MINISTRY OF AGRICULTURE, FISHERIES AND FOOD **CSG 15**

Research and Development

Final Project Report

(Not to be used for LINK projects)

Project title	Organic Sheep and Beef Production in the Uplands
MAFF project code	**OFO302**
Contractor organisation and location	ADAS Redesdale Rochester, Otterburn Newcastle upon Tyne NE19 1SB
Total MAFF project costs	£ 204835
Project start date	01/04/2001
Project end date	31/03/02

Executive summary (maximum 2 sides A4)

The organic unit at ADAS Redesdale was established to evaluate the physical and financial implications of converting a progressive hill/upland unit to an organic system. Conversion of 400 ha, 600 breeding ewes (in 3 flocks) and 35 suckler cows was completed in 1993. One organic flock (Organic Dipper) was managed as a direct comparison with a conventionally managed system (Conventional Dipper). During the early years following conversion, an organic system was developed which, financially, enabled the organic unit to compete favourably with a comparable conventional system. This was on the basis of maintaining similar stocking rates, and pushing the organic system towards maximum output. As the experiment progressed, it became increasingly clear that a different balance of farming and environmental objectives were required if the broader ecological and ethical objectives of organic farming were to be better met. Stocking rate reductions had been made in two of the organically managed flocks (Cairn and Burnhead) in 1995. On the basis of the divergence in flock and individual animal performance, and following recommendations by the Project Steering Committee, sheep stocking rates were reduced by 25% on the Organic Dipper flock from November 2000. From mating in November 2001, breeding ewe numbers on the Burnhead flock were reduced by a further 45% in line with Countryside Stewardship prescriptions.

The overall objective of the study was to compare the long-term performance of organic and conventional hill and upland systems. The project was funded as a one-year extension, pending a review of DEFRA's organic research programme. The 2000/01 production year covered in this report, represented the eighth year under full organic production, and coincided with the redirection of management on the unit towards better integration with agri-environmental objectives. Data were collected on physical and financial performance, animal health and welfare, and market performance. However, the outbreak of foot and mouth disease in February 2001, forced management changes, which significantly affected the systems comparison. Absolute results therefore need to be viewed against this background.

In the direct comparison (split Dipper heft), organically managed ewes were significantly lighter, produced fewer lambs and had higher barren rates than those managed conventionally. Growth rates of twin lambs were also significantly reduced. Selling lambs as stores was not an option during 2001 and, in contrast to previous years, all lambs had to be finished on farm. Organic lambs tended to produce lighter, and leaner carcasses, reflecting poorer finishing conditions.

Lamb losses were also much higher than in previous years (mean 13% across the four experimental flocks), peaking at 18% in the conventionally managed flock. Gross margins (£/ewe) were £25, £17, £23 and £26 for Conventional Dipper, Organic Dipper, Cairn and Burnhead flocks respectively. Compared to the conventional flock, relative flock gross margins were 66%, 81% and 99% for each of the organic flocks respectively. The original organically managed spring calving herd at Redesdale consisted entirely of Angus X Friesian cows, mated with a continental bull. Two additional sub-herds were formed, from calving in April/May 2000.These provided a comparison of conventional beef production with organic production for both wholesale (continental cross) and traditional (Aberdeen Angus) markets. Conception rates in the Angus X Friesian (organic), (Angus X Friesian) conventional and Angus suckler herds were 96%, 100% and 92% respectively. Calf weaning weights were 264 kg, 293 kg and 225 kg. All organic cattle were sold dead-weight, at approximately 40% above conventional finished prices. Suckler herd gross margins (£/cow) were £653, £438 and £366 for each of the three herds respectively.

Analysis of a 10-year data set, resulting from a range of monitoring methods, indicates that changes in vegetation on the hill, reseeds and inbye land were consistent with those expected under the respective management regimes. The main contrasts on the hill land were the result of the higher stocking levels on the Dipper Hill in comparison with the other two hefts, and in the recovery of burnt vegetation sampled on the Burnhead Hill. The vegetation dynamics under organic management were similar to those expected under conventional management of similar intensity. The most important ecological effects were therefore related to the level of intensity of management, rather than the organic status of the unit.

Eight commercial organic farms were costed to provide information on physical and financial performance (related to 2000 born lamb and calf crops) in support of the main study. Stocking rates varied from 0.6 to 1.6 grazing livestock units (GLU) per adjusted hectare. Across the sample of farms, the effect of replacing HLCA (Hill Farming Compensatory Allowance) with HFA (Hill Farming Allowance) in 2000 was generally neutral, but tended to favour more extensive systems. Performance of sheep and cattle were within expected limits for hill and upland production. Farm output (£ per adjusted hectare) was £770, £407, and £592 for linked farms, Newcastle University and IRS FBS costed farms respectively. Whole farm gross margin averaged £587/adj. ha (range £265 – £628), representing extensive and value added production systems respectively. Fixed costs ranged from £332 - £498, compared with fixed costs of £184 and £337 for Newcastle and IRS respectively. Based on the identical sample of five farms, average Net Farm Income (NFI) was £46/adj. ha higher in 2000 than in the previous year. On all but one farm, NFI was equal or lower than the value of manual labour from the farmer and his spouse, resulting in a negative Management and Investment Income.

To investigate the potential to finish organic lambs on home produced forage, a replicated experiment was conducted using Scottish Blackface wether lambs fed diets based on either perennial ryegrass/white clover (PRG/WC) silage or red clover (RC) silage, supplemented with concentrate made up of differing proportions of wheat and beans. There were no statistically significant treatment effects on lamb growth rate, which ranged from 68 – 92 g per day. Lambs fed red clover took an average of 10 days longer to finish, which increased carcass weight (15.5 kg vs. 14.9 kg), and sale value (£32.3 vs. £30.0). Red clover enabled higher dry matter intakes to be achieved, compared with wetter white clover silage. However, neither of the forages were able to achieve the minimum 60:40 forage concentrate ratio required, and all trial lambs were sold onto the conventional market. The experiment confirms the importance of making high quality, high dry matter silage with good intake characteristics if optimum lamb performance is to be achieved. The results question the need for additional protein supplement, when legume silages are fed to finishing organic lambs.

It is difficult to draw precise conclusions on the performance of the organic unit during 2001, given the disruption to management caused by FMD. However, the relative physical performance of organic and conventional systems was broadly in line with previous years. Choice of stocking level and the availability of market premia for organic stock will have a profound effect on animal performance and economic return. Good levels of technical performance are increasingly important, as the price differentials between organic and conventional beef and lamb are eroded. Added value strategies such as direct selling, can significantly boost returns, but are not universally applicable. To generate significant ecological improvements a much more proactive management approach is required. Information from the linked farm study shows that organic farmers are generally willing to spend money on conservation projects. However, in order to make this investment a level of underlying profitability is required. The linked farm study also shows that once conversion aid payments are no longer payable, only a minority of organic hill/upland beef and sheep farms make a significant profit. With profitability increasingly fragile, and organic beef imports running at approximately 35%, any major changes in the organic standards which increase the costs of production could have a disproportionate effect.

Scientific report (maximum 20 sides A4)

1.0 Introduction

The organic unit at ADAS Redesdale was established to evaluate the physical and financial implications of converting a progressive hill/upland unit to an organic system. Conversion of 400 ha, 600 breeding ewes (in 3 self-contained flocks) and 35 suckler cows was completed in 1993. One organic flock (Organic Dipper) was managed as a direct comparison with a conventionally managed system (Conventional Dipper). During the first 5 years following conversion, an organic system was developed which, financially, enabled the organic unit to compete favourably with a comparable conventional system. This was on the basis of maintaining similar stocking rates, and pushing the organic system towards maximum output. As the experiment progressed, it became increasingly clear that a different balance of farming and environmental objectives were required if the broader ecological and ethical objectives of organic farming were to be met more fully. Stocking rate reductions had already been made in two of the organically managed flocks (Cairn and Burnhead) in 1995. On the basis of the substantial divergence in flock and individual animal performance at similar stocking levels, and following recommendations by the Project Steering Committee, sheep stocking rates were reduced by 25% on the Organic Dipper flock from November 2000. From mating in November 2001, breeding ewe numbers on the Burnhead flock were reduced by a further 45% in line with Countryside Stewardship prescriptions. The 2000/01 production year covered in this report, represented the eighth year under full organic production, and coincided with the redirection of management on the unit more towards better integration with agri-environmental objectives.

