces the presence of soil macro-invertebrates. Keeping cattle inside yards and or sheds and off pasture fields can result in fewer ground and dung beetles present as prey. Use of avermectins (indirect impacts), Sheep grazing can result in the loss of heather and the spread of course grasses, and the sheep compete directly with hares for food. Repeated heather burning can be detrimental to some species.</td>
<td>Agri-environment schemes have encouraged taking land out of crop production, in the form of rotational and non-rotational set-aside. Organic farming. Permanent pasture tends to be rich in soil macro-invertebrates, livestock (especially cattle) grazing and trampling is good for insect attraction and disturbance. Care needed in order to optimise grazing intensity. Sensitive management of heather burning.</td>
<td>Increase in set-aside on marginal areas will benefit</td>
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<tr>
<td>Mammals continued</td>
<td>Shelter</td>
<td>Large scale losses of hedgerows, dredging of ditches and the clearance of bankside vegetation.</td>
<td>Hedgerow loss halted and new plantings undertaken. Creation of buffer strips between cultivated land and watercourses. Farm woodlands.</td>
<td>Maintenance of hedgerows will provide benefits. Increase in set-aside on marginal areas will benefit</td>
</tr>
<tr>
<td></td>
<td>Breeding</td>
<td>Change from hay production to silage (affects Brown Hare only).</td>
<td>Ensure timing of cutting does not coincide with when leverets are using the grass fields for feeding and cover.</td>
<td>Concentration of intensive grass conservation production in some areas due to larger intensive dairy farms.</td>
</tr>
<tr>
<td>Plants</td>
<td>Abundance</td>
<td>Grass leys less popular, introduction of fungicides has allowed many farmers to dispense with ‘break crops’: has led to declines in some sp. but increase in others. GMHT crops (uncertain implications). Reduced cultivation systems, including minimal tillage, direct drilling and non-inversion cultivation means that seed is not buried during cultivation and has led to the increased abundance of some perennials and annual grass weed species and may encourage the establishment of wind dispersed species. Improved methods of seed cleaning. Herbicides. Drift and deposition of agrochemicals (particularly with spinning disk machinery). Drainage influences the species present, reducing wetland species. Silage rather than hay. Reduction of hedgerow management, especially in livestock areas has led to overgrown and gappy hedges. Drainage influences the species present, reducing wetland species.</td>
<td>Growing a conventional crop within a GMHT rotation. Timing of herbicide applications. Margin strips at field edge, particularly permanent strips. Temporary margin strips including conservation headlands and uncropped but cultivated wildlife strips. Organic farming. Hedgerow coppicing in combination with gapping-up.</td>
<td>Decrease in arable areas due to reduction in grass as break crop as arable rotations simplified. Increase in minimum tillage and greater targeting of herbicides as costs are cut resulting in more perennial and annual weed species. Livestock extensification resulting in increased abundance on grasslands. Loss of beef cattle will be detrimental to grassland diversity.</td>
</tr>
<tr>
<td>Natural resources</td>
<td>Impact</td>
<td>Associated farming practices/mechanism</td>
<td>Mitigation</td>
<td>Predicted changes as a result of CAP reform</td>
</tr>
<tr>
<td>-------------------</td>
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<td>----------------------------------------</td>
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<td>-------------------------------------------</td>
</tr>
<tr>
<td>Plants continued</td>
<td>Diversity</td>
<td>Crop type affects the weeds that are found, primarily due to crop management: fertiliser, pesticide and harvesting/cutting requirements. Change to winter cereals from spring cereals. Use of inorganic fertilisers. Misplaced nitrogen fertiliser. High levels of phosphorus. Liming. Herbicides. Use of animal slurries as organic fertiliser may reduce diversity. Set-aside where vegetation cover is sown suppress weeds. Heavy cattle grazing leads to defoliation, trampling, deposition of dung and urine and poaching. Low grazing can also be detrimental. Reseeding with high-yielding grass species. Flail cutting too intensively or at the wrong time of year can reduce biological diversity. Heavy sheep grazing (also in combination with industrial nitrate deposition). Repeated heather burning. Hedgerows: Flail cutting too intensively or at the wrong time of year can reduce biological diversity.</td>
<td>Bio-energy crops may lead to greater plant diversity. Timing of herbicide applications. Managed and dredging set-aside, uncultivated headlands and field corners. Mowing to maintain the floral diversity of ditches and cutting should be timed. Optimise grazing intensity. Timing of grazing. Reinstate some semi-natural grassland communities. Livestock type influence species found. Sensitive management of heather burning. Mowing and dredging to maintaining the floral diversity of ditches and cutting should be timed.</td>
<td>Variable pattern in arable areas - increase in block cropping will reduce variety, whilst increase in non-cropped areas on marginal land will improve diversity. Replacement of fertilisers with animal slurries to cut costs may reduce diversity. Replacement of spring barley with winter wheat will reduce diversity.</td>
</tr>
<tr>
<td>Landscape &amp; Historic</td>
<td>Pattern</td>
<td>Block cropping and arable monocultures. Larger farm units. Abandonment of grassland and moorland areas.</td>
<td>Introduction of greater crop variety. More organic farming systems. More mixed farming systems. Support for beef cattle systems on sensitive grassland habitats.</td>
<td>Increase in organic practices likely to add more local variety to landscape. Block cropping in arable areas will reduce landscape diversity. Zones of large pasture and forage conservation areas created around large dairy farmsteads. Significant impacts due to habitat changes on moorland resulting from livestock removal.</td>
</tr>
<tr>
<td>Natural resources</td>
<td>Impact</td>
<td>Associated farming practices/mechanism</td>
<td>Mitigation</td>
<td>Predicted changes as a result of CAP reform</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Historic/cultural features</td>
<td>Survival</td>
<td>Damage and/or removal of many cultural features due to functional redundancy. Increasing field size resulting in the loss of historic boundaries. Lack of labour for maintenance of boundaries and replacement with modern materials. Damage to the historic built environment from lack of maintenance, dereliction and inappropriate adaptive re-use.</td>
<td>Withdrawal of damaging practices. Maintenance and enhancement of features. Adaptive re-use informed by the historic character of the building.</td>
<td>Restructuring of farms and field units along with reduction in labour will leave many cultural features vulnerable to neglect, damage and removal. Maintenance and enhancement of cultural features on those farms adopting ES</td>
</tr>
<tr>
<td>Archaeology</td>
<td>Survival</td>
<td>Introduction of crops requiring deep ploughing will damage buried archaeology. Introduction of energy crops with high water demands damaging archaeology through cyclic variations in soil water content. Extensification of grazing, particularly in the uplands, will lead to the damage of visible archaeology. Bracken encroachment and scrubbing will damage buried archaeology.</td>
<td>Reduction of invasive cultivation techniques use of minimum tillage systems. Livestock grazing densities to ensure appropriate sward cover and prevention of scrub encroachment.</td>
<td>Extensification of upland grazing leading to damage to visible and buried archaeology. Maintenance and enhancement of archaeological sites features on those farms adopting ES</td>
</tr>
</tbody>
</table>
4.2 Environmental impacts of predicted agricultural changes

Table 3 summarises key points in relation to anticipated changes and their specific impacts in relation to the main areas of environmental interest, drawing on evidence from the baseline assessment in OBS 01, expert opinions in OBS 02 and the literature review in OBS 03. Table 4 summarises the major impacts on a regional basis. It should be borne in mind that these are generalisations, and that changes and associated impacts will vary according to local circumstances and conditions. This is illustrated by the case studies, described in Section 4.3 below.

Table 3: Environmental impacts of expected changes to agricultural structures and practices.

<table>
<thead>
<tr>
<th>Expected change</th>
<th>Implications for environmental priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arable areas</strong></td>
<td></td>
</tr>
<tr>
<td>1. Declines in area sown to (spring) barley and sugar beet, in favour of winter wheat or rape (for either food or biofuels)</td>
<td>Change from sugar beet to winter sown crops could reduce soil erosion due to increased crop cover over winter and less soil compaction. Spring barley is generally preceded by stubbles, and later by rough plough, less prone to erosion than bare and possibly compacted land following sugar beet, so the move away from spring barley to wheat and rape is likely to have less of an impact on soil erosion. Use of nitrogen fertiliser is likely to increase where wheat or rape replace spring crops. The potential for nitrate leaching is higher from oilseed rape and spring barley than from winter wheat or sugar beet, so net effects will depend on local changes. A reduced area of sugar beet will reduce levels of herbicide and nematicide use, but levels of other pesticides applied are likely to be higher. Impacts on biodiversity will be generally negative, due to (i) reduced crop diversity, and corresponding reduction in habitat diversity; (ii) loss of more open spring crops, which provide higher quality nesting habitat for ground-nesting birds (e.g. skylark, lapwing); (iii) fewer over-winter stubbles, which provide feeding areas for seed-eating birds, mammals and invertebrates although this may be offset by a greater area of set-aside/fallow; (iv) fewer spring-germinating weeds, including species such as Polygonums and fat hen, favoured by seed-eating birds, (v) higher levels of pesticide use may reduce numbers of invertebrates in crops, with knock-on effects through the food-chain. However, oilseed rape provides breeding habitat and a food source for some bird species, and these may benefit from an increased area. Landscape will also be negatively affected due to greater uniformity of cropping Little impact on historic features (already threatened in these areas)</td>
</tr>
<tr>
<td>2. More block-cropping</td>
<td>Larger areas treated uniformly, and possibly a greater tendency for prophylactic use of agrochemicals resulting from</td>
</tr>
</tbody>
</table>
maximisation of area/labour ratios and greater use of contractors, with potential negative effects on biodiversity, habitats and water pollution.

Reduced habitat diversity could have major effects on biodiversity, especially species requiring a range of habitats to provide the resources they need through the year (e.g. brown hare, lapwing). However, increase in fallow may partially offset this (see 3).

Larger blocks of crops will produce more monotonous landscapes.

3. The area of set-aside and fallow land increases in less profitable areas. Alternatively, more land is cropped with energy crops (this depends upon energy policy).

An increase in the area of set-aside and/or fallow land is likely to be beneficial to soil, water and air (subject to good compliance with GAEC conditions). Lack of soil disturbance and maintenance of ground cover will reduce soil erosion, nitrate leaching and production of nitrous oxide. Minimal application of pesticides, fertilisers and organic waste materials will also reduce potential sources of agrochemical pollutants.

Set-aside/fallow is also potentially beneficial to biodiversity, though the level of benefit depends on how it is managed. Greatest benefits arise from natural regeneration where species-rich seed sources are present. Sown set-aside generally has lower biodiversity value, but this depends on the seed mixture used. Greatest value for birds is derived from set-aside sown to wild bird cover. Naturally regenerated rotational set-aside can also provide high quality feeding habitat, (depending on levels of weed control in preceding crop) and nesting habitat (but this is lost if treated with glyphosate in spring). Fixed or permanent set-aside is useful for protecting features (e.g. hedgerows, watercourses) or extending existing habitat.

Set-aside or fallow can add diversity and interest to the landscape, though some may consider its appearance ‘untidy’. It is likely to be beneficial to historic features owing to the lack of disturbance.

The impacts of increased cultivation of energy crops will depend on which crop is grown. Increased production of wheat and/or oilseed rape will be generally negative for reasons given in 1 above. Sugar beet production for biofuel would have largely positive, but also some negative effects (see 1 above).

Introduction of short-rotation coppice (SRC) (and probably Miscanthus, though evidence for this crop is sparse) will increase habitat, landscape and species diversity and provide habitat for species normally not represented or uncommon on farmland.

