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Meeting the future demands for grassland production

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Increasing the supply of herbage mass during autumn in pasture-based dairy systems

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Abstract

The effects of increasing the supply of herbage mass (HM) available in a pasture-based dairy system during autumn (1 Aug to end of the grazing season [closing]) on late lactation milk production and other key performance indicators have not been evaluated. Multiple regression models were fitted to a dataset containing 63 grazing system experiments conducted with spring-calving dairy herds between 2001 and 2018 at Solohead Research Farm, Ireland (52°30'N, 08°12'W). The supply of HM per system was measured as average herbage cover (AHC; HM >4 cm; average of all paddocks) and pre-grazing HM. Increasing AHC and pre-grazing HM had no effect (P>0.05) on late lactation milk production. On average over the 17 years, each increase in peak AHC (highest AHC during autumn) of 100 kg dry matter (DM) ha^{-1} increased the length of the grazing season in autumn by 1.9±0.46 days (P<0.001, partial R^2=0.43) and increased closing AHC by 47±7.2 kg DM ha^{-1} (P<0.001, partial R^2=0.38). Opening AHC in February increased with closing AHC (P<0.001, R^2=0.37). Therefore, increasing AHC during autumn allows for extended grazing while not compromising milk production.

Keywords: autumn, extended grazing, grazing management, pasture-based milk production

Introduction

The length of the grazing season, the period when herbage growth rate (GR) meets the demand for herbage mass (HM) by grazing cattle, is limited in temperate latitudes. Several studies reported that a long grazing season improves profitability of pasture-based dairy systems by maximizing low cost grazed grass in the diet of dairy cows and thereby reducing costs of production (Hanrahan *et al.*, 2018). Extending the total length of the grazing season requires making HM available for grazing at all times of low herbage GR, particularly before and after pastures are closed for the winter. In late summer and early autumn the GR generally exceeds demand by grazing cows. This surplus HM can be harvested for grass silage or used to accumulate HM. By increasing the rotation interval, the accumulated HM is transferred *in situ* to later in the grazing season. The supply of HM is quantified as average herbage cover (AHC; HM >4 cm; average of all paddocks) at system level and as pre-grazing herbage mass (PGHM) at paddock level. However, accumulating high AHC and PGHM during the autumn to extend the grazing season could negatively affect the nutritive value of the sward and, hence, milk yield.

Materials and methods

A dataset was created for the purpose of this study from grazing system experiments conducted at Solohead Research Farm in Ireland (52°30'N, 08°12'W) between 2001 and 2018. They were all system studies of spring-calving pasture-based dairy herds over an entire grazing season (n=63 systems). Assignment of cows to herds and paddocks to systems, grazing management and recording of days at pasture was described by Humphreys *et al.* (2008, 2009), Phelan *et al.* (2013) and Tuohy *et al.* (2014). Data for this study encompassing the 'end of season management period' were from 1 Aug to 31 Dec of each year. Autumn was defined as the timeframe from 1 Aug to closing, which demarks the end of grazing and the beginning of the 'closed' period during winter when all cows were housed, generally during December and January (of the following year). 'Early spring' turnout in February was denoted opening in this study. Average herbage cover (AHC) was measured once per week on each system using a rising plate meter (measuring compressed sward height (cm) which was converted into herbage mass (kg dry matter (DM) ha^{-1}) with a sward density of 240 kg DM cm^{-1} ha^{-1}). Peak AHC was the highest AHC recorded in each system during autumn. AHC at closing and at opening where recorded accordingly. Some systems were missing data for either closing AHC or opening AHC as defined above and were removed from the dataset for the corresponding analysis. PGHM (kg DM ha^{-1}) was determined before each grazing on every paddock by harvesting a strip of grass to a cutting height of 40 mm above ground level. A subsample was dried for DM determination. Mean GR in autumn was the mean of GR of each system determined at each grazing by dividing PGHM by the rotation interval. Soil moisture deficit (SMD) (Schulte *et al.*, 2005) during autumn was modelled assuming a poorly drained soil. The number of days where SMD was 0 mm or above (threshold for trafficability with bovine livestock (Herbin *et al.*, 2011)) was recorded. Mean daily milk yield per cow and daily yield of fat and protein per cow (milk solids yield) were recorded in late lactation from 1 Aug to dry off (mean date 3 Dec) and are presented as the mean yield of all cows in a herd in a system. The dataset was analysed for factors associated with days at pasture during autumn, closing AHC, opening AHC and daily milk yield and daily milk solids yield in late lactation using multiple regression analysis in the GLMSELECT procedure in SAS 9.4. A stepwise selection process was applied with a 5% significance level for inclusion and exclusion of factors into the model. The dataset was tested for interactions between independent variables and quadratic relationships. Results are presented as means ± standard error.

