APPENDIX 3D

BIO-ECONOMIC MODELLING OF MOORLAND GRAZING SYSTEMS – THE DEPENDENCY UPON AGRICULTURAL AND AGRI-ENVIRONMENTAL SUPPORT PAYMENTS

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BACKGROUND

A downward trend in sheep numbers has been evident in the UK for some time and has continued since the introduction of SPS in January 2005 (Table 1). Overall, breeding female sheep numbers declined by some 6% from December 2004 to December 2006 and suckler cows numbers by 3% over the same period (Table2).

Table 1 Numbers of breeding female sheep (thousands) – selected northern regions of England

Year:	1999	2000	2001	2002	2003	2004	2005	2006
North East	1076	960	780	849	847	846	819	820
North West	1775	1699	974	1347	1321	1356	1321	1302
Yorkshire & The Humber	1163	1052	901	971	954	971	941	915
England	9024	8188	6698	7131	7117	7210	6905	6769

Source: Defra, December Census data

Table 2 Suckler Cow numbers (,000)

Year:	1999	2000	2001	2002	2003	2004	2005	2006
North East	95	87	67	78	76	76	71	72
North West	110	93	60	85	86	90	86	88
Yorkshire & The Humber	99	91	78	81	81	82	78	81
England	850	753	666	693	692	720	676	696

Source: Defra, December Census data

Whilst these data are not specific to the uplands, local information suggests that numbers are declining and some data suggest a shift towards intensification of the lower parts of the hill farm and extensification of the upper moorland parts (Cumulus 2005, Eftec 2006). Data from the Farmers' Voice postal survey work undertaken in England (ADAS, 2006) have been used to compare farmers' intentions on lowland versus Less Favoured Area (LFA) farms. These suggest that reductions for suckler cows and sheep may be greater on LFA farms, at 17% and 8% respectively, than on lowland farms - 13% and 2% respectively. Indeed a significant number of lowland farms appear to be planning to increase or start sheep flocks.

In a study targeting hill farmers in Mid Wales, the Lake District, Speyside/Wester Ross in Scotland and the Peak District, Waterhouse and Morgan-Davies (2007) asked farmers about their livestock systems, recent changes and future plans. The results suggest that changes are likely with respect to both stock numbers and management. Around 40% of responses were registered in each of the three 'no change' categories, but these were not the same farms throughout. Some farmers have already made changes and have no further plans, whilst others have done little yet and will do more in the future. Change is thus the majority view, perhaps best illustrated by the 54% of farmers who thought their neighbours would reduce their sheep numbers. There are many other factors that interact to influence farmers' plans, such as farm size, tenure, age of the farmer and geographic location. Nevertheless, the underlying trend is for stock to be reduced, albeit variably, on livestock grazing farms, and for cattle rather more than for sheep.

Table 3 Preferred strategies for future hill farming

Four strategies for future of hill farming	Farmers[1]	Conservationists[2]
Intensify (more livestock)	0.09	0.05
Extensify (fewer livestock)	0.29	0.29
Change breed or output type	0.09	0.16
Target Environmental Schemes	0.53	0.50

[1] Results from four focus group meetings held in mid-Wales, Scottish Highlands, Lake District and Peak district (Defra Project AW1024)

[2] Results from a workshop held at National Trust for Scotland on CAP reform for upland land use.

Hill farmers offered a choice of four future strategic directions for their farming system (Waterhouse & Morgan-Davies 2007) showed a preference for managing their farms according to environmental schemes (Table 3). Similar results emerged from a Scottish workshop focused on upland conservation workers. A preliminary analysis of these data suggested that farmers saw environmental management schemes as a means of obtaining some guaranteed financial benefit whilst reducing or diversifying labour or freeing up time. Potential benefits to wildlife were given a lower priority and there was no support for the notion that environmental schemes might be of benefit to the farm itself. Farmers considered high levels of bureaucracy and farming according to other people's rules as issues of concern in implementing agri-environmental management schemes, and undergrazing and irreversible grazing land degradation as possible negative consequences arising from their adoption (Waterhouse & Morgan-Davies 2007).