2.0 Objectives of the study

The overall objective was to compare the long-term performance of organic and conventional hill and upland systems. However, the project was funded by DEFRA as a one-year extension, pending an overall review of the organic research programme. The specific objectives of the research during financial year 2001/02 were:

- To compare the performance of organic and conventional sheep systems
- To establish a comparison of organic and conventional suckled beef production
- To measure effects on vegetation change
- To determine relative economic performance
- To study the physical and financial performance of commercial organic farms
- To examine the potential for finishing lambs on white clover/ryegrass or red clover silages
- To provide effective technology transfer

3.0 Comparison of organic and conventional sheep systems

3.1 Materials and methods

The sheep study comprises four self-contained flocks in a systems study approach. These flocks provide;

- a comparison of organic and conventional systems (Organic and Conventional Dipper flocks), originally at the same stocking levels (2.3 ewes/ha), but with stocking levels of 1.5 ewes/ha in the Organic flock from November 2000.
- an assessment of organic sheep production at reduced stocking rates on the Cairn (1.0 ewes/ha) and Burnhead flocks (1.5 ewes /ha). In addition, the Cairn flock has been managed under a lower level of veterinary inputs relative to the other two organically managed flocks, following the removal of clostridial and pasteurella vaccination in 1995.

Sheep were managed under a modified ‘Two Pasture’ system of hill land management, making strategic use of unimproved native hill (80%), improved hill (17%) and inbye fields (3%) to improve sheep production. Comprehensive data were collected on physical and financial performance, animal health and welfare, and market performance. However, the outbreak of (FMD) in February 2001, imposed management constraints which significantly affected the direct organic vs. conventional comparison. This mainly affected twin-bearing ewes, which could not be moved to their normal in-wintering accommodation. Although organic sheep were turned out onto organic fields after lambing, stocking levels and post lambing management were not wholly consistent between years, or between organic and conventionally managed sheep. Furthermore, the prohibition imposed on the sale of store animals meant that stocking rates both of organic cattle and sheep were significantly higher than planned. The results presented below attempt to put these effects into context. Where appropriate, data from 2001 has been compared with the previous three-year average.

3.2 Results

Physical performance

Since conversion, differences in ewe live weight have progressively widened, so that ewes in the Organic Dipper flock were from 3 kg to 5kg lighter during the production cycle ($P < 0.001$) than the conventionally managed flock (Figure 1).

Fig 1. Ewe liveweight change (kg) - Nov 00 to Nov 01

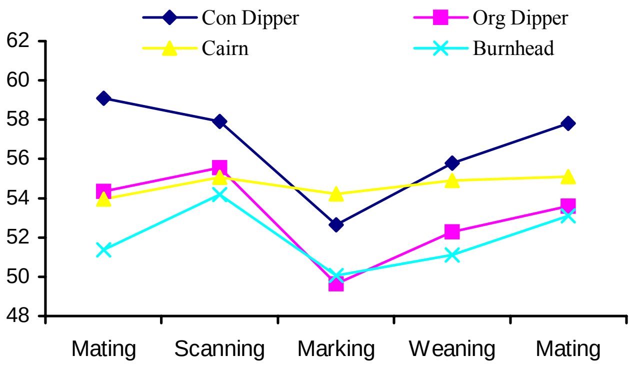
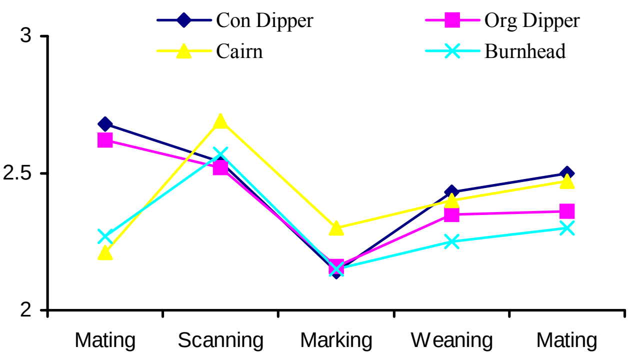


Fig. 2 Ewe body condition score -Nov 00 to Nov 01



In 2000/01, differences in ewe body condition score between Organic and Conventional Dipper flocks were not statistically significant. However, this may be a reflection of the reduction in breeding ewe numbers, when the poorer sheep in each generation would have been removed from the Organic Dipper flock.

Reproductive performance

Established differences in reproductive performance were maintained (Table 1). These differences were magnified by the fact that prolificacy in the Conventional Dipper flock has been exceptionally high, even compared with other pure-bred, conventionally managed Scottish Blackface flocks at Redesdale.

Table 1. Ewe reproductive performance (2000/01)

Parameter measured	Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
Lambs/100 ewes mated				
Born (April 2001)	143	113	114	112
Born alive	130	110	111	109
Weaned (Sept 2001)	127	106	106	108
Scanned (Feb 2002)	143	130	122	129
Ewe barren rate				
% empty (Feb 2002)	3.9	6.3	5.2	2.7

Reducing sheep number in the Organic Dipper and Burnhead flocks from November 2000 and 2001 respectively, seemed to promote an improvement in the numbers of lambs at pregnancy scanning the following February. This may be due to a combination of more grazing available in the late autumn, and the opportunity to cull poorer performing animals from the flock. Barren rates were still tending to be higher in the organically managed flocks. Mean barren rates for the previous three years were 4.4%, 10.7%, 6.3% and 8.3% for Conventional Dipper, Organic Dipper, Cairn and Burnhead flocks respectively.

Wool yield can be a further indicator of ewe size and nutritional status. Average fleece weights (ewes and hoggs combined) were 1.9 kg, 1.8 kg, 1.9 kg and 1.6 kg for Conventional Dipper, Organic Dipper, Cairn and Burnhead flocks respectively.

Lamb performance

There were no statistically significant differences in the performance of single lambs (Table 2). However, twin lambs in the Organic Dipper flock were significantly ($P < 0.05$) lighter and grew more slowly than their conventionally managed counterparts.

Table 2 Lamb live weight and daily liveweight gain (2001 born lamb crop)

Lamb live weight (kg), and Daily Liveweight Gain (g) from birth to weaning		Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
Singles	Birth (kg)	4.2	4.4	4.3	4.2
	Marking (kg)	14.8	14.7	15.7	15.5
	Weaning (kg)	32.3	32.7	33.6	30.3
	DLWG (g)	192	196	203	182
Twins	Birth (kg)	3.6	3.3	3.5	3.5
	Marking (kg)	14.1	12.4	13.7	14.3
	Weaning (kg)	30.7	27.9	29.9	28.2
	DLWG (g)	185	168	183	169

Lamb disposals and carcass data

In a typical hill flock, the proportion of the lamb crop retained as future flock replacements is generally 25% - 30%. Provided they are of sufficient quality, a proportion of 'second-draw' ewe lambs might be sold for breeding, usually at prices considerably higher than those achieved for stores or finished lambs. In previous years, the sale of store lambs from the organic flocks has been very successful. This was not an option in 2001 due to movement restrictions imposed to combat FMD, and all lambs had to be finished, kept as flock replacements within their flock of origin, or transferred for breeding to another flock at ADAS Redesdale (Table 3).

Table 3. Lamb disposals (2001 born lamb crop)

Proportion of total lambs born		Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
Retained	2001	26	31	30	18
for breeding	Previous 3-year av.	24	29	30	29
Sold or transferred	2001	18	0	4	7
for breeding	Previous 3-year av.	11	1	3	2
Sold finished	2001	54	67	63	71
	Previous 3-year av.	65	9	11	23
Sold store (or	2001	2	2	3	4
Welfare Disposal)	Previous 3-year av.	0	61	56	46

As an underlying pattern, the organic flocks have struggled to provide additional quality ewe lambs for sale as breeding stock. The policy of finishing all lambs from the conventional flock continued successfully. Data on carcass classification, and prices actually achieved, are given in Table 4. This combines data from lambs sold to an organic market, with (the majority of) lambs from the organic flocks which had to be sold conventionally (see section on lamb finishing trial below).

Table 4. Carcass data and sale prices achieved (2001 born lamb crop)

Carcass parameter		Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
Conformation (% distribution): best	E	0	0	0	< 1
	U	9	2	9	5
	R	81	69	72	74
	O	10	29	17	21
: poorest	P	0	0	2	0
Fatness (% distribution): leanest	1	0	0	4	4
	2	28	21	27	24
	3L	64	74	56	0
	3H	8	5	13	16
	4L	0	0	0	56
	4H	0	0	0	0
:fattest	5	0	0	0	0
Mean carcass weight (kg)		16.6	15.6	15.5	15.1
Mean killing out %		42.5	42.5	42.5	41.9
Mean price per lamb (£)		34.21	33.89	33.87	33.21
Mean return (£/kg carcass)		2.05	2.17	2.18	2.19
Mean disposal date		12 Jan	7 Jan	5 Jan	30 Dec

In previous years, data from store lambs finished in Wiltshire have compared favourably with similar lambs conventionally produced and sold from Redesdale. In 2001, organic lambs tended to be leaner, which may also have contributed to the poorer conformation scores. Given the season, the results might not be that representative. However, the data does indicate the knock-on effect of poorer growth rates and finishing conditions on carcass quality. Higher mean prices per kg reflect the proportion of lambs sold organically.