The permanent crop cover would limit soil erosion, and low levels of pesticide and fertiliser inputs would minimise sources of water and air pollution. Increased energy cropping would have a positive impact on climate change provided it replaced energy production from fossil fuels. SRC and Miscanthus have high water demand and could deplete ground water levels in areas where rainfall is limited.

Effects upon landscape character could be positive, but will depend critically upon design and scale of planting, and impacts on historic features will usually be negative.

4. Some grassland and other bio-diverse areas

Generally beneficial for most environmental priorities.
<table>
<thead>
<tr>
<th><strong>Pastoral areas</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Productive areas - continuing concentration of dairying into larger and more intensive units</strong></td>
<td></td>
</tr>
</tbody>
</table>

| 5. Some intensive livestock enterprises expand (beef finishing, outdoor pigs), along main transport links, onto land vacated by arable (probably still in rotation) | Potential for locally increased soil compaction and poaching leading to soil erosion and nutrient loss. Increased losses of ammonia to air from livestock wastes. Methane production from cattle. Disposal of slurry/manure could lead to soil/water pollution by pathogens and/or veterinary medicines if good practice guidelines are not followed. Potential benefits for terrestrial biodiversity arising from greater habitat diversity and increased food resources (e.g. animal feedstuffs, greater insect diversity associated with livestock and waste products such as dung pats). However, aquatic biodiversity may suffer from locally increased pollution levels. Could be negative for landscape: buildings can be obtrusive, though outdoor livestock may add to landscape quality.  |
| 6. Slow / modest increase in novel crops, wine, and if FVP restrictions are eased, horticulture. | May be positive or negative for soil and water, dependent on management techniques. Horticulture and vines may increase water demand. High levels of fertiliser and pesticide use in horticulture are detrimental for biodiversity, and provide a source of potential water and air pollution. Harvesting may lead to soil compaction. Increased crop diversity may be beneficial for biodiversity, provided benefits are not completely negated by high pesticide use. Landscape diversity and interest may be increased, but intensive production techniques involving polytunnels or use of polythene, fleece etc. may be detrimental in landscape terms. May be neutral or negative for the historic landscape, depending on what is replaced.  |

| 1. Productive areas - continuing concentration of dairying into larger and more intensive units | Increased stocking rates more likely to cause poaching and soil compaction, greater potential for erosion and nutrient loss to water. GAEC Soil plans may reduce damage. Potential for pollution by pathogens and veterinary medicines. Greater densities of cattle will lead to locally increased production of methane (though this may be offset by reduced production from lower cattle numbers elsewhere, as methane is a global problem). Greater slurry production increases the potential for losses of ammonia, nitrous oxide and methane, depending on methods of storage and disposal. NVZ designation may mitigate some of this in certain areas. High levels of nitrogen fertiliser use on intensive dairy farms increase the potential for losses to water and air. Herbicide use on intensive grassland is likely to be greater than on other types of grassland. High yield ryegrass swards are of little value for biodiversity. Increases in size of dairy farms may therefore reduce habitat quality in the area if other types of grassland or crops are replaced. Impacts on landscape may be negative if larger areas are managed uniformly.  |
## Increased soil compaction and erosion may adversely affect below ground **archaeological features**

### 2. Increased maize area

Land growing maize is particularly vulnerable to soil erosion, and associated pollution of watercourses with sediment and nutrients, due to the extended period with low ground cover and late harvesting leaving bare and potentially compacted soil at times of high rainfall.

Inefficient root system results in poor uptake of fertiliser and hence greater potential for nutrient loss through leaching and runoff.

Maize is generally of low value for biodiversity as it contains few food resources in the form of seeds or invertebrates, though it does provide a source of cover after other crops have been harvested. May increase habitat diversity if it replaces intensive grassland.

Some maize in an intensive grassland landscape may add visual diversity, but may detract from pastoral character, depending on the context.

Reduced potential for water and air pollution by nutrients, pesticides and veterinary medicines as a result of lower input use (NB certain pesticides and fertilisers are permitted, and medicines may be used where welfare is an issue).

**Soil structure** and organic matter levels are likely to increase which, coupled with lower livestock densities, will reduce susceptibility to compaction and erosion.

Lower livestock numbers will reduce methane and nitrous oxide emissions and extensive management will reduce levels of ammonia production.

Mixed crop and livestock farming increases habitat diversity, and is beneficial to biodiversity, providing a wider range of resources.

Limited use of pesticides permits greater weed and invertebrate diversity in many crops. However, use of mechanical weed control, flame weeding etc. may have negative impacts due to disturbance of nesting birds and soil damage.

Mixed farming provides greater landscape diversity than single enterprise farms. Maintenance of field boundaries is often of a higher standard on organic farms.

Increased cultivation and growing of root crops may have negative impacts on archaeology, where present, depending on what previous practices it has replaced.

### 3. Slow expansion of the organically farmed area in middle England and the South West

Reduced potential for water and air pollution by nutrients, pesticides and veterinary medicines as a result of lower input use (NB certain pesticides and fertilisers are permitted, and medicines may be used where welfare is an issue).

Soil structure and organic matter levels are likely to increase which, coupled with lower livestock densities, will reduce susceptibility to compaction and erosion.

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Mixed farming provides greater landscape diversity than single enterprise farms. Maintenance of field boundaries is often of a higher standard on organic farms.

Increased cultivation and growing of root crops may have negative impacts on archaeology, where present, depending on what previous practices it has replaced.

### 4. Marginal areas - dairy farms shift into beef and sheep. Beef farms decline in favour of sheep.

Lower intensity of management will reduce potential for nutrient pollution of water and air. Change from cattle to sheep will decrease methane emissions.

Lower stocking rates and shift from cattle to sheep will reduce risk of poaching and accompanying soil compaction and erosion (except where heavy stock are wintered outside).

Lower stocking rates will benefit biodiversity, but replacement of cattle by sheep will reduce habitat quality for biodiversity, including invertebrates and nesting birds. Sheep grazing is more uniform and sward heterogeneity is lost. For high conservation value and species-rich grassland, the negative
impact on flora and fauna could be significant.

Large scale replacement of cattle by sheep could impact negatively on landscape, but where both are present, landscape could be enhanced in comparison with its condition under dairying.

Impacts neutral or positive for below ground archaeology.

**Uplands**

1. Extensification on out-bye and open moor

Reduced stocking rates will decrease risk of soil erosion and pollution of water by nutrients and sediment on currently over-grazed areas. In wet areas, an increased rate of peat formation will improve carbon sequestration.

Reduced stocking rates will decrease methane emissions (but not overall, if offset by stock increases elsewhere).

Effects on biodiversity are complex and will vary according to local conditions (see upland case study, Section 4.3). Relaxing of stocking rate on over-grazed areas will allow some recovery of vegetation and associated fauna, though where heather has disappeared, it will not naturally re-establish. However where grazing pressure is too low, habitat quality for some species of conservation interest (e.g. nesting waders) may decrease. If grazing pressure becomes very low or land is abandoned, scrub will eventually form. Limited scrub development may be beneficial in some areas, but large scale scrub formation will have major impacts on habitat value for species of open moorland.

Greater diversity of vegetation may improve landscape where it occurs, but eventually large scale bracken/scrub/woodland formation could dramatically alter character. Taller vegetation would increase fire risk.

Scrub growth on historic or archaeological features could cause damage through root penetration.

2. Stocking increases on in-bye land, and balance of stock shifts in favour of more sheep and fewer cattle.

Change from cattle to sheep may reduce soil compaction and erosion, but if numbers of sheep are high, damage may still occur (e.g. to river banks).

Greater use of nitrogen fertiliser will increase the risk of leaching and pollution of watercourses.

Change from cattle to sheep will reduce methane emissions.

Increased stocking rates and a shift towards sheep will have negative impacts on biodiversity – more uniform, shorter, species poor swards with lower habitat value and more disturbance of nesting birds by stock.

Impacts on landscape are likely to be negative – greater uniformity of vegetation and stock type, less attention to maintain traditional buildings.

3. Farms enlarge and simplify management regimes

Impacts on soil, air and water depend on the nature and intensity of management. Reduced management/labour input could have a negative impact on the intended application of good practice via GAEC rules.

Impacts on biodiversity are likely to be negative due to greater uniformity of land cover, less attention to habitat management, less attention to boundary features etc.
Detrimental to **landscape** owing to greater uniformity and less active maintenance/restoration of **hedges, walls, buildings** etc.

Possible negative impacts on **historic features** due to lack of attention to appropriate management requirements.

| **Both lowland and upland areas across the country** | Effects on **soil** and **water** could be positive or negative, depending on previous land use. Possibility of increased poaching and damage to soils, depending on what is replaced and the quality of husbandry. Reduction in **methane** production if horses replace cattle.

Likely to be negative for **biodiversity** due to poor quality of horse-grazed pastures and negative impacts of increased use of veterinary medicines. However, may encourage traditional hay-making which would be beneficial. Replacement of **hedges** by fences is detrimental.

Impacts on **landscape** could be negative due to less attention being paid to hedgerow/wall maintenance and their replacement by fences.

Damage to **historic features** may increase, depending on what is replaced. |
| 1. More land shifts into equine use | 2. More land shifts into amenity/leisure or lifestyle uses. |

Most options would be beneficial for **soil, water and air**, as a result of reduced inputs, fewer or no livestock and less soil disturbance.

Effects on **biodiversity** depend on nature of change. Although positive habitat management would be beneficial, over-emphasis on ‘tidiness’ (e.g. large areas of fertilised and mown grass) would be negative. Disturbance is likely to be a major issue for some species.

Impact on **landscape** and **historic features** depends on the nature of change and subsequent management. Landscape is likely to become more varied and small scale, but changes may not be in keeping with local landscape character, may encourage blandness and loss of ‘sense of place’, restrict views etc. |
| 3. More land lost to development | Negative for **soils, water** - ecosystem functions reduced, though this will depend on the nature and amount of green space (parks, gardens etc.). **Air quality** could increase if development is residential, or decrease if it is industrial.

Impacts on biodiversity will depend on species and the nature of development, e.g. some bird species, some mammals, amphibians etc are more abundant in suitable gardens than in intensive farmland. Plant diversity may increase where native species are encouraged. There would be negative impacts for species not adapted to habitats in developed areas or sensitive to disturbance.

Impact on landscape is dependent on sensitivity of siting and design. Landscapes generally are likely to become smaller scale and more complex, but views may be restricted. There is a danger of blandness and loss of local character (as for 2 above).

Impact on historic features is likely to be negative unless deliberately incorporated into development plans. Historic landscapes likely to be severely damaged or destroyed. |
4. Cross compliance conditions encourage better environmental management

Should be beneficial for all aspects but critically depends upon levels of compliance (effective enforcement) and how well they comply (good advice and information).

5. More land enters the ELS scheme

Benefits for all aspects increasing with extent of take-up. Levels of benefits will depend on option choices. Some benefits, e.g. for biodiversity, may take some time to become apparent.

6. Changing higher level agri-environment scheme membership, especially in uplands

Possible negative impacts to biodiversity and landscape where old agreements end and are not replaced/enhanced via HLS.

HLS agreements will enhance all aspects, including resource protection, historic and archaeological features and in some cases, new objectives of flood management and conservation of genetic resources.

