ENGLISH NATURE

Review of the impact of extensive livestock farming systems on nature consevration and the environment

Phase 2 - Final report

No. 69 - English Nature Research Reports

working today
for nature tomorrow

English Nature Research Reports

Prepared for English Nature by

CEAS Consultants (Wye) Ltd
and
Wye College (University of London)

Further copies of this report can be obtained from Rural Land Use Branch, Policy Directorate, English Nature, Northminster House, Peterborough PE1 1UA

ISSN 0967-876X

REVIEW OF THE IMPACT OF EXTENSIVE LIVESTOCK FARMING SYSTEMS ON NATURE CONSERVATION AND THE ENVIRONMENT

PHASE 2 FINAL REPORT

Report for

English Nature

by

CEAS Consultants (Wye) Ltd
Centre for European Agricultural Studies

in collaboration with

Wye College (University of London)

Telephone: 0233 812181
Fax: 0233 813309
Telex: 849228 PROMAR G

CEAS 1400/NW

February 1993

Contents

1 INTRODUCTION 1
1.1 The English Nature study of livestock extensification 1
1.2 The MAFF pilot schemes 1
1.3 Objectives of the pilot schemes 1
1.4 The coverage and nature of the pilot schemes 2
1.4.1 Rules that apply to other products on the participant's holdings throughout the duration of the schemes 4
1.4.2 Rules on the maintenance of the environment 4
1.4.3 Rules which the farmer must follow when reducing his ewe numbers 5
1.5 Effectiveness of the pilot schemes 5

2 SUMMARY OF PROPOSED EXTENSIFICATION PRESCRIPTIONS 7
2.1 Reduce stocking rates 7
2.1.1 Flat rate stocking densities 7
2.1.2 Stocking rate adjusted to sward composition 8
2.2 Reduced fertiliser application alongside lower stocking rates 9
2.3 Switch from silage to hay 10
2.3.1 Hay 10
2.3.2 Silage 10
2.4 Ban on over-wintering on outbye 11
2.5 Ban on supplementary feeding on the outbye over winter 11
2.6 The problem of common grazing 13

3 FARMING SYSTEMS IN THE ENGLISH UPLANDS 15
3.1 Cumbrian Pennine Moors 15
3.2 Lake District 15
3.3 Exmoor 16
3.4 Dartmoor: Blackface type 16
3.5 Yorkshire Dales 16
3.6 Northumberland: Scottish Blackface 17
3.7 Description of hill sheep breeds within the models and assumptions about performance 17
3.7.1 Blackface 17
3.7.2 Swaledale 18
3.7.3 Herdwick 19
3.7.4 Exmoor Horn 19
3.7.5 Bluefaced Leicester rams 20

4 THE FARM MODELS 21
4.1 Methodology 21
4.2 Date sources and assumptions 21
4.2.1 Fertiliser response functions 21
4.2.2 Metabolisable energy requirements 22

4.2.3 Flock performance 23
4.2.4 Costs of away-wintering 23
4.3 Validation of models 24

5 FINANCIAL EFFECTS OF THE PROPOSED SCHEMES 27
5.1 Change in income by farm type and prescription 27
5.2 Transition period for each farm type and prescription 29
5.3 Change in physical production 29
5.4 Changes in input use 31
5.4.1 Fertilisers 31
5.4.2 Other variable inputs 31
5.4.3 Fixed inputs 32
5.5 Comparison of hay and silage making systems 32

6 FARMER RESPONSE TO THE PROPOSALS 37
6.1 Reduction in stocking rates on areas of common grazing 37
6.2 Nitrogen reductions 37
6.3 Reduction in stocking rate on unenclosed areas only - no restriction on fertiliser applications 37
6.4 Subsidies/premiums 37
6.5 Sheep quota 38
6.6 Administrative detail 38
6.7 Switching from silage to hay 38
6.8 Destocking the rough grazing over winter 39
6.9 Supplementary feeding on fells in winter 39
6.10 Conclusion 39

7 ECONOMIC EFFECTS OF THE PROPOSED SCHEMES 41
7.1 Change in exchequer costs of the schemes 41
7.2 Interactions between proposed schemes and existing support measures 41
7.3 General observations 41
7.4 Ewe premia 43
7.4.1 Trading quota 43
7.4.2 'Setting aside' quota 43
7.4.3 Full compensation 44
7.4.4 Summary 44
7.5 Environmentally Sensitive Area 44

8 CONCLUSION AND RECOMMENDATIONS 45

REFERENCES 47

GLOSSARY 49

APPENDIX 1: Farm models 51

1 INTRODUCTION

1.1 The English Nature study of livestock extensification

This report was commissioned by English Nature as part of a review of the impact of extensive livestock systems on nature conservation and the environment. The first part of the review concentrated on sheep extensification, leaving the second part covering beef and dairy extensification to a future date.

The sheep study was divided into two phases, both of which were carried out as a collaborative venture by staff of Wye College (University of London) and CEAS Consultants (Wye) Ltd. Phase 1 mainly comprised a literature review and was concerned with conceptualising, defining and evaluating extensification in its different forms in order to identify the main conservation and policy opportunities that it provides. The results of Phase 1 of the study are recorded in the 'Review of the impact of extensive livestock farming systems on nature conservation and the environment, Phase 1' (CEAS Consultants and Wye College, 1993).