Thus grazing schemes need to be financially sensible, offer opportunities for reducing labour and to not be too constraining in terms of rules or paperwork if they are to be adopted.

There is thus a period of change afoot in the uplands and a range of views on the future, with agri-environmental schemes being a favoured option. The changing background of CAP support is a key issue and creates complex issues both for real farmers and in undertaking any finance-based modelling.

Over the duration of this study, the economic drivers and support mechanisms for hill and upland land management changed profoundly. The introduction of the Single Farm Payment (SFP) as a de-coupled payment replacing direct subsidies was a major change. The 'freedom to farm' implicit within the reforms makes it feasible to consider a much wider range of livestock management systems and financial support mechanisms than previously. In tandem with the introduction of the SFP and continuation in a modified form of LFA payments, new agri-environmental schemes were developed within each of the countries of the United Kingdom.

Modelling approach

The aim of this part of the study included the economic modelling of a series of scenarios based on the field experimental sites (Pwllpeiran and Redesdale) and case study sites (Birkbeck and Molland). Examples from Redesdale are presented here in the most part as the result illustrate the issues. In simple terms there is more variation ‘within’ the models scenarios at a given site, than between them. The economic modelling required assumptions and significant planning with respect of the farming and labour systems and potential management criteria of different schemes for each of the scenario case studies in which they resided. The work up-dated an existing computer based bio-economic model for hill sheep systems (Conington et al., 2004) to which new algorithms for cattle were added. The model (both existing sheep and new cattle) featured two core elements, firstly an energy based model focussing on hill pasture systems (which fed energy requirement data to the vegetation model), this working at the flock/herd level and then secondly a farm-scale model which fitted the outputs from this model into a simple farm model context. This latter scaled up the plot data to a partial farm, bearing in mind the elements of the system outside the ‘moor’ of study. Different scenarios were run, for which the main issue and the main set of assumptions dwelt upon this time off the ‘moor’. For both field experimental and case studies, livestock are removed from the moor for a range of management reasons including mating, lambing, grazing twins on inbye and removal of cattle for all but the main summer season. The focus of this work was to determine the economic considerations of the ‘moor’, not of the inbye area or the whole farm. This was because a) the moor was the focus of the study including the other modelling exercises and b) a wider and much more presumptive series of assumptions would have been needed to move to whole farm situation. The SFP, LFA and agri-environment schemes also pose considerable difficulties in terms of how they are included in economic scenarios. For example, stocking rates under the English Higher Level Stewardship Scheme (HLS) are site-specific, with various supplements potentially available. For widest applicability and simplicity, rather than building layer upon layer of assumptions into the scenarios, a simplistic approach for eligibility was taken for scheme elements.