Table 4: Summary of implications of predicted changes to farming on a regional basis

<table>
<thead>
<tr>
<th>Region</th>
<th>Expected change and environmental implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern/central areas</td>
<td>Cereal production is likely to centre on Lincolnshire and Nottinghamshire with an increase in specialist wheat production. Larger blocks of wheat will tend to reduce biodiversity and potentially pose a greater risk to soil structure. Declines in the area sown to barley, other broad-acre crops and sugar beet may be detrimental to wildlife habitat and landscape, although rape, fallow and more variable break crops may provide sufficient diversity to compensate for this. An increase in voluntary set-aside is also anticipated which is believed beneficial to biodiversity. The predicted decline in sugar beet may have negative consequences for some bird species. Predicted growth in the area of energy crops is not thought to bring significant concerns for the environment except when on set-aside where it is though to have a negative impact. Lower use of some inputs, where simplified block cropping is practised, should have benefits for certain aspects of biodiversity and water quality. Reductions in N and P in water are expected and pesticide reductions are anticipated in the South East, East Midlands, East and Yorkshire and Humberside regions. Anticipated growth in the use of contractors brings with it concerns over the ‘level of care’ applied to land management. Increase in extensive livestock grazing is possible in some parts of Eastern England and would be beneficial. The broader spread of sheep into some lower-grade arable areas might have benefits, whereas shifts into outdoor pigs could have potentially negative implications for water quality. Anticipated decline in dairying will be positive in water quality terms. There is concern however that cattle may also disappear from the least productive parts of existing lowland semi-natural grazed habitats such as heathlands and marshlands, unless they can be sustained on purely environmental management rationales. Loss of traditional land management skills and insufficient labour for conservation management could be a problem in this respect. The increase in use of permanent pasture for horse grazing would tend to have a negative or neutral impact. Possible localised increases in more intensive, larger scale and earlier beef finishing suggested for lowland grass in the west of the East Midlands will put environmental pressures on water, soils and air.</td>
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</table>

More land in arable areas will tend to be put into ELS following decoupling. ELS agreements are currently higher in the East Midlands and Yorkshire and Humberside compared to others regions. However the regional workshop suggested that farmers will put 5-10% of their low yielding land into specific ELS management options and keep the rest of the land in the same intensity of cropping. Expansion of, and newcomers to, organic farming in all sectors are expected with benefits for the environment.

Where land leaves regular cropping, grazing by horses, amenity tree planting and non-farming use are likely, with neutral or positive effects. Loss of farmland to housing and other forms of built development will increase from a low base, with localised but significant, largely negative environmental consequences.

<table>
<thead>
<tr>
<th>South-West and dairying areas</th>
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<tbody>
<tr>
<td>Arable cropping reductions are most likely to occur in this region and land removed from arable cropping is likely to revert to productive grassland or become forage for dairying. The workshop predicted there will be a polarisation, farming on the ‘worse’ land in the west will extensify or be virtually abandoned, while production will intensify on the ‘better’ land in the east. Spatial concentration of dairying will decrease the risk of ‘pollution incidents’ but increase the severity of incidents when they occur. Larger herds will increase the intensity of land management on these holdings with generally negative environmental implications, not least for shipping in feed and disposing of manure for larger herds. Although nutrient management may become more sophisticated, nutrient loading will remain a problem. Dairy farming regions of the South West, West Midlands and North West have been identified as high risk areas for siltation, where herds are intensively managed outdoors, and/or maize growing increases. Increases in areas of maize particularly in the South West have already occurred. Large blocks of grass ploughed for maize and forage cereal production will also be detrimental to biodiversity. A negative trend of greater landscape uniformity, more intensive land management (associated with dairy expansion and intensification) and neglect is predicted. However where less productive land leaves dairying and moves into more extensive livestock (beef) production, there could be benefits to biodiversity and water, soils and air. In south-west and central England conversion to organic production among more mixed, mainly dairy farms is already a marked trend; OELS agreements are more strongly biased towards the SW (and virtually absent from the North-West and West Midlands regions). South West is also one of the regions with the most ELS agreements. The influence of leisure enterprises, horses, hobby and lifestyle farming, is greater in this region. The increase in use for pasture for horse grazing would tend to have a negative or neutral impact.</td>
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<table>
<thead>
<tr>
<th>Uplands</th>
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<tbody>
<tr>
<td>There is the prospect of significant changes in grazing patterns and practices on farms in the uplands. Although reductions in both suckler cow and sheep numbers in upland areas will reduce grazing pressure on sensitive habitats, significant reductions in suckler cow numbers may lead to undergrazing problems for some habitats (where SSSI favourable condition depends on cattle grazing). The possible decline in interest in the management of stock on open moor areas (due to reforms and LFA changes), and the possibility of hill farms ceasing to manage hefted flocks on common grazing land (preferring to concentrate farming activity on in-bye and in-take land) could lead to severe degradation of upland landscapes and reduced</td>
</tr>
</tbody>
</table>
biodiversity.

Progressive abandonment of moorland management is a possibility. Biodiversity losses would result from the loss of grass and heather mosaics in the short to medium term (2-7 years), and the longer term implications (10 years plus) would be for significant habitat change in these landscapes with more scrub, coarse grasses and bracken and gradually, more trees in less exposed sites. However a combination of tradition, interest in game management and support for environmental management and income diversification via agri-environment schemes and other rural development projects, might prevent these changes.

Arable is likely to revert to productive grassland to support developing livestock enterprises (the impact of this will depend on the intensity of the livestock system) while dairying is anticipated to see a significant decline, with positive results for water quality.

Currently ESA agreements cover and protect a large proportion of uplands, if farmers decide to switch for ELS rather than HLS there will be a decline in environmental management. Simplification of management systems and reduced labour input, aggravated by diversification, which often means that farm labour is diverted elsewhere, means labour and environmental skills will be lost.

Sporting estates are large enterprises, their management approach will be important for the environment in the uplands.

### 4.3 Case studies

Table 3 summarises the general environmental outcomes that would be expected as a result of the predicted changes in farm structures and practices resulting from CAP reform. However, these will vary across the country according to local conditions including climate, soil type, altitude and topography, overlaid by human, or socio-economic elements such as local culture and traditions, distance to markets etc. A methodology has been developed to study the impacts of change in specific areas at e.g. JCA or catchment level. Two case studies illustrate the operation of this methodology; the study areas were chosen to represent an upland catchment in the Peak District and a lowland arable area in East Anglia, though the method could be applied equally well to other areas in England or elsewhere in the UK.

The methodology used expert assessment of potential changes in agricultural practice to generate two contrasting, quantitative change scenarios, linked to predicted changes resulting from CAP reform (see Box 1). Baseline conditions were established and mapped from existing land use and land cover databases, and the agricultural change scenarios were then translated into spatially explicit adjustments to the baseline, using a Geographical Information System (GIS). Maps representing pre- and post-change crop and livestock distribution were produced, and the potential environmental impacts examined, using local survey data where available.
BOX 1: Summary of scenarios

The table below summarises the key features of the scenarios developed for each case study area. The scenarios were developed from the range of changes identified as likely to occur from the evidence gathered in OBS 02. From these potential outcomes, scenarios incorporating those changes perceived likely from the evidence review to result in the most negative (market-led scenario) or positive (environment-led scenario) environmental outcomes were selected*. In reality, the outcomes are likely to be somewhere between these two. However, it is important to realise that although environmental outcomes may be predicted to be positive or negative in general terms, variations in local circumstances may result in different outcomes than predicted. The advantage of the case study approach is that it allows such local circumstances to be taken into account. In some cases, a type of management or combinations of management predicted to have negative environmental effects may turn out to be more positive than predicted, and vice versa.

Due to time constraints, it was not possible to quantify the environmental impacts of the environment-led scenario for the lowland arable case study.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Scenario</th>
<th>market-led</th>
<th>environment-led</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upland</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall stocking</td>
<td>10% decline in livestock units/unit area</td>
<td>10% decline in livestock units/unit area across all grass and rough grazing</td>
<td></td>
</tr>
<tr>
<td>density</td>
<td>across all grass and rough grazing</td>
<td>10% reduction in sheep numbers across the study catchment. No intensification of in-bye.</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>No overall change in numbers, but</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>80% reduction in sheep numbers on moorland.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intensification and higher</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>stocking rate on in-bye</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suckler cows</td>
<td>20% reduction in numbers of suckler cows</td>
<td>No change in numbers but extend over greater area thus reducing average</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>stocking rates</td>
<td></td>
</tr>
<tr>
<td>Dairy cows</td>
<td>50% reduction in numbers of dairy farms and</td>
<td>60% reduction in numbers of dairy farms and cows. Small dairy farms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cows. Small dairy farms most likely to</td>
<td>most likely to change enterprise or cease farming.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>change enterprise or cease farming.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cropping</td>
<td>Reduced area of crops</td>
<td>Reduced area of crops</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Low uptake</td>
<td>High uptake</td>
<td></td>
</tr>
<tr>
<td>Stewardship</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lowland arable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cropping</td>
<td>No change in overall cultivated area. In</td>
<td>6% reduction in cultivated area. 15% reduction in wheat, 5-8% reduction in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>crease in area of wheat (35%) and oilseed</td>
<td>areas of other combinable crops. 10% increase in area of temporary grass.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rape (25%). Reduction in area of all other</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>crops. 75% decrease in temporary grass.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased tendency to grow single crops in</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>large blocks of fields (mono-cropping).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>Higher use of pesticides related to block-cropping and economies of scale.</td>
<td>Inputs reduced to cut costs. Inputs more targeted to crop needs.</td>
<td></td>
</tr>
<tr>
<td>Set-aside</td>
<td>75% set-aside used for production of non-food/energy crops. 5% increase in bare fallow</td>
<td>12% increase in permanent or rotational set-aside and 10% increase in bare fallow</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td>Reduction in numbers of all grazing livestock</td>
<td>More mixed farming. 10% increase in sheep and beef, 20% decrease in dairy cows. 5% reduction in livestock units/km²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(sheep –21%, beef –26%, dairy –19%). 10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>overall reduction in livestock units/km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Low uptake</td>
<td>High uptake</td>
<td></td>
</tr>
<tr>
<td>Stewardship</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* These are labels of convenience and too much should not be read into them. Both could provide economically viable solutions to the challenges arising from CAP reform.
**Upland case study**

This was located in the Etherow river catchment, within the Dark Peak JCA, also known as the North Peak, part of the Peak District National Park. The vegetation comprised mainly moorland with areas of in-bye. Land use is sheep grazing, grouse shooting, and some dairy and beef production. Sources of digital vegetation data were a Phase 1 survey and the CEH Land Cover Map 2000. Data from a bird survey were also available.

Grazing intensity was mapped using June Survey and RLR data, and used to create risk maps for over- and under grazing in relation to sensitive vegetation types. The stocking density was then revised in relation to two separate change scenarios, and new risk maps produced (e.g. Figure 4.). The potential impacts on the vegetation and habitat value for bird species known to be present were assessed.

The study concluded that there were likely to be significant changes to livestock farming as a result of CAP reform. In particular, the loss of dairy farming will be widespread, and under both scenarios cattle will be redistributed or reduced in numbers. This will have implications at a local scale for the vegetation structure, as cattle grazing produces more varied swards than sheep grazing.

The first, 'market-led' scenario showed a significant decline in livestock density across the catchment, with large areas becoming under-grazed. Without grazing, heather regeneration may be affected by competition with grasses, particularly purple-moor grass (*Molinia caerulea*). Bird species that require shorter vegetation for example Golden Plover and Lapwing, will be negatively affected by this. Also under this scenario some sensitive areas may be subject to localised over-grazing, which may be a problem in the northern part of the catchment favoured by several moorland bird species.

