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Alternative upland grazing systems: Impacts on livestock performance and sward characteristics

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ABSTRACT

Grazing management influences both economic sustainability and ecosystem change within farming systems. As part of an integrated study we progressively added elements to an upland sheep farming system in order to quantify the impacts on livestock performance and sward characteristics of (i) introducing cattle, (ii) incorporating semi-natural rough grazing (SNRG), (iii) altering the cattle:sheep stocking ratio, and (iv) replacing the mainstream breed of cattle (Limousin cross) with a rare breed (Belted Galloway). Data were collected for four years from 2005. Mixed grazing with cattle improved the liveweight gains of lambs, particularly post weaning, regardless of the duration of cattle grazing or the cattle:sheep ratio. Calf growth rates were highest on improved pasture, but acceptable weight gains were also recorded for both breed types when grazing the SNRG, with the Limousin cross calves gaining in excess of 1.0 kg d^{-1}. Overall, there was little evidence that altering the grazing system led to increased sward heterogeneity at the field scale under conditions representative of normal agricultural practice. Utilisation of *Molinia caerulea* was similar for the traditional and modern breeds of cattle. The results challenge common perceptions regarding the relative value of different elements within upland livestock systems.

1. Introduction

The UK uplands have always provided public benefits beyond food and timber production, but heightened awareness of their ability to deliver a range of resources and functions has led to much policy debate in recent years (Gibon, 2005; Milne, 2005; Orr, 2008; SAC, 2008; WAG, 2008; Acs et al., 2010). The traditional basis of farming in these areas is the keeping of breeding sheep and suckler cows, and livestock farming has shaped, and sometimes damaged, the upland landscape. At the time this research began the uplands carried around 12 million ewes and more than a million cows; in each case just over 60% of the UK total. Average incomes on upland farms have been, and remain, low and heavily dependent upon support payments (Acs et al., 2010). Since the reform of the Common Agricultural Policy (CAP) in 2003 this support has been decoupled from production, and farmers have been offered financial incentives to manage the land to meet nature conservation and/or heritage objectives. There is however, a dearth of robust data to support many of the management prescriptions advocated by the associated agri-environment schemes. This study sought to test assumptions made by both farmers and conservationists regarding the relative economic and environmental value of different elements within upland livestock systems. In particular it focussed on the use of different pasture types and the role of cattle.

From the 1950s onwards great efforts were made to improve agricultural productivity in the UK uplands. Large areas of land were ploughed and drained, and swards of cultivated grasses established (Newbould, 1974). Herbage production from these 'improved grassland' swards can be over five times higher than from indigenous grasslands (Davies et al., 1984), and consequently such pastures are vital to the viability of livestock farming in the hills. The semi-natural communities which account for the remaining two thirds of the grazing land resource in the uplands are also the product of man's intervention, and declines in the extent and condition of many of these vegetation communities have been linked to inappropriate management (Thompson et al., 1995; Yeo and Blackstock, 2002). Priority Habitats such as Purple Moorgrass and Rush Pastures are highly susceptible to agricultural modification throughout their range (BAP, 2008). In situations where farmers stop actively farming them, because of a perception that the inconvenience outweighs the economic returns, the vegetation can rapidly become rank and impenetrable. Cattle are less selective in their grazing behaviour than sheep (Grant et al., 1985; Fraser et al., 2009c) and have been shown to be beneficial in terms of controlling invasive hill species such as *Molinia caerulea* (Grant et al., 1996; Critchley et al., 2008). Consequently the steady decline in

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beef suckler herds within the uplands has been of particular concern in relation to management of such habitat types.

Incorporating grazing by cattle may also increase production efficiency on improved swards. Results from earlier experiments indicate both mixed and sequential grazing systems have the potential to improve the performance of one or both species (Nolan and Connolly, 1977; Abaye et al., 1994; Fraser et al., 2007). Additional advantages claimed for mixed as opposed to single species grazing include better matching of the animals' seasonal energy requirements to herbage production, diversification of animal production, manipulation of botanical composition of swards and a more balanced use of vegetation resources, thereby promoting ecological stability and reducing the risk of landscape degradation (Nolan and Connolly, 1992). In some cases improvements in lamb growth are achieved at the expense of cattle performance (Wright et al., 2006), suggesting that cattle are more sensitive than sheep to sward conditions and may be disadvantaged in situations where these two species become competitive. However, most of the studies to date have been based on growing stock. The grazing behaviour of cows is known to be different to that of calves (Grings et al., 2001), with mature animals shown to be less selective grazers. Consequently opportunities for complementary grazing may be greater when sheep are mixed grazed with cows, provided intake levels can be maintained. Theoretically the ratio of cattle:sheep within a mixed grazing systems will also influence the degree of competition between these two species (Connolly and Nolan, 1976; Nolan and Connolly, 1977), with evidence suggesting low ratios are required if opportunities for complementary grazing are to be maximised. This has important implications for the implementation of mixed grazing systems in practice since agricultural statistics reveal that there is considerable regional variation in the numbers of these two species within the UK, with the national average prior to CAP reform around 1:10 (MAFF, 2000).