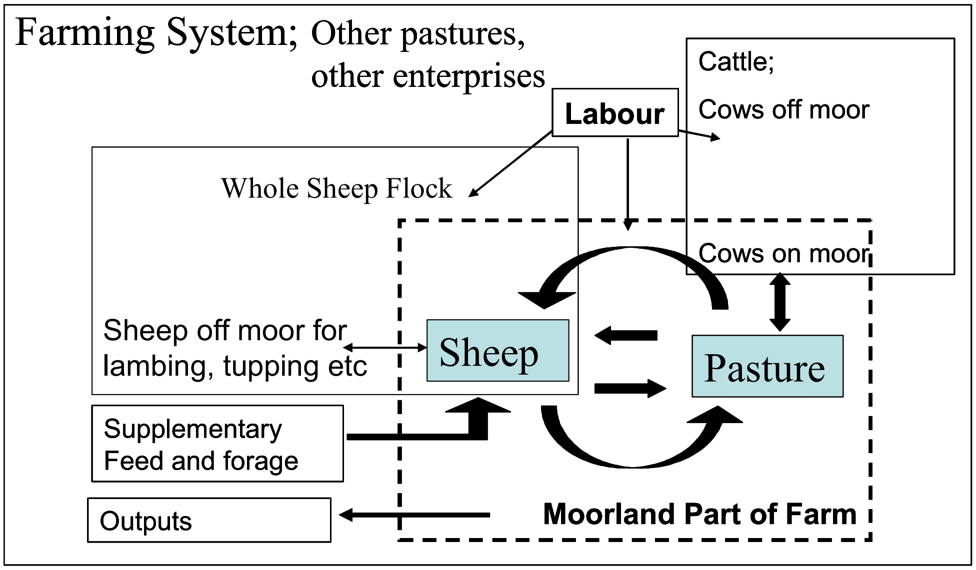

Figure 1 Modelling moorland component of a whole farm system

Modelling exercise 1

There were five scenarios, using the Redesdale system study (72 ha, scaled up to 200 ha). These were selected deliberately to be extreme in relation to evolving policy mechanisms and possible land manager strategies;

1. High sheep stocking (aiming to **maximise sheep** production system without agri-environmental support, but retaining SFP) – 2.1 ewes per ha, the historical level of grazing for the site.
2. A **mixed grazing** model with 0.66 ewes ha^{-1} plus 0.75 cows per ha for 2 months (to retain SFP and obtain the **HLS** payment of £40 ha^{-1}) – coinciding with one of the grazing treatments at the site.
3. Low summer only sheep (aiming to **minimise sheep** numbers, whilst retaining SFP) – sheep at 0.25 ewes ha^{-1}
4. An alternative lower intensity **HLS** strategy, mixing the '**minimise sheep**' with **added cattle -** 0.25 ewes ha^{-1} plus 0.2 cows ha^{-1} for summer.
5. **Abandon** the land with no income – no grazing

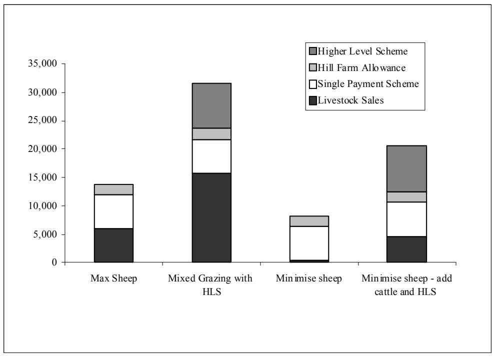

Figure 2a **Income elements (no grazing has nil income), £ per 200 ha annum^{-1}**

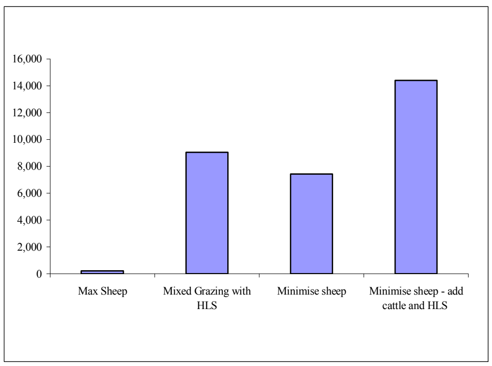

Figure 2b **'Net Margin' (income less variable & labour costs), £ per 200ha annum^{-1}**

