Extensification of upland pasture in Britain

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Abstract

There is a conflict in British grassland farming between management for agricultural purposes, centring on profit maximisation, and that of nature conservation and the enhancement of biological diversity. Within the European Union's Common Agricultural Policy there is a growing emphasis on reducing output from the community's livestock sector and this is achieved through allocation of quotas (sheep and milk) whilst maintaining a long-term agricultural base. This could result in the widespread adoption of more extensive grazing regimes. An experiment was set up in upland Wales in 1991 to study the effect of reducing inputs and defoliation on species balance and animal production in a *Lolium/Agrostis* dominant pasture. Spectacular changes in species balance took place in the first grazing season. Elimination of CaPK and N applications encouraged *Agrostis capillaris* at the expense of *Lolium perenne* and *Poa* spp. and led to a 43% reduction in stock carrying capacity by the 3rd year. Where no defoliation took place important pasture species such as *Lolium perenne* and *Trifolium repens* were lost from the swards by the 2nd year. However, an annual mid-summer cut maintained these potentially highly productive species within the sward.

Keywords: extensive grazing, low inputs, ryegrass, sheep, species balance, *Trifolium repens,* upland Britain

Introduction

Present UK agricultural policy aims to counteract over-production. Further changes in the agricultural support system are inevitable and it is likely that these will result in lower farm incomes. Upland areas in the UK account for 47% of the agricultural land, 36% of the agricultural holdings and employ 27% of agricultural labour force. Although carrying 12.2 million ewes and 1 million suckler cows (60% of the UK total) these areas are associated with the poorest agricultural land in the UK (Burrell *et al.* 1984). However, there is a commitment to support viable upland communities in these less favoured areas of the European Union (Waters 1994). Increasingly financial incentives are offered to farmers to manage their land with the objectives of meeting the needs of nature conservation and maintaining the aesthetic value of the landscape (Maxwell 1994): One response available to the farmer, in an effort to maintain economic viability, is to reduce the main variable costs associated with the grazing enterprise. This could lead to a reduction in the use of lime and fertiliser and the adoption of a more extensive grazing regime. Whereas much is known in Britain about the botanical change and the increase in production associated with intensification of grassland management there is a scarcity of information on the consequences of a reduction of nutrient input on both sward dynamics and animal output.

Method

An experiment was initiated in 1991 on a 25-year-old perennial ryegrass/bent (*Lolium perenne/Agrostis capillaris)* dominant pasture at Bronydd Mawr Research Station, South Powys, Wales (51° 58'N, 3° 38'W). The site was at a height of 370-390 m above sea level on brown earth soils of the Milford series overlying Devonian red sandstone (Rudeforthet *al.* 1984). Average rainfall was 1500 mm per year with a mean annual temperature of 8°C.

Six experimental treatments were established in a randomised complete block design replicated three times to study the effects of reducing inputs and stocking rates on upland pasture. The effects of the removal of applications of a) N, b) N, P and K, and c) N, P, K and Ca were compared with a treatment which received applications of all four nutrients. Lime was applied at 5 t/ha in September 1990 and 150 kg N /ha, 25 kg P /ha and 50 kg K/ha were applied each year to the appropriate treatments. For these four treatments plot size was 0.4 ha and each plot was continuously stocked with Brecknock Cheviot ewes and their single pure-bred lambs from early May until weaning in August and thereafter with ewes only until the end of October. Animal numbers were regularly adjusted to maintain swards at a constant height of 4 ± 0.5 cm, as measured by the HFRO sward stick (Barthram 1986). During the winter months (November -April) the plots remained ungrazed, re-stocking each year in the spring when the sward reached 4 cm. Two further treatments, plot size

0.2 ha. were initiated at the same time to study the effect on biodiversity of withholding both nutrient application and grazing. One treatment (treatment 5) was defoliated mechanically in July each year (simulating a hay cut) and the herbage removed, whilst the other was left completely undisturbed.

Plant population densities were monitored during the spring and autumn of each year by taking 20 cores of 5 cm diameter, at random, from each of the grazed plots. In the ungrazed treatments, lower tiller densities coupled with greater individual tiller size necessitated a different approach and plant population densities were assessed by randomly selecting 6 cores of 10 cm diameter. Grass tillers from each core were identified and counted and white clover *(Trifolium repens)* removed allowing stolon length to be assessed. Thus the data provided a global description in terms of species range and density for each treatment. Animal production information was provided by stocking density changes and regular 3-weekly weighing of all animals on the experiment.

