The agronomic and biodiversity value of semi-natural grassland types under different grazing management

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Abstract

Traditional grazing regimes are likely to be the most effective and sustainable way to maintain the rich biodiversity of semi-natural grasslands within Annex I priority farmland habitats on the Aran Islands. A key question for the sustainable management of Aran pasturelands is does the available forage resource alone meet livestock nutritional requirements? We investigated the seasonal variability of forage mineral status, nutritional quality, annual aboveground net primary production, grassland utilisation and botanical composition on representative grasslands on 25 farms across the three Aran Islands over two years. Multivariate analysis identified two principal grassland communities: winter-grazed pastures and summer-grazed pastures. Forage quality parameters exhibited community-dependant seasonal variation (e.g. crude protein ranged from 5 to 23% DM), and forage types were seasonally deficient in phosphorus, copper, zinc, selenium and cobalt. Yields ranged from 508 to 5,256 kg DM ha^{-1} $year^{-1}$, and sward species-richness ranged from 11 to 43 plants per 4 m^2. Results suggest mineral imbalances and deficiencies affect Aran forages, and winter-grazed forages alone do not meet the nutritional requirements of the suckler cow. This knowledge will be used to develop an optimal-grazing management model that promotes biodiversity and sustains livestock production on semi-natural grasslands.

Keywords: calcareous grasslands, forage quality, forage production, AranLIFE

Introduction

The agricultural landscape of the Aran Islands is largely a mosaic of rare Annex I European farmland habitat types of high conservation value – limestone pavement, orchid-rich calcareous grassland and machair; 75% of total land area (4,500 ha) is designated as Natura 2000 under European legislation. Typical farm holdings are relatively small-scale with below national average stocking rates (< 0.5 LU ha^{-1}), and contain an exceptionally high proportion of semi-natural grasslands. Grazing is essential for the conservation management of these semi-natural calcareous grasslands. However, it is not known if the forages meet the nutritional requirements of livestock. The objective of this study was to determine the production potential within these grazing systems and ascertain whether the forages meet livestock nutritional requirements. Information will be used to develop optimal grazing (for biodiversity) and supplementary feeding management guidelines that ensure habitats are managed for biodiversity and production outputs. This study is part of the larger EU LIFE-funded AranLIFE project (2014 to 2018).

Materials and methods

Forage quality sampling was performed on 50 randomly selected sites, i.e. two land parcels from 25 farms across the three Aran Islands (Inis Mór, Inis Meáin and Inis Oírr). Forages were collected from homogeneous stands of vegetation over ten sampling dates between March 2015 and January 2017 and analysed for DM, nitrogen (N; Dumas method), crude protein (CP) (N × 6.25), ash, acid detergent fibre (ADF), and neutral detergent fibre (NDF) (Van Soest *et al.*, 1991) at the Agri-Food and Biosciences Institute, Northern Ireland. In addition, 76 forage samples were analysed for dietary minerals, i.e.

phosphorus, magnesium, calcium, sodium, potassium, chloride, manganese, copper, zinc, selenium, cobalt and iodine (Inductively Coupled Plasma – Mass Spectrometry), during May 2015 and January 2016. Annual above-ground net primary production (ANPP) was quantified as kg DM ha-1 per annum using the moveable cage (1 × 1 × 0.4 m) method (Mc Naughton *et al.*, 1996), across nine representative sites. Forages were cut to ground level within a 0.5 × 0.5 m quadrat and oven-dried to constant weight (60 °C for 48 h) to determine percentage DM. Botanical surveys were carried out between June and July 2016 using national methodologies (O'Neill *et al.*, 2013). Non-metric multidimensional scaling ordination and hierarchical, agglomerative, polythetic cluster analysis (PC-ORD vers. 4; Euclidean relative distance measure and Ward's linkage method) was used to identify vegetation types (McCune and Grace, 2011).

Results and discussion

The main management activity within semi-natural grassland habitats was grazing and spring-calving suckler cow/drystock herd was the prevalent farm enterprise. Grazing systems on the Aran Islands can be described as 'reverse transhumance' agriculture; livestock graze the relatively more exposed pastures on the south side of islands from November to April, and once spring-calving commences, herds are moved to sheltered fields to the north from mid-April to October. Reflecting management trends, multivariate analysis identified two vegetation types. For the purpose of this paper they are called 'winter-grazed pastures' (WGP) and 'summer-grazed pastures' (SGP). Summer-grazed pastures had low to moderate plant species-richness and higher ANPP (Table 1). The production potential of SGP enables repeat (two to three) rotational grazing between April and October. In contrast to SGP, WGP had the highest levels of plant species-richness and lower ANPP. In general, WGP are grazed once after the growing season – a practice that it likely to promote the higher plant species-richness found in this grassland type.