This report covers Phase 2 of the study which was concerned with devising workable and effective sheep extensification schemes, taking into account the recommendations made in the report on Phase 1. Having identified workable schemes, the financial and economic consequences of them were estimated using computer models of representative or modal farm types that are typical of the upland areas where such extensification schemes might be implemented. Representative farm models were built for Cumbrian Pennine Moor (Mules), Cumbrian Pennine Moors, Lake District, Lake District (Herdwick), Exmoor, Dartmoor, Northumberland, Yorkshire Dales and Yorkshire Dales (Mules). These farming systems are described in more detail later in the report.

The models enabled estimates to be made of the effects of different management constraints on input use, production levels, farm profitability and exchequer costs. Conclusions were drawn from the results of the analysis and some recommendations made about what key features a new sheep extensification scheme would need in order to be effective.

1.2 The MAFF pilot schemes

Before proceeding further, it is appropriate to examine the existing extensification schemes in the UK. Beef and sheep pilot extensification schemes were introduced in a limited number of counties in England, Wales, Scotland and Northern Ireland in September 1990.

1.3 Objectives of the pilot schemes

The objectives for the beef and sheep pilot extensification schemes were as follows:

a) to estimate, as far as possible, the cost effectiveness of the pilot schemes and to draw conclusions for the eventual definitive schemes;

b) to provide data from the participants and a sample of non-participants with which to estimate the impact of a definitive scheme;

c) to secure, on each participating farm a reduction in production of beef and sheep meat of at least 20% without an increase in other surplus products. To at least maintain environmental features at the level and quality on joining the scheme.

1.4 The coverage and nature of the pilot schemes

The extensification schemes were voluntary and designed to reduce the amount of beef and sheep meat produced. To be eligible for the pilot schemes, the whole of the beef or sheep business, even where this was carried out at more than one location, had to be wholly situated within:

England
The counties of Humberside, North, South and West Yorkshire, Cumbria, Northumberland, Durham, Tyne and Wear, Cleveland, Cheshire, Staffordshire, Shropshire, Nottinghamshire, Derbyshire, Leicestershire, Lancashire, Merseyside, Greater Manchester, Warwickshire, West Midlands Metropolitan County and Hereford and Worcester.

Scotland
Districts served by the DAFS Borders Area Office in Tweedbank, Galashiels (ie, the whole of the Borders Region) and Districts served by the DAFS Highland Area Office in Inverness (ie, Highland Region excluding Ardnamurchan and Morvern, but including the part of Strathclyde Region north of the A85).

Wales
The county of Powys.

Northern Ireland
All areas.

Beef pilot scheme: The farmer was required to reduce total annual sales of beef animals by at least 20%, but by no more than 70%, in comparison with eligible sales (ie, sales of animals kept on the holding for nine months or more) in the base period. The base period is 1 January 1989-31 December 1989. Farms with dairy herds were not eligible.

Sheep pilot scheme: The farmer was required to reduce the size of his/her breeding flock by at least 20%, but by no more than 70%, in comparison with the size of the breeding flock in the base period. This base period was the chosen Sheep Annual Premium Scheme (SAPS) retention period for marketing year 1989.

Provided they were eligible, farmers could enter one or both schemes.

Eligibility: To enter the pilot extensification schemes, the existing beef or sheep enterprise must have contained at least:

- 10 eligible beef animals in the base period if entering the beef scheme;
- 65 ewes for which ewe premium was claimed under SAPS for marketing year 1989 if entering the sheep scheme.

For the purposes of these schemes, the farmer's obligations applied to the whole of the beef or sheep business, even where this was carried out at more than one location or on more than one holding.

Compensation: The compensation payment is calculated per eligible animal reduced and is paid annually in arrears for each of the five years of extensification agreement. Rates of payment are:

Beef scheme: £55 per eligible beef animal reduced.

Sheep scheme: £14 per eligible ewe reduced.

The payments are made annually after the end of each year of extensification on the basis of an annual claim for payment. Because these were pilot schemes farmers will be given the option on the implementation of any definitive national schemes:

a) to continue with the extensification undertaking as laid down at the outset of the agreement; or

b) to amend the terms of the undertaking to those which apply to participants in the definitive extensification schemes.

If a farmer breaks the rules, he could lose future payments and be required to repay amounts already received together with interest. There are criminal penalties for fraud or deception.

Number of participants accepted into the pilot schemes:

Limits England 70 (35 from MAFF Northern Region, 35 from MAFF Midlands and Western Region); Scotland (DAFS Borders and Highlands Areas) 20; Wales (Powys) 10; Northern Ireland 5.

1.4.1 Rules that apply to other products on the participant's holdings throughout the duration of the schemes

Other products on the holding
These rules are designed to make sure that the farmer's participation in an extensification scheme leads to the less intensive use of his land, and that his participation in the schemes does not lead to an increase in his production of other surplus products.

Grazing land and land used for fodder and feed
The farmer was required to list on his application form all the production capacity (ie, land, buildings and fixed equipment) which he used in the base period for grazing the livestock entered into the extensification agreement, or for producing fodder and feed for that livestock. Throughout the five years of extensification the farmer must not reduce the production capacity given over to these purposes.

Other livestock
The farmer was required to list on his application form the average numbers and ages in the base period of livestock which he is entering into the schemes. This had to include all of his:

- beef animals (if he was entering the sheep scheme only);
- sheep (if he was entering the beef scheme only);
- goats.