The second, 'environment-led' scenario showed little change in the pattern of overgrazing and undergrazing risks in comparison to 2004. Overall, risk of overgrazing on higher land was lower. On in-bye land, grazing pressure was likely to increase. However, this may not necessarily be detrimental to the species that prefer this habitat, as it presently includes a range of farmland bird species as well as moorland birds. Grazing will occur across the whole catchment, and thus if managed sensitively may promote diversity and abundance of both vegetation habitats and bird species.
Figure 4. Example output from upland case study: risk of overgrazing in (a) 2004; (b) under ‘market-led’ change scenario.
Arable case study

This covered the East Anglian Chalk JCA, a relatively uniform area of primarily arable agriculture dominated by combinable crops, with few livestock or urban areas.

A baseline map was created from a combination of IACS and Rural Land Registry (RLR) data to show cropping and grass cover at a field scale, and individual maps were also produced showing the locations of each of the main crops. A change scenario with adjusted areas for each crop was then applied, including the creation of ‘mega-blocks’ of uniform cropping, and revised maps prepared.

Landscape metrics were calculated for the baseline and a fairly radical change scenario, using ‘Fragstats’ software, and the potential impacts on biodiversity (particularly birds) briefly considered. A simple calculation of nutrient loads entering surface waters was also performed, based on published average estimates of losses from different crops.

The study indicated that, under the ‘market-led’ scenario adopted, the landscape would become more aggregated, with oilseed rape and wheat dominating (Figure 2). These dominant crops will occupy somewhat different field structures, with wheat being farmed on larger fields whereas rape will occupy smaller fields on average. There would be a large reduction in the amount and density of set-aside land in the landscape, and an overall reduction in landscape diversity. The outcomes were expected to be generally negative for bird species, though the increase in oilseed rape may benefit some species. Losses of both nitrogen and phosphate to water were predicted to increase, as a result of large increases in losses from arable crops, offset to some extent by smaller losses from livestock enterprises, thus restricting the predicted increase in losses to 1.8% for N and 9.1% for P.

The environment-led scenario contrasts quite strongly with the market-led scenario, and it is likely that the environmental impacts would be at the least, considerably less negative, and may indeed be positive. A full assessment would be useful in determining the range of possible environmental impacts of changes in this area.

Application of case study methodology

Case studies such as these have a number of benefits: (i) they allow visualisation of the potential impact of agricultural changes at a local level; (ii) they provide the opportunity to examine the spatial distribution and extent of impacts in a local context; (iii) they provide a basis for quantification of impact at a local level; (iv) they can be validated on the ground. These two studies used data sources which are available for the whole of England, so the approach could be applied elsewhere. Further potential applications are discussed in section 6.
Figure 5. Land use within the East Anglian Chalk JCA, in (a) 2004; (b) under change scenario.
SECTION 5. MONITORING AGRICULTURAL CHANGE AND ENVIRONMENTAL IMPACTS

5.1 Monitoring framework, review of monitoring schemes and selection of indicators

A key role of the Observatory is to monitor agricultural and environmental change. This provides the basis for the analysis and interpretation of the effects of drivers of change (particularly CAP reform), and the environmental impacts resulting from change caused by these drivers (as opposed to change due to other causes), in so far as it is possible to separate them.

It was therefore necessary to develop a monitoring framework covering the key Mechanisms by which drivers of change affect agriculture, the Processes through which these changes occur, and the resulting Environmental Impacts. A major element of this was the selection of appropriate indicators. A baseline assessment was then carried out to define the current status and past trends for each indicator, and provide a starting point for the measurement of future changes.

Before selecting indicators it was necessary to determine what sources of data were available from existing surveys and monitoring programmes. Selection of indicators for which data are already available has two major advantages: (i) development of new surveys is time-consuming and expensive; (ii) an existing time series defines the direction of existing trends, changes in which imply alterations in the nature or extent of underlying causal factors. These advantages are so over-riding, that only where major gaps are identified is the collection of new data likely to be justified. Accordingly, a review of surveys and monitoring schemes was carried out to inform the choice of indicators for the Observatory monitoring framework.

A significant number of existing indicators already exist that were seen to be of relevance, for example the Sustainable Farming and Food (SFFS) indicators. These were considered along with a range of other potential indicators derived from the review of monitoring schemes. The selected indicators were then scored according to criteria of Policy relevance, Responsiveness, Analytical soundness, Spatial resolution, Time series, and Data Accessibility, and classified as having low, medium or high potential for use in an environmental monitoring assessment for the Observatory Programme. A subset of indicators was then recommended to form the monitoring framework. This indicator set is summarised in Table.

Data were collected for each of the indicators listed in Table, and summaries presented in OBS 01, in the form of a baseline assessment indicating the current status and, where available, a time series prior to the baseline year (usually 2004 or 2005 depending on availability of data availability). Spatial data were presented as maps at Joint Character Area (JCA) level or as tables where only regional data were available.
Table 5: Indicators selected for Observatory monitoring framework

<table>
<thead>
<tr>
<th>No.</th>
<th>Indicator</th>
<th>Existing policy indicator¹</th>
<th>Reason for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SFP registrations</td>
<td>SFFS</td>
<td>No. farms receiving CAP subsidies</td>
</tr>
<tr>
<td>2</td>
<td>Value of subsidies</td>
<td>SFFS</td>
<td>Income source, incentive for cross compliance</td>
</tr>
<tr>
<td>3</td>
<td>Number and area of farms in agri-environment schemes</td>
<td>SFFS, SD, EBS</td>
<td>CAP Pillar 2 support for environment</td>
</tr>
<tr>
<td>4</td>
<td>Input costs</td>
<td></td>
<td>Impact on profitability, decision driver</td>
</tr>
<tr>
<td>5</td>
<td>Product prices</td>
<td></td>
<td>Impact on profitability, decision driver</td>
</tr>
<tr>
<td>6</td>
<td>Holding size</td>
<td></td>
<td>Determinant of potential profitability and viability</td>
</tr>
<tr>
<td>7</td>
<td>Proportion of land owned or rented</td>
<td></td>
<td>Impact on farm business &amp; decisions</td>
</tr>
<tr>
<td>8</td>
<td>Farm type</td>
<td></td>
<td>Defines main enterprise(s) &amp; environmental context</td>
</tr>
<tr>
<td>9</td>
<td>Farm sales</td>
<td></td>
<td>Measure of change in farm viability</td>
</tr>
<tr>
<td>10</td>
<td>Land prices</td>
<td></td>
<td>Affects potential for farm size increase</td>
</tr>
<tr>
<td>11</td>
<td>Rental values</td>
<td>SFFS</td>
<td>Impact on profitability, decision driver</td>
</tr>
<tr>
<td>12</td>
<td>Net Farm income</td>
<td>SFFS</td>
<td>Determinant of business viability</td>
</tr>
<tr>
<td>13</td>
<td>Indebtedness</td>
<td></td>
<td>Determinant of business viability</td>
</tr>
<tr>
<td>14</td>
<td>Diversification</td>
<td>SFFS</td>
<td>Determinant of profitability and viability; environmental impacts</td>
</tr>
<tr>
<td>15</td>
<td>Labour profiles</td>
<td>SFFS</td>
<td>Impact on profitability, potential for environmental management</td>
</tr>
<tr>
<td>16</td>
<td>Contracting costs</td>
<td></td>
<td>Measure of contractor use; impact on farm business &amp; environment</td>
</tr>
<tr>
<td>17</td>
<td>Crop &amp; milk yields</td>
<td>SFFS</td>
<td>Associated with level of intensification and input use</td>
</tr>
<tr>
<td>18</td>
<td>Livestock numbers</td>
<td>SFFS</td>
<td>Levels of livestock enterprises, land use intensity</td>
</tr>
<tr>
<td>19</td>
<td>No. &amp; area of Organic farms</td>
<td>SFFS</td>
<td>Determinant of profitability and viability; environmental impacts</td>
</tr>
<tr>
<td>20</td>
<td>Agricultural land use</td>
<td>SFFS, SD, EA</td>
<td>Defines environmental context</td>
</tr>
<tr>
<td>21</td>
<td>Pesticide use</td>
<td>SFFS, EA</td>
<td>Potential impacts on water and biodiversity</td>
</tr>
<tr>
<td>22</td>
<td>Fertiliser use</td>
<td>SFFS, SD, EA</td>
<td>Potential impacts on water, air, biodiversity</td>
</tr>
<tr>
<td>23</td>
<td>Pests &amp; diseases in wheat &amp; rape</td>
<td></td>
<td>Associated with levels of pesticide use</td>
</tr>
<tr>
<td>24</td>
<td>Populations of weed species</td>
<td></td>
<td>Associated with herbicide use, food resource for farmland fauna</td>
</tr>
</tbody>
</table>

¹ SFFS: State of the Farm Survey; SD: Soil Data; EBS: Environmental Baseline Study