Results and discussion

The initial botanical assessment took place in the spring 1991 and showed the sward to be uniform in nature and dense with a total of 32 580 tillers/m^2. The sward was dominated by three main grasses *Agrostis capillaris* (13 100/m^2) *Poa* spp. (9670/m^2) and *Lolium perenne* (6930/m^2). White clover was evenly distributed throughout the area at a modest abundance of 20.0 m stolon /m^2.

Autumn 1991

After the first growing season of the experiment significant differences were detected between the treatments (Table 1). Sheep grazing combined with fertiliser inputs favoured *Lolium perenne* and *Poa* spp. *(Poa annua* and *Poa trivialis)* whilst reducing the density of *A. capillaris* by 27%. Grazing in the absence of fertiliser inputs produced the opposite trend with *A. capillaris* increasing its density by 32% whilst *L. perenne* and *Poa* spp. declined in density by 33% and 51% respectively. Total grass tiller density fell slightly under grazing, ranging from 26 200-28 630 tillers/m^2. The tiller density of all the above species fell dramatically in the absence of the grazing animal (treatments 5 and 6). Under these treatments total tiller density of the sward fell by 68% and 86% respectively. Clover stolon density within the swards changed rapidly over the first growing season. Application of 150 kg N /ha reduced the density of clover by 43%. Where nitrogen was withheld but the sward received applications of P, K and Ca, white clover stolon density rose by 199%. Withdrawal of the grazing animal coupled with a single mechanical defoliation in July maintained a substantial amount of clover, whereas complete lack of defoliation almost, eliminated white clover from the sward (31.5 and 1.2 m stolon /m^2 for treatments 5 and 6 respectively).

Table 1 Grass tiller density (nos./m^2) and length of clover stolon (m/m^2) Nov. 1991.

Treatment	Lolium	Aarostls	Poa spp.	Cvnosurus	Holcus	Total	Trifolium
1. CaPKN	7540	9570	9320	2170	0	28630	11.0
2. CaPK	6900	10430	7400	1540	90	26200	59.9
3. Ca	7930	9939	5630	2420	70	26320	31.7
4. Nil	4630	17290	4690	2040	0	26600	28.0
5. Cut/Nil	4640	1360	2220	390	1560	10320	31.5
6. Nil/Nil	1300	740	400	0	1720	4400	1.2
LSD (5%)	3160	3300	4070	1870	1100	3760	•
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Autumn 1992-1993

Data from cores taken in the autumn of 1992 and 1993 confirm and reinforce the changes initiated during the first grazing season (Tables 2 and 3). *A. capillaris* was greatly favoured by the nil input grazing treatment whilst *L. perenne* and *Poa* spp. showed declining densities with reducing inputs. The treatment receiving a full range of inputs recorded a rapid increase in ryegrass density over the 1991 value (83% and 119% increase for 1992 and 1993 respectively) whilst the treatment withholding nitrogen, but receiving other inputs, demonstrated a more gradual increase of this species (37% and 126% for 1992 and 1993 respectively). Where a single defoliation was employed the total grass tiller density remained low and although the sward was dominated by *A. capillaris* and *H. lanatus,* all the species encountered in the original sward were maintained, albeit at a much reduced density. However, in the absence of inputs and defoliation, useful pasture species such as *L. perenne,* and *Cynosurus cristatus* were rapidly lost and the sward became dominated by the large tiller species such *as H. lanatus.* Total tiller density remained extremely low (16% and 15% of the mean grazed-sward value for 1992 and 1993 respectively) and large clump species such as *Dactylis glomerata* and *Alopecurus pratensis,* which were present in the original sward at very low densities, accounted for 5% and 6% respectively, of total tiller density by 1993, visually dominating the treatment through their large size and densely-tufted growth habit.