There is a clear trend of declining CP concentrations in WGP from May onwards (Figure 1), with the lowest feeding value (indicated by lower CP and higher ADF concentrations) recorded between November and March. The feeding value of winter forages reach an annual low in March when cows are typically well into the last trimester of gestation and nutritional demands are highest. Mineral analyses data indicate that Aran forages are seasonally deficient throughout the year in P, Cu, Se and Co (National Research Council, 2000). Mineral supplementation is required to reduce the likelihood of mineral deficiencies arising in the herd.

Table 1. Mean (SEM) of species richness per 4 m^2, annual dry matter (DM) yields and forage quality variables for broad vegetation types on the Aran Islands.

Grassland types (sites)	Summer-grazed pasture (18)	Winter-grazed pasture (38)
Species no. (per 4 m^2)	21 (0.6)**	34 (0.4)**
Yield (kg DM ha^{-1} $annum^{-1}$)	5,580 (941)** (4)	1,760 (420)** (5)
Dry matter (g kg^{-1})	227.0 (10.8)**	381.3 (17.6)**
Crude protein (g kg^{-1} DM)	153.1 (7.2)**	100.3 (3.5)**
Acid detergent fibre (g kg^{-1} DM)	307.7 (7.1)**	324.5 (11.7)**
Phosphorous (%)	0.28 (0.01)	0.12 (0.007)
Selenium (mg kg^{-1})	0.08 (0.01)	0.11 (0.007)
Cobalt (mg kg^{-1})	0.05 (0.02)	0.02 (0.002)
Copper (mg kg^{-1})	7.65 (0.4)	5.30 (0.18)

**$P < 0.01$ = Significant differences between grassland types.

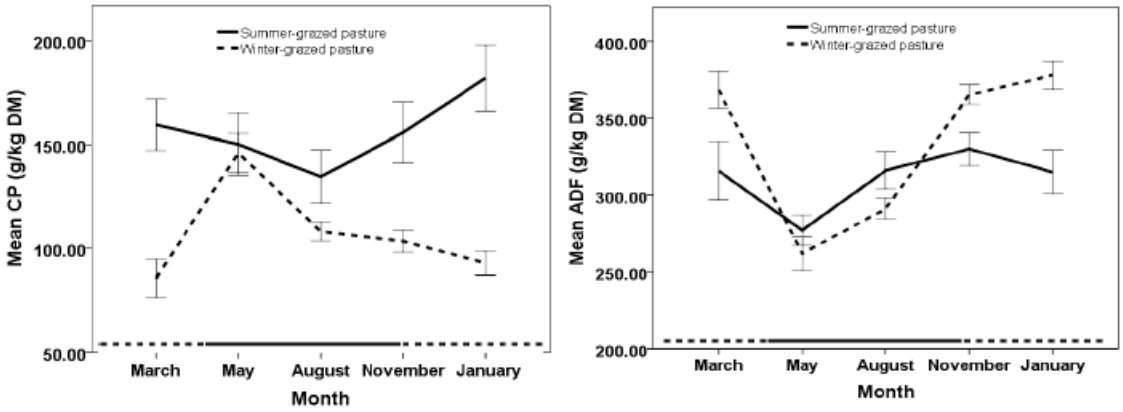

Figure 1. Seasonal changes to (a) crude protein (CP) and (b) acid detergent fibre levels (ADF) in winter-grazed pasture and summer-grazed pasture. Error bars: ± 2 SE. Horizontal line (bottom) indicates main grazing period for each pasture type.

Conclusions

The semi-natural calcareous grasslands sampled throughout this study are priority Annex I habitats for conservation under the EU Habitats Directive and are dependent on grazing for their survival. However, results from this study indicate that the grazing potential of pastures with the highest species-richness, i.e. WGP, do not fully meet nutritional demands of livestock – especially when cows are in late stages of pregnancy. The grazing management system that has been developed by farmers on the Aran Islands to best suit the forage supply throughout the year involves a cyclic pattern of loss and gain (cows gain weight on SGP when forage quantity is abundant and quality is high and slowly lose weight on WGP when forage quantity is limited and quality is low). This management system exploits compensatory growth on SGP and minimises supplementary feed costs but depends on optimum management of suckler cow energy reserves throughout the year so that compensatory gain after restriction and reproductive efficiency (e.g. timely estrus) is not negatively affected. From this work, nutritional advice can be tailored to suit the grazing system by identifying times when additional appropriate supplementary feeds may be required, thereby maximising livestock production within grazing systems that maintain high plant diversity.

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