

The impact of grazing by Irish Moiled and Dexter cattle on soft rush (*Juncus effusus*)



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Aim

To assess the ability of Irish Moiled and Dexter cattle to control the problem species soft rush (*J. effusus*). It is often assumed that traditional breeds of cattle are more 'hardy' and better able to graze species of low nutritional value. This project aims to assess the ability of these traditional breeds as a method of controlling an Ireland wide pest species.

1. Introduction

The soft rush (*Juncus effusus*) is a densely tufted perennial that occurs in grassland throughout the UK (Merchant., 1995) and has a very broad distribution in Ireland, being found in nearly all the 10 km x 10 km grid squares surveyed for the New Atlas of the British and Irish Flora (Preston et al., 2002). This species prefers a wet acidic environment with slightly enriched nutrient conditions and seasonal water level fluctuations, but has a broad ecological range. It is unclear what environmental or other factors influence the development of *J. effusus*. There is no relatively unique set of environmental characteristics that distinguishes *J. effusus* dominated areas from other similar areas. This species is successful in its ability to outcompete other vegetation and in a survey by Mc Corry et al., (2003) on the ecology and management of *Juncus effusus* on cutaway peatlands in Ireland, soft rush has been identified as one of the most important species causing problems through competition. (Mc Corry et al., 2003)

In agricultural situations, certain quick establishing grasses have been prescribed to eradicate the re-establishment of soft rush in ground prone to infestation and experiments have shown wide differences in the efficiency of various plant species in keeping out rush seedlings. A mix of white clover sown with certain species of grass generally produces a denser sward than one or other planted alone and so allowing fewer rushes to establish from seed (Lazenby, 1955 (a)). It also appears high fertility conditions affect rush seedlings as Lazenby (1955 (a)) reported of a higher mortality rate of rush seedlings under these conditions.

Various methods of control have been attempted in pasture with varying results. Cutting, herbicide application, fertiliser application and grazing management have all been used as aids to the control of rushes in pasture (McCarthy, 1971). There has also been a lot of emphasis on drainage as the first step in the control of rushes on agricultural land. Most of the material suggests that a single approach may be successful in the short term, but for long term eradication, this requires the combination of two or more approaches. In the literature, different means of controlling and eradicating rushes have been tested, some of which have conflicted with one another (Mc Corry et al., 2003). Mercer (1939) emphasised the importance of cutting rushes exactly at the right time (first cut July) when rushes seemed to be most susceptible to cutting, but Connell (1936) noted that rushes seemed to be most susceptible to weakening if cut shortly after mid-summer. More recent research by

Merchant (1995) found that even though there were no significant differences in the number or timing of the cuts on *J. effusus* control, cutting rushes to ground level twice during the growing season for at least two consecutive years was probably the best option (Mc Corry et al., 2003).

Unwanted growth of *J. effusus* is not a recent problem. It is well known as an agricultural weed of damp grasslands in Ireland, Britain and New Zealand. It is considered a weed since it is unpalatable to animals and has a low nutritional value (Hopkins and Peel, 1985). Merchant (1993; 1996) carried out research on the potential of controlling soft rush (*J. effusus*) in grass pasture by grazing goats but little accounts have been made on the potential of cattle, especially rare and traditional breeds, in controlling this problem species (Mc Corry et al., 2003). The importance of controlling rush has been emphasised by the Countryside Management Branch of the Department of Agriculture and Rural Development Northern Ireland. Although a certain level of covering can be beneficial to wildlife for breeding waders in certain habitat types, when not managed, dense coverings of rush can affect the agricultural quality of land and the eligibility for DARD land-based schemes such as Single Farm Payment and Agri-Environment scheme payments. Permitted methods of rush control are limited to 'overall application of herbicide, 'weed wiper application of herbicide' and 'rush control by cutting' (DARDNI.com) but in reality, the process of rush control is a lot more complex and requires a combination of control measures with correct timing.

Within this experiment, I will be assessing the potential of rare and native breeds in controlling the grassland problem species *Juncus effusus* through grazing. The breeds I have used in this study are Irish Moiled and Dexter cattle.

2. Literature review

2.1.1. Soft rush (*J. effusus*) ecology and lifecycle

A combination of low fertility with fairly high and constant rainfall has led to one of the North of Ireland's worst pests – rushes (Mercer, 1939). It is common report, and no doubt well founded, that rushes have increased heavily during the past decades. Mercer (1939) notes that assuming that rushes grow in 'wet, sour land' is an untrustworthy generalisation and drainage and the application of lime alone are not, by themselves, necessarily cures. The limited amount of research conducted specifically on *J. effusus* is surprising, as it is a moderately important agricultural weed (Mc Corry et al., 2003). Mc Corry et al, (2003) supposed that the limited documentation on *J. effusus* was due to the plant having not caused substantial agricultural management problems or that management problems have been solved. It may be possible that it is due to the need for better understanding and education on managing rush-infested or rush-prone land. Lazenby (1955a; 1955b) and Agnew (1961) carried out research in relation to the status of *J. effusus* as an agricultural weed but there has not been much recent published research on the biology or ecology of *J. effusus* in Britain and Ireland (McCorry et al., 2003).

J. effusus usually flowers in the second year and probably sets seed every year (Lazenby, 1955b). Fruiting occurs in July and August, and seed are shed over a long period after opening and may still be collected during the following spring. Seeds are very light (c. 13 mg) small (2–2.5 mm) capsules (Stockey and Hunt, 1994). The plant produces copious amounts of seed with potentially 8,500 seeds produced per fertile shoot per annum (McCarthy, 1971). A figure of 8 million seeds per square yard per season on an "average piece of rushy land" has been suggested (Moore and Burr, 1948). Ervin and Wetzel (2001) calculated that 4 million seeds were produced per square metre. However, despite the large quantity of seeds produced, the estimated biomass of seeds represented only 0.27% of *J. effusus* annual net production (Mc Corry et al., 2003).

Seeds are dispersed naturally, mainly by wind and probably also by water. Dispersal of seed by wind usually occurs in dry weather and the lateral spread of seed by the wind may be restricted to 1.3 m from the parent plant (Agnew, 1961). Dry rush seed also floats on water so surface run-off is likely to contribute to its spread (McCarthy, 1971). Seeds may also be

dispersed by machinery and by adhering to animals, aided by the stickiness of the seed-coat. Seeds do not germinate until April following ripening (Lazenby, 1955b). *J. effusus* is capable of vegetative reproduction and can form extensive clonal patches due to the growth of rhizomes (Richards and Clapham, 1941b). Once a stand has developed however, seedlings do not contribute much to its maintenance (Wetzel and Howe, 1999). The establishment of this species requires an open habitat because of its susceptibility to competition from other plants, and seedlings have low resistance to disturbance such as grazing and cutting (Lazenby, 1955a; Agnew, 1961). Lazenby suggested that soil fertility had no effect on the initial establishment of *J. effusus* seedlings but that it could indirectly increase total germination and establishment (Mc Corry et al., 2003) through creating greater competition from other species which favour higher fertility.

J. effusus is tolerant of a wide range of ecological conditions. It may be abundant or locally dominant in a range of damp or waterlogged habitats including wet meadows, moorland and woodland, and on a wide range of soils, particularly where the water-table fluctuates (Richards and Clapham, 1941b). While *J. effusus* is characteristic of damp situations, it can tolerate a broad range of water-table fluctuation (Smart et al., 1989), but it rarely occurs on permanently submerged habitats (Grime et al., 1990), appearing to be confined to soils that are aerated for at least part of the year. *J. effusus* appears to be relatively frost tolerant in winter (Grime et al., 1990).

2.2.2 Nutritional values of soft rush (*Juncus effusus*)

Soft rush is considered unpalatable to animals and has a low nutritional value (Hopkins and Peel, 1985). Trinder (1975) reported on the nutritional values of *Juncus conglomeratus*, which closely resembles *Juncus effusus* and it appears the digestibility differs for time of year. Trinder (1975) noted values of organic matter digestibility for new season's growth of *Juncus conglomeratus*, of 570gkg⁻¹ in May, falling rapidly to 386gkg⁻¹ in August. The feeding value of this early growth is surprisingly high but such changes in digestibility are likely to affect grazing preference and intake of rush as the season progresses (Merchant, 1993). It is also possible that starting levels of a vegetation type will affect intake as Petrides (1975) indicated that generally, the intake of a component of pasture declines as its presence in the sward decreases, unless it is highly preferred.

2.2 Control of *J. effusus*

As previously mentioned, unwanted growth of *J. effusus* is not a recent problem. It is well known as an agricultural weed of damp grasslands in Ireland, Britain and New Zealand. *J. effusus* is most likely to colonise older permanent pastures where the drainage is impeded, rainfall is high and grazing provides patches of disturbed soil suitable for seed germination (Chervil, 1995). In Ireland, there have been references to management of 'rushy' pasture as far back as 1776 (McCarthy, 1971). There has been some effort to investigate the best ways to eradicate or limit the spread of rushes, mainly to improve land for pasture, dating back to the 1930s. Some of this research or these accounts of rush control may be outdated as technology has improved however; the principles that were used remain relevant and can be applied to more modern methods (Mc Corry et al., 2003).

Some different methods of control have been attempted in pasture with varying results. Cutting, herbicide application, fertiliser application and grazing management have all been used as aids to the control of rushes in pasture (McCarthy, 1971). There has also been a lot of emphasis on drainage as the first step in the control of rushes. Some workers applied manure or fertilisers in conjunction with cutting or grazing. In some cases this had the effect of controlling rushes via the disturbance due to grazing or cutting and via the increased competition from other plants that favoured the more fertile conditions. Most of the accounts indicate that a single approach, be it cutting or spraying herbicide, could be effective if managed properly, but better results were usually obtained when two approaches were taken together or in combination, e.g. draining the land and then cutting, or cutting and then spraying herbicide. (Mc Corry et al., 2003). These accounts also indicated that while rushes could be controlled with good pasture management it could be a slow process over several years but, rushes could also be successfully eliminated in one year (Howard, 1949).