Sheep health and welfare

Ewe and lamb mortality

Historically, sheep losses across the four experimental flocks have been well below the accepted averages (typically 5% for ewes, and 15% for lambs) for the industry. However, in 2001 losses were at relatively high levels for the Redesdale system (Table 5).

Table 5. Sheep losses (% of total number)

Proportion of total flock		Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
Ewe deaths	2001	3.9	2.8	5.2	4.0
	Previous 3-year av.	2.4	5.0	2.4	3.9
Lamb deaths	2001	17.8	14.7	11.8	6.8
	Previous 3-year av.	8.6	7.6	7.6	8.3
Hogg deaths	2001	1.8	6.8	0	3.0
	Previous 3-year av.	1.2	1.8	2.0	1.8

Most striking was the exceptionally high levels of lamb deaths (taken as total losses from scanning to sale). These losses were even greater in the conventionally managed flock, which may be a reflection of the high number of total lambs born.

There was no single reason for this loss, which could be a general consequence of the greater difficulties of management pre- and post-lambing in 2001, associated with control of foot and mouth disease (FMD).

The Organic Dipper flock also tended to have a lower proportion of ewe lambs selected for further breeding as hoggs (89% vs 98%), which were of sufficient size and quality to enter the flock 12 months later. This is further evidence of the increased pressure on livestock within the organically managed flock. The exceptionally low numbers of shearlings required for the Burnhead (62%) was as a result of a 45% reduction in breeding ewe numbers from November 2001.

Incidence of clinical disease

Following an outbreak of sheep scab in the locality, infection was confirmed in some of the (non-organic) flocks at Redesdale. Given the contagious nature, and potential severity of the disease, all flocks were treated in January 2001. With prior approval of the Sector Body, the organic sheep were treated with doramectin.

Relying on alternate grazing of inbye land and improved hill for worm control in cattle and sheep, a high level of clinical control was achieved. There was no routine use of anthelmintic before or after lambing. Ewes and lambs were monitored for nematode faecal egg count at weaning. Counts were sufficiently low throughout, such that only 2% of organic lambs were treated on an individual basis at weaning. As a precautionary measure, ewes were also faecal sampled in the autumn for the presence of fluke eggs; none were recorded.

Blood trace element levels (Cu, Co and Se) were within normal ranges.

There was no indication of significantly higher lamb losses in the Cairn flock, following the long-term withdrawal of clostridial and pasteurella vaccination.

4.0 Comparison of organic and conventional suckled beef production

4.1 Materials and methods

The original organically-managed spring calving herd at Redesdale consisted entirely of Angus X Friesian cows, mated with a continental bull. These integrate with the organic sheep flocks, grazing improved areas of the hill from June to October.

In order to create a more direct comparison, two additional sub-herds were formed, from calving in April/May 2000.

These provide an assessment of organic beef production for both wholesale (continental cross) and traditional (Aberdeen Angus) markets (Table 6). For comparison, a conventional sub-herd was formed, by removing from the original Angus x Friesian herd those animals which could not provide the required declaration of BSE-free status for the originating herd. These animals were therefore of similar parity to their organically managed counterparts. A new, predominately Angus (¾ and ⅞ Angus) herd was established by buying bulling heifers. The aim was to adjust the size of each sub-herd to 15-20 suckler cows. However, no breeding animals could be brought onto the farm during summer 2001.

Table 6. Suckler herds at ADAS Redesdale (November 2000)

No.of cows in herd	Dam type	Terminal sire	Management
28	Angus x Friesian	Charolais	Organic
13	Angus x Friesian	Charolais	Conventional
12	Angus	Angus	Organic

All three herds were managed under a similar spring (April/May) calving regime. In recent years the proportion of organic feed dry matter consumed by the suckler herd has been in excess of 99%, for both cows and growing stock. In 2000/01, a greater proportion of non-organically produced forage had to be fed. Over the housed period, 92% of the total dry matter consumed by the suckler cows was fully organic. A further 7% came from second year in-conversion silage, and the remaining 1% the mineral inclusion in the concentrate feed. Weaned calves consumed 23% conventionally produced feed, almost exclusively as hay. Taken on an annual basis and allowing for fully organic forage consumed during the following summer period, the proportion of non-organic feed was below the maximum allowance of 10%.

4.2 Results

Herd fertility

Fertility rates for the suckler herd on the unit have been consistently high. For cows mated in July 2000, conception rates were 96%, 100% and 92% for Angus X Fr (organic), Angus X Fr (conventional) and Angus (organic) herds respectively.

Calf live weight

Overall calf performance was acceptable for a hill suckler herd (Table 7). As expected, pure-bred Angus calves were consistently lighter. This might be due to a combination of younger (first and second calving) cows, lower potential milk yield than halfbred dairy cross cows, and lower genetic growth potential compared to Charolais-sired calves.

Table 7 . Live weight (kg) of spring 2001 born calves

	Steers			**Heifers**		
Live weight at	**Angus X Fr** Organic **(n = 17)**	**Angus X Fr** Conventional **(n = 8)**	**Angus** Organic **(n = 6)**	**Angus X Fr** Organic **(n = 8)**	**Angus X Fr** Conventional **(n = 6)**	**Angus** Organic **(n = 5)**
Birth (April 01)	47	44	35	43	42	35
Weaning (Dec 01)	276	311	218	253	274	231
Turnout (May 02)	429	467	363	404	415	384

Cattle disposals and carcass data

Previous management on the unit has been to sell steers as stores each spring at approximately 13 months of age, while heifers were retained and finished in the autumn at approximately 18 months. In 2001, no cattle could be sold store and growing stock were fed a daily concentrate supplement (2 kg for steers and 1 kg for heifers) from turnout in June. Sales data for the 2000 born organic cattle, sold dead-weight from September 2001 to January 2002, are given in Table 8.

Overall, carcass weights were within target specifications and met the minimum requirement of 240 kg dead-weight, even for heifers. The prices received reflected carcass grades achieved for conformation, and compare well with published prices (MLC market survey) for conventional cattle over the same period of 170p and 165 p for steers and heifers respectively. Heifers tended to have better carcass conformation scores, but this result was likely to be due to higher carcass fatness. The number of animals sold from the Angus sub-herd, were still too low to draw firm conclusions.

Table 8 . Sales and carcass data (Spring 2000 born calves)

Parameter measured		Steers		Heifers	
		Angus X Fr (n = 18)	Angus (n = 2)	Angus X Fr (n = 9)	Angus (n = 3)
Live weight at sale	kg	522.0	518.5	487.9	481.3
Carcass weight	kg	272.3	260.5	251.3	253.8
Killing out	%	52.2	50.2	51.5	52.7
Price live weight	p/kg	127	127	131	129
Price dead-weight	p/kg	244	253	254	245
Carcass conformation	U	6	-	11	-
(% distribution)	R	6	50	45	-
	O+	71	50	33	100
	O-	17	-	11	-
Carcass fat class	2	22	-	-	-
(% distribution)	3	72	100	33	-
	4L	6	-	67	100

Health and welfare

The overall health status of the spring calving herds was very good. The only routine veterinary input to the suckler herd was a single treatment with deltamethrin at housing for ectoparasite control. A homeopathic preparation was given to new-born calves as a preventative against calf scour, and again before weaning against respiratory problems. No anthelmintic was used, even on an individual basis.