During the period of his participation in the schemes, he must not increase his production of these other livestock.

Arable and other land
He was also required to provide full details of the areas of land used for producing arable and any other crops on his holding in the base period, and to list and describe all farm buildings and fixed equipment. Throughout the extensification period he must neither increase the land used for arable production nor reduce the land used for grazing or fodder production from that in the base period.

1.4.2 Rules on the maintenance of the environment

Environmental features
Participants are required to observe, for the five years of their extensification obligation, conditions which will ensure the environmental protection of their holding. Therefore on entering the schemes, the farmer had to undertake to maintain features of the following type on or adjacent to land on the holding subject to extensification which he is entitled to maintain:

- hedges;

- rows of trees, including hedgerow trees;
- lakes, ponds, lochs and pools;
- watercourses and ditches;
- stone walls;
- vernacular buildings (buildings traditionally found in the locality);
- any areas of existing unimproved grassland, moorland and heath.

On applying for the pilot schemes the farmer was required to submit a map indicating all features in the above categories on his enterprise at the time of application.

1.4.3 Rules which the farmer must follow when reducing his ewe numbers

The farmer had to ensure that all ewes which he disposed of in order to reduce his flock size to the level required under the scheme either went for slaughter or were exported from the European Community. He was required to provide independently certified evidence of the destination of all the ewes which had left the flock.

1.5 Effectiveness of the pilot schemes

The pilot schemes were evaluated by Wye College and CEAS Consultants and the findings published (Young and Williams, 1992). The study found that many of the participants in the sheep scheme were apparently worse off than they would have been had they not joined, the grant being insufficient to compensate fully for the reduction in ewe numbers and subsidies attached to them. However, it was also evident that, following two dry summers, many of the farmers intended to reduce their ewe numbers because of worries about overstocking. The effect of this was to increase the attractiveness of the scheme to the farmers, but to reduce its cost effectiveness in exchequer terms as some destocking would have occurred anyway.

2 SUMMARY OF PROPOSED EXTENSIFICATION PRESCRIPTIONS

This part of the report examines the possible extensification prescriptions that were identified in Phase 1 of this project. Their financial consequences for participating farmers and economic consequences for government will be considered later. The most obvious form of extensification is through reduced livestock numbers and hence stocking densities. This may be combined with reductions in fertiliser use on the inbye and a number of management prescriptions. These latter include either a ban on over-wintering of sheep on the outbye or a ban on supplementary feeding of sheep that are over-wintered on the outbye. Another option is to encourage a switch from silage to hay making on the inbye. These issues are now considered in turn.

2.1 Reduce stocking rates

The most obvious way to reduce damage from overgrazing of moorland vegetation is to reduce stocking densities. These can be 'broad brush' prescriptions or more closely tailored to individual sites.

2.1.1 Flat rate stocking densities

The first policy prescription is based on a simple reduction in sheep stocking densities. Two rates are chosen:

i) set stocking rate at 1.5 ewes per hectare where present stocking rates are >1.5 ewes per hectare on average; and

ii) set stocking rate at 1 ewe per hectare where present stocking rates are 1-1.5 ewes per hectare on average.

The areas where average stocking rates are currently above 1.5 ewes per hectare are Cumbria Pennine Moors (1.7 ewes per hectare), Lake District, Herdwick (2.3), Exmoor (2.5) and Dartmoor (2.0). Those where average stocking densities are between 1 and 1.5 ewes per hectare are Lake District (1.5), Northumberland (1.25), Yorkshire Dales (1.22) and Yorkshire Dales (Mules) (1.43).

The effects of altering the average stocking rates that are incorporated in the model includes changes in flocks' forage requirements, in optimum fertiliser use, in flock performance (lambing per cent, quality of draft ewes, lamb finishing) and in enterprise variable costs. Flock forage requirements are based on effective stocking rates (ie, including an allowance for lambs which increases over the summer) rather than on the basic ewe number. Hence a lamb is assumed to have the forage requirement of 0.25 of a ewe in April to May, 0.5 in June, 0.75 in July and 1 in August.

2.1.2 Stocking rate adjusted to sward composition

An alternative, more sophisticated approach, based on work by Rawes and Welch (1969), Moorhouse National Nature Reserve, was identified. This is a system which avoids 'broad brush' stocking rates and allows for variation in effective grazing densities in 'response to different sward composition'.

The concept takes account of the different stock carrying capacities of the constituent elements of the sward. The effective grazing densities for the most commonly occurring species are shown in Table 2.1:

Table 2.1: Effective grazing densities of moorland vegetation species

	ewes/ha
Bent/Fescue areas	5.0
Matt grass dominant	3.0
Heathland/rush	1.0
Heather	0.5
Cotton grass	0.3
Heather bog	0.1

Source: Rawes and Welch (1969)

Example 1: Northumberland Moor

Species	% of sward	ewes/100 ha
Heather	40	20.0
Cotton grass	15	4.5
Matt grass	30	90.0
Heathland	10	10.0
Bents and fescue	5	15.0
	100	139.5

Source: ADAS plus author's calculations

Example 1 shows the typical mixture of species on the Northumberland Moor in percentage terms. When combined with the effective grazing densities from Table 2.1, it is possible to estimate the stock carrying capacity of the land. The results suggest that the optimum effective grazing density is 1.39 ewes per hectare on average. The present stocking rate is 1.25 ewes per hectare on average.