Many of the accounts also emphasised that control measures do not remove or alter the environmental conditions that caused the rushes to occur in the first place. Targeting or trying to prevent reproduction is an important strategy in the control of the plant. Control during flowering or before seeds are produced could severely reduce the potential for reproduction during the season, although this may be difficult with *J. effusus* because of its

broad period of flower emergence. Timing appears vital in the management of rushes. The optimal time to control this perennial plant is during the time of peak growth rates. *J. effusus* has a seasonal growth cycle with growth rates and shoot emergence peaking in summer (June – August) therefore, this is regarded as the best time to target the plant. Control of the plant is restricted by the limited research of its growth cycle but it is said to be probably correlated with seasonal climatic factors such as temperature and rainfall (Mc Corry et al., 2003).



Figure 1. Tussocks of mature soft rush (*J. effusus*) in plot 3.

2.2.1 The role of the grazing animal in controlling soft rush (*J. effusus*)

Once established, the tussocks of *Juncus sp.* are quite resilient and are typically left by animals, as the surrounding softer grasses and herbs are grazed. McCarthy, (1971) noted that *Juncus sp.* tussocks are only grazed in extreme cases when there are heavy stocking rates. While sheep, cattle and goats can graze *J. effusus*, grazing alone does not easily eliminate the plant (Lazenby, 1955a; Merchant, 1993) and it is moderately resistant to trampling (Richards and Clapham, 1941). In agricultural situations, *J. effusus* is relatively easy to control using a variety of mowing and herbicide applications, along with land

improvement (drainage) (Mc Corry et al., 2003). Experiments carried out by Jones (1935) illustrate the wide differences between the contributions made by rushes to the sward when the management is varied. It has been suggested by Jones (1935) that rushes need grazing as a contribution to rush management as he noticed that rushes tended to thrive in the absence of grazing animal. It was noted that rushes grew well on most grazing plots especially those undergrazed, but hard grazing throughout the year practically killed them, and they were markedly reduced in number and vigour by hard grazing in the summer.

The lifecycle of *J. effusus* has possible weak points that are easily exploited to enhance control efficiency. This may be necessary to achieve eradication through grazing as Jones (1951) noted that although young shoots are fairly palatable, they soon become coarse and are then neglected by stock; because of this, grazing without cutting seems insufficient seriously to reduce rush infestation (Long, 1930, Jones 1951). Particularly noticeable is the grazing animal's aversion to the tufted type of rush; such plants are often ignored completely and usually grow relatively undisturbed. Species of herbivores appear to affect rush differently as Lazenby (1956) noted that cattle tend to be less selective than sheep in their grazing habits and will eat the younger rush shoots and even some of the older ones.

2.2.2 The use of goats to control rush-infested pasture

Goats have been used to control a range of plant species in Australia and New Zealand (Holst and Campbell, 1987) and have been assessed in their potential to control *J. effusus*. Goats are known for their ability to graze rushes even when grass is plentiful and when there was access to other species of indigenous vegetation (Merchant, 1993). The rush consists of a densely branching rhizome system running 0.6-5.0cm below the soil surface, from which develop crowded erect flowering or sterile aerial shoots. Nutrients stored in the underground stem make the plants moderately resistant to defoliation and mechanical damage (Richards and Clapham, 1941). Merchant (1993) found the goats selected green rush stems and were observed to eat these from the tip downward, often including flowering heads in the first bite. As goats continued grazing rushes at low stem heights, they were observed pulling the stems from the sheath of scale leaves, increasing the severity of defoliation beyond that which could be achieved by cutting.

Merchant (1993) concluded that rushes can survive severe but occasional defoliation and concluded that defoliation of 90% of current season's growth over 2-3 months, from July to September in 1 year, seriously weakened the rushes, and maintaining this grazing pressure for two summers appeared to kill mature rush tussocks. Goats will select a mixed diet to maximise their rate of nutrient intake and under certain conditions, the goats grazed a mixed diet of rush and grass. (rush cover at or below 10% and intertussock sward heights between 3cm and 6cm) (Merchant, 1995). Accessibility of green stems appears to be related to rush intake by goats as maximum intakes of rush per head are likely to be achieved in early summer and where the rushes have previously been cut to remove dead material which allows easy access to green stems.(Merchant, 1995) Merchant (1993; 1995) found the level of stocking, in this case of goats, is unlikely to reduce the vigour of mature rushes although, it may prevent an increase in size and spread of tussocks.. While achieving rates of rush defoliation that will affect rush control, it is important to maintain a desired level of animal performance (Merchant, 1995).

2.2.3 Effect of grazing on the rush

Timing has shown to be important in the degree of control achieved but further detailed studies on the effects of timing and severity of defoliation on the vigour of the rush are required before the grazing animal can be used to best advantage. Grazing with cattle (Howard, 1949) or sheep at stocking levels greater than 40 ha⁻¹ (Jones, 1935) in association with cutting has been shown to be effective in reducing rushes in pasture, and is likely to be related to frequency of defoliation. Goat grazing was also progressive, in that once the tussocks had been grazed down, the goats ate regrowth as it appeared, thus exhausting reserves of the plant. Although evidence exists that grazing by defoliation alone can be successful, Jones (1935) obtained a reduction in rushes through mowing four times between April and October and lightly grazing with sheep.

2.2.4 The effect of pattern and severity of cutting on the vigour of soft rush

There is conflicting evidence regarding the reduction in rush vigour that can be achieved by cutting in summer (Davies and Harris, 1953), and further disagreement exists regarding the optimum time for cutting during the growing period. Mature plants can withstand

defoliation to ground level at least once annually, particularly during the dormant winter period. (Connell, 1936; Grant et al., 1984). The results suggested that cutting rushes to ground level twice during the growing season is more effective at reducing rush vigour. Where only a single cut is possible, cutting in August after flowering is the best option.

Campbell (1953) thought that cutting was most effective when carried out from May to June but the results obtained in Merchant's (1993) results are in line with those of Connell (1936) and Elliot (1953), who found that defoliation by cutting after flowering, from mid-summer onwards, was most effective at weakening the rush. Merchant (1995) found, after testing three levels of defoliation at two cutting dates (June and August), that there was no significant effect of number or timing of the cuts. Mercer (1939), Elliot (1953), and Davies and Harris (1953) reported that cutting from July onwards was most effective at reducing rush vigour than cutting earlier in the year, but Campbell (1953) suggested that cutting between May and June was most effective. However, none of these reports gives any details about mowing heights or severity of defoliation, or any detailed information about the vigour of individual tussocks as most of these authors recorded changes in estimated ground cover (Merchant, 1995).

In comparisons made of cutting rushes and grazing rushes with goats, cutting rushes to ground level once or twice annually weakened the tussocks but this contrasts with a complete kill of mature tussocks after defoliation by grazing goats from June to mid-September for two consecutive years (Merchant, 1993). Merchant (1995) concluded that goats were more effective than mowing in reducing rush in the pasture due to their ability to damage the rhizomes of the rush which occur from 1 to 5cm below the soil surface (Richards and Clapham, 1941), which cutting is unlikely to do. For long term results, both Davies and Harris (1953) and Connell (1936) stressed the importance of maintaining a dense, close sward to compete with rushes for the success of any cutting regime.

2.2.5 The use of Herbicides

J. effusus poses particular problems for the application of herbicide to control the plant. For one, *J. effusus* has a thicker waxy cuticle and epidermal layer that can affect absorption. Furthermore, good weather conditions are required as poor environmental conditions can reduce the effectiveness of the herbicide. Several different herbicides have been used on

rushes with varying success over the past sixty years. Both MCPA and 2, 4-D products have been effective when used on rushes in Britain and New Zealand (Elliott, 1953). Campbell (1953) reported that better results were obtained when spraying 2, 4-D in May/June compared to spraying in July/August, while Davies and Harris (1953) found no real differences in effectiveness of spray applied in June and August.

The use of weed wiping has been stated as a method to greatly increase the possibility of getting sufficient herbicide into the plant and creating good control. Different methods of application can be adopted. Some investigators found that cutting before and/or after herbicide applications increased the effectiveness of control (McCarthy, 1971). Cutting before herbicide applications would stimulate growth, produce new shoots and use more resources from the rhizomes. Cutting after herbicide applications may prevent recovery via unaffected green shoots as long as the herbicide has been translocated to the growth centres in the rhizomes. Cutting before the herbicide has been translocated to the roots and rhizomes would allow these parts to remain unaffected by the herbicide (Mc Corry et al, 2003).

2.3 Matching livestock type to desired outcomes in pastures

2.3.1 The use of traditional cattle breeds in grazing systems

The use of traditional or rustic livestock breeds is often recommended for nature conservation management (e.g. Bullock and Oates, 1998). Such recommendations are partly based on the perceived hardiness of these animals and their ability to be more sensitive to natural vegetation. Indeed this is implicit in such publications as the Breed profiles handbook produced in the UK by the Grazing Animals Project that give for each breed an assessment of its impact on vegetation. The underlying differences in foraging behaviour between breeds have received relatively little attention (Isselstein et al, 2007). In an experiment of grazing behaviour on EU biodiverse grassland of commercial breeds of cattle there were few differences in the diet selection of livestock from commercial and traditional breeds, although North Devon cattle expressed a greater selection for tall grazing sites compared with Charolais x Holstein steers. At the other sites, traditional breeds were slightly less selective than commercial breeds (Dumont et al. 2007).

Time period may also be important in attaining a desired outcome for a habitat type. During an experiment by Talyor et al., (2001) on the impact on sward composition and stock performance on Molinia-dominant grassland, there was an overall reduction of Molinia on cattle grazed plots over a period of two months. However, this reduction was not enough to reverse the long-term increase in Molinia dominance. The rate of change could potentially be increased by imposing a higher Molinia utilisation level (Grant et al., 1996), but this would be likely to have a detrimental effect on stock performance (Fraser et al, 2011). Breed type is likely to have less impact than age and physiological status, as previous studies have shown utilisation of Molinia by traditional and modern breeds of cattle to be similar (Fraser et al., 2009).

2.3.2 Age, sex and size effects

It has been written that breed differences and their preferences, like species differences, can largely be explained by differences in body size and the consequent allometric relationships with food intake, digestibility and selectivity (e.g. Illius and Gordon, 1987). Body mass and associated allometric relationships with food intake and digestibility mean that cattle are more dependent on quantity than quality of vegetation, and they are less able to graze selectively at a fine scale (Rook et al., 2003). Small herbivores generally require more energy relative to their gut capacity than large ones and thus have to select higher quality foods. In contrast, larger animals with relatively large gut capacity in relation to their metabolic requirements can retain digesta in the gastro-intestinal tract for longer and thus digest it more thoroughly (Illius and Gordon, 1993).