5.0 The long-term effects of organic or conventional management on vegetation change

5.1 Materials and methods

Vegetation monitoring has been undertaken since the Unit entered conversion in 1991. Up to 1994, vegetation was analysed at the community level using ordination techniques (Young & Rushton 1994). Since then, changes in individual species abundance over time have been assessed (Oatway & Sanderson 2001). Building on these previous reports, changes at the community and individual species level from 1995 to 2001 were analysed and are presented below. Vegetation monitoring was carried out on the three hefts (Dipper, Cairn and Burnhead) and three land types (open hill, formerly reseeded hill and inbye grassland). Vegetation had been sampled mainly from fixed locations on either a grid or a transect in each block of land. Grids had been used to provide representative coverage of the area sampled. Transects had been used to sample specific vegetation types. A range of monitoring methods had been used, based mainly on fixed quadrats or plots to focus on different aspects of vegetation change:

- Dominance scores of species within 1m × 1m quadrats (Young & Rushton 1993)
- Rooted frequency of plant species at a range of scales within 8m × 4m ADAS plots to maximise sensitivity to change (Critchley & Poulton 1998)
- Presence and grazing frequencies of *Calluna vulgaris* in 1m × 1m quadrats
- Species composition in 2m × 2m quadrats for National Vegetation Classification (NVC) (Rodwell 1991 *et seq.*)

Plant community analyses were carried using a combination of Detrended Correspondence Analysis (DCA) and fuzzy clustering (Equihua, 1990). Changes in the dominance of individual species and in other variables were analysed using Analysis of Variance models.

5.2 Results

Open Hill

Five vegetation types were identified in the Dipper Hill sample. These were *Calluna* wet heath, *Calluna* – *Molinia* wet heath, *Molinia* wet heath, *Nardus* grassland and acid grassland. Over time, all communities on both the organic and conventional units became increasingly dominated by rough grasses such as *Nardus stricta* and *Molinia caerulea* (Fig. 3). The most notable changes in dominance of individual species occurred in the *Calluna* wet heath and in the acid grassland communities. In the *Calluna* wet heath, *Calluna vulgaris* decreased significantly over time on both the organic and the conventional units (both $P<0.001$). There was a corresponding increase in *Carex nigra* on both the organic and conventional units, though this was only significant on the conventional unit ($P<0.01$) (Fig. 4). In the acid grassland community *Trifolium repens* decreased on the conventional unit ($P<0.01$). No significant change was detected in the organic unit, although there was some indication of a decreasing trend in *Trifolium repens*. The grazing assessment that was carried out on *Calluna vulgaris* in 2001 revealed that it had suffered from a serious attack of heather beetle (*Lochmaea suturalis*).

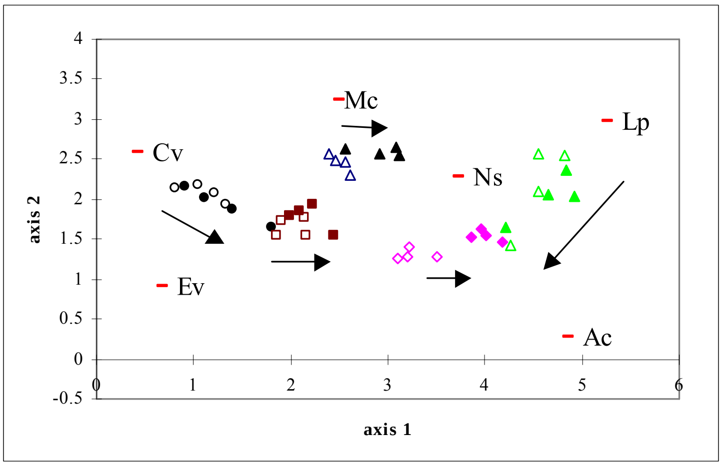


Fig. 3. DCA ordination of first two axes of variation of the Dipper Hill samples. The solid symbols represent the conventional unit and the open symbols the organic unit. Each point represents the mean position of a vegetation type for either the organic or conventional unit in each year (sampling years 1992, 1994, 1997 and 2000). The circles represent *Calluna* wet heath, squares – *Calluna* – *Molinia* wet heath, triangles – *Molinia* wet heath, diamonds – *Nardus* grassland and pale triangles – acid grassland. The arrows indicate the approximate direction of change for each vegetation type over time. The positions of the key species, *Calluna vulgaris* (Cv), *Eriophorum vaginatum* (Ev), *Molinia caerulea* (Mc), *Nardus stricta* (Ns), *Agrostis capillaris*. (Ac) and *Lolium perenne* (Lp) have been plotted to assist interpretation.

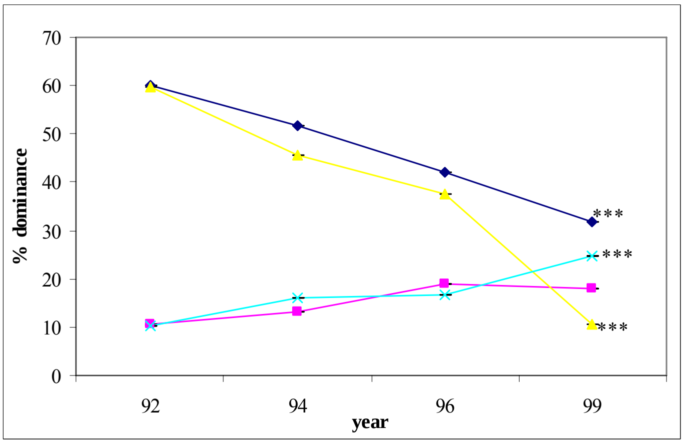


Fig. 4. Changes in cover/dominance of *Calluna vulgaris* and *Carex nigra* in the *Calluna* wet heath community on the Dipper Hill organic (n = 12) and conventional (n = 14) units. Diamond – *Calluna vulgaris*, organic; triangle – *Calluna vulgaris* conventional; square – *Carex nigra* organic; cross – *Carex nigra* conventional.

The Cairn Hill sample consisted mainly of *Calluna* heath, with also some *Calluna* – *Eriophorum* wet heath/blanket mire and *Nardus* grassland. No notable trend over time was evident in any of these at the whole community level. However, *Carex nigra* dominance increased from 2-5% to 9-10% in all the communities (P<0.001). *Nardus stricta* increased in the *Nardus* community from 15% to 21% (P< 0.01), at the expense of *Galium saxatile* which decreased from 21% to 4% (P< 0.001).

The Burnhead Hill comprised *Molinia* dominated wet heath (equivalent to the M15 NVC community), rough *Carex* dominated heath/grassland, and drier *Calluna* heath (similar to NVC communities H12 and M15). A transect was located through an area of *Calluna* heath and *Calluna/Molinia/Nardus* heath. Part of this area had been recently burnt, giving rise to a *Vaccinium* dominated community and a *Deschampsia* – *Carex* dominated community. Over time, changes at the community level were consistent with vegetation succession after burning, with a trend towards *Calluna vulgaris* and away from *Vaccinium myrtillus* and *Deschampsia flexuosa*. The *Calluna/Molinia/Nardus* community also showed a trend towards *Calluna vulgaris* (Fig. 5).

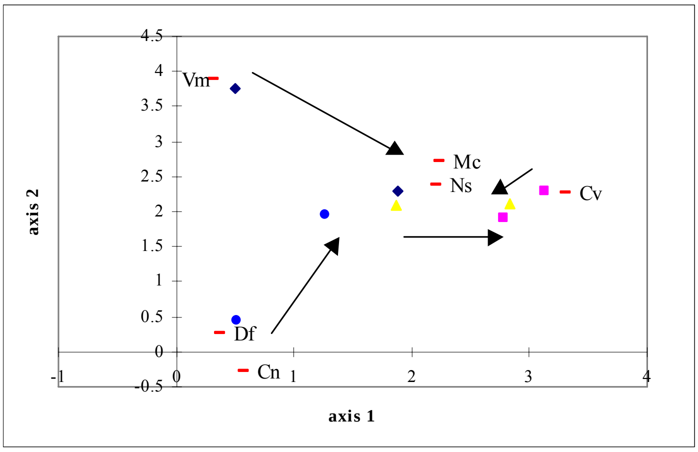


Fig. 5. DCA ordination of first two axes of variation of the Burnhead Hill transect samples. Each point represents the mean position of a vegetation type in each year (sampling years 1997 and 2000). The arrows indicate the approximate direction of change for each vegetation type over time. The diamonds represent recently burnt *Vaccinium* heath, circles – *Deschampsia* – *Carex* recently burnt heath, triangles – *Calluna/Molinia/Nardus* heath, squares – *Calluna* heath. The positions of the key species, *Vaccinium myrtillus* (Vm), *Deschampsia flexuosa* (Df), *Carex nigra* (Cn), *Nardus stricta* (Ns), *Molinia caerulea* (Mc) and *Calluna vulgaris* (Cv), have been plotted to assist interpretation

Analysis of individual species confirmed these trends, with a general increase over time in the dominance of *Calluna vulgaris*. In the recently burnt *Vaccinium* heath, no change in *Calluna vulgaris* dominance was detected (P=0.084), although it did show an increasing trend. *Eriophorum vaginatum* dominance increased (P<0.05) at the expense of *Vaccinium myrtillus* (P<0.001). In the recently burnt *Deschampsia* – *Carex* heath, there were increases in *Calluna vulgaris* (P<0.05) and *Eriophorum vaginatum* (P<0.01) dominance and a corresponding decrease in *Carex nigra* (P<0.001). In the *Calluna/Molinia/Nardus* heath, *Calluna vulgaris* dominance increased at the expense of *Molinia caerulea*, which decreased (both P<0.001). In the *Calluna* heath, no change in *Calluna vulgaris* dominance was detected although, unlike in the other groups, there was a decreasing trend. *Molinia caerulea* dominance decreased whilst *Carex nigra* increased (both P<0.05).