- **Mechanisms**
- **Process: Farm Business**
- **Process: Farm Management**
- **Environmental impacts**
<table>
<thead>
<tr>
<th>No.</th>
<th>Indicator</th>
<th>Indicator Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Status of farmland BAP habitats</td>
<td>SFFS, SD, EBS</td>
<td>Measures impacts on habitats of high conservation value</td>
</tr>
<tr>
<td>26</td>
<td>SSSI condition</td>
<td>SFFS, EBS, EA, PSA</td>
<td>Measures impacts on habitats of high conservation value</td>
</tr>
<tr>
<td>27</td>
<td>Landscape features</td>
<td>EBS, EA</td>
<td>Measures impacts on features of high conservation/landscape value Alternative land use, impacts on soil, water, air, biodiversity</td>
</tr>
<tr>
<td>28</td>
<td>New woodland planting</td>
<td>EBS, EA</td>
<td>Measures impacts on species of high conservation value</td>
</tr>
<tr>
<td>29</td>
<td>Landscape Change</td>
<td>SFFS</td>
<td>Measures impacts on landscape Plant species are basis of food chain, linked to levels of input use etc BAP species, linked to invertebrate densities &amp; habitat quality BAP species, linked to habitat diversity</td>
</tr>
<tr>
<td>30</td>
<td>Status of farmland BAP priority species</td>
<td>SFFS, SD, EBS</td>
<td>Measures impacts on species of high conservation value</td>
</tr>
<tr>
<td>31</td>
<td>Plant diversity in fields &amp; field margins</td>
<td>SFFS, EBS</td>
<td>Measure of biodiversity; linked to levels of input use etc Plant species are basis of food chain, linked to levels of input use etc</td>
</tr>
<tr>
<td>32</td>
<td>Plant diversity on river banks and stream sides</td>
<td>EBS</td>
<td>Measure of biodiversity, indicates compliance with good practice Plant species are basis of food chain, linked to levels of input use etc</td>
</tr>
<tr>
<td>33</td>
<td>Cover abundance of common plants</td>
<td>EBS</td>
<td>Measure of biodiversity, indicates compliance with good practice Plant species are basis of food chain, linked to levels of input use etc</td>
</tr>
<tr>
<td>34</td>
<td>Numbers of pipistrelles</td>
<td>EBS, EA</td>
<td>Key policy indicator of biodiversity and ecosystem health Plant species are basis of food chain, linked to levels of input use etc</td>
</tr>
<tr>
<td>35</td>
<td>Numbers of brown hares</td>
<td>EBS, EA</td>
<td>Measure of invertebrate numbers in crops and bird food</td>
</tr>
<tr>
<td>36</td>
<td>Numbers of Farmland Bird Index spp.</td>
<td>SFFS, SD, EBS, EA, PSA</td>
<td>Additional indicator of biodiversity and ecosystem health</td>
</tr>
<tr>
<td>37</td>
<td>Trends in populations of farmland butterflies</td>
<td>SFFS, SD, EBS, EA, PSA</td>
<td>Measure of invertebrate numbers in crops and bird food</td>
</tr>
<tr>
<td>38</td>
<td>Grey partridge chick-food index</td>
<td>SD, EBS, EA</td>
<td>Measure of water quality as affected by pollutants</td>
</tr>
<tr>
<td>39</td>
<td>Biological quality of rivers</td>
<td>SD, EBS, EA</td>
<td>Measure of water quality as affected by pollutants</td>
</tr>
<tr>
<td>40</td>
<td>Chemical quality of rivers</td>
<td>SD, EA</td>
<td>Measure of pollution (70% N &amp; 40% P comes from agriculture)</td>
</tr>
<tr>
<td>41</td>
<td>N &amp; P levels in rivers</td>
<td>SFFS, EBS</td>
<td>Measure of pollution</td>
</tr>
<tr>
<td>42</td>
<td>Pesticides in water</td>
<td>SFFS</td>
<td>Measure of water quality as affected by pollutants</td>
</tr>
<tr>
<td>43</td>
<td>Water abstraction for agriculture</td>
<td>SFFS</td>
<td>Measure of water quality as affected by pollutants</td>
</tr>
<tr>
<td>44</td>
<td>Methane emissions from agriculture</td>
<td>SFFS</td>
<td>Measure of pollution</td>
</tr>
<tr>
<td>45</td>
<td>Ammonia emissions from agriculture</td>
<td>SFFS</td>
<td>Measure of pollution</td>
</tr>
<tr>
<td>46</td>
<td>Nitrous oxide emissions from agriculture</td>
<td>SFFS</td>
<td>Measure of nitrogen oxides as affected by pollutants</td>
</tr>
<tr>
<td>47</td>
<td>Energy derived from agricultural biomass</td>
<td>SFFS</td>
<td>Measure of nitrogen oxides as affected by pollutants</td>
</tr>
<tr>
<td>48</td>
<td>Soil phosphate</td>
<td>SFFS</td>
<td>Measure of nitrogen oxides as affected by pollutants</td>
</tr>
</tbody>
</table>

1 SFFS: Sustainable Farming and Food Strategy Indicator
SD: Sustainable Development Indicator
EBS: England Biodiversity Strategy Indicator
EA: Environment Agency Indicator
PSA: Part of Defra Public Service Agreement

Affects potential productivity, source of water pollution

Effect of agriculture on water supplies; impact on water quality, biodiversity

Contribution to climate change (greenhouse gas) Eutrophication & acidification of soil & water, impacts on biodiversity

Contribution to climate change (greenhouse gas) Alternative land use, mitigation of climate change, potential impacts on soil, water, air, biodiversity, landscape

Affects potential productivity, source of water pollution
5.2 Summary of baseline assessment

The baseline assessment provides a benchmark against which to assess changes due to the 2003 CAP reform, implemented in 2005. It also provides an overview of recent trends, so that future changes in trajectories can be readily identified. For most of the indicators, it is too early to make confident statements about changes due to CAP reform or their impacts at this stage on the basis of these summary data, but more detailed analysis of June Survey data has provided some early indications of changes which have been reported in OBS 02 and other Observatory reports (Defra, 2006a, b, c).

Mechanisms

1. **SPS registrations**: Over 90% of land was registered for SPS, though this represented only 55% of holdings overall. Low uptake was evident among specialist pig, poultry, horticulture and the numerically numerous ‘other’ holdings. Pig, poultry and horticulture farms were previously unsubsidised, so do not benefit from the historic element of payments. In addition, they can produce a high value of output from a small land area, so that the area-based element is of lower importance for many holdings in these categories. Many holdings in the ‘other’ category are very small; such holdings are much less likely to register because the payments are less likely to justify the effort of completing forms and complying with cross-compliance conditions.

2. **Value of subsidies**: Total payments in 2005 were similar to 2004 (slightly increased), but crop and livestock payments have now virtually ceased and most payments now fall under the SPS. Thus, because the SPS is decoupled, there is a marked change in incentives compared to the previous regime. Payments under the SPS amounted to some £2,400 million in 2005. Between 1997 and 2001, set-aside payments were approximately equivalent to all environmental payments, but these have since increased whilst set-aside payments declined. Environmental payments totalled £257 million in 2005, and are set to increase further as a result of the Government’s commitment to increase spending on agri-environment schemes; nevertheless they still represent only a small fraction of total subsidies.

3. **Agri-environment schemes**: Numbers of agreements and the area of land in the Entry Level Scheme (ELS) increased in an approximately linear fashion up to mid-May 2006, at which time there were nearly 2.5 million hectares in the scheme, representing nearly 45% of the target area for December 2007 (5,520,000ha). The area of land in the Organic Entry Level Scheme (OELS) reached over 73,000 ha by mid-May, equivalent to nearly 22% of the target of 340,000ha. The areas under the Higher Level and Organic Higher Level Scheme agreements were nearly 50,000 ha and just over 3,200 ha respectively by mid-May; the total area representing 26% of the December 2007 target of 200,000ha. The greatest uptake of ELS was in the South West, followed by Yorkshire and the Humber, and the East Midlands. Lowest uptake was in the North East and South East. OELS agreements accounted for only 1.65 of the total, and were concentrated in the South West.

4. **Input costs**: Price indices of agricultural inputs in general rose from 84 to 115 between 1988 to 2005, an average annual increase of 1.7%. The trends in price indices for plant protection products, fertilisers and energy reflected this general pattern, although for fertilisers and energy there was an exaggerated rise from 1999 onwards, with a steep rise more recently, both in response to
oil price increases. In contrast, livestock foodstuff indices fluctuated between 120 and 140 until 1997-8 and then fell to levels around 100. Price indices for seeds have also fluctuated but have declined since 1996 to below 100 in 2001-3, before rising slightly to just over 100 in 2005, compared to 129 in 1988. As SPS payments are independent of the commodity being produced, production decisions are likely to be more sensitive to the costs of inputs relative to the value of the product in future.

5. **Product prices:** Milk prices increased between 1990 and 1996 to a maximum of around 27p/l, but have since declined to around 17p/l. Prices for heifers in milk and freshly calved heifers rose from 1991 to a peak in 1993-4 of >1000p/kg for heifers in milk and freshly calved heifers and then declined to between 400 and 500p/kg in 2000 before increasing again. In recent years, price fluctuations have become increasingly erratic, for example prices rose from £678 in January 2006 to £1300 in March, and then fell to around £960-970 in April. Beef cattle prices were relatively stable around 90p/kilo from 1999 until 2003, then rose to around 100p/kilo in 2003 and continued to climb steadily to over 110p/kg in 2006. Pig prices climbed from a very low point around late 1998 of less than 70p/kg to peak in 2003 at more than 110p/kg. They continued at around 100p/kg from 2003 and thereafter were relatively stable. Sheep prices followed a similar upward trend in this period with prices peaking in 2003 at around 400p/kg, then falling before rising again to over 320p/kg in June 2006.

Wheat prices fell between 1997 and 2002, then rose in 2003 to over £100/t for feed wheat and £110/t for breadmaking wheat, before failing again to around £80/t in 2005. Barley prices showed a similar pattern. As SPS payments are independent of the commodity being produced, production decisions will be relatively more sensitive to the product prices than prior to the 2003 CAP reform.

**Process: farm business**

6. **Holding size:** Holding sizes were reported in terms of European Size Units (ESU), which are categories based on economic information, and also by area. There was a large rise in the number of very small holdings after 1999, levelling off again in 2002. In contrast, there has been a long-term decline in numbers of holdings in the small, medium and large categories. Numbers in the very large category have remained relatively constant. Most Lowland Grazing Livestock, Pigs, Poultry, Horticulture and ‘Other’ farm types were in the very small category. In terms of area, the farm types with the largest holdings on average were General Cropping, LFA Grazing Livestock, Cereals and Mixed farms, whilst horticulture, specialist pigs and poultry farms had the smallest average holding size. Many of the largest holdings (by area) were found in upland regions, Lincolnshire, North West Norfolk and Breckland, and the Berkshire, Hampshire, and Wiltshire, Downs. The smallest holding sizes on average were found in the western half of the country, including the South West, also along the south coast, the Thames Valley and the Weald.

7. **Proportion of land owned or rented:** Ownership patterns are likely to change considerably, as full time farmers with insufficient land to sustain their livelihood sell up, amalgamate or acquire more land to increase profit margins. The proportion of land owned increased steadily from around 61% in 1987 to nearly 68% in 2002, then declined slightly to below 67% in 2005. The proportion of land owned is low in many of the upland areas.
8. **Farm type:** Numbers of dairy holdings showed a downward trend from the late 1980s to the present, as have General Cropping farms, though the downward trend is less steep. Mixed farms have also declined, but the trend is even more shallow. Numbers of LFA Cattle and Sheep, Horticulture and specialist Pigs and Poultry producers all declined slightly during the 1990s, but have since increased again. Numbers of Lowland Cattle and Sheep farms have fluctuated but shown no clear trend over most of the period, though there has been an increase since 2001. Numbers of Cereals farms have remained remarkably constant, but showed a small increase between 2003 and 2004. There was a large increase in numbers of holdings in the ‘Other’ farm type between 1999 and 2003, but this was at least partly due to changes in categorisation, with the inclusion of minor holdings from 2000 onwards.

9. **Farm sales:** Farm sales fell throughout all regions of England following a peak in 1996-1997, so that in 2004 farmer buyer activity was at its lowest level since 1992. The highest number of sales was in the South West region, but when expressed as a percentage of farms in the regions, the highest percentage of sales was in the East Midlands and the East of England and the lowest percentage in the South-East, whilst the South West was close to the average.

10. **Land prices:** From 1993 to 1997/1998 the trend in agricultural land prices was upwards, from 1997 onwards the trend continued to rise in most regions, but at a slower rate, albeit with some appreciable fluctuations. Since 2000, trends have levelled off in most regions (the South East and the East Midlands being exceptions), and prices have declined in the North East. Sales were low in 2005 and prices high, but during 2006/07 commercial farmland values are expected to be flat, with the expectation that the resolution of Single Payment problems will encourage more farmers to bring land to the market.

11. **Rental values:** Rental values are highest for General Cropping, followed by cereals and Dairy, and lowest for Cattle and Sheep (LFA) holdings. The main trend is for Farm Business Tenancy rents to have experienced a slight fall since 1996, but for Full Agricultural Tenancies rents have remained mainly static in recent years.

12. **Net Farm Income:** Since 1996/97, Net Farm Income (NFI) has generally fallen, with some significant fluctuations, and was at its lowest between 2000 and 2001. Incomes then rose to 2003-4, particularly on Cereals and General Cropping farms, but fell again in 2004-5. Average NFI fell by over 50% in 2004/05 on Cereal farms and 43% on General Cropping farms. Lower falls were experienced on Cattle and Sheep, Mixed, and Horticulture farms.