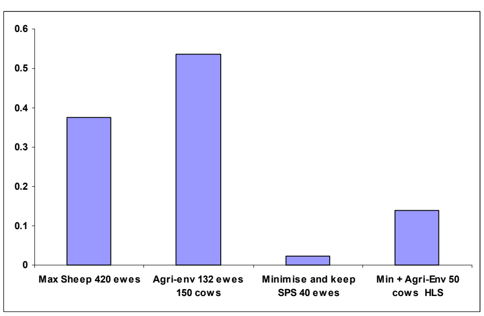

Figure 2c **Full time labour units based on livestock numbers**

This modelling exercise predicted an annual financial turnover of £37,603, £53,508, £9,647, £19,987 and zero, for the five scenarios respectively. The first four scenarios included CAP area payments (SFP and LFA) of £7878, and second and fourth had payments of £8,000 from HLS (Fig. 2a). Using standard figures for labour requirements per livestock head (Stott et al., 2005) and the number of stock involved, estimates of farm labour requirements were made of 0.37, 0.54, 0.02, 0.14 and zero labour units/year to manage the stock on the hill. Margins were calculated for total income less variable costs and an estimate of labour costs only (Fig. 2b). As the moorland component of a farm is responsible for a low proportion of many farm fixed costs, this provided one way of comparing these systems. The 'minimise sheep' scenario produced better margins than the 'maximise sheep' system even if the two CAP payments (SFP and HFA) were re-included. True decoupling, removing the CAP money (of £7878) to a separate account, would leave the maximise sheep scenario with a large deficit, unless the money were notionally re-coupled within the farm accounts. Perhaps the biggest issue in the uplands is labour or the time resources of occupiers of farms, as many are family units still living a lifestyle rather than costing their labour carefully. Figure 2c provides a view of labour trends with these contrasting systems from no labour on the abandoned system, to very high labour levels for the systems with higher stock levels. The labour assumption figures are very simplistic and probably over-estimate labour needs in the 'high' systems and under-estimate it in the 'low'. These labour figures heavily influence fixed costs and net margins and illustrate the issue of labour efficiency more than anything else. Nevertheless they also illustrate the potential gain or loss in labour need under different sorts of scenarios.

Modelling exercise 2

Grazing scenarios were modelled for all 4 sites using the assumptions and approaches tested, and validated with stakeholders. In this exercise a proportion of other whole farm fixed costs (machinery, rents, buildings) were included to produce net margins, rather than only labour.

In this set of scenarios, instead of a simple ELS/HLS payment as used in Exercise 1, differential and additive payments for different cattle systems were included in line with the new HLS Handbooks (Defra 2006). For grazing systems and use of specific breeds under genetic diversity threat, the payment indications refer to 'up to', and advice from Natural England suggests that considerable variation in practice in amount paid per hectare. Nevertheless as an exercise, the stated figures 'up to' are applied here to model the extremes.

The results illustrate the dramatic and divergent impacts that different management scenarios will have on livestock numbers, labour demand and on economic outcomes at farm, local and regional levels. These exercises both confirm that net margins without recoupling of SFP and LFA payments and any agri-environmental payments will be deeply negative (Fig. 3a). Re-coupling the relevant SFP and LFA payment within the farm account moves some of systems theoretically into the positive, but largely by reductions in livestock numbers and subsequent costs (particularly labour). Unless this labour is truly variable (e.g. re-deployed or not hired in the first place) then the whole farm position will not improve, even though marginal economics of the moorland does. Agri-environment payments do have a major impact on margins as modelled (Fig. 3b). Some scenarios move into significant surplus, with low labour inputs and could easily withstand the true decoupling (and eventual disappearance) of SFP and LFA. By contrast with the traditional livestock management scenarios, the agri-environment schemes modelled here had lower inputs of labour, especially seasonally, and much lower outputs of livestock. Fundamental questions arise as to the sustainability of such systems through the time when the stock are not present on the moorland. The scenarios propose high numbers of cattle for short summer grazing periods and scaling these systems up would require significant numbers to be retained on non-moorland farmland and housing for the balance of the time. The key role that different levels of agri-environmental and other support payments make to margins is illustrated by Figure 4, showing the different income sources for each scenario. The low levels of real farm income compared to potential levels of support is highlighted.