All communities in the Dipper Hill showed a similar trajectory towards rough grass and sedge dominated vegetation. This suggests an overall loss in the diversity of plant communities towards a more uniform type of vegetation across the hill. In particular, where *Calluna vulgaris* was dominant or co-dominant in a community, it declined. In addition, a trend towards rough grass domination was also apparent in the acid grassland community, which contained palatable species such as *Lolium perenne* and *Trifolium repens*. There were similar trends, although not always statistically significant in both the organic and conventional units. The vegetation changes are consistent with those expected as a result of the high stocking rates and consequent high levels of grazing intensity. The loss of *Calluna vulgaris* also appears to have been exacerbated between 1991 and 2001 by the heather beetle attack. It is likely that the affects of overgrazing increased the vulnerability of *Calluna vulgaris* to the heather beetle.

On the Cairn Hill, the plant communities appeared to be fairly stable. The stocking rate, although reduced, had always been fairly low and overgrazing damage to the *Calluna* community did not occur as it had on the Dipper. The increase in *Nardus stricta* might be explained by the reduction of stocking density and grazing pressure resulting in a general increase in biomass, with consequent overtopping of *Galium saxatile*. It is interesting to note the increase of *Carex nigra* on this hill as well as on the Dipper.

Vegetation changes on the burnt areas of the Burnhead Hill were mainly associated with the recovery of *Calluna vulgaris* and associated heath vegetation after burning. This was also reflected by a decline in dominance of *Vaccinium myrtillus*. This is the expected response of heathland vegetation where regeneration is successful. In the *Calluna/Molinia/Nardus* group, *Calluna vulgaris* appeared to have out-competed *Molinia caerulea. Calluna vulgaris* will out-compete *Molinia caerulea* when grazing pressure is not high and when the *Calluna vulgaris* is in a vigorous building or mature phase. In this case, *Calluna vulgaris* was in the mature phase. However, there was also some indication that *Calluna vulgaris* might be declining in the *Calluna* dominated heath, although the magnitude of change was not considered to be of concern. Overall, the condition of this *Calluna vulgaris* dominated part of the hill was favourable. Regeneration of burnt heather was successful whilst the established heather did not appear to be unduly threatened. There was also no evidence of potentially troublesome species such as *Molinia caerulea* increasing.

<u>Improved hill</u>

The Dipper Reseed was primarily *Lolium – Trifolium* improved grassland (similar to the MG7b NVC sub-community), and semi-improved grassland (similar to the MG6 NVC community). Over time, there was a general trend of reversion to the *Holcus – Trifolium* community on both the organic and conventional units. No change was detected in species' dominance in either of the two organic fields. However, in both conventional fields there was a decline in *Trifolium repens* dominance between 1995 and 2001 (90 Acre Top $P<0.05$; 90 Acre Bottom $P<0.001$).

The Burnhead Reseed fields most closely matched the MG6b *Lolium perenne – Cynosurus cristatus* grassland (*Anthoxanthum odoratum* sub-community), with areas of MG10 *Holcus lanatus – Juncus effusus* rush pasture. The Ellenberg N (nitrogen) index showed a small increase between 1998 and 2000 in all the fields ($P<0.05$). Species richness also increased between 1998 and 2000 from 9.2 to 11.5 species per m^2 ($P<0.01$), as did the G (grazing) suited species score ($P<0.05$).

Overall, the reversion of improved to semi-improved grassland seen on the Dipper Reseed typically occurs under permanent pasture management. There might be potential for the MG6 pasture to develop into the more species-rich MG6b *Anthoxanthum odoratum* sub-community, which has higher wildlife conservation value. In time, the pasture is likely to revert further towards MG10 *Holcus lanatus – Juncus effusus* rush pasture. The reduction in *Trifolium repens* dominance in the conventional Dipper fields was probably attributable to applications of inorganic N fertiliser, which are not permitted under organic systems. From 1996 to 2000, up to 64 kg N ha^{-1} was applied in most years. Other inputs on the conventional unit were herbicide applied by wick applicator to control rushes, and insecticide to control leatherjackets.

On the Burnhead Reseed, the increase in the Ellenberg N index (Ellenberg, 1988) suggests that the inputs of farmyard manure, which were introduced after 1997, caused a slight overall increase in productivity. The increase in G suited species score suggested that the introduction of the clean grazing system did have some effect on the vegetation, although the change was indicative of an overall increase in grazing pressure. Rushes have previously been shown to be increasing here (Sibley, 2000), so the area available for stock to graze would be decreasing and the stocking rate might effectively be higher. Also, silage cutting and aftermath grazing by cattle could potentially exert a greater effect of disturbance and defoliation than sheep grazing alone.

<u>Inbye fields</u>

On the North Hayfield (organic), there was a decrease in *Lolium perenne* and *Trifolium repens* dominance (both $P<0.001$) since reseeding in 1992, from 45-50% to approximately 30%. There were corresponding increases in *Ranunculus repens* ($P<0.01$), *Holcus lanatus* ($P<0.01$), *Phleum pratense* ($P<0.001$) and *Poa trivialis* ($P<0.001$), although of a smaller magnitude (from 0-5% to 10-15%).

The West Hayfield (organic) was reseeded in 1999. In 1998 there was a reduction in the dominance of *Lolium perenne* and *Trifolium repens*, and corresponding increases in *Holcus lanatus*, *Poa trivialis*, and *Phleum pratense* (all $P<0.001$), and *Ranunculus repens* ($P<0.01$). Following reseeding, *Lolium perenne* returned to its previous level of dominance, (48%) as did *Trifolium repens* (40%), while the dominance of the other species declined. Between 2000 and 2001, *Lolium perenne* dominance decreased again.

The South Hayfield (conventional) was reseeded in 1997. This resulted in an increase in the sown *Lolium perenne* ($P<0.001$) and a decrease in *Holcus lanatus* ($P<0.01$). In the years following reseeding *Lolium perenne* remained at approximately 50% dominance, then decreased to 18% in 2001, with corresponding increases between 1998 and 2001 of *Poa trivialis* ($P<0.001$), *Ranunculus repens* ($P<0.05$) and *Phleum pratense* ($P<0.001$).

All the fields showed a similar pattern following reseeding. Short-term changes in species composition reflected the establishment of the sown *Lolium perenne* and *Trifolium repens*, followed by an increase in *Phleum pratense* and agricultural weed species.

6.0 Economic performance of conventional and organic systems

6.1 Materials and methods

Comprehensive records of inputs, outputs and financial data were recorded on an individual flock basis to enable enterprise gross margins to be calculated.

6.2 Results

<u>Sheep Gross Margin</u>

Sheep gross margin data (excluding Hill Farming Allowance (HFA)) for each of the four flocks are given below. To adjust for limitations on the movement and finishing of organic stores, the lambs have been valued on the basis of £1.10 per kg weaning weight. This price is £0.10 below that achieved previously, but is realistic in the prevailing market conditions. In addition, flock depreciation has been normalised on the Burnhead flock, to eliminate the effect of the once-off cut in stocking rate as ewe numbers were reduced to Countryside Stewardship levels in November 2001.