Example 2: Exmoor

Species	% of sward	ewes/100 ha
Heathland	40	40
Bents/fescue	10	50
Matt grasses	10	30
Heather	30	15
Bog	10	1
	100	136

Source: ADAS plus author's calculations

Example 2 shows the identical calculation for Exmoor. The results indicate that the optimum effective grazing density is 1.36 ewes per hectare on average. This compares with the present stocking rate of 2.5 ewes per hectare on average.

Another model that is relevant is that devised at the Macaulay Land Use Research Institute (MLURI) which is described by Armstrong (1990). The MLURI model is used to calculate the maximum number of sheep that a hill farm can support without causing a decline in heather cover. The model takes account of the area of different types of grassland and of heather moorland. It also adjusts for sheep size (a proxy for breed). The model can be used to identify whether overgrazing is likely to be occurring on a site. If the evidence of a short site visit and the model points to overgrazing, then there is a strong case for action and the model output can indicate an appropriate stocking density. The advantage of this approach is that it obviates the need for detailed heather monitoring which is a fairly resource-consuming process and hence expensive.

Unfortunately, there were not sufficient data available to enable us to use either of these approaches in our analysis so we were forced to use the less specific stocking densities identified in Section 2.1.1. However, the models used for this report can be adapted to make use of more site specific stocking densities.

2.2 Reduced fertiliser application alongside lower stocking rates

The absence of a management prescription for reductions in fertiliser use may lead farmers to intensify production on inbye areas to compensate for reductions in stocking rates on rough grazing. In the absence of some constraint, this might lead to increased use of nitrogen fertiliser. In contrast, there is some evidence from our models to suggest that a 0.5 ewe decrease in stocking rate on a fell, with an equivalent reduction in the stocking of the inbye, could lead to a 60% decrease in fertiliser applications as the energy requirement from the inbye is reduced.

The interaction between stocking rates and the level of N fertilisation has been estimated using standard response curves for grassland to N application. In this case five categories of grassland sites have been identified and the models incorporate the appropriate site category in their structure. The grassland requirements of the grazing stock are then assessed on the amount of estimated energy production that is required for a given stocking rate as is the amount of N fertiliser required to sustain that level of production.

The effects of prescribed changes in stocking rates and fertiliser use on the farming system can be modelled using the link between energy requirement, energy production, site category and fertiliser application rates.

2.3 Switch from silage to hay

There are significant environmental benefits that derive from the use of grassland to produce hay rather than silage. The third policy prescription considered is a change from silage to hay for winter feeding. Some of the technical issues are considered in the following sections. The data sources are Brockman (1961 and 1988).

2.3.1 Hay

Yields of hay vary considerably, and high N rates should not be used to grow a hay crop because it aggravates the curing problem: a maximum N rate of 80 kg/ha for the growth period is recommended (although in the upland areas the quantity of N applied is less). Depending upon site class, the expected yields per hectare would be:

Light crop	=	2-3 tonnes of made hay
Medium crop	=	4.5 tonnes of made hay
Heavy crop	=	5 tonnes of made hay

It is assumed that the hay is of moderate quality at a dry matter of 85%. Fertiliser is applied at 75 kg N/ha, at which level it is assumed that no adverse environmental effects are caused.

2.3.2 Silage

Given the vagaries of the British weather, silage is the safe option for the upland farmer as it provides a better opportunity for successfully conserving grass. Farmers' perceptions of the relative merits of hay and silage will be heavily influenced by recent experience. A wet summer in the year prior to the introduction of a prescription requiring a switch to haymaking would provoke a more adverse reaction from farmers than would be expected if the season had been dry and suitable for haymaking. The most popular method is to make silage in big bales which can then be transported to the livestock. The weather still places a limit on the amount of silage-type fodder that can be preserved and in upland areas one or possibly two cuts may be made, yielding up to 15 tonnes of silage per hectare, dependant upon fertiliser application. To achieve the top end of the yield scale, the farmer must apply large quantities of fertilisers - up to 180 units of N in addition to high levels of P and K (the most common fertiliser formulation being 20:10:10 of N:P:K).

2.4 Ban on over-wintering on outbye

The fourth policy prescription considered is a ban on over-wintering on the outbye. For the purposes of the analysis, we assume that a ban on over-wintering on the outbye will not result in an increase in the required forage area as the animals will be less stressed which will compensate for the nutritional intake previously provided by the upland sward (Allen and Kilkenny). Where the inbye proves incapable of providing sufficient forage to support in-wintering, we could suggest that compensation for the cost of away-wintering should be provided.

2.5 Ban on supplementary feeding on the outbye over winter

Concern is expressed about the localised damage caused to moorland that is associated with the provision of supplementary feeding. The evidence on supplementary feeding of sheep over winter is drawn from the ADAS reports and is summarised below.

According to ADAS/NCC reports:

Cumbria	-	feed blocks flown onto moor by helicopter in inaccessible areas.
Dartmoor	-	supplementary feeding to sheep on inbye.
Exmoor	-	supplementary feeding would be carried out on the inbye.
Northumberland	-	concentrates fed on fell two months prior to lambing in April, hay fed on fell during storm conditions.
Yorkshire	-	supplementary feeding from mid January to lambing. Ewes remain on fell until due to lamb in mid-April.