Age also effects selectivity (Ferrer-Cazcarra and Petit, 1995) as mature stock have shown to be less selective feeders than young stock, and barren or dry cows could be a more viable alternative due to their lower relative nutritive requirements (Rook et al.,2003). The animal's physiological state will also affect its dietary selection. For example, hungry animals have been shown to be less selective (Newman et al., 1994), and sheep and cattle have also been shown to alter their foraging behaviour differently as a response to fasting (Dumont et al., 1995).

2.2.2 *Grazing pressure*

Experiments have shown how grazing pressure effects animal preference and at moderate grazing pressures animals are more able to express their dietary preferences levels (Milne and Osoro, 1997). Further, the importance of forage types and dietary choices may change in different habitats and these will alter over a period of time. This is due both to the physiological state of the animal, that is demand effects, and supply effects such as the availability of herbage and the phenology of the plant. Within a plot, patch size and more generally the spatial distribution of preferred food patches (Dumont et al., 2003) can affect diet selection by herbivores. Independent of herbivore species and of the abundance of the preferred patches, animal selectivity is greater when preferred patches are aggregated rather than dispersed over the whole plot area. This is consistent with what would be the optimal trade-off between the benefits of eating a preferred food and the costs of foraging for that food (Thornley et al., 1994), suggesting that the costs of searching for patches is increased when they are dispersed.

2.3.3 *Effects of learning and experience*

Prior experience of certain pastures in early life may affect subsequent selection. Learning early in life is known to affect intake of relatively undesirable forages (Distel and Provenza, 1991) and foraging skills of domestic ruminants (Flores et al., 1989). Consequently, sheep, cattle and goats placed in unfamiliar and complex environments spend up to 20% more time eating, but ingest as much as 40% less food than animals experienced in these environments (Provenza and Balph, 1987). There is experimental evidence that briefly exposing animals to new plant species at a young age affects their subsequent grazing choices (e.g., Ramos and Tenessen, 1992; Ganskopp and Cruz, 1999).



Figure 2. Plot 6 after grazing for several weeks.

3. Materials and Methods

3.1 Site details and treatments

The experimental site was located at Oxford Island, part of Craigavon Borough Council owned land. The study site undergoes annual grazing and is currently under the Countryside Management Scheme as Species Rich Wet Grassland. Forage quality is poor and infested by soft rush (*Juncus effusus*). Cattle grazed plots in three treatments – high density (6 traditional Irish Moiled cattle), light density (4 traditional Irish Moiled cattle) and low density (2 traditional Dexter cattle). The treatments were imposed during the period from July to October and replicated in adjacent sites. An already enclosed area of pasture, of approximately 19 acres, was subdivided randomly into 6 plots of 50mx100m and treatments were allocated randomly. Initial rush and vegetation cover was estimated from measurements of percentage ground cover, made by ten randomly chosen 2mx2m quadrats per plot. This was repeated after animals exited the study plots. Baseline vegetation heights were also recorded in each plot prior to entry and exit heights measured after removal of animals. A secondary part to the experiment included the re-use of plot 1. After Irish Moiled cattle had exited, it was used to test grazing of soft rush regrowth. The plot, named plot 7, was cut with a harvester and left to grow for 3 weeks prior to animals entering. Vegetation height and type was measured immediately after cutting, prior to entry and after exiting; following the same method as above. Cut material was not lifted from the plot and was left to decompose.

Plot no.	Enter Date	Exit Date
Plot 1	06/07/2012	17/07/2012
Plot 2	06/07/2012	31/07/2012
Plot 3	06/07/2012	06/09/2012
Plot 4	26/07/2012	20/08/2012
Plot 5	07/08/2012	06/09/2012
Plot 6	11/09/2012	16/10/2012
Plot 7	27/09/2012	09/10/2012

Table 1: Displays entry and exit date for plots 1 – 7.

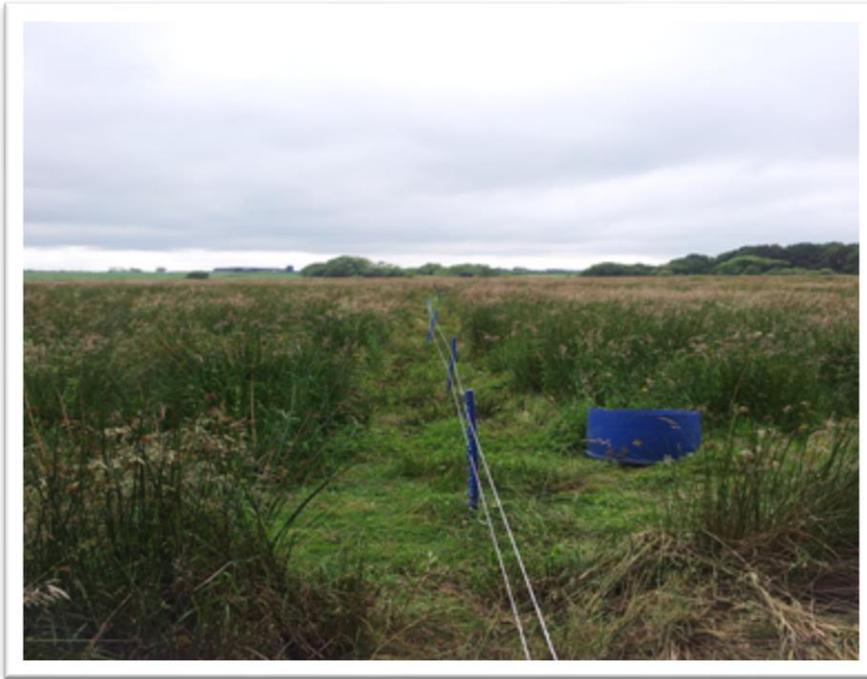


Figure 3. Plot perimeters were strimmed and temporary electric fencing was used to enclose animals.

3.1.1 Animals

Experimental stock comprised of traditional Irish Moiled Cattle of varying ages (see table 2) including lactating and non-lactating cows, heifers and castrated males. The two Dexter cattle included an adult non-lactating cow, and a heifer. In one plot, cows nursing calves were used but calves were not counted in the experiment. The total experimental grazing period lasted from 06 July to 09 October. See Table 1 for individual plot entry and exit dates. Throughout the experiment it was important not to stress the animals and prevent stock from losing condition. Animals were kept in until grass availability became too low to support them. Forage cover was not uniform throughout plots with sparse forage availability in some sections of the plot and dense levels in another.

3.1.2 Sward measurements

Botanical composition measurements were made once prior to animal entry and after animals were removed from the study plots. Species composition was recorded by measuring percentage cover through ten randomly positioned 2mx2m quadrats. Weekly data was collected by walking a 'W' of the plot and recording the height with a sward measurement stick, plant type and signs of grazing (recorded as Y/N) after every fifth step.

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
22/01/2011	17/2/2009	08/12/2010	17/12/2009	12/12/2008	08/12/2010	22/01/2011
01/06/2008	10/07/2011	01/06/2007	10/09/2009	12/07/2011	01/06/2007	01/06/2008
30/07/2007	08/04/1998		19/07/2008	01/06/2008		30/07/2007
09/07/2008	10/09/2012		08/03/2009	09/07/2008		09/07/2008
08/03/2009			12/12/2008			08/03/2009
12/12/2008			30/07/2007			12/12/2008

Table 2: Displays animal dates of birth for each grazing plot.

Utilisation of rush was measured by the proportion of stems apparently grazed. Baseline vegetation heights prior to animal entry were also recorded using this method and again for final vegetation measurements after animal exited study plots. To simplify presentation of the results, plants with similar functional and morphological characteristics have been grouped together. The category grasses includes, 'yorkshire fog, crested dog tail, creeping bent, velvet bent, common bent and meadow fox tail. Species Richness includes, 'creeping and marsh buttercup, creeping and marsh thistle, mouse ear, common sorrel, curly leafed and broad-leafed dock, nettle, creeping jenny, ragged robin, bog pimpernel, marsh willow herb, cut leaves crane bill, bush vetch, birds foot trefoil, burnet saxifrage, greater stitchwort and black medic. The dominant rush type was soft rush (*Juncus effusus*). Bare ground and poaching; dung; trampled rush; and dead rush were also included in measurements. Sward measurements for plot 7 were carried out immediately after the vegetation was cut. The plot was left to grow for 3 weeks and measured prior to animal entry and again once animals exited the plot.

4. Results

4.1.1 Statistical analyses of rush data

Weekly grass and rush heights and percentage cover of vegetation were subjected to analysis of variance between treatments. Baseline grass and rush heights and initial percentage cover of quadrats were used to determine change within treatments. Weekly grass and rush heights were also compared between treatments, where data was available. Other variables such as trampled rush and species richness were tested within the different treatments and initial levels were compared against exit levels.

Treatment	Rush ht wk 1	Rush ht wk 1- baseline rush ht	Rush ht week 2	Rush ht wk2 -baseline rush ht	Rush ht wk 3	Rush ht wk 3 - baseline rush ht	Rush ht wk 4	Rush ht wk 4 - baseline rush ht
6 moileys	102	-5.5						
4 moileys	79	-22.5	102	0.5	97	-4.5	94	-7.5
2 Dexters	109.5	3	97.5	-9	99.5	-7	89.5	-17
e.s.e	7.19	14.12	8.16	1.458	9.25	5.06	15.35	12.49
Sig	0.114 NS	0.512 NS	0.734 NS	0.044 *	0.866 NS	0.76 NS	0.855 NS	0.645 NS

Table 3. ANOVA results. Mean rush heights (cm) per sampling occasion. Baseline vegetation heights are those taken prior to animal entry. Baseline heights are compared against weekly heights to calculate change in height (cm).

4.2 Rush Heights

Measures of initial rush heights showed no significant difference between treatment plots. Heights of rush in week 1 showed no significant difference between treatments and although 6 IM cattle and 4 IM cattle showed a decrease of -5.5cm and -22.5cm respectively, there was no significant change between treatments of initial rush heights and week 1 heights. There was no significant difference in rush height during week 2 samples between the 4 IM plots and 2 Dexter plots although, there was however, a significantly valid difference found between treatments of rush heights in week 2 against baseline rush heights. Results indicate that 4 IM cattle had no real impact on rush height by week 2 (0.50) in comparison to a decrease of -9.00 in Dexter grazing plots.