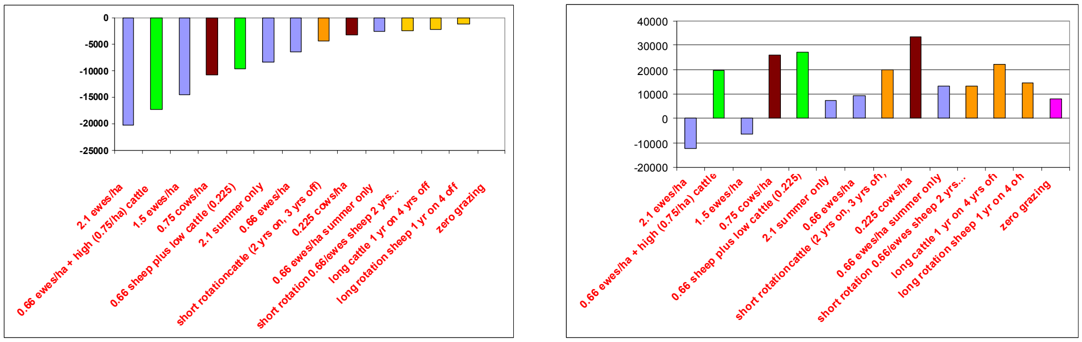

Figure 3 **Net margins for Redesdale a) without SFP and HLS and b) re-coupling SFP and with possible HLS payments including higher cattle supplements**

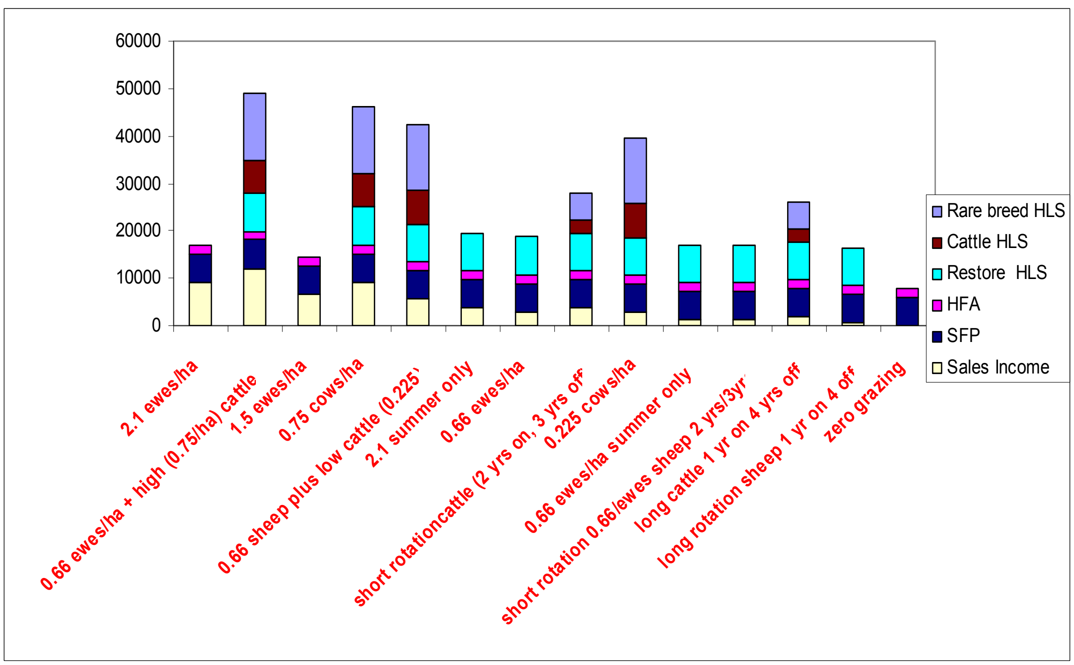

Figure 4 **Sources of income for different management scenarios ranked as in Figure 2**

Modelling exercise 3

The systems studies provide a useful measure of variation in animal performance, outputs and potential margins for land managers adopting different approaches. In this exercise, the stocking densities, outputs could be used to indicate sensitivity of economic outcomes to these different approaches. The mean performance results for each of the four grazing treatments at Redesdale (LS, LSC, HS, HSC) were run through the bio-economic model to provide estimates of offtakes from the moorland portion of the experimental systems and then lonked with the financial model as described above to provide economic data. The plots were scaled up to 200 hectares and thus flock and herd sizes were increased to 132 ewes, 132 ewes &150 cows, 300 ewes and 300 ewes and 150 cows for the four treatments respectively.

Assumptions used in the model included many already used in Exercise 1, so that there is some comparability. Whilst actual animal performance was used where available, many of the financial figures use the same standard costs as in Exercise 1, namely input and fixed costs from SAC Farm Management Handbook. Keeping the differences down to those that matter, inputed output values and inputed labour costs enables some focusing on these issues.