It appears from these reports that the only significant occurrence of supplementary feeding is in Cumbria where feed blocks are air lifted onto the fell. Since the quantities of nutrients supplied per ewe are very limited, eg, c5 kg per head over the entire winter, it is difficult to see that proscribing this activity will have any significant effect on flock performance. Indeed the high cost of the operation means that there may be an increase rather than decrease in income from such a ban[1]. Clearly though, there would need to be some educational/advisory input to raise the farmers' awareness of the relative costs and benefits of this option. There may also be an adverse reaction from the animal welfare lobby to the suggestion that farmers would not be permitted to feed their stock over winter.

It became clear during the preparation of this report that the ADAS/NCC reports understate the problem of supplementary feeding on the outbye over the winter period.

---

[1] Although it may appear to be irrational for a farmer to do something that has no benefit and costs him money, there are precedents. The application of nitrogen fertiliser to crops of oilseed rape in the autumn is one such example. Once common, this has now all but ceased as awareness has spread through the industry that autumn nitrogen has no effect on yield even though it makes the crop look 'healthier'.

Following consultation with a number of English Nature staff a different picture emerged, especially with regard to Cumbria. Fuller (pers. comm) reports that the provision of hay, silage or other supplementary feeds (eg, concentrates such as 'hay nuts') is normal agricultural practice for outwintered stock throughout Cumbria. It is typically carried out during January to March when higher standards of ewe nutrition are sought in late pregnancy.

Supplementary feeding was virtually unknown in the 1950s except in extreme winter conditions and has largely arisen through:

a) many moors now being stocked at a level over and above that which the semi-natural vegetation can support stock in good condition in winter; and

b) the availability of new machinery (eg, ATVs) capable of getting feed out onto the moors.

Supplementary feeding is generally done routinely in the same place. As a result stock gather and remain at such sites for many hours before and after feeding. This local concentration of stock tends to cause overgrazing, trampling and nutrient enrichment of the area. Overgrazing and trampling damages heather, particularly if old and woody, leading to the conversion of dwarf shrub heath into grassland. Heather, once lost, recovers slowly, if at all, and the enrichment leads to more palatable grasses colonising the area, which further concentrates the stock in the following spring. Evidence of the loss of dwarf shrub heathland from points can apparently be seen throughout Cumbria.

English Nature also point to a 'decline in shepherding' exacerbating the adverse effects of supplementary feeding as the farmer is less dependent on heather for winter feed and has less incentive to manage the heather for optimum utilisation. This is not a view that the authors of this report share. Rather we take the view that the hill farmer has been forced to increase stocking rates to maintain his/her income in the face of a cost-price squeeze. At the same time the loss of many of the next generation of farmers through outmigration has meant that those remaining have been placed under ever increasing pressure. The result is that good shepherds are forced to adopt practices that save labour even though they are aware that they may have an adverse environmental impact. This was a view that came through strongly in the evaluation of the beef and sheep pilot extensification schemes (Young and Williams, 1992).

In Yorkshire there is evidence (English Nature, Pers. Comm) that farmers locate supplementary feed at strategic points on the edge of the heather line, thereby encouraging the animals to trample it and so push it back allowing grass to grow in its place. This is a crude form of fell improvement. We do not foresee any particular difficulty with banning this practice as the gains to the farmer are marginal and would have no net benefit once the other prescriptions are implemented.

2.6 The problem of common grazing

One particular difficulty that an extensification scheme will face is that of common grazing. This was an issue identified by CEAS Consultants (1992) in their report on the Tir Cymen scheme for the Countryside Council for Wales (CCW). The problem arises because such common land is frequently used by more than one farmer so that an agreement with one to reduce his stocking could be largely negated by the other rightholders continuing to stock their land at the previous levels. A further complication arises because there may be some rightholders who are currently not exercising their rights to common, but who might conceivably do so in the future. Although CCW are looking at this problem, they have not yet derived a procedure for dealing with it (Jones, Pers. Comm.).

While it is not possible to propose a solution within the terms of reference of this report, it does seem likely that providing the majority of rightholders (measured in terms of their stocking entitlement) are prepared to join an extensification scheme, then it should be feasible to incorporate farmers with access to common land in such a scheme. Each case will need to be assessed individually so that account is taken of the extent to which scheme non-participants are already using their grazing entitlement - and so are unable to legally increase their livestock numbers to exploit the increased food supplies.

3 FARMING SYSTEMS IN THE ENGLISH UPLANDS

The characteristics of the farm models for each area are summarised in Table 3.1 which shows the areas of inbye, intake and rough grazing as well as the number of breeding ewes and suckler cows. The farming systems are described in more detail in the following sections.

Table 3.1: Summary table of model farm areas and stocking

	Inbye (ha)	Intake (ha)	Rough grazing (ha)	No breeding ewe (hd)	Suckled cows (hd)
Cumbrian Pennine Moors (Mules)	40	100	470	800	60
Cumbrian Pennine Moors	40	100	470	800	60
Lake District	30	80	566	850	35
Lake District (Herdwick)	30	80	434	1,000	60
Dartmoor	80	0	200	400	50
Exmoor	100	0	400	1,000	20
Northumberland	34	50	480	600	25
Yorkshire Dales	40	30	490	600	25
Yorkshire Dales (Mules)	34	50	400	570	25

3.1 Cumbrian Pennine Moors

System 1 Swaledale/Blackface ewes
This is a traditional self-contained system, with only replacement lambs retained on the enterprise, the remainder are transferred to lowlands for finishing. Ewes are sold as draft animals after 3-4 crops of lambs and over-wintering charges are only incurred on flock replacements. The enterprise is run alongside a suckler herd of typically 50-60 cows. No evidence of off-wintering is given in the ADAS data.