Results and discussion

The dataset created for this study represents a wide range of grazing management practices and grazing conditions as well as varying weather and grass growing conditions. Peak AHC (ranging between 634 and 1,800 kg DM ha^{-1}), closing AHC (ranging between 36 and 855 kg DM ha^{-1}) and opening AHC (ranging between 118 and 1,191 kg DM ha^{-1}) encompassed a range of HM supply scenarios that have not been captured by previous studies. As peak AHC was highly correlated with mean AHC during autumn (Pearson's r=0.96, P<0.001) and with mean PGHM during autumn (r=0.81, P<0.001), peak AHC was used as the main indicator of the supply of HM in this study. Over the 17 years, there was no detectable impact (P>0.05) of peak AHC, PGHM or days at pasture on daily milk yield (16.31±0.26 kg cow^{-1} day^{-1}) or daily milk solids yield (1.39±0.02 kg cow^{-1} day^{-1}) in late lactation. That means neither higher PGHM nor a change in the proportion of grazed grass vs grass silage in the diet impacted milk production in late lactation, similar to that found by O'Neill *et al.* (2013) and Claffey *et al.* (2020). Of the variables associated with days at pasture during autumn (Table 1) only peak AHC and SR were factors controlled by grazing management. On average, each increase in peak AHC of 100 kg DM ha^{-1} increased the length of the grazing season in autumn by 1.9±0.46 days (P<0.001). Variations in peak AHC also explained the largest part of the variation in closing AHC (partial R^2=0.38). Opening AHC was positively associated with closing AHC (P<0.001, R^2=0.37). Claffey *et al.* (2020) proposed that earlier closing dates in autumn increase both closing AHC and opening AHC for early spring grazing. Accumulating a high AHC as presented in this study combines the benefits of a long grazing season in autumn with an increased supply of HM in early spring and, hence, higher milk production associated with early spring grazing. As the increase in HM per system is usually generated by utilising surplus GR in late summer, there is no extra cost associated with creating higher peak AHC in autumn.

Conclusions

Increasing the supply of HM available in a pasture-based dairy system during autumn allows for extended grazing in late autumn and early spring while not compromising milk production. This strategy has potential to increase the total annual length of the grazing season and hence, increase profitability on pasture-based dairy farms.

Table 1. Summary of the stepwise selection process from multiple regression analyses of factors associated with days at pasture in autumn (1 Aug to closing), AHC at closing and AHC at opening (February) in a multi-year dataset (2001 to 2018).[1]

Dependent variable	Step	Independent variable	Estimate (SE)	Partial R^2	Model R^2
Days at pasture	0	Intercept	11.5 (18.33)		0.72 (n=63)
(days per cow)[2]	1	Peak AHC[3,4] (kg DM ha^{-1})	1.9 (0.46) ***	0.43	
	2	Stocking rate (cows ha^{-1})	-11.5 (2.43) ***	0.14	
	3	SMD >0 mm (days)	0.15 (0.04) ***	0.06	
	4	Growth rate[2] (kg DM ha^{-1} day^{-1})	0.46 (0.13) ***	0.04	
	5	Date of peak AHC (day in year)	0.22 (0.07) **	0.06	
Closing AHC	0	Intercept	-446 (255.2)		0.56 (n=57)
(kg DM ha^{-1})	1	Peak AHC[3,4] (kg DM ha^{-1})	46.6 (7.21) ***	0.38	
	2	Days at pasture[2] (days per cow)	-7.8 (1.83) ***	0.08	
	3	Date of peak AHC (day in year)	4.1 (1.16) ***	0.10	
Opening AHC	0	Intercept	314 (62.7) ***		0.37 (n=53)
(kg DM ha^{-1})	1	Closing AHC[4] (kg DM ha^{-1})	71.5 (13.18) ***	-	

[1] SE = standard error; DM = dry matter; AHC = average herbage cover; SMD = soil moisture deficit; ** = $P<0.01$; *** = $P<0.001$.

[2] During autumn.

[3] Highest AHC during autumn.

[4] Increase of 100 kg DM ha^{-1}.

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