Including cattle financial data in the models is problematical. Two approaches have been used. The first, adopts the same as in Exercise 1, namely attributing a share of costs and income from a suckler herd kept elsewhere on the farm. Given there were dry cows tis would be an autumn calving herd with weaned cows going to the hill, so it is arguable to what extent the hill should bear which proportion of costs and overall incomes. The second approach is the ‘parachute’ the cows in as a flying dry cow herd. A rental of £1/per cow per week is presumed to be paid with no additional costs, though arguably there might be costs of fencing and some extra labour burdens.

Figure 5 shows actual energy offtakes for a mean of all grazing seasons. These provide an indication both of the relative resource use of the moorlands by the livestock and the grazing pressures imposed. The cattle offtakes are very high relative to the sheep and clearly more seasonally biased. The impacts described elsewhere in this report relate to these grazing impacts. The reduced time that cattle spent on the moor in the cattle treatments (64,68,42 and 28 days for 2003-2006 respectively) appear to reflect reduced availability of grass biomass over time. These high levels of cattle numbers appear to be unsustainable in the long term. Growth rates appear more than acceptable, but it is the overall role of the moorland grazing phase in the lifetime of the farm that is questionable, and also poses the most challenges in economic assessment.

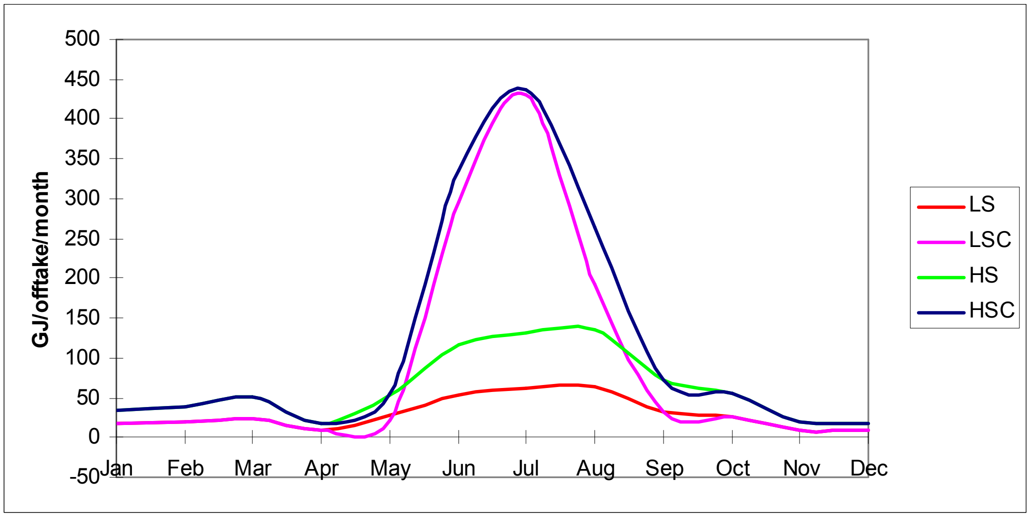

Figure 5 Calculated energy offtakes by the four grazing systems (using livestock values meaned over all four years)

Figure 6 shows standard gross margin figures for the different sheep systems using mean performance figures for the sheep flocks. The systems with high sheep numbers show lower margins per 100 ewes, but because of greater numbers, have greater flock margins. There are small differences between the systems with and without cattle that reflect the small differences in performance noted.