System 2 Swaledale/Blackface ewes (mules)
Breeding lambs are produced from a self-contained flock, producing mule 'gimmers', which account for approximately 50% of lamb output. Wether lambs and excess ewe lambs are finished in lowland units. There are away-wintering charges for flock replacements. Ewes are drafted after 4 crops of lambs. There is an accompanying suckler herd numbering up to 80 cows. The flock is wintered on enclosed rough grazing.

3.2 Lake District

System 1 Herdwick ewes
This is a traditional self-contained flock. All lambs are over wintered and any surplus to flock replacement requirements are sold as shearling stores at 18 months. Ewes drafted after 3-4 lamb crops. There is an accompanying suckler herd up to 30 cows (spring calving). The flock is over-wintered on fell or within enclosed rough grazing.

System 2 Swaledale ewes
The majority of ewes are mated to a hill breed ram, however each season some will be tupped by a Bluefaced Leicester to produce mules. All lambs, less retained replacements, are sold at 5-6 months as stores. Ewes are sold as drafts after 4 lamb crops. There is an accompanying suckler herd 30-35 cows.

3.3 Exmoor

This is a complex system with many different sheep breeds even within a single unit. Many are crossbred Exmoor Horn/Suffolk, Texel, Leicester ewes. There are also large numbers of mules. Sheep are classified locally as either being 'blackfaced' reflecting either 'blackfaced' Suffolk heritage or 'whitefaced' Closewool/Texel/Leicester heritage. The system may produce crossbred breeding animals and/or finished lambs.

There are large areas of inbye in comparison with other upland areas. This is typically a less harsh upland climate which suits farming systems that are akin to lowland production systems. Most unenclosed areas are destocked of sheep in winter. The flock is run alongside a suckler beef enterprise of an average 20 cows.

Ewes are sold as drafts to lowland areas. Replacement ewe lambs will typically be over-wintered on 'keep', on dairy farms or on folded crops on arable enterprises.

3.4 Dartmoor: Blackface type

There is no stratification system in operation for sheep produced on Dartmoor. Ewes are disposed of as culls and lambs surplus to flock replacement are sold as stores. Sheep have tremendous freedom of movement on very extensive areas of open grazing. Ewes are culled when unable to produce economically, usually at broken mouth stage. There is no system of over-wintering stock and there is no general pattern of winter destocking.

3.5 Yorkshire Dales

System 1 Swaledale ewes
A traditional Swaledale flock, producing flock replacements and stores for lowland finishing. Ewes are disposed of as drafts, often entering a lowland unit within the same farm after three lamb crops.

Fell areas are usually enclosed and subject to freehold possession.

Those lambs retained for flock replacements are overwintered on lowland farms and the lambs are returned early to the fell, usually at about ten days of age. The fells are destocked in February/March.

There is a suckler herd of approximately 25 cows and followers or 20-30 dairy herd heifer replacements are reared each year.

System 2 Swaledale ewes (mules)
Up to 50% of the flock is crossed with a Bluefaced Leicester ram to produce the Swaledale Mule.

One in 6 ewes produce twins and these will remain on inbye until August weaning. Ewes are sold as draft after 4-5 lamb crops and lambs are either sold as mule 'gimmers' or as stores. Replacements are away-wintered from November to March.

Ewe lambs may be creep fed after weaning until sale in November.

There is a suckler herd of an average of 40 cows.

3.6 Northumberland: Scottish Blackface

This is a self-contained flock producing store lambs and flock replacements. Ewes are sold draft after 4 lamb crops and stores are sold in October.

Replacements are away-wintered on lowland farms. Fells are destocked in November/December.

There is a suckler herd of 20-30 cows.

3.7 Description of hill sheep breeds within the models and assumptions about performance

3.7.1 Blackface

Importance
The most numerous British sheep breed, representing 30% of Britain's pure bred stock. To be found on the high ground of Scotland, through the Pennines range, Dartmoor and Cornwall. As a cast/draft animal it is to be found countrywide. It is ideally suited to areas of England that are between 500 and 2000 ft above sea level.

Its primary role is a fat lamb producer, whether on upland or lowland pasture. Its secondary role is that of being the pinnacle of the sheep stratification pyramid.

Primary genetic source of the Greyface and Scottish Mule; important halfbred breed of fat lamb producing sheep.

History
First flock books date from 1895, although documented and noted as a breed since the reign of James II. At this time located in the forest of Ettrick (Scotland).

Biological Data
Ewe weight (lwt) 54 kg.
Lamb carcase weight: 'milk' lambs 15-17.5 kg, 'finished' stores 16-20 kg.
Lambing Percentage: average 100%

3.7.2 Swaledale

Importance
The breed originates from the valley of the river Swale, a Yorkshire Dales river, which rises high on the summits of the remote fells of North Yorkshire, near the boundary of Cumbria. Ideally suited to acid fells, moorlands.