The data suggests there was no significant difference of rush height between treatments of 4 IM and 2 Dexters in weeks 3 and 4. Both treatments of 4 IM cattle and 2 Dexter cattle showed a change in rush height during week 3 from baseline rush height but results suggest there was no difference in effect of treatment on the rush height. Both treatments of 4 IM cattle and 2 Dexter cattle showed a change in rush height during week 4 from the baseline heights (decrease of -7.5 and -17.0 respectively). There was no significant difference between treatments. Due to the nature of the site and the uneven water table, I was unable to carry out complete sampling of plot 5 (4 IM) on certain weekly occasions during the experimental grazing period. This meant that I was unable to get a true representation of heights within this plot. This experimental error may have affected results and would explain the irregularity of heights for the 4 Moileys in Table 3.

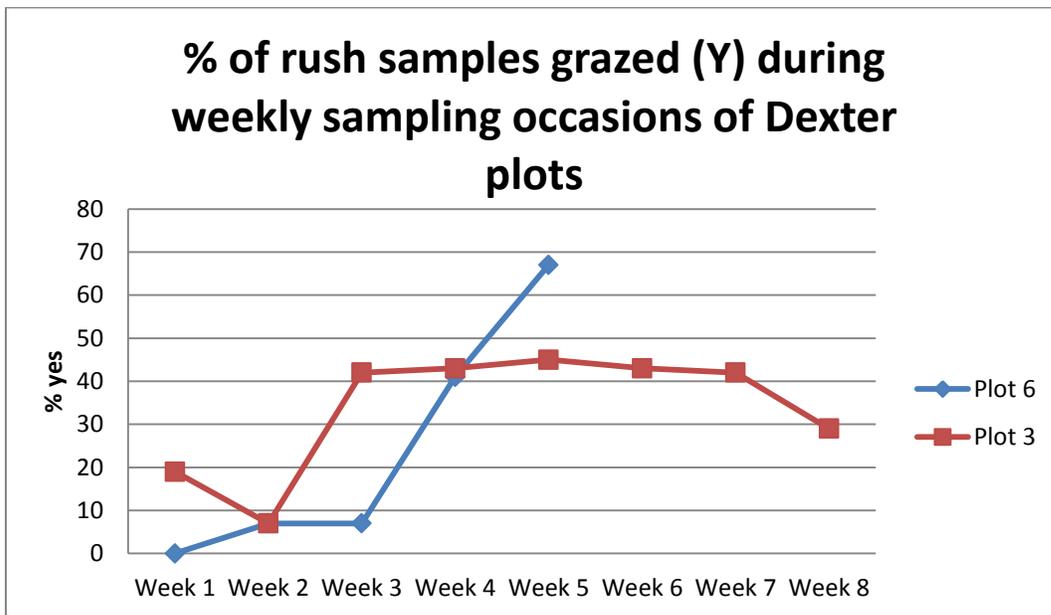


Figure 4. The graph above displays the percentage of rush recorded as being positively grazed by Dexter cattle throughout the grazing period for plots 3 and 6. Figures for this graph are worked out by calculating the amount of rush samples recorded as yes as a percentage of the total rush samples recorded in that week (a collection of Y and N samples). Plot 6 experiences an initial low level of rush grazing until recordings of grazed rush begin to rise after week 3. Plot 3 experiences an initial drop in percentage of grazed rush until it begins to increase after week 2. From week 3 to week 7, levels of rush grazing become quite steady until a final reduction in week 8.

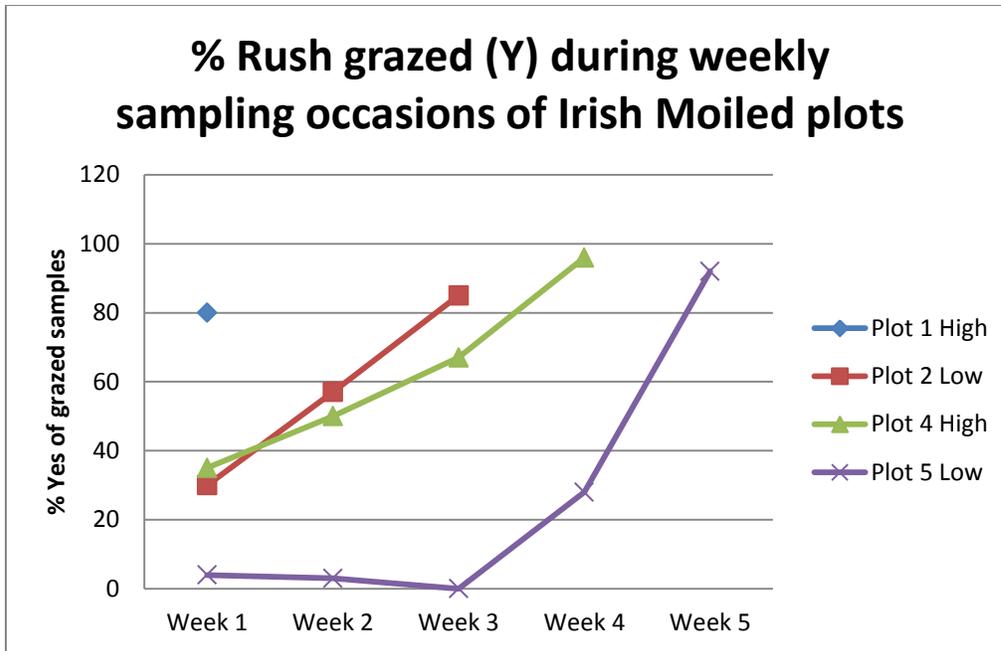


Figure 5. The graph above displays the percentage of rush samples visibly grazed for each plot (1,2,4,5) grazed by Irish Moiled cattle. Figures for this graph were calculated by working out the number of rush samples recorded as positively grazed (Y) as a percentage of the total amount of rush samples recorded for that week. The Irish Moiled plots were treated separately and not grouped due to treatment. At the time of exit, 80% of samples were positively grazed in plot 1 (6 IM). Plot 2 (4 IM) experiences a steep rise in the percentage of rush samples grazed throughout the survey period and at the time of animal exit, 85% of rush samples were recorded as being grazed. Plot 4 (6 IM) experiences the highest number of grazed rush samples out of all the plots at time of exit and after week 3, the number of rush samples grazed rises steeply to a final number of 96%. Plot 5 (4 IM) experiences low levels of rush grazing during the first half of survey. After week 3, there is a rise from 0% to 28%, this then rises promptly to 92% by the final week 5.

4.3 Grass Heights

No significant difference of weekly grass height between treatments was found. Baseline heights were also tested against weekly grass heights and again, treatment had no effect on grass heights throughout the weeks. As mentioned previously, I was unable to carry out complete sampling of plot 5 (4 IM) on certain weeks during the experimental grazing period. This meant that I was unable to get a true representation of heights within this plot. This experimental error may have affected results and would explain the irregularity of results for the 4 Moileys in Table 4.

Treatment	Grass ht week 1	Grass ht wk 1 - baseline grass ht	Grass ht week 2	Grass ht wk2 - baseline grass ht	Grass ht wk 3	Grass ht wk 3 - baseline grass ht	Grass ht wk 4	Grass ht wk 4 - baseline grass ht
6 moileys	60	-28						
4 moileys	35.5	-64	62.5	-37.5	38	-62	35	-65
2 dexters	53	-20	43.5	-29	31.5	-41	38	-34.5
e.s.e	17.8	24.1	6.02	11.75	6.17	12.9	9.19	15.27
Sig	0.653 NS	0.486 NS	0.155 NS	0.66 NS	0.534 NS	0.369 NS	0.839 NS	0.293 NS

Table 4. ANOVA results. Mean grass heights (cm) per sampling occasion. Baseline vegetation heights are those taken prior to animal entry. Baseline height is compared against weekly heights to calculate change (cm).

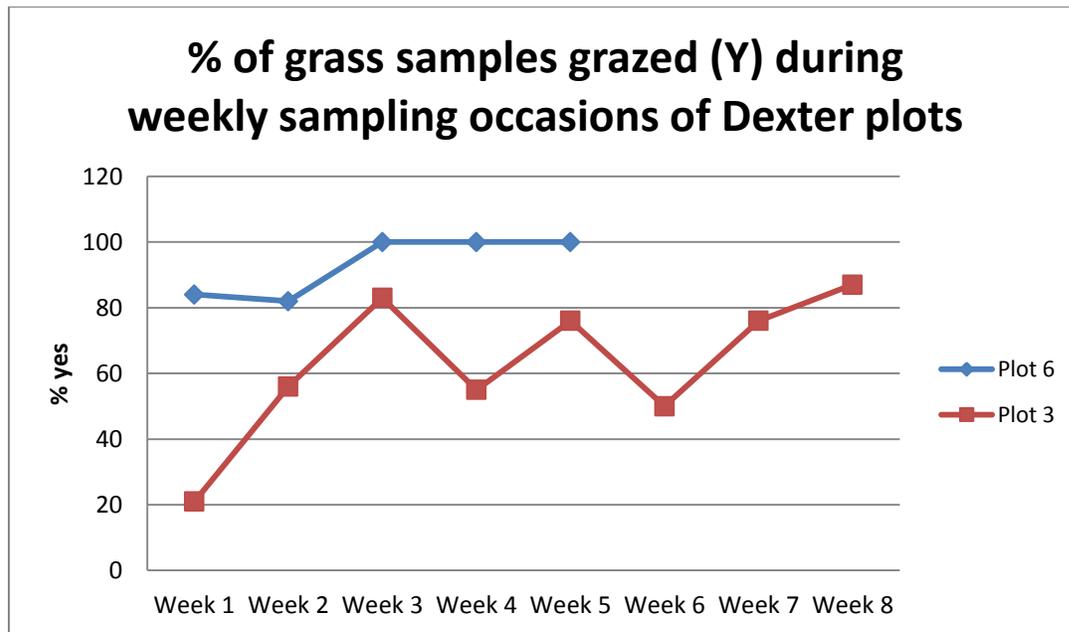


Figure 6. The graph above displays the percentage of grass eaten during weekly samples of Dexter grazing plots. Figures for this table were calculated by working out the amount of grass samples which were recorded as being grazed as a percentage of the total amount of grass sampled recorded for that week. Plot 3 shows a sporadic pattern of grazing throughout the weeks which rise from week 6 until animals were removed from the plot. Plot 3 shows a rise in the level of grass grazed after week 2 when it reaches a steady level after week 3.