Table 9. Flock gross margin (£/ewe)

Flock	Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
No. of ewes mated	181	144	153	173
Output				
Ewe premium	9.43	9.43	9.43	9.43
Lamb sales	29.23	22.73	23.54	26.71
Ewe sales	5.75	2.98	4.22	4.17
Wool sales	0.69	0.66	0.65	0.64
Less flock replacement cost	0.18	3.86	1.73	2.09
Gross output	**44.92**	**31.94**	**36.11**	**38.86**
Variable costs				
Concentrate feed	8.41	6.09	6.12	5.87
Forage	2.23	0.20	0.15	0.16
Vet and Med	4.38	3.99	2.22	2.93
Transport/levies	1.56	0.65	0.61	0.74
Straw	0.31	0.24	0.25	0.24
Misc.(incl. casual labour)	3.42	3.33	3.37	3.29
Total variable costs	**20.31**	**14.50**	**12.72**	**13.23**
Gross margin	**24.61**	**17.44**	**23.39**	**25.63**

Gross output from the organic flocks was £6 to £13 below that achieved from the conventionally managed sheep, as a consequence of fewer and lighter lambs at weaning, and fewer ewe lambs sold for breeding. Flock replacement cost on the Organic Dipper flock was significantly higher, due to a reduced flock valuation in November 2001, compared with zero change or a small appreciation in the other flocks. Total variable costs (before forage) were £4 to £6 lower in the organic flocks. This arises mainly from the additional cost of anthelmintic, and finishing costs for the conventional lambs. Concentrate costs per ewe for the organic sheep was almost £1 higher due to the additional cost of organic beans and barley. Forage costs (£/head) were approximately £2 higher for the conventional sheep, reflecting the cost of fertiliser inputs. Flock gross margins relative to the conventional were 66%, 81% and 99% for the Organic Dipper, Cairn and Burnhead flocks respectively (Table 10).

Table 10 . Gross Margin (£/flock)

Flock	Con. Dipper	Org. Dipper	Cairn (organic)	Burnhead (organic)
No. of ewes mated (2000)	181	144	153	173
Gross Margin before HFA	4456	2512	3580	4434
HFA payments	1260	1260	1065	1204
Gross Margin after HFA	5716	3772	4645	5638
No. of ewes mated (1990)	181	181	200	210
Simulated flock GM (1990)	5716	4417	5745	6586

Taking ewe numbers (112) in the Burnhead flock from November 2001, flock gross margin would fall to 64% that of the Conventional Dipper. Simulated flock gross margin, assuming similar gross margins per head, coupled with the numbers of sheep carried prior to conversion, indicates the scale of additional income support required to maintain parity with conventional production, particularly where significant price premia for organic stock are not available.

6.3 Cattle Gross Margins

Table 11 Suckler herd gross margins (£/head)

	Halfbred Organic	Halfbred conventional	Angus
No. of cows mated	28	13	12
Output			
Suckler cow premium	172.81	172.81	172.81
BSP/Slaughter premium	101.95	79.25	24.11
Sales: Finished	579.50	0	50.35
: Store	0	103.85	0
: Cull cows	8.17	0	19.06
Herd valuation change	- 23.59	240.62	250.29
Gross output	**886.02**	**596.53**	**516.62**
Variable costs			
Concentrate feed: cows	10.34	2.88	10.34
Concentrate feed: calves	104.27	45.35	62.35
Forage	42.06	53.33	29.01
Vet and Med	3.66	3.11	3.29
Commission/levies	21.21	0	9.90
Straw	36.74	46.86	28.60
Miscellaneous	14.39	6.77	7.25
Total variable costs	**232.67**	**158.30**	**150.74**
Gross margin	**653.35**	**438.23**	**365.88**

The comparison of suckler sub-herds has yet to fully stabilise. The high level of performance of the halfbred organic herd, reflects good prices (up to £2.65 kg dead-weight), a preponderance of steers eligible for BSP payments, and the fact that all cattle had to be retained until finished. Concentrate feed represented the greatest proportion of variable cost, particularly for the organic herds. As expected, forage costs were significantly higher for the conventionally managed animals. Organic calves consumed on average 370 kg of organic concentrates (organic beans and barley) over a 222 day winter feeding period, at a cost of £179/t. On average, the conventional calves consumed 280 kg of concentrate, however this figure reflected the sale of heifers in January which reduced stock numbers by 38%. Non-organic straw, imported onto the farm, cost £28 to £47 per cow. Vet and med costs were particularly low, reflecting the good health status of the spring calving herd.

7.0 Physical and financial performance of commercial organic farms

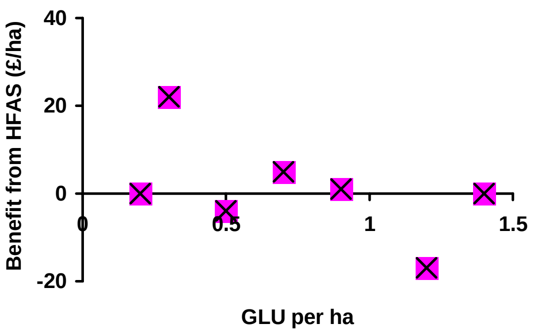
7.1 Materials and methods

Eight commercial organic farms (including ADAS Pwllpeiran) were costed to provide information on the physical and financial performance of organic hill and upland systems. Of these, one was still in conversion during the 2000/01 financial year i.e. stock were not sold as organic, and this farm was not included in the aggregated organic costings. The information collected from the seven converted farms has been compared with results from conventional farms in Farm Business Surveys (FBS) done by University College Wales (IRS) and Newcastle University, and with performance of the organic unit at Redesdale. Two farms were costed to Gross Margin level only. The remaining five farms, were fully costed using ADAS business recording software to provide a management account, balance sheet and individual enterprise gross margins. Data is presented below for the 2000/01 financial year, covering the 2000-born lamb and calf crops.

7.2 Results

Farm area ranged from 55 to 743 hectares; with six farms extended to 100 ha or more. Agricultural output was based mainly on sheep and cattle production, but one also grew arable crops. All farms had less favoured area status. Pasture quality varied, from a very traditional hill farm with little improved land, to a farm with a high proportion of sown swards and some arable cropping. Stocking rates ranged from 0.6 to 1.6 Grazing Livestock Units (GLU) per adjusted ha, with an average of 0.9. This figure is lower than that for conventional units from FBS survey data by IRS (1.2 GLU/ha), but exceeds that for Newcastle University (0.7 GLU/ha). Smaller units tended to be more intensively stocked. Forage costs (£/GLU) ranged from 0 - £72, with an average of £26. This compares with conventional averages of £14 and £37 for Newcastle and IRS costed farms respectively. In 2000, HLCA (Hill Livestock Compensatory Allowance) was replaced by HFA (Hill Farming Allowance). The effect of the change was generally neutral (Fig 6), but tended to favour more extensive systems.

Fig. 6 Impact of HFAS on linked farm revenue



Sheep represented 21%-85% of GLU's on the units. Flock size ranged from 94 to 954 breeding ewes (average 523). Overall levels of physical and financial performance were acceptable for a hill sheep production system. Lamb rearing percentage averaged 108% (range 98% to 140%), compared with means of 102%, 97% and 110% for three organic flocks at Redesdale, Newcastle FBS and IRS FBS farms respectively. The proportion of lambs sold which were finished ranged from 0 to 100%.

Most used a proportion of non-organically produced feeds, but several did not make full use of the derogation available. All farms retained lambs for breeding and most ran closed flocks, only buying in tups. Flock replacement rates varied from 21% to 35%. Terminal sires were chosen to meet market requirements, including Suffolk, Texel and Meatlink. FMD indirectly affected some farms at the end of the financial year, and some stock were culled on the Livestock Welfare Disposal Scheme.

Lambs were sold through producer groups (e.g. OLMC, Organic Farmers Scotland, Border Livestock Exchange), as well as through local abattoirs e.g. Graig Farm Organic Meats in Powys. Two producers sold directly to Waitrose and Marks & Spencer. Organic lamb prices ranged from 180p- 300p /kg dead-weight, depending on carcass classification and time of sale.

Gross Output per ewe was £54, £41 and £39 for linked farms, Redesdale and IRS-FBS flocks respectively. For the linked farm sample, headage subsidies represented 34% of gross output. Mean lamb price was £43, excluding lambs sold directly to the consumer (mean £72). Carcass weights ranged from 12 kg – 20 kg. Newcastle FBS conventional flocks averaged £33 per lamb, 30% lower than organic lambs in the survey. Store lambs often had to travel long distances to a finishing farm. Variable costs, excluding forage costs averaged £14 per ewe. Average veterinary costs (£3; range £0.50 - £6.59) were 50% higher than conventional farms in the IRS sample, due to significant additional expenditure for scab control on two farms. Sheep gross margin per ewe (before forage) was £40, £26 and £26 for linked farms, Redesdale and FBS flocks respectively. Gross margin per ewe in the identical sample of farms was £7 lower than in the previous year (and £17 lower than in 1998), mainly due to lower SAPS and the replacement of HLCA with HFA payments.