Unlike other upland breeds, who rely on grass within the moorland habitat mosaic, the Swaledale's principal diet is fibrous plant life, for which they have become phenotypically adapted to consume heather and other harsh vegetation.

Primary economic role at farm level is as a lamb producer. However, within the system of stratification within the British Sheep Industry, it is important in its secondary role as a producer of halfbred ewes.

Primary genetic source for the Masham and Swaledale Mule breeds[2], collectively the most numerous of halfbred breeds in England.

History
Although long established in the fells of North Yorkshire, its important role in the British Sheep Industry has been developed since the end of the First World War. It now competes in certain areas with the Blackface.

A substantial breed society now exists,with in excess of a thousand flocks, predominantly in the breeds natural surroundings of high moors and fells.

Biological data
Ewe weight: 48 kg.
Lamb carcase weight: 16 kg on average.
Lambing Percentage: average 100%.

---

[2] The Mule/Halfbred: this is the breeding of a halfbred female suitable for fat lamb production. Traditionally this operation was carried out with draft ewes on lowland areas. However, there is now a trend on some of the less harsh fells and moorland areas at altitudes less than 700 ft above sea level for this operation to be adopted as an alternative commercial enterprise to traditional systems.

3.7.3 Herdwick

Importance
Naturally indigenous to the Lake District, and numerically small in number in comparison with other breeds of Fell sheep.

The importance of this breed in the Lake District is their extreme hardiness and their ability to survive at altitudes up to 3000 ft above sea level, in the wettest environment in England. The only rivals in terms of hardiness will be found in the high mountains of Wales.

Because they are smaller than most other Fell type breeds, stocking rates tend to be higher.

They are used primarily for fat lamb production.

History
They show no marks of affinity with any other British breeds, although they are similar in some characteristics with some breeds of Scandinavian sheep. For these reasons they can still be regarded as Feral.

Biological Data
Ewe Weight: 35-45 kg.
Lamb carcase weight: 14-18 kg.
Lambing percentage: 80-90%.

3.7.4 Exmoor Horn

Importance
A dual purpose sheep, which is both hardy and cheap to keep. They are used extensively to produce crossbred ewes, with whitefaced rams traditionally such as the Bluefaced Leicester, Border Leicester, and more recently the Friesland and Texel. Alternatively they are crossed extensively with the Suffolk. It is these crosses that make up the majority of breeding ewes to be found in the Exmoor area.

History
The breed society was formed in 1906, although the breed was well established before this date. Within the last 15-20 years much work has been carried out to improve the commercial assets of the breed.

Biological Data
Ewe Weight: 65 kg.
Lamb carcase weights: 17 kg on average.
Lambing Percentage: 135-150%.

3.7.5 Bluefaced Leicester rams

Importance

Arguably the most important sire in the British Sheep Industry. Producing a substantial part of the national breeding flock: the Bluefaced Leicester ram crossed with a wide range of hill ewes under a great number of environments has consistently produced a quality cross bred ewe (called a Mule) which will subsequently show the necessary characteristics of lean carcase and prolificacy important to the continuation of the sheep industry. Despite its importance as a breed, upland flocks tend to be small and run 'in parallel' with commercial flocks of other breeds. Excess ewe lambs, ie those not required as replacements, are sold as breeding stock.

Bred in the Dales of Northumberland, it is hardy and is often the only other feasible choice of sire available for tupping with the traditional fell sheep breeds.

History

Indigenous to Hexham in Northumberland, it evolved at the beginning of this century, and is descended from Robert Blakewells experimentation in the 19th century. The breed has been expressively bred as a sire.

4 THE FARM MODELS

Having identified the five possible extensification prescriptions, the next stage was to estimate the financial impact of them on farms in the upland areas. The financial effects of the stocking rate and fertiliser reduction prescriptions were analysed using whole farm models whilst the other prescriptions were analysed using budgets because of their more qualitative aspects.

4.1 Methodology

Data from ADAS reports were aggregated to create a typical or 'modal' farm type for the nine farm types identified in the preceding chapter. For Cumbria the modal types were devised from a combination of ADAS and ECONECO data. These typical farms were then modelled on a spreadsheet package enabling different policy prescriptions to be examined for each area and farming system in turn. The printouts of these models are shown in the Appendix.

4.2 Date sources and assumptions

Data from ADAS sources include areas of inbye, intake and rough grazing, numbers of breeding ewes and suckler cows. Data on lambing rates and flock structure were also based on the above data. Prices of cull and finished stock were those obtained at local markets as published in Farmers Weekly for each type of animal in the appropriate month. Store prices were obtained direct from local auctioneers.

Forage production was based on site classification and level of fertiliser use. Variable costs were derived from Farm Business Survey regional data for 1991/92 converted into physical quantities using typical prices. Data sources were annual reports from Exeter, Manchester and Newcastle Universities.

4.2.1 Fertiliser response functions

Five quadratic response functions for grassland to nitrogen fertiliser were identified to allow for variations in site quality (ADAS Booklet 2315). Response was measured in terms of units of Metabolisable Energy (ME[3]) to kg of nitrogen applied. The site types ranged from poor to very good. The functions are set out in Table 4.1.

[3] One unit of ME = 1,000 Mega Joules of ME per hectare.