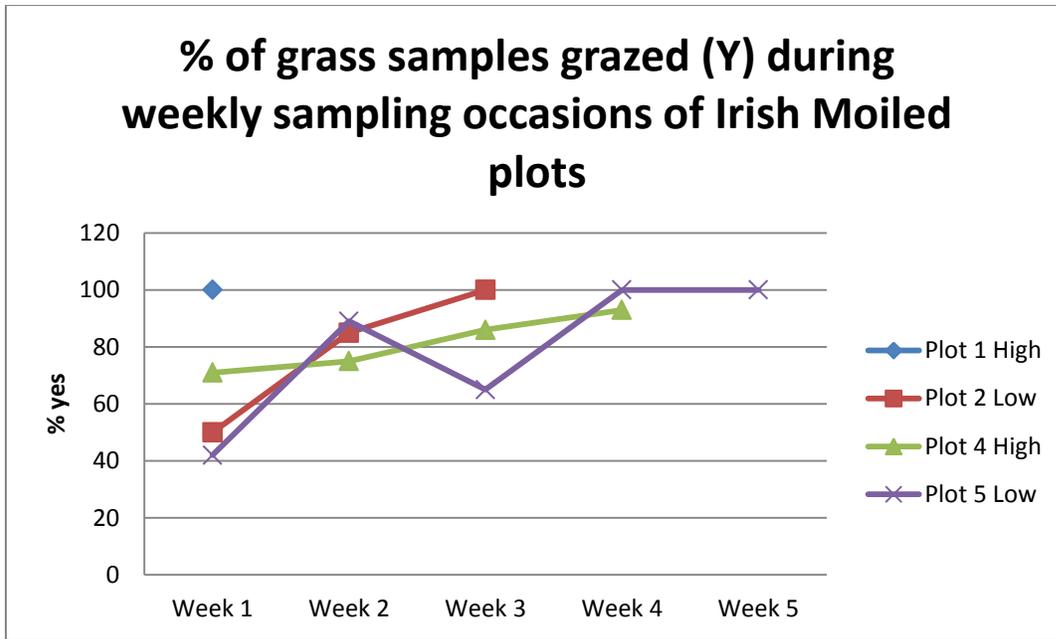


Figure 7. The line graph above displays the average percentage of grass samples grazed during the grazing period for each Irish Moiled cattle plot (Plot 1,2,4,5). Figures for this graph were calculated by working out the total number of grass samples that showed signs of grazing (Y) as a number of the total grass samples recorded for that month (this will include Y and N samples). The Irish Moiled cattle plots are not grouped together due to treatment but are treated separately. At the time of exiting in plot 1 (H), 100% of grass samples showed positive signs of grazing. Plot 2 (L) experiences a steep rise in yes samples where samples increase from 50% to 85%, this is followed by a steadier rise to week 3 when they reach 100%. Plot 4 (H) experiences a continual rise from week 1 to week 4. During week 1, 75% of grass samples showed signs of grazing and once the animals had been removed, 93% of samples showed signs of being grazed by Irish Moiled cattle. Plot 5 (L) displays a sporadic trend as numbers of grass samples grazed rises from week 1 to week 2, drops again at week 3 and rises at week 4. After week 4 and 5, yes sample numbers level off to 100%. As stated previously, this may be explained by experimental error in sampling of plot 5.

4.4 Percentage cover of grass

There was no significant difference found between percentages of grass cover in plots prior to animal entry. The treatment density did not appear to effect percentage of grass cover after animals exited plots as there was no significant difference found when tested.

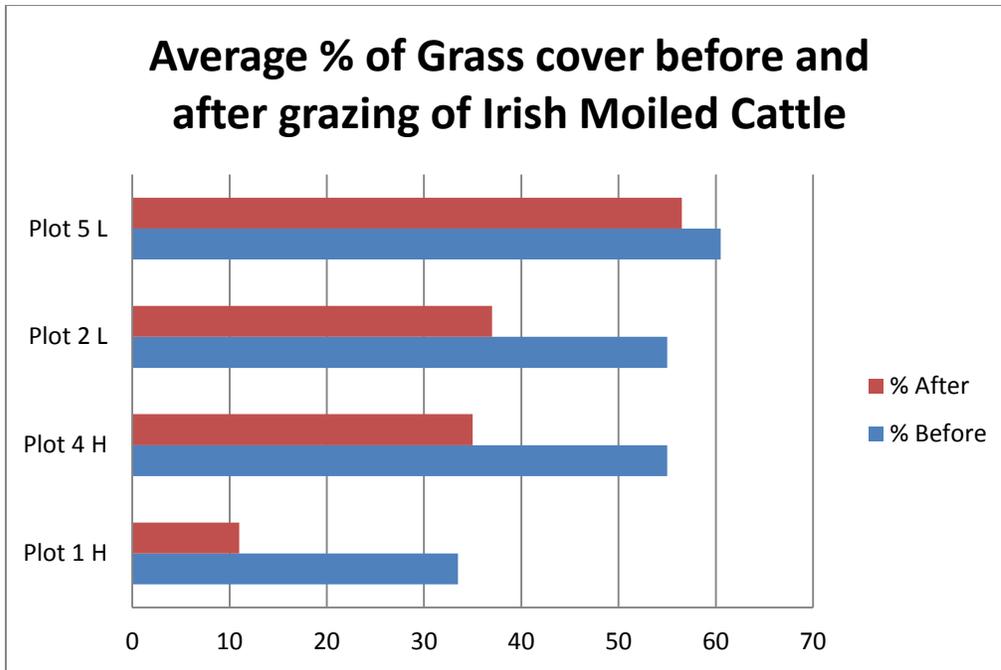


Figure 8. The chart above displays the mean percentage of grass cover before and after grazing of Irish Moiled cattle in plots 1,2,4 and 5. High grazing plots 1 and 4 had grass cover of 33.5% (± 8.69) and 55% (± 9.91) prior to animal entry and recorded levels of 11.25% (± 6.78) and 35% (± 5.42) respectively after grazing. The lower density plots, 2 and 5, recorded pre-grazing grass cover of 55 (± 9.57) and 60.5% (± 8.86). After grazing of 4 Irish Moiled cattle within these plots, levels decreased to 37% (± 7.27) and 56.5% (± 5.67) respectively.

4.5 Percentage cover of rush

The percentage cover of rush within plots was found to be nearly significantly different. Plots with 6 IM cattle would appear to have had higher levels of rush cover in comparison to plots with 4 IM and 2 Dexters. Comparisons made of rush percentage cover on plots after grazing found no significant difference between treatments with levels in all 3 treatments (34.8%, 34.3%, 36.8% respectively) showing similar percentages of rush cover upon exit. Comparison of change in rush cover before and after animals grazed plots showed a nearly significant difference between treatments. Results would appear that in plots with 6 IM cattle, there was a greater change in percentage cover in comparison to plots with 4 IM and 2 Dexters.

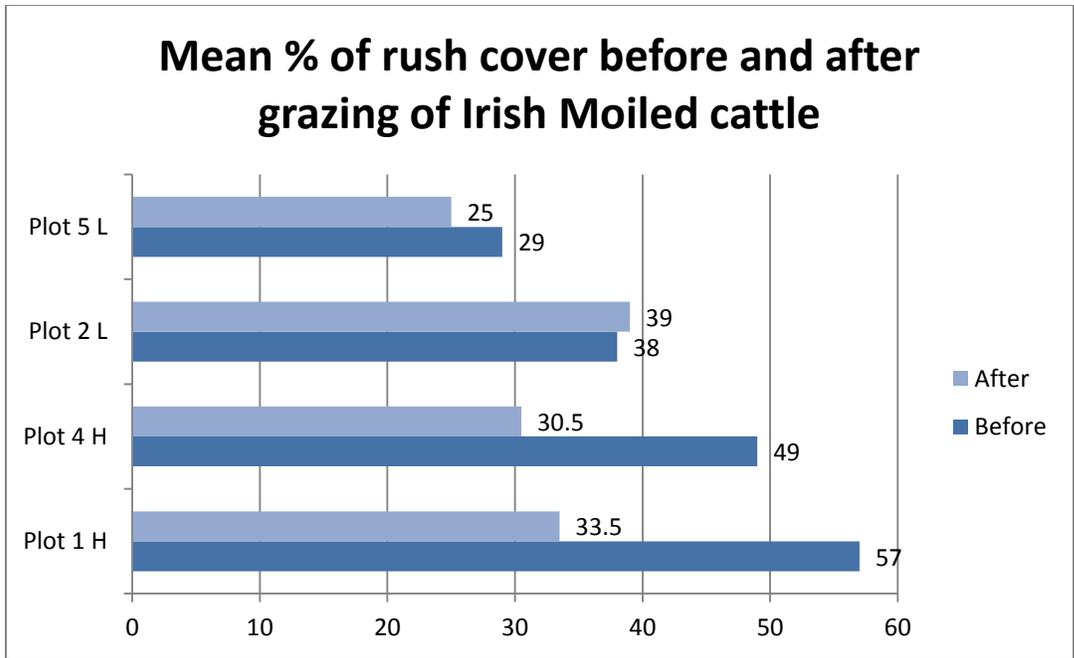


Figure 9. The chart displays the average percentage cover of rush before and after grazing of Irish Moiled cattle. The plots were not grouped due to treatments but were treated separately (Plot 1, Plot 2, Plot 4, Plot 5). The graph above would suggest that higher grazing densities experienced a higher level of change of species richness. Mean rush cover in plot 1 began at 57% (± 7.60) and after grazing decreased to a 33.5% (± 6.23). Within the other higher density treatment, the mean percentage of rush cover decreased from initial levels of 49% (± 11.51) to 30.5% (± 4.11). In lower density plots, it would appear that there was less of a change in percentage cover of rush. Prior to animal entry in plot 2, the percentage cover of rush was 38% (± 9.80). It appears that the Irish Moiled cattle had little influence on the rush in this plot as levels did not decrease (39%, ± 4.98). Within the other lower grazing plot – plot 5, percentage of rush cover showed a slight decrease from 29% (± 6.25) to 25% (± 8.86). No significant difference was found of the rush cover at time of exit on all plots as exit levels were quite similar irrelevant of grazing pressure.