Six of the eight farms had suckler cows. Analysis of the cattle enterprise was split between the rearing phase for suckled calves (transferring calves out of the herd at 6 months of age), and a beef rearing/finishing enterprise. Herd size ranged from 10 to 110 cows, with an average of 44. Generally a high level of reproductive performance was achieved, however an infertility problem on one farm brought the average calving rate down to 82% (range 34% - 100%). Herd replacement rates in 2000 averaged 14%, ranging from 5% - 24%. Subsidies contributed 48% to total output. Variable costs at £78/cow (excluding young-stock costs) were considerably higher than both the Redesdale organic herd (£44/cow), and the conventional herds in the IRS-FBS sample (£94/cow). At £269 per cow, suckler gross margins (to production of a weaned calf) was similar to the previous year (£264), despite the introduction of HFA, and very comparable to the Redesdale organic herd (£263), and IRS conventional costed farms (£245).

On most farms male cattle were kept until they were eligible for Beef Special Premium, and all claimed extensification premium. Gross margin per head for cattle rearing and finishing enterprises ranged from £94 to £351, averaging £237/head. Finished cattle prices varied from 220p-300p kg carcass weight.

Six of the eight farms participated in conservation schemes, such as ESA, National Park Farm Scheme and Countryside Stewardship Scheme (CSS, CPS, Tir Gofal). While there were some constraints such as late cutting of forage (resulting in additional feed costs), farmers were generally very positive and used the schemes to benefit the environment through woodland planting, and wildlife features. Three were in receipt of financial assistance under the Organic Aid Scheme. Sources of income other than from livestock sales e.g. land management grants or cash crops, had a significant effect on farm output. On the only farm in the sample with significant cropping enterprises, swedes returned a saleable yield of 4.7t/ha @£230/t, while oats yielded 5.0t@£157/t. Two of the collaborating farms had significant business interests outside of agriculture.

Full farm costing was available for five farms, providing information on whole farm profitability. Farm output (£ per adjusted hectare) was £770, £407, and £592 for linked farms, Newcastle University and IRS FBS costed farms respectively. Whole farm gross margin averaged £587/adj. ha (range £265 – £628), representing extensive and value added production systems respectively. Fixed costs also varied greatly (£332 - £498) between linked farms, reflecting different levels of capital investment required for different enterprises, the individual nature of the business, and the willingness of the owner/occupier to invest in farm infrastructure. Compared to the previous year average fixed costs increased by 12%. Fixed costs (£/adj. ha) for Newcastle and IRS FBS were £184 and £337 respectively. None of the farms felt that organic production *per se* required extra investment or employed labour. Based on the identical sample of five farms, average Net Farm Income (NFI) was £46/adj. ha higher in 2000 than in the previous year. The relative position of most of the units was very similar between years. The scale of average NFI (£89/adj. ha) is still modest, relative the average labour inputs for a farmer and spouse of £110/adj. ha.

For 2000 at least, NFI in the linked farm survey compared favourably with Newcastle (£90/adj. ha) and IRS costed conventional farms (£43/adj. ha) respectively. However, this reflected more the general malaise in farming incomes, rather than high levels of profitability from organic production.

Key components to profitability appear to be farms size (smaller units have concentrated fixed costs), value added (finishing stock is an important factor in realising market premia), and reliance on purchased inputs. The most profitable linked farm (in terms of NFI/adj. ha) combined high output and gross margin, with below average levels of fixed cost. The latter was aided by economies of scale, as this was also the largest unit in the sample. For all but this farm, NFI was equal or lower than the value of manual labour provided by the farmer and spouse, giving a negative Management and Investment Income.

Higher levels of fixed cost may in part still reflect some degree of optimism regarding the organic sector. The recovery in conventional prices together with the expansion in organic supplies, is creating concern over the medium and long-term prospects for the profitability of organic production relative to the conventional. Formal marketing structures have tended to become less significant as farmers try to diversity outlets. There appeared to be wider concern regarding the increasing regulation of farming in general, which increase cost and time demands, particularly, as organic farmers felt they already keep good records, which can be duplicated by Government requirements and other QA Schemes.

8.0 Finishing lambs on white clover/ryegrass or red clover silages

8.1 Materials and methods

An experiment was carried out to determine voluntary feed intake (VFI), liveweight gain (LWG), feed conversion ratio (FCR), and carcass characteristics in Scottish Blackface wether lambs fed diets based on either perennial ryegrass/white clover (PRG/WC) silage or red clover (RC) silage, and supplemented with one of four concentrate feeds consisting of different proportions of wheat and beans. The trial was a continuous design arranged as a 2 x 4 factorial (Table 12) with 2 silage types (PRG/WC and RC) and 4 concentrate types (24 pen replicates each containing 6 animals). The fresh weight (FW) proportion of wheat to beans in the 4 concentrate feeds varied from 100:0, 67:33, 33:67 and 0:100 respectively (i.e. W, WB, BW and B), fed to a maximum daily allowance of 450 g/lamb/day.

Table 12 . Lamb finishing treatments

Treatment		**Description of diet**		
		Wheat (g/lamb/day)	Beans (g/lamb/day)	Silage (*ad libitum*)
Diet 1	(W)	450	0	PRG/WC
Diet 2	(WB)	300	150	PRG/WC
Diet 3	(BW)	150	300	PRG/WC
Diet 4	(B)	0	450	PRG/WC
Diet 5	(W)	450	0	RC
Diet 6	(WB)	300	150	RC
Diet 7	(BW)	150	300	RC
Diet 8	(B)	0	450	RC

8.2 Results

Feed composition

Crude protein content (g/kg DM) of the concentrate fed increased from 136 in W to 196, 256 and 296 in WB, BW and B respectively. Estimated ME was 13.1 – 13.2 MJ/kg DM for all concentrate feeds. The red clover silage fed was made up of first and second cut material (Table 13).

Table 13 Chemical composition of white clover/ryegrass and red clover silages

	PRG/WC	Red Cover 2	Red Clover 1
Dry matter (g/kg)	229	592	233
Crude protein (g/kg/DM)	210	140	215
D value	75.1	54.1	50.6
Estimated M.E. (M.J./kg/DM)	12.0	8.7	8.1
pH	4.1	6.3	7.2
Ammonia – N (g/kg total N)	104	143	162

Both the RC silages had high pH's of 6.3 and 7.5, lower lactic acid levels and higher ammonia-N contents indicating a poorer, much less extensive degree of fermentation.

Lamb performance and feed intakes

Days on trial varied from 81 to 112 across all treatments. Lambs on RC took on average 10 days extra to finish, but this difference was not statistically significant. Type of concentrate fed had no significant effect on days to finish. LWG ranged between 68 and 92 g/day, but again there were no statistically significant differences across treatments. Mean LW at slaughter of 36.3 kg and CCW of 15.2 kg compares with figures of 38.2 kg (LW) and 17.3 (CCW) for Scottish Blackface lambs cited by Conington *et al*, (1998). Lambs on the RC silage were 37.3 kg at slaughter, compared with 35.3 kg for the PRG/WC silage ($P<0.001$). CCW's were 15.5 and 14.9 kg for the RC and PRG/WC silage respectively ($P<0.05$). No significant differences were seen in killing out (KO) proportion, fat score, or conformation score.

Silage DMI's were broadly similar to the values of 494 - 532 g/day recorded by Merrell and Murray (1994) when PRG silage was offered to similar hill lambs *ad libitum*. In this study, voluntary DMI's of 59 - 76 g/kg $LW^{0.75}$ recorded across all diets compare with values of 71 - 81 g/kg $LW^{0.75}$ for Suffolk cross wether lambs given a range of legume forages including early or late cut RC, early or late cut Lucerne, Lotus or Sainfoin (Fraser *et al*, 2000).Voluntary intake of the RC silage was higher compared with the PRG/WC silage on a FWI and DMI basis, and also when DMI was expressed as g/kg LW or g/kg $LW^{0.75}$. Voluntary DMI of RC (586 g/day) was significantly higher ($P<0.001$) than that obtained from PRG/WC silage (458 g/day). It is likely that the higher dry matter content of the RC silage was able to stimulate higher dry matter intakes even when fermentation characteristics were relatively poor.

Forage:Concentrate ratio (F:C) was significantly higher ($P<0.01$) for the RC (60.4:39.6) compared to the PRG/WC silage (54.2:45.8). Forage intakes for both silages were insufficient to meet the minimum prescribed forage concentrate ratio for organic systems (therefore the experimental animals were not sold as organic). This illustrates the practical difficulty encountered by many organic producers when offering forages on an *ad libitum* basis. It is virtually impossible to predict accurately how much silage the animals will eat. Consequently, the farmer has to either adopt the complete diet approach to diet formulation with its expensive machinery costs to ensure a fixed forage:concentrate ratio or adopt a conservative approach to supplementation to ensure that animals do not inadvertently exceed the 40 % concentrate regulation. Generally, the concentrate types containing a high proportion of beans resulted in higher silage intakes, particularly for the RC silage. F:C was highest for the concentrate types containing a high proportion of beans. Feed conversion ratio (FCR) was only affected by concentrate type, such that when beans were fed as the sole concentrate ingredient (B), FCR declined significantly ($P<0.05$).