Table 4.1: Response of grassland to fertiliser nitrogen by site quality

Site quality	Response function
Poor	$16.2 + 0.303N - 0.0002N^2$
Fair	$20.2 + 0.313N - 0.000208N^2$
Average	$24.3 + 0.332N - 0.000265N^2$
Good	$27.6 + 0.359N - 0.00031N^2$
Very good	$32.5 + 0.361N - 0.000305N^2$

Source: MAFF

The site classification for each model farm was derived by inference from ADAS data on stocking densities and fertiliser application rates. These are of necessity, average figures for each region.

Cumbrian Pennine Moors	Fair
Lake District	Average
Lake District (Herdwick)	Average
Dartmoor	Fair
Exmoor	Good
Northumberland	Average
Yorkshire Dales (traditional Swaledale)	Good
Yorkshire Dales (Mules)	Average

Applications of P and K were assumed to vary in fixed proportions with fertiliser N as the most commonly used fertiliser on this type of farm is 20:10:10 NPK compound. This compound fertiliser was included in the models at a cost of £125 per tonne.

4.2.2 Metabolisable energy requirements

The metabolisable energy (ME) requirements of each system were calculated in the model. These calculations are based on standard data which suggest that the nutritional requirement of a dairy cow for maintenance for a year is 25 units of ME. A beef suckler requires 25 x 0.8 and a ewe 25 x 0.15 (ie, 20 units of ME for a beef animal and 3.75 for a ewe) (Blaxter, 1962).

These standard requirements per head were then multiplied by the number of animals that would give the desired stocking density. This gave an ME requirement for that particular farm type. The ME demand was adjusted on a month-by-month basis to take account of the increased nutrient requirements of the growing lambs. The fertiliser application rates were then adjusted to generate sufficient ME to sustain the flock from the forage area taking into account the site quality. Thus for a given site quality, ME and hence fertiliser requirements per ha will fall as stocking rate is reduced.

4.2.3 Flock performance

A reduction in stocking rates at the same level of N fertilisation is predicted to lead to an improvement in ewe performance. Through better nutrition the ewe could be expected to increase her prolificacy and produce stronger lambs. The value of the ewe as a draft or cull animal will also increase.

There should also be improvements in general flock health and a lower incidence of disease. This is reflected in a greater proportion of high grade rather than low grade draft ewes and fewer cull ewes. Under these circumstances an improved gross margin per ewe should be achieved which in turn will offset, to some extent, the reduction in the enterprise total gross margin.

The performance of the ewes was assumed to improve as stocking densities were reduced. However, under the pro rata fertiliser reduction prescription, lambing percentage was assumed to fall back to the original level, although other gains in performance were assumed to be retained.

The lambing rates used in the analysis are set out in Table 4.2. The table shows three values for each model; current lambing rates under no prescription; lambing rates under a stocking rate prescription but no control on nitrogen use (prescription 1a); and lambing rates under a stocking rate prescription plus a nitrogen use prescription (prescription 1b).

4.2.4 Costs of away-wintering

Typically charges for away-wintering are between 25-35 pence/head/week and travel costs £1-3/head. Periods of up to 20 weeks away are not uncommon, from November to April and December to May, depending on region/farming practice. In this project, the average total away-wintering charges have been taken from survey data.

Table 4.2: Stocking densities and lambing percent for each system

	Stocking density	Lambing per cent
Cumbrian Pennine Moors (Mules)	Current 1.70	108.00
	Prescription 1a 1.50	110.18
	Prescription 1b 1.50	108.00
Cumbrian Pennine Moors	Current 1.70	100.00
	Prescription 1a 1.50	102.02
	Prescription 1b 1.50	100.00
Lake District	Current 1.50	82.00
	Prescription 1a 1.00	86.11
	Prescription 1b 1.00	82.00
Lake District (Herdwick)	Current 2.30	60.00
	Prescription 1a 1.50	64.82
	Prescription 1b 1.50	60.00
Dartmoor	Current 2.00	85.00
	Prescription 1a 1.50	89.25
	Prescription 1b 1.50	85.00
Exmoor	Current 2.50	94.00
	Prescription 1a 1.50	103.4
	Prescription 1b 1.50	94.00
Northumberland	Current 1.25	90.00
	Prescription 1a 1.00	92.25
	Prescription 1b 1.00	90.00
Yorkshire Dales	Current 1.22	90.00
	Prescription 1a 1.00	92.02
	Prescription 1b 1.00	90.00
Yorkshire Dales (Mule)	Current 1.43	105.00
	Prescription 1a 1.00	109.46
	Prescription 1b 1.00	105.00

4.3 Validation of models

The models were tested by altering various key parameters, eg, area, stocking density, etc, and the results compared with data from actual farms/groups of farms. The models were based on the structure developed by the NCC/ADAS reports for assessing the income effect of extensification measures. They are, however, more complex and use present day values. Some areas of the models are based on assumption, especially lambing percentages, and a broad brush approach is adopted which encompasses all breeds and all regions.

Subsequent validation indicates that the results obtained are realistic and generally the models compare favourably with other contemporary models generated by FBS data, MLC data and farming press data. In particular, the gross margins obtained are similar, and the structure of output and costs appear to be flexible enough to represent actual farms. Where 'actual' current data was available the gross margins generated by the models are within plus or minus 10-15%.