13. **Indebtedness:** Total external liabilities (TEL) generally increased since 1999, from £82,027 per farm to £95,112 per farm in 2003/4, but then fell to £92,103 in 2004/5. The increasing trend reflects the low profitability of farming over this period. The trend also reflects changes in base lending rate, which fell from approximately 5.5% in 2000 to around 3.5% for a while during 2002/3, then rose to 4.5% in 2005-2006. Specialist Pigs and Poultry farms tended to have the highest levels of borrowing (greater than £160,000 and £130,000 respectively in 2003/4), followed by General Cropping, Cereals (both >£120,000) and Dairy farms (>£100,000), whilst Grazing Livestock farms had the lowest levels of debt.

14. **Diversification:** Diversification provides alternative business opportunities where agricultural enterprises no longer provide sufficient income. Between
46 and 48% of farms are diversified and of these, most (36-39%) let out buildings. Cereal and cropping farms have a higher percentage of farms with diversified activities whilst grazing LFA farms have the lowest. Of the livestock farms, the Lowland Grazing Livestock farms have a higher proportion of diversified activity than dairy or LFA Grazing Livestock farms. There is more letting of buildings and sports and leisure activities on cropping/cereal farms. Food retailing is important for horticulture farms, while tourism is most common on grazing farms. The proportion of farms with diversified activity is generally higher in the South and East. The average output per farm in 2004-5 from diversified activities was £14,801.

15. **Labour profiles**: The labour force in English agriculture is in long-term decline, and has reduced by around 20% (or just under 1% per annum) since 1987. The total number of farmers recorded declined by nearly 11,000, or 5%, between 2001 and 2005; however the number of managers increased by 20%. Numbers of employees fell by nearly 13,000 (13.7%) over this period. There was a shift towards part-time workers in all categories. Holdings in the Horticulture and General Cropping farm type categories had the highest labour requirements, 5.40 and 4.72 workers per farm on average respectively), and Lowland Cattle and Sheep holdings the lowest (1.81), among the major commercial categories, though the ‘Other’ category had just 0.77 workers per farm, indicating that most of these holdings are very much part-time businesses.

16. **Crop & milk yields**: Commodity yields are major determinants of profitability. Yields of wheat, barley, potatoes and sugar beet increased in the UK by 36%, 17.5%, 14.2% and 13.2% respectively between 1986-1990 and 2001-2005 but yields of oilseed rape have changed little. However, most of these increases occurred prior to the late 1990s, since when yield trends have levelled off. Milk yields have risen steadily over the last 20 years, and this trend shows no sign of slowing. With milk prices relatively static in recent years, and production costs rising, increasing productivity has been the key survival strategy for dairy farms over a number of years.

17. **Livestock numbers**: There has been a long-term decline in the number of dairy cows, and an associated fall in numbers of calves, consistent with the decline in the number of dairy farms. Numbers of beef cows increased up to 1999, decreased from 1999 to 2002, but subsequently increased again up to 2005, though there was a slight reduction in the numbers of suckler cows between 2004 and 2005. The factors influencing numbers of suckler and dairy cows are fully analysed in Defra (2006 b, c). Lamb numbers declined from 1993 to 1996 following the 1992 CAP reform, but increased again from 1996 to 1999, after which there was a sharp decline to 2001/2, followed by a levelling off at around 800,000. Numbers of pigs were relatively stable at around 650,000 until 1998, after which numbers declined steadily to just under 400,000 in 2005. Numbers of poultry were relatively stable until 1995, after which numbers increased to 2000 and then leveled off. In 2004, dairy cattle were mainly distributed in the South West, the West Midlands and the North West, with densities highest in the lowland areas. The highest densities of beef breeding cows were found in the upland areas of the South West, the Welsh Marches, the Pennines, North Yorkshire Moors and throughout Cumbria and most of the North East. In contrast, beef cattle for fattening were mainly distributed in the lowland parts of the South West, and the upland fringes in the midlands and the north. In general, sheep were

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5 Including spouses, partners, directors etc.
found in the north and west of England, though densities were low in the dairy
dominated area around the Shropshire, Cheshire and Staffordshire Plain.

**Process: Farm Management**

18. **Number and area of organic farms**: Currently, organic land covers around
3% of the total agricultural area of England. Organic farming increased
rapidly in the UK from 1998 to 2002. However, the area has now stabilized
and indeed, since 2003 has fallen slightly. English producers constitute 64% of the UK total, but only 38% of the UK total of organically farmed land is in England. Thirty-nine percent of English organic farmers are in the South West. The number of organic producers in England decreased slightly between March 2003 and December 2004.

19. **Agricultural land use**: Agricultural land use is a key determinant of
environmental impact. The type of vegetation covering land used for
agriculture, whether crop, grass, or rough grazing, determines the habitat
structure over the majority of the land surface in England, and is a major
influence on the landscape. Wheat is the major arable crop grown in
England, covering 39% of the total cropped area in 2005. Although there
have been fluctuations, the wheat area has not changed substantially since
the late 1980s. Historically, spring barley was the major crop in England.
Since 1970, barley has declined dramatically, and winter barley has
increased at the expense of spring barley. By 2005 however, the area of
winter barley had declined to the point where the areas of winter and spring
barley were similar. Oilseed rape is now the dominant non-cereal crop, as a
result of its dramatic rise in popularity during the 1970s and 1980s. Potatoes
and sugar beet have continued to see long-term declines, albeit at a slower
rate. Sugar beet is likely to decline more rapidly from 2005 onwards, as a
result of changes to the EU sugar regime. Conversely, maize has continued
a long-term upward trend which started in the 1970s.

Permanent grassland is the dominant land-cover type in England, comprising
43% of the total farmed area. The area of permanent grass has changed little
since the late 1980s, but the area of short-term grass has decreased. The
area of rough grazing has also decreased slightly. Conversely, there has
been a steady increase in the area of woodland on farms since 1987,
encouraged by the Woodland Grant Scheme and other incentives for
woodland planting.

20. **Pesticide use**: Areas of crop treated with herbicide have increased for all the
major arable crops over the last decade. The highest levels are used in
sugar beet (over 800% of crop area treated in 2004). Wheat has the highest
average level of herbicide use among the remaining major crops (>400% in
2004). Around 86% of set-aside was treated with herbicide in 2004; almost
all of this was glyphosate applied to naturally regenerated rotational set-
aside. Highest levels of insecticide use were seen on potatoes in the mid-
1990s, but these have been much lower in recent years. In 2004, a higher
proportion of the pea crop (>200%) was treated than any other crop. Around
160% of beans and oilseed rape were treated, 140% of wheat and 112% of
potatoes. The lowest levels of use were on spring barley. The only
significant use of nematicides is in potatoes and sugar beet; usage in sugar
beet has declined in recent years to less than 10% of the crop area, but it has
increased to 30% of potato crops in 2004.
21. **Fertiliser use**: Nitrogen application rates on tillage in England have fallen by about 10 kg/ha or 6% over the last 20 years, but average rates on grassland have fallen by over 50 kg/ha (40%) over the same period. Phosphate application rates on both tillage and grass have both fallen by around a third of 1984 levels. Levels of nitrogen use on cereals have shown little overall change over the past two decades, though levels of use on wheat have risen slightly. Nitrogen use on oilseed rape however fell dramatically during the 1980s, before rising slightly following the lowest levels in the mid-1990s. Mean rates of nitrogen use have also declined on potatoes and sugar beet. Rates of phosphate fertiliser use have declined on all major crops except spring barley, where despite fluctuations there has been little overall change.

22. **Pests & diseases in wheat and oilseed rape**: The use of insecticides in June is most damaging ecologically, because of effects on non-target arthropods and their predators at the height of the breeding season for birds and other insectivorous animals. Formerly, the main reason for using insecticides on wheat at this time of year was to control aphids. Numbers of grain aphids were high in the early 1990s, reaching a peak in the hot summer of 1995. Since then however, numbers have been consistently low. This may be at least partly a result of spraying for wheat blossom midge, which has been an annual problem since 1993.

For the last 15 years, the most severe foliar disease of wheat has been *Septoria tritici*, which affects both leaves and ears of wheat. Of other diseases, yellow and brown rust occur sporadically, but levels of both these diseases and mildew remained relatively low throughout the period 1985-2005. In recent years, increasing levels of *Fusarium* ear blight have been observed. This is of concern because of the potential to produce mycotoxins which can make grain unfit for consumption. Fungicides are usually directed to the control of a spectrum of diseases, and fungicide use has increased without any apparent relationship to specific diseases.

23. **Populations of weed species**: As well as being important agriculturally, weeds are key components of the food chain on agricultural land. Annual weeds, monitored on the Game Conservancy Trust’s study area in the South Downs, increased until the early 1980s, but then declined from the late 1980s to the present day. Over the period of decline, an increasing proportion were classified as susceptible to the herbicides used. In contrast, perennial weeds have demonstrated a long-term increase, and the proportion classified as resistant to the herbicides used has also increased.

**Environmental Impacts**

24. **Status of farmland BAP priority habitats**: Data on the status of Biodiversity Action Plan priority habitats in England are collected every three years. Of the ten priority habitats which are predominantly agricultural, one (Cereal field margins) was assessed as having ‘increasing’ status between 1999 and 2002, five were classed as ‘stable’ (Ancient and/or species rich hedgerows, Lowland calcareous grassland, Purple moor grass and rush pastures, Upland calcareous grassland and Upland hay meadows), one (Blanket bog) as ‘declining (continuing/accelerating)’, one (Upland heathland) as declining(slowing) and the status of two (Lowland dry acid grassland and Lowland meadows) was unknown. Data from the 2005 reporting round were not available at the time of writing.
25. **SSSI condition**: Overall, 55% of the area of agricultural SSSIs was in favourable or recovering condition. Arable habitats had the highest proportion in favourable or recovering condition (98%). The habitats with the lowest proportions were bogs (44%) and upland heaths (45%). The main agricultural causes of damage to SSSIs were overgrazing (38% of area), burning of moorland (28%), drainage (9%) and undergrazing (6%). The proportion of SSSIs in favourable or recovering condition increased between 2003 and 2004.

26. **Landscape features**: Field boundaries such as hedges, stone walls and grass banks, and farm ponds, can be valuable wildlife habitats, enhance the landscape and, in some cases, may be of historic importance. Data are available from the Countryside surveys for 1984, 1990 and 1998. Lengths of hedgerow declined between 1984 and 1990, but this decline was subsequently halted so that there was no change between 1990 and 1998. The total lengths of stone wall declined in both periods, but the reduction between 1990 and 1998 was less than between 1984 and 1990. There were no significant changes in lengths of boundary banks and strips or numbers of ponds, despite a high turnover rate.

27. **New woodland planting**: Woodland is an alternative land use which may increase on land where agricultural profitability is marginal. Most woodland is multi-purpose, being used for shooting, amenity etc. as well as a potential source of timber. Levels of new planting on non-Forestry Commission land in England declined from 2000-01 to 2001-02, but have remained relatively stable since. Levels of restocking have declined throughout the period.

28. **Landscape change**: Landscape quality is key to the public enjoyment of the countryside. The Countryside Quality Counts (CQC) Indicator devised by the Countryside Agency is a composite assessment of landscape quality measured over time against descriptions of countryside character. Between 1990 and 1998, large areas of England show major changes inconsistent with the character of the countryside. Some of these include major cities and conurbations, but changes have also occurred in some more rural area. However, over the majority of England, changes in boundary features were consistent with the maintenance of character.