4.6 Trampled rush

A significant difference was found between the mean percentages of trampled rush in the two IM grazing treatments with 6 IM cattle creating the greatest percentage of trampled rush.

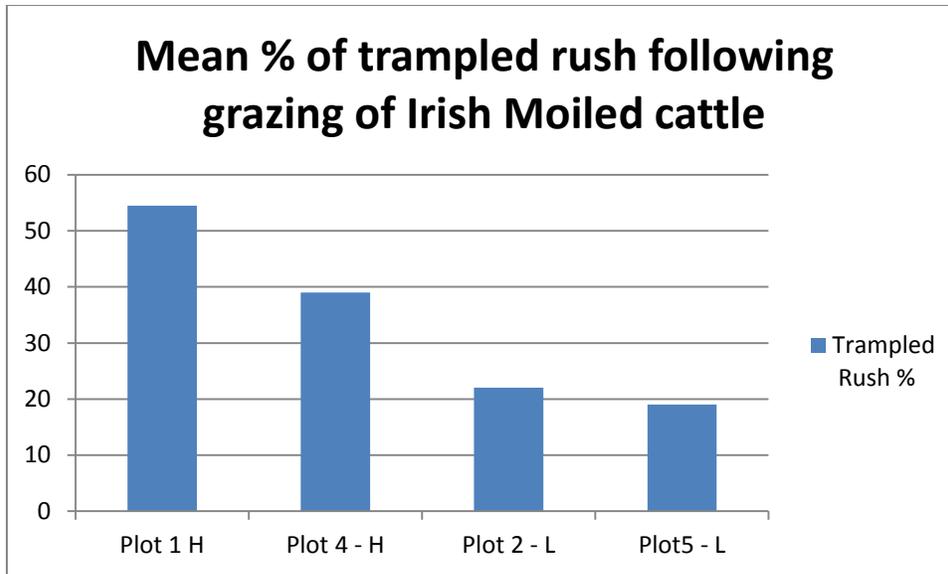


Figure 10. The chart above displays the mean percentage of trampled rush for each treatment of Irish Moiled cattle. High and low treatments are not grouped together and plots are treated separately. A significant difference of the % of trampled rush was found between the grazing treatments as those plots with 6 IM cattle had a greater level of trampled rush in comparison to other treatments. Quadrats in plot 1 (H) and 4 (H), after animals had exited, recorded a mean % of 54.5 (± 8.51) and 39 (± 4.87). Within the lower grazing density plots, plot 2 recorded percentages of 22 (± 4.60) and plot 5, a percentage of 19 (± 4.76) was recorded.

Treatment	Grass % after	Grass % before - grass % after	Rush % before	Rush % after	Rush % after - rush % before	Trampled rush	Species richness before	Species richness after	S.richness after - s.richness before
6 moileys	27.8	-21.5	54.5	34.8	-22	47	8.8	0.5	-8.3
4 moileys	43.2	-11	34	34.3	-2	20.5	15.3	4.3	-11
2 dexters	45.9	-4.5	34	36.8	2	4	19.8	14.7	-5.1
e.s.e	6.02	4.88	3.97	3.52	4.51	4.73	4.33	2.54	4.03
Sig	0.22 NS	0.187 NS	0.055 *	0.875 NS	0.061 *	0.017 *	0.336 NS	0.06 *	0.631 NS

Table 5. ANOVA results. Mean percentage cover for grass, rush and species richness before and after grazing. Percentage change was also tested and levels of trampled rush between treatments.

4.7 Species richness

There was no significant difference found in the mean percentage of species diversity between the three treatments prior to animal entry. The comparison between treatments of species diversity after grazing is nearly significant as species diversity was found to be lowest in plots grazed by 6 IM cattle. The probability plot indicated that the data was not very normal but it suggests that the Irish Moiled cattle grazed more of the different species within the plots in comparison to Dexter cattle.

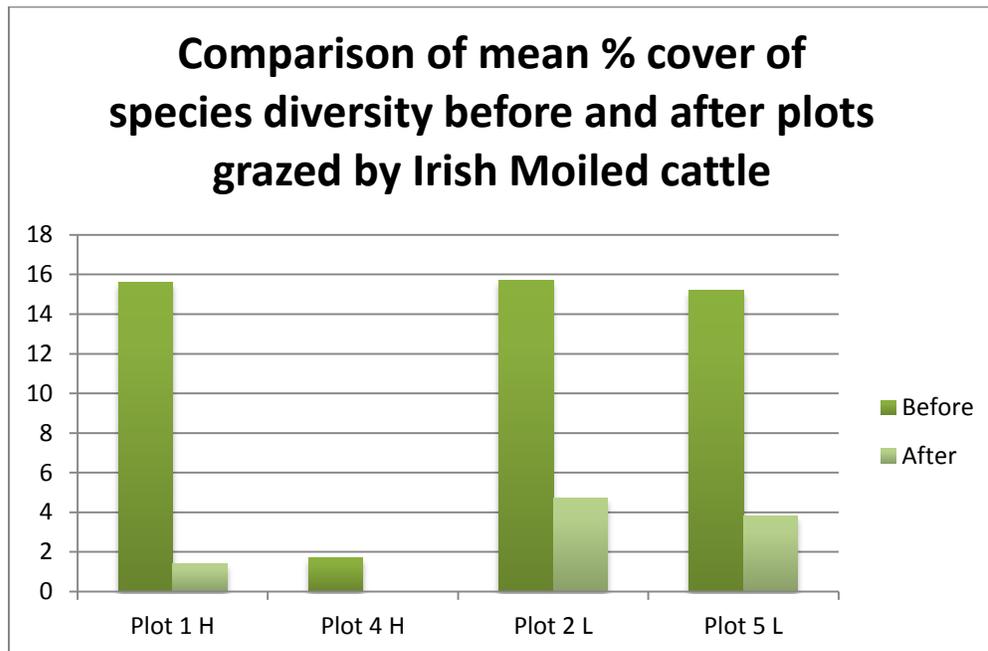


Figure 11. The chart above displays the mean percentage cover of species diversity within Irish Moiled cattle grazed plots. Plots are treated separately and levels are displayed prior to animal entry and after exit. Within the higher density plots, prior to animal entry, the mean percentage of species diversity within quadrats for plot 1 and 4 is 15.6% (± 5.80) and 1.7% (± 1.48) and exit levels of 1.4 (± 0.93) and 0% respectively. Initial percentages of species richness were quite similar within the lower grazing plots (plot 2 and plot 5) of 15.7% (± 6.20) and 15.2% (± 5.55) respectively. Exit levels were recorded as 4.7% (± 1.31) and 3.8% (± 0.82) respectively.

4.8 Grazing soft rush re-growth

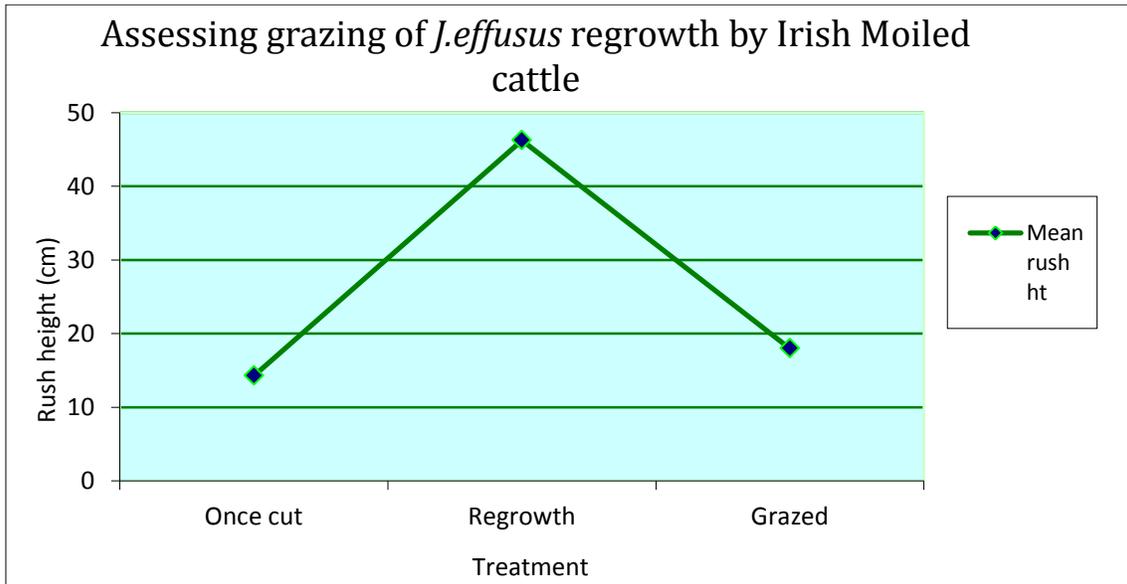


Figure 12. The graph above displays the rush height in plot 7, directly after cutting ($14\text{cm} \pm 0.71$); once left to grow for three weeks ($46\text{cm} \pm 1.43$;) and after grazed ($18\text{cm} \pm 1.10$).

5. Discussion

5.1 Rush heights

Prior to animal entry, initial rush heights showed no significant difference between treatment plots. All treatments showed a decrease in rush height throughout the grazing duration but it would appear that treatment had no effect on weekly rush heights. When the 2 grazing treatments of Irish Moiled cattle (6 IM, 4 IM) were compared, results showed no significant difference between the two grazing densities. It is difficult to make assumptions on the effect of grazing densities of IM cattle from the data, as grazing conditions such as forage availability differ in the two at time of comparison. Comparable data for the highest grazing density was limited due to the fact that in plot 1, animals grazed for a short period and thus only 1 week of height samples were collected. For weeks 2, 3 and 4, rush heights showed no significant difference between treatments of 4 IM cattle and 2 Dexters. When weekly heights within each treatment plot were compared against baseline heights, results from week 2 suggest that Dexters had more of an effect on rush height from initial baseline heights in comparison to the 4 IM cattle. This result is significant but should be treated with caution as the probability plot is not very normal. Limited data i.e. experimental replicates, affects the significance of this assumption.