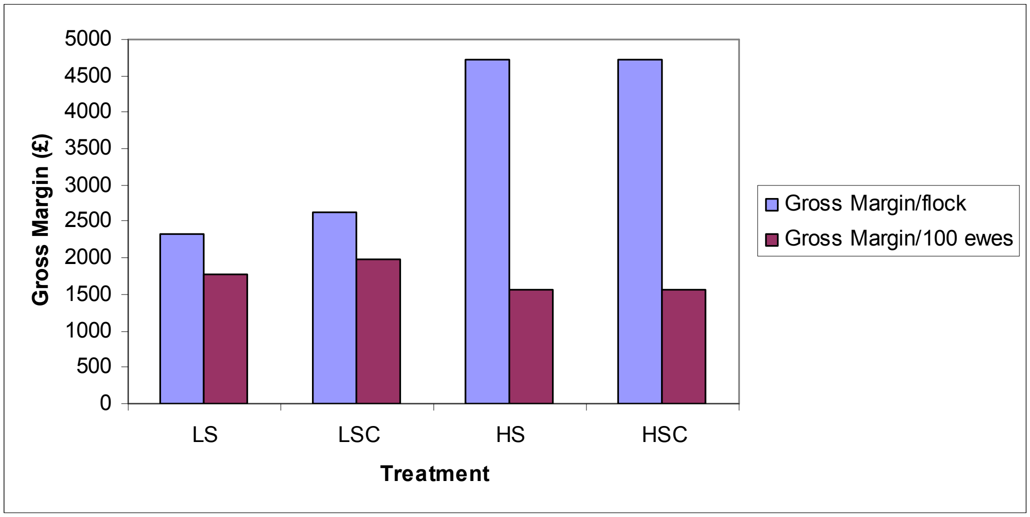

Figure 6 Gross margins for the four Redesdale treatments, scaled up to 200 hectare systems

Using the same basic approach as described in Exercise 1, Table 4 shows the core outputs from this series of modelling taken to incorporate fixed costs. Fixed costs pose the greatest challenge for farming and for modelling. Systems with more sheep have greater gross margins, but because of higher fixed costs diluting out the re-coupled Hill Farming Allowance and Single Farm payment attributable to the moorland part of the farm, net margins become more deeply negative. Removing all support payments, makes the systems deeply negative.

Only by making the moorland system a more marginally costed system (by including labour but not other core fixed costs of an upland farm, as shown with the 'modified' margins) can some margins move back into a positive. Because suckler cow systems have on average high fixed costs and negative net margins a conventional costing including them will always produce margins with greater negativity. Only by adding the suckler herd as a truly 'flying herd' with a small marginal income (from inputted rent) does this effect disappear. However, the fixed costs are still be borne by the imaginary farm supplying the cattle, so net sustainability is hardly improved by this process.

Table 4 **Economic values for Redesdale experimental systems, scaled up to 200 hectares and linked to a larger farm, or where cattle are only included as a marginal activity from a 'neighbour', paying rent**

	LS	LSC	HS	HSC	LSC (marginal cattle[2])	HSC (marginal cattle)
Sales output	2037	16015	4337	18168	3228	5381
Gross Margin	1169	3709	2363	4757	2359	3407
Fixed costs	4205	20134	9557	25486	4205	9557
Labour need (proportion of FTE)	0.07	0.49	0.17	0.59	0.07	0.17
Standard Net Margin (incl SFP)	-3036	-16424	-7194	-20728	-1846	-6150
Net Margin – modified[1] (include SFP)	7,247	2,970	6,151	1,727	8438	7195
Net Margin – exclude SFP	1,247	-3,030	151	-4,273	2438	1195

1 this modified Net Margin only uses labour fixed costs

2 a rental of £1 per cow per week paid, rather than full farm fixed cost model

SOME CONCLUSIONS AND QUESTIONS

- Margins for moorland grazing systems are poor, and usually negative, if true fixed costs for the whole farm are inputted
- Fully decoupled livestock systems have large negative margins
- 'Recoupling' within the farm account can push some scenarios back towards breakeven, but not all
- Potential agri-environment payments can provide very large relative incomes to systems without these payments

- Without some extra support can moorland grazing systems be economically positive?
- To provide an apparently economically sustainable margin, both Single Farm Payments have to be re-coupled within the farm accounts and extra payments made (agri-environment)
- Will they be enough to encourage management change and will agri-environmental management be the priority driver, rather than production or headage-based subsidy?
- Can the budget holders (national governments) afford payments of these levels across the scale of uplands
- Without both the level or the spread of these payments will cattle management of moorlands happen?
- Without both the level and spread of these payments can any form of livestock system continue?

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