29. **Status of farmland BAP priority species**: as for BAP habitats, assessments of BAP species status are carried out every three years. Of 78 farmland BAP priority species, in 2002, six had been lost, 13 were declining, three were fluctuating or had no clear trend, 14 were stable, 12 were increasing, and the status of the remaining 13 was unknown.

30. **Plant diversity in fields and field margins**: Data on plant diversity are available from the countryside surveys for 1978, 1990 and 1998. Plant diversity in arable fields decreased between 1978 and 1990, but increased again by 1998. In intensive grassland, infertile grassland and hedge bottoms, plant species diversity declined in both periods, the decline being greatest for infertile grassland. These declines are of significance not only in terms of conservation of plant species and communities, but also for other forms of wildlife which depend on plants for food and shelter. Increased nutrient availability was identified as a major driver of vegetation change in the analysis of data from the most recent Countryside Surveys.

31. **Plant diversity on river banks and stream sides**: Plant diversity adjacent to aquatic habitats is important for the same reasons as for field margins. Species richness declined slightly between 1978 and to a greater extent between 1990 and 1998.
32. **Abundance of common plants**: The annual Plantlife survey of common plant species, which started in 2000, could be used as the basis for an indicator of change in these species or a subset relevant to agricultural land. As such plants are by definition widely distributed, they may provide a more sensitive indicator of the impacts of changes in farming practices than BAP species, which are generally rare and often not found in 'typical' farmland. Indicative data for three common farmland species suggest that presence of both nettles and cleavers have increased between 2000 and 2005, but there is no clear trend for cow parsley.

33. **Numbers of pipistrelles**: Pipistrelles are the commonest bat species, are widely distributed and commonly found on farmland. They also have BAP status. As they are dependent on insects, they could be a useful indicator of changes at lower levels of the food chain on farmland. Field surveys in randomly selected square kilometres are carried out as part of the National Bat Monitoring Programme, and data are presented here for both common and soprano pipistrelles. The trend for common pipistrelles rose for the first few years then levelled off between 2001 and 2004 before rising again between 2004 and 2005. Soprano pipistrelles appear to have declined initially followed by a levelling out, with a suggestion of a rise in 2005, though again it is necessary to wait for the 2006 results to confirm this.

34. **Numbers of brown hares**: Brown Hares are characteristic animals of agricultural land which are widespread across England and sensitive to agricultural management, particularly type and diversity of cropping. The brown hare is a BAP species, as it appears to have declined in parts of its range. Data are collected as part of the British Trust for Ornithology (BTO) Breeding Bird Survey. Although there are fluctuations over the period for which data are available (1995-2003), there is no overall significant trend for England as a whole, however, there are indications of declines in abundance in North West and South East England, and an increase in South West England. BTO analyses also indicate a significant decline in upland areas of England and Wales.

35. **Numbers of Farmland Bird Index species**: Birds are considered to be good indicators because they are easily monitored, they occupy a range of habitats, and are near the top of the food chain, so their status generally reflects the populations of the plants and invertebrates on which they feed. Defra's Public service agreement (PSA) for 2005-2008 includes a commitment to reversing the long-term decline in an index of farmland bird populations by 2020. Farmland Bird Index (FBI) decreased by over 40% between the late 1970s and the early 1990s, but in recent years the trend has levelled off. Farmland specialists have declined overall to an even greater extent, by around 60%; in contrast, populations of farmland generalists have remained relatively stable overall since 1970. However, these overall trends hide a considerable amount of variation between species within the categories.

36. **Trends in populations of farmland butterflies**: Proposals have recently been drawn up for butterfly indicators, analogous to the Wild Bird Indicators, using data collected from over 500 sites for the UK Butterfly Monitoring scheme (UKBMS). The farmland index includes 42 of the 51 native resident English butterfly species occurring on farmland, and is broken down into 19 specialist and 23 generalist species. The general trend is downward for specialist species, and for the line representing all species, which was 83% of the 1990 baseline in 2005. In contrast, generalist species have remained relatively stable over the period represented. Since 2001, there has been an
apparent recovery, which may be partly due to the effects of agri-environment schemes. Comparisons of scheme and non-scheme sites indicate better performance for BAP species on scheme sites, particularly since 2000.

37. **Grey partridge chick-food index**: Pesticides have been shown to be important in the decline of the grey partridge, through impacts on insect populations important in the diet of young partridges. Long-term monitoring of insect populations in arable fields is carried out by the Game Conservancy Trust in their Sussex study area, and a ‘chick food index’ has been developed. There are large fluctuations from year to year caused mainly by weather conditions, but there is a significant underlying downward trend, though this appears to have levelled off in recent years. Interestingly, trends for grey partridge and some other species that feed their chicks on insects, e.g. corn bunting, skylark, tree sparrow, have also stabilised over the last few years.

38. **Biological quality of rivers**: The biological quality of rivers, as determined through the composition of invertebrate communities is a guide to the level of pollution present in the water. Between 1990 and 2004, the percentage of river length which was of good biological quality rose from just under 60% to over 70%. Water quality improved in all regions, though there was considerable variation between regions. The highest percentage of river length with good biological quality was in the South West (>90%), and the lowest was in the Midlands and the North West, both around 55%.

39. **Chemical quality of rivers**: Three chemical properties determine chemical water quality: dissolved oxygen, biological oxygen demand (BOD) and ammonium nitrogen. The percentage of river length of good chemical quality in England rose from 43% in 1990 to 62% in 2004. There was considerable variation between regions, and also fluctuations between years. In most regions, percentage lengths of good quality increased to 2001 before levelling off or falling slightly, but in the Southern and Anglian regions there were marked dips in the mid-late 1990s and also from 2001 to 2003/4. As for biological quality, the highest levels in 2004 were seen in the South West, but the lowest levels of chemical quality were found in the Southern and Anglian regions.

40. **Nitrogen and phosphate levels in rivers**: Both nitrates and phosphates can cause eutrophication of surface waters. There has been relatively little change in percentages of river length exceeding threshold levels of nitrate between 1995 and 2004 in most regions, though there was some reduction in the two regions with the highest levels, Anglian and Midlands, after an increase between 1995 and 2000. Similarly, after decreases in most regions between 1990 and 1995, there has been little subsequent change in percentages of river length exceeding threshold levels for phosphate. Average nitrate levels in English arable landscapes were around twice those in lowland pastural landscapes; levels of nitrate loss from the uplands are much lower than from the lowlands. Levels of phosphate in water have fluctuated much more than nitrates in lowland landscapes, however the general trend in phosphate levels has been downwards since 1997.

41. **Pesticides in water**: Pesticides are of concern because of their unacceptability in drinking water, and some may also affect aquatic fauna and flora. Levels of individual pesticides should not exceed 0.1µg/l, and total pesticides should not be above 0.5µg/l. The pesticides most commonly occurring in water above the limit in 2004 were mecoprop, MCPA and
isoproturon (13.8, 12.9 and 10.8% of samples respectively). Others were diuron, 2,4-D, dichlorprop, simazine, chlorotoluron, bentazone and atrazine.

42. Water abstraction for agriculture: Water use is becoming an increasingly important issue, and it is likely that the availability of abstraction licenses for irrigation will become more restricted. In terms of overall volume, agriculture is a minor user, for example, spray irrigation plus non-irrigation agricultural use accounted for 0.76% of actual usage, and 1.0% of licensed usage in 2003. However, the impact of abstraction for agriculture can be significant locally during the irrigation season. Usage has fluctuated but overall has not changed greatly since the 1990s, though the amount of water licensed for extraction has increased. The Anglian region is the largest user of water for spray irrigation.

43. Methane emissions from agriculture: Methane is a greenhouse gas, accounting for around 7% of the UK’s greenhouse gas emissions. Agriculture is now the largest source of methane, and produced 41% of the total in 2004. The major agricultural sources of methane are enteric fermentation (digestive processes) and manure management. Enteric fermentation by cattle is by far the largest contributor to methane emissions, followed by sheep. Cattle manure is also the dominant source of methane from manure management sources.

44. Ammonia emissions from agriculture: Ammonia emissions are of concern because atmospheric depositions cause eutrophication of sensitive habitats and cause acidification of upland soils, watercourses and lakes. Agriculture is the main source of ammonia emissions; in 2004 90% were from agricultural sources. Nearly half of the total derives from cattle slurry. Overall, manure and slurry management accounts for around three quarters of ammonia emissions. Ammonia is also produced following the spread of nitrogen fertiliser, especially urea. Agricultural emissions fell by nearly 17% between 1990 and 2003, but rose by 3.5% between 2003 and 2004.

45. Nitrous oxide emissions from agriculture: Nitrous oxide (N\textsubscript{2}O) is a greenhouse gas, which accounted for about 6 per cent of the UK’s man-made greenhouse gas emissions in 2004. Around two thirds of N\textsubscript{2}O emissions are produced by agriculture, and around 95% of this is from soils, particularly as a result of fertiliser application and leaching. Agricultural emissions have declined over the last 15 years; in 2004 they were 17% lower than in 1990.

46. Net energy derived from agricultural biomass: Farm products or by-products are used to generate electricity (mostly off-farm) and heat (mostly on-farm). At present, short rotation coppice (SRC) is the main source of biomass, but other crops such as Miscanthus and Eucalyptus are likely to increase in significance in the future. Sources of energy for production of on-farm heating are mainly straw, but farm waste material and SRC are also used. The amount of electricity generated from agricultural biomass has increased from zero to 353 tonnes of oil equivalent (TOE) since 1990. In contrast, the amount of heat generation has changed little, remaining at around 70 TOE. The amount of energy crops grown will depend on the level of Government incentives, and relative profitability of alternative crops and other land uses. If energy crops achieve returns comparable with more conventional crops, they have the potential to become a major form of land use.

47. Soil phosphate: Soil attributes potentially important in environmental terms include soil compaction, erosion potential, nutrient contents and soil organic matter). The only one of these attributes for which regularly collected data
are available is soil phosphate. For fields that never receive manure, data from the Representative Soil Sampling Scheme suggest that the proportion of fields with higher levels of phosphate declined up to 2001, but for those receiving manure, there appears to have been little change. More recent data are not available.
SECTION 6. GAPS AND FURTHER WORK

Section 6.1 describes gaps in monitoring data arising from the review of monitoring schemes and baseline assessment in OBS 01, with suggestions for action by the Observatory, where appropriate. Section 6.2 gives recommendations for further work on the analysis of agricultural and environmental change, arising from OBS 03.

6.1 Agricultural and Environmental Monitoring

This study highlights the importance of developing and enhancing both qualitative and quantitative tracking and reporting systems over the next few years. The research identified a number of areas where there are gaps in existing datasets and other sources of information which are relevant to the monitoring, analysis and evaluation of CAP reform impacts upon the environment. Some of these gaps relate to information about the nature and extent of farm change, while others particularly concern environmental impacts and their monitoring.

Farm change

Farm business

1. There is a need for more information to be gathered on the structure of the farm business as opposed to land holding. The Defra June Survey cannot indicate the scale of farming practised by individual businesses nor the complex nature of management control over land which is contract-farmed or held in similarly indirect ways.

2. It was recommended that more detailed information on the nature and significance of diversified and non-farm incomes and enterprises which can influence farming motivations and decisions, should be gathered. This might include types of enterprise, whether on or off-farm, and rough proportion of total household income generated, as well as which family members are involved.