Figure 13. Irish Moiled cattle grazing soft rush in plot 5.

In the literature, there are only a small number of direct breed comparisons that indicate consistent differences in the choice made by cattle breeds. However, it has been indicated that traditional breeds may have somewhat greater ability to exploit patches of low quality herbage (Dumont et al, 2007). The negative result of grazing treatment on height of herbage is obviously related to high variability within data. The pasture structure showed a high spatial variation on all sites with patches of short rush and tall rush throughout. Table 1 displays the variation between treatments of rush height in week 1. Herbage from tall vegetation patches are likely to be more preferred by traditional cattle (Dumont et al, 2007) and this may have better enabled these animals in their ability to graze tall patches of rush. However, differences between grazing densities are more likely to be expressed where the total above-ground herbage mass is sampled i.e. where herbage is cut to a low height as accessibility of green stems appears to be related to rush intake (Merchant, 1993).

Irish moiled cattle grazed plots, plots 1 (H) and 2 (L) experienced steep levels of rush height reduction over a shorter grazing period. Plots 4 (H) and 5 (L) experience similar levels of rush reduction as each other. Within Dexter plots, rush heights begin to decrease at a more accelerated level after week 3. It would appear that after this time, levels of rush grazing increase in both Dexter plots. In plot 3, there is a sporadic trend of rush height throughout the grazing period. From observation, the Dexters were unable to keep up with grass regrowth in this plot which may have effected rush utilisation. It was found that within plots, low levels of rush were grazed while grass was available. Due to the limited information that exists on the ability of cattle to graze rush, I am unable to support such a result with prior documentation but, my results support the work of Merchant (1996) who found that goats will select a mixed diet to maximise their rate of nutrient intake and will graze rush while grass is available.

Rush ht wk 1	Plot 1 6 IM	Plot 2 4 IM	Plot 3 2 D	Plot 4 6 IM	Plot 5 4 IM	Plot 6 2 D
Min ht (cm)	105	115	130	130	110	150
Max ht (cm)	50	70	80	90	15	80

Table 3. The table above displays the maximum and minimum rush height for week 1 across the grazing treatments.



Figure 14. Rush grazed by Irish Moiled cattle in plot 2

5.1.1 Rush cover

There was a nearly significant difference found in initial rush cover with plots of 6 Irish Moiled cattle, in comparison to other treatments. Irrelevant of initial rush cover, all treatments have been eaten down to similar levels. It would be interesting for further study, to ensure initial levels of rush cover were similar to assess the true effect of density on rush. Comparisons of percentage cover following grazing found no significant difference between treatment plots. The change of rush in plots with 6 Irish Moiled cattle after grazing, is nearly significant. This would suggest that a higher number of Irish Moiled cattle resulted in a greater reduction of rush. However, the results are not quite significant and warrant further investigation. It is possible that this result is related to the higher levels of rush within the 6 IM treatment plots. Due to the timing restrictions of the project resulting in little replicates, precise estimates of random error could not be obtained and although, sizeable differences in the means were obtained, because of the imprecise estimate of random error, the differences in the treatment means could not be shown to be fully significant i.e. have not occurred as a result of random error. Future investigation would require more replicates.



Figure 15. A Dexter cow in plot 6

The results of this project support the work of McCarthy (1971) to a certain extent, as he said that *Juncus* sp. tussocks are only grazed in extreme cases when there are heavy stocking rates. In contrast to this, my results found a reduction in rush height and percentage cover in all treatments following grazing. The greatest difference in percentage cover was however, found in higher density plots. Hypothesis has been made that breed differences can be largely explained by differences in body size and consequent allometric relationships with food intake, digestibility and selectivity (Rook et al., 2004). A limitation of this study is that direct comparisons between breeds cannot be made due to different stocking rates between breeds and, although results suggest no difference in breed type, the different stocking rate between breeds means that true comparisons cannot be made.

The effect of higher density on rush is nearly significant and it appears that at higher densities of IM cattle, increased rush grazing occurred. Separate genetic differences between breeds cannot be ruled out, as it may be possible that environmental effects such as grazing experience may have affected uptake (Dumont, 2007) as longer running animals in this herd graze this pasture annually. I can however note that animals entered plots (6 IM) 2 (4 IM) and 3 (2 D) at the same time so this may rule out any vast differences in digestibility of rush at that time (Trinder, 1975).

The increased rush utilisation as a result of density will support the work of Newman et al (1994) who said that under higher grazing densities, animals are not able to express normal dietary preferences and become less selective, in comparison to moderate grazing pressures. My results on the change of percentage cover of rush after grazing, supports the work of Merchant, (1993; 1995), who said that grazing may prevent an increase in size and spread of mature tussocks and markedly reduce numbers (Jones, 1935).

It is difficult however, to conclude on the success of these treatments in the long term. Unfortunately, Merchant (1993) found the level of stocking, in the case of goats, is unlikely to reduce the vigour of mature rushes and for long term success, animals need to exhaust plant reserves i.e. graze regrowth. To conclude on the success of Irish Moiled cattle on the control of rush in the long term, would require longer experiment times, greater plot sizes and increased replication. Taylor et al (2001) concluded that due to limited experiment time, it was not possible to see long term reverse in dominance of *Molinia* in grassland through grazing, and Merchant (1993) said that hard grazing was required throughout the year or over 2 summers to significantly reduce the vigour of rush.

5.2 *Grass heights*

The results showed no significant difference between treatments of initial grass height and weekly grass heights, throughout the grazing period. On removal of animals in plot 1, 100% of weekly grass samples were recorded as being positively grazed and at this time, 80% of rush sampled were grazed. Plots 2 (L) and 4 (L) showed that as the percentage of grass grazed recordings (Y) increased i.e. forage levels decrease, so too did the percentage of rush grazed (Y) recordings. Within plot 5 (L), initial levels of grass and rush grazing did not follow a similar pattern, this may be explained by the limited ability to get a true representation of vegetation heights during certain weekly sampling occasions. Following week 3, there is a steep rise in grass samples positively grazed and rush utilisation follows a similar trend. It is possible, that after week 3, grass levels deplete and cattle begin to graze rush. It is not an unlikely assumption, that as grass availability decreases, rush utilisation increases. This would support the work of Newman et al (1994), who found that hungry animals have been shown to be less selective and cattle have also been shown to alter their foraging behaviour differently as a response to fasting (Dumont et al., 1995).

5.2.1 Grass cover

There was no significant difference in grass cover found between treatment plots prior to animal entry. Treatment density did not appear to affect grass cover after grazing. This could be due to animals being left to graze until grass levels reached similar levels within plots and forage availability was too low to support the animal's nutritional needs. It would have been difficult to suggest removal of cattle from all treatment plots once grass was grazed to a certain level due to the irregular nature of forage within plots.

5.3 Trampled rush

There was a significant difference found between the mean percentage of trampled rush for plots with 6 IM cattle. Data suggests higher rush levels, by chance; have been allocated to the 6 IM cattle. It is possible that the higher level of trampled rush was a direct effect of the greater percentage cover of rush and higher number of animals within these uniformly sized plots. It is difficult to suggest whether higher levels of trampled rush will facilitate soft rush control but Richards and Clapham (1941) noted that rush is moderately resistant to trampling. Further investigation on the resistance of rush to trampling is required.

5.3 Species diversity

No significant difference in species diversity was found across treatment plots prior to animal entry. Although the evidence is not quite significant, results suggest that a greater reduction in species diversity was achieved with Irish Moiled cattle. A decrease in species diversity levels was found for all treatments but results suggest that the 6 IM cattle have grazed a higher level of species within the plots. As stated previously, this could be an effect of hunger and as grass levels deplete within plots, animals become less selective. Within plots of 6 IM cattle, levels of grass would have depleted quicker and so, this would have an effect on selectivity as cattle were unable to express dietary preferences (Newman et al., 1994). The increased species diversity within plots of Dexter cattle could support the work of Illius and Gordon (1993) who said that small herbivores generally require more energy relative to their gut capacity than large ones and thus have to select higher quality foods. As

previously mentioned above, I am not able to conclude on breed effect due to differences in grazing pressures.

5.4 Grazing rush re-growth

After animals exited plot 1, vegetation was cut and given time to grow, with the aim of testing would Irish Moiled cattle eat soft rush re-growth (re-named plot 7). Due to limited replications of this treatment, the data was unable to be statistically analysed. It was clear though, upon observation, and from height samples, that cattle had grazed the soft rush regrowth. The heights following grazing by cattle were above those that were achieved by cutting. This contrasts to the work of Merchant (1993) who found that goats were able to graze rush to lower heights than those which could be achieved by cutting. Although, behavioural ecology of different species should be taken into account as goats have the ability to graze swards lower than cattle (RBST, 2010). It should be said however, that following grazing of plot 7, rush heights were on average lower (18cm \pm 0.10) in comparison to those in plots 1-6, where grazing was used alone.

Much of the research suggests the need for a combination of one control method with another (Mc Corry et al., 2003) and so, on rush infested sites, where mature rush tussocks exist, grazing of regrowth may be a more effective management form than grazing alone. Following cutting, young shoots are more palatable to livestock (Jones, 1951) and grazing these, exhausts the plant reserves (Merchant, 1995). There is emphasis, within literature, on the importance of cutting at exactly the right time but there is conflicting research on when rushes are most susceptible to cutting (Mercer, 1939; Connell, 1936; Merchant, 1995; Mc Corry et al, 2003). Future study would require greater replicates to assess the potential of traditional breeds in controlling rush re-growth and the ability of this method as a long term means to eradicate rush within pasture.



Figure 16 and 17. Plot 7 was cut and left to grow for three weeks before Irish Moiled cattle entered the plot. The pictures above show the plot three weeks after cutting and following grazing.

It is clear from the results that Irish Moiled and Dexter cattle have been successful in their ability to reduce the size and height of the mature rush tussocks within the plots. Although positive outcomes were achieved, it remains unlikely that this control method would be able to achieve long term eradication of soft rush over short time scales. This experiment has created the ground work for further investigation on how these breeds could be used in their full potential to manage soft rush infestation in pastures, and whether the use of native and traditional breeds would generate better results than modern breeds. For future study, many factors need to be considered such as, longer experiment times to assess long term success; optimum timing to manage soft rush; and whether grazing combined with another control method would achieve greater control results. From the literature, the use of a combination of methods is promoted as a better means of control (Mc Corry et al., 2003).