While much of the research to date exploring the impact of different foraging strategies has focussed on between-species differences, the potential for intra-species differences in grazing behaviour must also be addressed if grazing prescriptions, particularly those relating to semi-natural vegetation, are to be evidence-based. In the past changes in nutrition and husbandry practices led to an increase in the use of larger cattle breeds within upland production systems at the expense of traditional hill breeds. In comparison to these modern breed types, native breeds are perceived to have been bred under conditions that ensured they were hardy and able to survive on nutritionally poor vegetation (EN, 2001), and a number of initiatives now exist within the UK to encourage their use as conservation grazers. This is in part due to a widely-held belief that their grazing behaviour is different to that of modern breeds, and more likely to promote biodiversity, although the evidence for this has been largely anecdotal (Rook et al., 2004; DEFRA, 2006). When the potential for cattle breed × pasture interactions were explored in an earlier series of experiments with continental-cross and native Welsh Black steers grazing improved permanent pasture and *Molinia*-dominated rough grazing it was found that utilisation of *Molinia* by the two breed types was similar (Fraser et al., 2009a), and recent experiments on heathland found little difference in the diets consumed by native Welsh Black and continental cross cows (Fraser et al., 2009c). However, the continental cattle failed to thrive at the exposed, high-altitude sites. These findings concur with earlier research suggesting there are differences in the way contrasting types of beef cow and their suckling calves perform in different nutritional environments (Wright et al., 1994; Lowman et al., 1996; Sinclair et al., 1998), and that the poorer quality swards found in the uplands may penalise large continental breeds with high nutrient requirements more than traditional, slower growing breeds. In practice this could create a conflict between meeting production or environmental goals, since although cattle grazing is recognised as a way of improving the biodiversity value of vegetation dominated by species such as *Molinia*, these swards would be expected to have a substantially lower nutritional value than cultivated pastures.

In order to provide an informed basis for future policy developments relating to upland farming an integrated study was initiated. Treatments were set up to quantify the impact on agricultural productivity and biodiversity of progressively altering elements within an upland farming system, *viz.*: incorporating cattle grazing into an upland sheep system; integrating grazing of semi-natural rough grazing (SNRG) into a mixed grazing system based on improved pasture; altering the stocking ratio within a mixed grazing system incorporating SNRG; and replacing the mainstream breed of cattle within a mixed grazing system incorporating SNRG with a traditional breed. All five experimental systems were managed in keeping with standard commercial practice. The specific hypotheses tested were: (1) that sheep productivity is improved under mixed grazing with suckler cows and calves regardless of sheep:cattle ratio or duration of grazing, (2) that cattle productivity is compromised at higher sheep:cattle ratios and when grazing SNRG, (3) that breed × nutrition interactions influence cattle performance on upland swards, (4) that incorporating grazing by cattle alters the structural heterogeneity of improved swards, and (5) that differences in the grazing behaviour of different breed types of cattle affect the impact they have on semi-natural communities.

2. Materials and methods

2.1. Experimental design

The experiment was conducted at the Bronydd Mawr Upland Research Centre, Powys, and was sited at 310 to 360 m a.s.l. on Devonian sandstone of the Milford series. The total experimental area covered over 43 ha of improved pasture and 24 ha of *Molinia*-dominated semi-natural rough grazing (SNRG). A total of five treatments (systems), replicated twice, were implemented as follows: (1) sheep-only, grazing improved permanent pasture (PP) throughout the growing season (S-PP), (2) sheep plus Limousin cross cattle at ratio of 6:1 grazing PP throughout the growing season (S/C6L-PP), (3) sheep plus Limousin cross cattle at ratio of 6:1 with cattle removed to SNRG for 3 summer months (S/C6L-SN), (4) sheep plus Limousin cross cattle at ratio of 12:1 with cattle removed to SNRG for 3 summer months (S/C12L-SN), and (5) sheep plus Belted Galloway cattle at ratio of 6:1 with cattle removed to SNRG for 3 summer months (S/C6BG-SN). Data collection ran for four years from 2005 to 2008.

Individual plot sizes on the PP were 2.25 ha for Treatment 1; 4.75 ha for treatment 2; 4.125 ha for Treatments 3 and 5; and 6.375 ha for Treatment 4. These plots sizes included land allocation for sufficient silage to feed the stock grazing them through the winter months (Table 1) and were designed to give an overall annual stocking rate of 1.6 LU ha^{-1} $year^{-1}$ on the improve pasture within each system. Silage requirement estimates were based on data from earlier experiments conducted at the site (Sibbald et al., 2003; Wright et al., 2006).

In 2004 soil analyses were carried out on samples collected across each of the PP plots and ground limestone applied as required to achieve a target pH of 6. Meteorological data were available from a weather station adjacent to the experimental plots. A comparison of data from each of the four years the experiment ran plus equivalent long-term means revealed that overall 2005 most closely resembled an 'average' season (Table 2). Rainfall was the most variable of all the meteorological parameters recorded, both within and between years.