Farm type and land use

3. More information on the mix of enterprises than is provided by the current farm type categories would be useful. One possible approach could be re-analysing June Survey data on the basis of enterprise diversity. This would be worth investigating as one way of measuring both spatial and temporal change in diversity of agricultural practice. A second approach is to develop a new classification based on crop and livestock data at farm level. Preliminary attempts at such a classification have been made in seedcorn-funded projects at CSL, but further work is needed. Information on livestock management could be obtained by including questions on this issue in the Farm Practices Survey.

4. The ‘farm type’ categories could be revised to enable more detailed investigation of the ‘other’ type. There is a need to distinguish commercial farms from leisure and lifestyle holdings and to monitor the anticipated development of more diverse types as a result of the reforms.

5. Mapping agricultural land cover data (crops and grass) at a square kilometre scale, would create a dataset compatible with many environmental datasets and create the potential for direct read across. A CSL project, conducted in
collaboration with Defra internal Observatory staff, has established a methodology for this, (see report on the Observatory website$^6$). Some further development is needed to overcome data quality issues and produce a national map. Unfortunately, changes in the IACS codes from 2005 will limit the future application of this method unless the original IACS codes are reinstated.

**Management aspects**

6. The environmental impact of livestock is often dependent on the management system adopted, e.g. whether and when housed (beef, pigs etc.), cutting programmes for hay or silage, grazing intensity and timing. All these issues can have major effects on the environmental impacts of the system. Consideration might be given to including questions on these aspects in the Farm Practices Survey.

7. Data on fertiliser use are only reported at national level in the British Survey of Fertiliser Practice (BSFP). It is recommended that future arrangements allow for reporting at regional level and permit access to data for further interrogation. Organic waste management is likely to become an issue of increasing concern, and the inclusion of regular questions on this topic in the BSFP is a welcome development. The value of these questions for the Observatory needs to be optimised. Data on manure management should inform annual estimates of gaseous air pollutants, especially ammonia and methane.

**General**

8. The Observatory should continue to check formal and grey literature and discuss emerging patterns with practitioners and environmental experts on a regular basis, to obtain short-term intelligence on qualitative/indicative trends and their impacts.

**Environmental Impact**

**Biodiversity**

Currently, national biodiversity monitoring is heavily biased towards birds, though schemes with robust sampling methodologies are now beginning to provide information on some mammals and butterflies, and proposals have been put forward for a farmland butterfly indicator. Further possibilities to widen the range of indicators are outlined below.

9. Data on bat populations and plant distribution are available through the National Bat Monitoring Programme and the Common Plants Survey respectively. It is recommended that the Observatory considers working with the Bat Conservation Trust and Plantlife to develop suitable indicators for these groups.

10. The absence of regular systematic monitoring of reptiles and amphibians may soon be remedied through the development of a National Amphibian and Reptile Recording Scheme by the Herpetological Conservation Trust. It is suggested that Observatory staff liaise with the HCT and, if the format of the

$^6$ Combining Defra June Census and IACS data to construct the first high resolution national 1 km$^2$ agricultural land cover map
scheme is appropriate, consider supporting the development of an indicator of amphibian and reptile population trends on farmland.

11. In view of their importance in the agricultural ecosystem (as established by the Farm Scale Evaluations and other studies), and their sensitivity to changes in agricultural management practices, there is a case for establishing a regular weed survey in key crops, using a statistically robust sampling methodology. This could possibly be attached to existing pest and disease surveys. Whilst the initiation of such a survey may be beyond the remit of the Observatory, staff may wish to discuss the possibility with other Divisions within Defra.

Landscape and historic environment

12. Enhanced data on the spatial patterns and occurrence of different landscape features and historic elements (scheduled and non-scheduled) at Joint Character Area level would also be particularly valuable for ongoing monitoring of impacts.

13. Information on landscape characterisation and change at JCA level is currently of a mostly qualitative nature. This could be usefully supported by more quantitative data, derived from the use of landscape metrics, of which a variety are available. Some preliminary work has been carried out on which the Observatory could build. Farm Environment Records (FERs) submitted in support of Entry Level Scheme (ELS) applications could also be a useful source of data on landscape features.

14. Baseline surveys of archaeological sites, historic buildings and designed landscapes have been carried out, but there are currently no plans to repeat these. The Observatory may wish to work with the appropriate bodies to consider how change in these areas could best be monitored in future.

15. Ancient trees are important components of the landscape and a valuable resource for biodiversity, but there is currently no systematic monitoring. Some information on in-field and hedgerow trees could be obtained from FERs, though not restricted to ancient trees. Ancient trees are recorded on Farm Environment Plans (FEPs) submitted with applications to the Higher Level Scheme, but these will cover a much smaller area.

Soil, water and air

16. Data from which to construct soil indicators are currently sparse. This issue is being studied by the UK Soil Indicators Consortium (UKSIC), with the aim of developing a set of soil quality indicators and setting up a national monitoring scheme, to commence monitoring in spring 2008. Of those already identified as likely to be included, it is considered that organic carbon, total N, extractable P, and heavy metals would be useful indicators for the Observatory. Bulk density could also be included to indicate levels of soil compaction. Indicators of management activity could usefully support these measurements. An indicator of erosion risk should also be developed, supported by information on management to limit erosion (e.g. from the Catchment-Sensitive Farming Initiative, cross-compliance monitoring). Phosphate entering watercourses could be a surrogate for measuring erosion directly.

17. In terms of monitoring catchments for better quantification of pollution from agricultural sources, currently the Environment Agency (EA) prepare risk maps for the different pressures such as N and P. These are used internally
within an integrated system to help identify high risk farms and target them. The EA water quality monitoring program has 8000 sites which are monitored monthly for a suite of chemical parameters – phosphates, nitrates as well as a large range of micropollutants (eg pesticides) etc but this does not pick up peak episodic rainfall-driven events which deliver nutrients from agricultural sources, this can only be done with long term data sets. In recognition that monitoring needs to be more sophisticated there is a new strategy through the CSFI to redesign the monitoring to make it more intelligent and include monitoring upstream and downstream from high risk farms. Monitoring of biological change could be improved. Currently, invertebrates are used as an indicator of biological water quality but there is a case for measuring algae and macrophytes etc. as well. The data available are often only upstream and down stream of sewage works. Biological monitoring is infrequent and therefore inadequate to describe what is actually going on. Also because it is expensive it is being reduced. Other pollutants which should be considered are veterinary products, pathogens and their interaction with climate change and endocrine disrupters.

**General**

18. Many datasets only provide reliable estimates at regional or even national level, where the number of samples are insufficient in relation to the inherent variability to have confidence in estimates at finer spatial scales. Linking data sets using spatial co-ordinates may provide additional insights into potential cause and effect relationships, through observed spatial and (if the data allow) temporal correlations. A basic example of this approach can be seen in the upland case study where bird survey data were linked through GIS mapping to vegetation and land use data. The potential for further work to integrate agricultural and environmental datasets should be considered as a method of investigating environmental impacts. An example could be linking data from the 1 km\(^2\) agricultural land cover map (see paragraph 5 above) to BTO Breeding Bird Survey (also at 1km\(^2\) resolution), in order to analyse relationships between agricultural land use and occurrence/abundance of farmland birds.

**6.2 Recommendations for future work on the analysis of agricultural and environmental change**

Analysis of agricultural and environmental change can be carried out at a range of scales, depending on the questions being asked, and the focus of interest. Several Observatory projects have examined change at a national and/or regional level (e.g. Defra, 2006a, b, c). However, whilst this provides a useful indication of likely patterns of overall change, it does not allow local conditions to be taken into account. The case studies examined the implications of change at a JCA or catchment level. At this scale, not only was it possible to analyse patterns of change at a local scale, but in the case of the upland case study, it was possible to link spatial changes to the spatial distribution of birds in the catchment, whilst in the lowland study landscape metrics (quantitative descriptors of landscape structure) were calculated. An overall estimate of likely changes in nutrient losses to water was calculated, but it was not possible with the resources available to provide a spatially explicit analysis of nutrient losses; however, this would be a useful extension of the approach.
The case studies successfully demonstrated a methodology that could be both applied more widely and extended to provide more detailed analysis of areas of specific policy interest. Some proposals are outlined below.

There is also a need for national/regional approaches, which should be viewed as complementary to the local case studies, and recommendations are also made for further studies at this level.

a) Based on case studies

1. The methodology developed for these case studies is generic, and applicable to other areas at a similar scale. It would be interesting to carry out similar exercises covering other upland and arable – dominated areas, to measure the effect of differences in local context on the outcomes. It would also be useful to conduct one or more similar case studies in areas dominated by lowland grassland and mixed farming.

2. Validation of the case studies would allow an assessment of the accuracy of the methodology in predicting both change and the effects of change, and hence its value for future use. This could include the gathering and analysis of current local knowledge and follow up fieldwork to assess the extent of changes in land use and environmental measures.

3. The lowland case study could be extended to provide a more comprehensive, spatially explicit analysis of impacts on water quality, taking into account distance from rivers and other watercourses, and using data on the spatial distribution of land use and fertilisers applied to each land use type; the numbers and distribution of livestock and the input of nutrients to the catchment through atmospheric deposition. The potential impact of policy initiatives to address pollution issues could also be examined.

4. Potential changes in the impact of pesticide usage could be calculated from pesticide usage data and toxic loading indices. This could be done at the JCA level as already done for nutrients, or as a spatially explicit analysis analogous to that proposed for nutrients in (3) above.

5. The calculation of functional landscape metrics in relation to specific organisms could be used to assess the impacts of change on species of conservation and policy interest, e.g. BAP species, species contributing to the Farmland Bird Index.

6. The impact of predicted changes on landscape character could be examined in relation to the landscape character assessment for the study JCAs, and compared with the results of the Countryside Quality Counts analysis for these areas.

Prioritisation of case study work

It is recommended that priority be given to the following areas, within the recommendations for case studies:

i). Completion of the arable case study by environmental evaluation of the ‘environment-led’ scenario.

ii). Validation of one or both of the case studies, to assess the reliability and accuracy of the predictions

iii). Conduct of further case studies in upland and crop-dominated areas, to assess the degree to which the resulting outcomes are locally specific or can be more generally applied, plus case studies in lowland grass areas
iv). A more detailed assessment of nitrogen and phosphate losses in the arable case study, including the impact of mitigation measures.

**b) National scale**

The above recommendations apply to extensions of the case study approaches. However, there is also a need for work at a larger scale.

7. One approach would be to consider adapting the case study methodology to provide an analysis of change across the whole of England at JCA level. Outputs would include estimates of changes in the balance of land use in different JCAs and potential environmental effects at a broad level.

8. It would be possible to carry out June survey-based studies next year on impacts of changes in arable and sheep farming, similar to studies already done on set-aside and fallow, dairy cattle and suckler cows, to examine early indications of change in more detail.

9. It could be useful to carry out studies to integrate the effects of predicted changes at farm level on environmental impacts of policy interest, e.g. emissions of ammonia, water pollution by nitrates and phosphates, impacts on pesticide usage, or the implications for declining bird species in the Farmland Bird Index. These could be linked to specific policy areas (e.g. implementation of the Water Framework Directive), and include the potential impacts of measures already implemented or planned for the near future (e.g. Catchment Sensitive Farming, Environmental Stewardship).

10. Some of the gaps identified in this analysis could be made the subject of specific survey-based analytical studies next year, to attempt to assess the significance of the information that could be gathered and thus to indicate the cost-effectiveness of integrating these elements into longer term monitoring approaches. This could be particularly useful for the ‘farm change’ gaps.
REFERENCES

ADAS (2005a) Farmers’ Voice Survey of 2004