Within plot 7, the trial to assess ability of Irish Moiled cattle to eat soft rush re-growth displayed positive results. The use of cutting prior to grazing may be required to cause any long term damage to the plant due to the maturity and size of the rush tussocks in these plots. To conclude on the success of this method, further investigation is required. Accounts in the literature have noted how hard grazing throughout the year could achieve an eradication of soft rush (Jones, 1935) however; while enclosing animals and creating conditions that may impose rush grazing, it is likely that the animal's condition will suffer

over time. It is important to achieve a balance between creating a grazing management outcome and maintaining the health and condition of the cattle.

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7. References

- Agnew, A. D. Q. 1954. Some problems in the ecology of rush infested pastures. Proc. Brit. Weed. Cont. Conf. 89-94.
- Agnew, A. D. Q. 1961. The ecology of *Juncus effusus* L. in North Wales. Journal of Ecology, 41, 83-102.
- Bullock, D.J., Oates, M.R., 1998. Rare and minority breeds in management for nature conservation: many questions and few answers? In: Lewis, R.M., Anderson, G.L.M., Mercer J.T. (Eds.), The potential Role of Rare Livestock Breeds in UK Farming Systems. British Society of Animal Science Meeting and Workshop Publication, Edinburgh, pp. 28-34.
- Campbell, S. 1953. The control of rushes by 2, 4-D. Proceedings of the British Weed Control Conference, 190-198.
- Chervil, A. 1995. Infestation of improved grasslands by *Juncus effusus* L. in the catchment of the River Tyne, Northern England: a field survey. Grass and Forage Science, 50(1), 85-91.
- Connell R.P (1936). Some measures to control rushes. New Zealand Journal of Agriculture, 52, 49-50.
- Davies, T. H. and D. J. Harris. 1953. Rush control in the South-West province. In: Proceedings of the British Weed Control Conference. pp. 198-203.
- Dumont, B., Petit, M., Dhour, P., 1995. Choice of sheep and cattle between vegetative and reproductive cocksfoot patches. Applied Animal Behaviour Science, 43, 1-15.
- Dumont, B., Carrere, P., Dhour, P., 2002. Foraging in patchy grasslands: diet selection by sheep and cattle is affected by the abundance and spatial distribution of preferred species. Animal. Research 51, 367-381.
- Dumont B., Rook A.J., Coran Ch and Rover K.-U. 2007. Effects of livestock breed and grazing intensity on biodiversity production in sustainable grazing systems. 2. Grazing behaviour and diet selection. Grass and Forage Science, 62, 159-171.
- Elliott, J. G. 1953. The use of growth regulator herbicides for the control of rushes. Joint NASS and ARC experiments 1952. In: Proceedings of the British Weed Control Conference. pp.190-198.

- Ervin, G. N. and R. G. Wetzel, 71,. 2001. Seed fall and field germination of *Juncus effusus*. *Aquatic Botany*, 71, 233-237.
- Ferrer-Cazcarra, R., Petit, M., 1995. The influence of animal age and sward height on the herbage intake and grazing behaviour of Charolais cattle. *Animal Science* 61, 497–506.
- Fraser M.D., Davies D.A., Vale J.E., G.R. Nute G.R., Hallett K.G., Richardson R.I., Wright 1.A., 2009, Performance and meat quality of native and continental cross steers grazing improved upland pasture or semi-natural rough grazing. *Livest. Sci.* 123, 70-82.
- Fraser, M. D et al. 2011. Impact on sward composition and stock performance of grazing Molinia-dominant grassland, *Agriculture, Ecosystems and Environment*. 114, 102-106.
- Grant S.A., Bolton G.R. and Russel A.J.F. (1984) The utilisation of sown and indigenous plant species by sheep and goats grazing hill pastures. *Grass and Forage Science*, 39, 361-3701.
- Rare Breeds Survival Trust Grazing Animals Project. 2010. Stock Husbandry course workbook. *Conservation Grazing in Practice*.
- Grime, J. P., J. G. Hodgson and R. Hunt. 1990. *Comparative plant ecology*. Unwin Hyman, London.
- Hopkins, A. and S. Peel. 1985. Incidence of weeds in permanent grassland. In: Brockman, J.S. (ed.) *Weeds, pests and diseases of grassland and herbage legumes*. British Crop Protection Council, Croydon, pp.223-227.
- Howard, R, 1949. Rushes to grass in a year. *The Farmer and stock-breeder*, 63, 334.
- Illius, A.W., Gordon, I.J., 1987. The allometry of food intake in grazing ruminants. *Journal of Animal Ecology* 56, 989–999.
- Illius, A.W., Gordon, I.J., 1993. Diet selection in mammalia herbivores: constraints and tactics. In: Hughes, R.N. (Ed.), *Diet Selection: An Interdisciplinary Approach to Foraging Behaviour*. Blackwell Scientific, Oxford, pp. 157–181.

- Isselstein, J. Griffith, B.A. Pradel, P. Venerus, S. 2007. Effects of livestock breed and grazing intensity on biodiversity and production in grazing systems. 1. Nutritive value of herbage and livestock performance. *Grass and Forage Science*, 62, 145-158.
- Jones, LL. J. 1935. Pasture management and its effect on the sward. *Welsh J. Agric.* 11, 96-120.
- Lazenby, A, 1955. (a) Germination and establishment of *Juncus effusus* L. The effect of different companion species and of variation in soil and fertility conditions. *J. Ecol.*, 43, 595-605.
- Lazenby, A, 1955 (b). Germination and establishment of *Juncus effusus* L. 2. The interaction effects of moisture and competition. *J. Ecol.*, 43, 595-605.
- Lazenby, A, 1956. The control of rushes. *Herbage Abstracts*, 26, 71-77.
- Long, H. C. 1930. The weeds of grassland. 4. *J. Min. Agric.* 37, 1192-8.
- McCarthy, J. 1971. Investigations into *Juncus* species in Ireland. M.Agr.Sc. thesis, University College Dublin, Dublin.
- McCorry, M. J. and Renou, F. 2003. *Ecology and management of Juncus effusus (soft rush) on cutaway peatlands*. BOGFOR Research Programme. Forest Ecosystem Research Group Report Number 69.
- Mercer S.P. (1939) Grassland problems in Northern Ireland. *Agricultural Progress*, 16, 142-148.
- Merchant, M, 1996. The intake of grass and rush (*Juncus effusus* L.) by goats grazing rush-infested pasture. *Grass and Forage Science*, 51, 81-87.
- Merchant, M, 1993. The potential for control of the soft rush (*Juncus effusus*) in grass pasture by grazing goats. *Grass and Forage Science*, 48, 395-409.
- Merchant, M, 1995. The effect of pattern and severity of cutting on the vigour of the soft rush. *Grass and forage science*, 50, 81-84.
- Milne, J.A., Osoro, K., 1997. The role of livestock in habitat management. In: Laker, J.P., Milne, J.A. (Eds.), *Livestock Systems in European Rural Development*

Proceedings of the 1st Conference of the LSIRD network (Nafplio, Greece). Macaulay Land Use Research Institute, Aberdeen, pp. 75–80.

- Moore, H. I. and S. Burr. 1948. The control of rushes on newly reseeded land in Yorkshire. *Journal of the British Grassland Society*, 3, 283-290.
- Newman, J.A., Penning, P.D., Parsons, A.J., Harvey, A., Orr, R.J., 1994. Fasting affects intake behaviour and diet preference of grazing sheep. *Animal Behaviour* 47, 185–193.
- Petit, M., Garel, J.P., Dhour, P., Agabriel, J., 1995. The use of forages by the beef cow herd. In: Journet, M., Grenet, E., Farce, M.-H., Theriez, M., Demarquilly, C. (Eds.), *Recent Developments in the Nutrition of Herbivores. Proceedings of the IVth International Symposium on the Nutrition of Herbivores*. INRA Editions, Paris, pp. 473–496.
- Petrides G.E. (1975) Principle foods versus preferred foods and their relations to stocking rate and range condition. *Biological Conservation*. 7, 161-169.
- Preston, C. D., D. A. Pearman and T. D. Dines. 2002. *New atlas of the British and Irish flora*. University Press, Oxford.
- Richards, P. W. and A. R. Clapham. 1941a. *Juncus* L. *Biological flora of the British Isles*. *Journal of Ecology*, 29, 362-391.
- Rook A.J., Dumont B., Isselstein J., Osoro K., WallisDeVries M.F., Parente G., Mills J. 2003. Matching type of livestock to desired biodiversity outcomes in pastures – a review. *Biological Conservation* 119, 137-150.
- Smart, P. J., B. D. Wheeler and A. J. Willis. 1989. Regeneration of peat excavations in a derelict raised bog. *New Phytologist*, 3, 733-748.
- Stockey, A. and R. Hunt. 1994. Predicted secondary succession in wetland mesocosms on the laws of autecological information on seeds and seedlings. *Journal of Applied Ecology*, 31, 543-553.
- Taylor, K., Rowland, A.P., Jones H.E., 2001. *Molinia caerulea* (L.) Moench, J. *Ecol.* 89, 126-144.
- The importance of rush control in countryside management | RuralNI | Department of Agriculture and Rural Development. 2012. *The importance of rush control in*

countryside management | RuralNI | Department of Agriculture and Rural Development. [ONLINE] Available at: [http://www.dardni.gov.uk/ruralni/print/index/environment/countrysidemanagement/pubs/cmbpress/press articles 2012-2/rushcontrol.htm](http://www.dardni.gov.uk/ruralni/print/index/environment/countrysidemanagement/pubs/cmbpress/press%20articles%202012-2/rushcontrol.htm). [Accessed 03 October 2012].

- Thornley, J.H.M., Parsons, A.J., Newman, J.A., Penning, P.D., 1994. A cost-benefit model of grazing intake and diet selection in a two species temperate grassland sward. *Functional Ecology* 8, 5–16.
- Trinder N. (1975) The feeding value of moorland plants. ADAS Science Service Annual Report. PP. 176-187.
- Wetzel, R. G. and M. J. Howe. 1999. High production in a herbaceous perennial plant achieved by continuous growth and synchronised population dynamics. *Aquatic Botany*, 64(2), 111-129.