Clover stolon lengths in 1993 reflected the applied managements and inputs. Under grazing, application of 150 kg N /ha per annum resulted in depressed abundance of clover stolon within the sward as did complete lack of inputs (16.4 and 35.3 m stolon/m^2 for treatments 1 and 4 respectively). Applications of Ca and Ca, P and K increased the abundance of clover within the sward to 61.0 and 108.5 m stolon/ m^2 respectively. Where the grazing animal had been withdrawn but a single mid-summer cut employed (treatment 5) clover abundance fell to 8.5 m stolon/m^2 and in the absence of inputs and defoliation (treatment 6) white clover was missing from the sward.

Animal production

The elimination of nutrient input caused a 32% reduction in lamb output to weaning and this was mainly due to a 43% lower ewe stocking rate for the nil input treatment compared to the full input control (Table 4). The difference in lamb output between the CaPKN and the CaPK treatments has declined over the 3 years, probably due to the increasing clover content of the latter. The experiment was stocked from mid-spring through until late autumn each year. Standard practice in British uplands would be to reduce stocking levels and graze lightly during the winter. However, the low productivity of the swards during the &inter months coupled with restricted individual plot size negated continuous winter grazing. Although the experimental protocol allowed for removal of excess winter herbage (above the 3 cm winter sward height guideline) by short periods of sheep grazing, no such winter grazing was deemed necessary during. the first three years. The stocking rates quoted are for the period May-October and are therefore much higher than those expected over a 12-month period. Larger scale sheep systems studies based at Bronydd Mawr, in which the requirements for all year-round grazing including winter feed and grazing for lambs from weaning to autumn sale are met, indicate annual ewe stocking rates of approximately half the quoted values (Jones et al. 1992)

Table 2 Grass tiller density (nos./m*) sad length of clover stolon (m/m^2) Nov. 1992.

	Treatment	Lolium	Agrostis	Poa spp.	Cvnosurus	Holcus	Total	Trifolium
1.	CaPKN	13620	13260	9360	2590	2260	41750	32.4
2.	CaPK	9330	9560	4630	2520	2760	27980	96.0
3.	ca	7780	14550	4300	2540	1260	33080	54.2
4.	Nil	4960	25550	1430	2350	2250	37540	58.8
5.	Cut/Nil	1970	6030	620	370	3500	15940	26.3
6.	Nil/Nil	0	1990	190	0	2460	5770	0.9
LSD (5%)		4760	9380	2060	1930	-	2340	29.3
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Table 3 Grass tiller density (nos./m*) and length of clover stolon (m/m^2) Nov. 1993.

	Treatment	Lolium	Agrostis	Poa spp.	Cynosurus	Holcus	Total	Trifollum
1.	CaPKN	16540	3700	5440	2560	11510	40120	16.4
2.	CaPK	15410	6450	6220	3440	4180	38900	106.4
3.	Ca	7570	8080	2760	2890	8980	31470	61.0
4.	Nil	3640	14370	1120	2050	12220	34770	35.3
5.	Cut/Nil	590	7600	150	550	3510	14800	8.5
6.	Nil/Nil	0	2650	640	0	1660	5440	0.0
LSD (5%)		4160	5790	3040	1640	6500	7360	25.9
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Conclusions

Vegetation change in the British uplands is considered to be a relatively slow process (Milne 1994). The information presented here suggests that by varying management and inputs, changes can be effected within the first grazing/growing season. Both sward density and relative proportions of the species present in the original sward changed rapidly, but with little indication that ingress of new species had taken place. These spectacular changes in grass-species balance effected by removal of nutrient input produce rapid reductions in pasture productivity. Where nitrogen only had been eliminated the elevated clover content of the sward has offset somewhat, the decline in productivity of the treatment and after 3 years the ryegrass tiller density was comparable to the treatment receiving 150 kg N/ha. With the removal of the grazing animal even greater botanical changes took place. In the absence of defoliation key pasture species such as ryegrass and clover were lost from the sward by the 3rd year. However, an annual mid-summer cut was sufficient to maintain these potentially productive species within the sward.

Table 4 Animal output, mean 1991-1993.

	CaPKN	CaPK	Ca	NIL INPUT
Lamb kg/ha (to weaning)	474	424	361	322
Ewes/ha (May-October)	29.6	23.0	19.6	16.9

ACKNOWLEDGEMENT

The work was commissioned by the UK Ministry of Agriculture, Fisheries and Food.

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