The effect of beans in stimulating DMI in some diets is difficult to explain, but may be related to either its protein content or its relatively low starch content. Under some circumstances where soluble silage protein is poorly utilised in the rumen, additional dietary protein in the form of amino acids can stimulate intake (Forbes, 1995). Alternatively the lower starch content of the beans compared to the wheat (308 *vs.* 620 g/kg DM) may have reduced any inhibitory effect that dietary starch can cause when fed with forage based diets (Mould *et al*, 1983). These possible effects, either acting single or in combination may explain the increased silage DMI when beans were fed.

Finishing costs and margins

Sale value of lambs (£/lamb) on the RC silage were significantly higher (P<0.01) compared with the PRG/WC silage (32.3 *vs.* 30.0) due to both the higher sale price achieved (mainly a result of later sale), and the heavier carcass weights of lambs achieved. Concentrate type did not influence lamb sale value.

Gross output was significantly higher (P<0.01) for lambs fed RC (£17.2) compared with the PRG/WC (£14.9). Concentrate type did not influence gross output but did significantly (P<0.01) affect concentrate variable cost and inter-acted with silage type. Total variable costs at £12.05/lamb were significantly higher (P<0.01) for RC compared to £10.72/lamb for PRG/WC lambs. Total variable costs were £10.69, £11.17, £10.92 and £12.77 per lamb on diets W, WB, BW and B respectively. For the purposes of comparison, costings were done on the basis of organic and conventional inputs and prices. Conventional GM/lamb ranged from £2.84 to £5.68 across treatments (mean £4.69). Adjusting organic prices to match the OLMC reference grid, increased gross margin to an average of £6.69 per lamb. Organic feed costs (£10.75/lamb) were 77% higher than average conventional feed costs (£6.09/lamb).

It is likely that energy intake was the first limiting nutrient for growth in this trial. The lack of any improvement in LWG on the higher dry matter RC diets can be explained by the fact that predicted ME value for the 2nd cut RC forage at 8.7 MJ/kg DM is much lower than the predicted ME for the PRG/WC at 12.0 MJ/kg DM. Any increase in energy intake which might have been expected as a result of higher DMI was offset by the lower energy value of the RC silage, such that overall similar energy levels are likely to have been available for growth.

The extra protein supplied by the inclusion of beans in the concentrate supplement was likely to have been excreted by the lambs, given that limited energy was available to utilise extra protein for lean tissue growth. The lower FCR when beans were fed also indicates that less energy was being utilised by the animal for tissue growth. This may have arisen as a result of the extra energy costs of excreting the additional protein supplied by the beans. This may have contributed to the occurrence of significant pizzle rot amongst the lambs, which required treatment with antibiotic spray. The condition is recognised in New Zealand, and is associated with urine scald of the pizzle in male lambs typically grazing high legume pastures. Furthermore, the additional cost of beans compared to wheat will reduce profitability. Since no growth rate benefit was obtained from the inclusion of beans, and excess environmental pollution is likely to have been resulted from nitrogen excretion, care is required in the balance of protein and energy supplied, particularly when high protein forages are used as the basal diet.

9.0 Technology transfer

The effects of FMD lasted in Northumberland from February until December 2001. Due to the overriding concerns of biosecurity, virtually no direct technology transfer activities were carried out during the project year. Two publications were produced as outputs from the project;

- KEATINGE, R., (2001) Organic sheepmeat production. In: Organic Livestock Farming. Eds. D Younie & J.M. Wilkinson, Chalcombe Publications 2001, pp145-158.

- STOCKDALE, E.A., LAMPKIN, N.H., HOVI, M, KEATINGE, R., LENNAETSSON, E.K.M. , MACDONALD, D.W., PADEL, S., TATTERSALL, F.H. , WOLFE, M.S. and WATSON, C.A. (2001) Agronomic and environmental implications of organic farming systems. Advances in agronomy. 2001. Vol. 70, p. 261-327.

10.0 Summary and conclusions

It is difficult to draw precise conclusions on the performance of the organic unit during 2001, given the disruption to management caused by the outbreak of FMD. The relative physical performance of organic and conventional systems were broadly in line with previous years. However, less clear is whether the Organic Dipper flock would have responded differently, following the reduction in ewe numbers in November 2000, had management and summer stocking of cattle and sheep been as originally intended.

FMD apart, there were no insurmountable technical problems in managing the unit to current organic standards. There were some indications of an improvement in individual performance in both Organic Dipper and Burnhead flocks following reductions in sheep stocking rates from November 2000 and 2001 respectively. Although cow numbers have yet to stabilise at target levels, there are early indications that the graded up Angus herd will require significant price premia to offset slower growth rates.

It would also be inappropriate to draw too many conclusions from the financial data generated in 2000/01. Broadly the results indicate that a high level of performance is achievable from suckled calf production, particularly if all or a high proportion of the animals could be finished on the farm. However, this is unlikely to be feasible on the unit at Redesdale, where in a normal year stock carrying capacity dictates that some of the cattle must be sold as stores. Relative economic performance of the sheep flocks will also have been upset by the enforced management changes. However, the gross margin data indicates the importance of good technical performance (weight and number of lambs produced) as the price differential for organic lamb begins to be eroded. While reducing sheep numbers may stabilise or improve individual performance, significant alternative income may be required to restore economic parity.

The changes evident in the vegetation of the hill, reseeds and inbye were consistent with those expected under the respective management regimes. The main contrasts on the hill land were the result of the higher stocking levels on the Dipper Hill in comparison with the other two hefts, and in the recovery of burnt vegetation sampled on the Burnhead Hill. On the reseeds, the introduction of the clean grazing system appeared to have had some effect on the vegetation, although this was not of ecological significance. Other changes in the reseeds and inbye were those normally expected in agricultural swards. The vegetation dynamics under organic management were similar to those expected under conventional management of similar intensity. The most important ecological effects were therefore related to the level of intensity of management, rather than the organic status of the unit.

11.0 Policy relevance

The ecological benefits of organic production are generally accepted in lowland farming systems. However hill and upland systems, any potential advantage over conventional production is less clear. This point is confirmed within the current study, where 10 years data on native and improved hill indicated few differences between organic and conventional production at similar stocking rates. To generate significant ecological improvements a much more proactive management approach is required. A reduction in stocking rates is often used to facilitate improvements in the environment and to achieve a more balanced organic system. However, the income foregone can be substantial and must be recouped through price premia, conversion aid, or payments through another agri-environmental scheme.

Good levels of technical performance are increasingly important as the price differentials between organic and conventional beef and lamb are eroded. Added value strategies such as direct selling, can significantly boost returns, but are not universally applicable. Hill farms generally rely on the sale of store stock. There is still a shortfall of lowland farms suitable for further finishing of organic lambs. Some better upland farms may have the potential to finish a greater proportion of home produced lambs. However, forage supply and quality are critical for acceptable technical and economic performance.

Information from the linked farm study shows that organic farmers are generally willing to spend money on conservation projects. However, in order to make this investment a level of underlying profitability is required. The linked farm study also shows that once conversion aid payments are no longer payable, only a minority of organic hill/upland beef and sheep farms make a significant profit.

With profitability increasingly fragile, and organic beef imports running at approximately 35%, any major changes in the organic standards which increase the costs of production could have a disproportionate effect. For example, the requirement to feed, where possible, 100% organic produced supplement is a significant challenge to the organic livestock industry. The situation is exacerbated in the hills and uplands by the greater distances and costs involved, and also the requirement to use formulations (feed blocks or manufactured nuts/pellets) which can be fed in extensive outdoor conditions.

12.0 Recommendations

Organic farming practice is coming under closer scrutiny, and must deliver consumer expectations for quality, animal welfare and environmental benefit. Many farmers remain unconvinced about the long-term viability of the organic system, perceived risks to animal health, and the maintenance of a robust market for organic produce. If the investment to achieve the current rate of conversion is to be sustained longer-term, and expanded, the successful evolution of sustainable, environmentally beneficial, organic systems need to be demonstrated. It is recommended that a research base be maintained on the organic unit at Redesdale, as a resource to assess the long-term agronomic and environmental impact of organic farming in the hills and uplands. In addition, a survey approach to on-farm data collection provides relatively superficial information on management and technical performance. The linked farm survey could be strengthened by the adoption of a more case study approach, which would provide a better insight into the technical and financial factors required for successful organic farming.

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