Winter rotation length effect on pasture production and animal performance

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Abstract

Data comparing pasture production in winter pastures subject to 16, 48 or 72-day rotation lengths were recovered from experiments at Massey University to support teaching of grazing management. ‘Farmlets’ with 16 breeding ewes on 0.8 ha were run from 2011-2016, and herbage production estimated from metabolic energy budgeting (MEB). The data illustrate: the roles of pasture cover and animal body weight as buffers to neutralise the impact of weather variability, the use of controlled cover release via the grazing rotation to partially meet winter feed deficit, and the potential value of MEB in systems research. Grass grown from May to September (early pregnancy to mid-lactation) was 3850, 4220 and 4840 kg DM/ha for 16, 48 and 72-day rotations, respectively. As a result of a reduction in herbage accumulation and the premature release of autumn-saved pasture to animals, the 16-day rotation failed to overwinter the animals in five of the 6 years, the exception being a winter with high pasture growth. Reduced animal productivity and profitability. Little definitive research exists on the question of whether the higher stocking rate possible in a CGS than in a set-stocked wintering system arises simply from the reconciliation of mismatches in time between when the feed grows and when animals need it, or whether the longer grazing rotations in a CGS actually increase pasture growth rates.

To assist teaching of grazing management theory and practice at Massey University, a series of ‘farmlets’ have been maintained for about 25 years, where final year veterinary students have also been provided with farmlets for the teaching of grazing management theory and metabolic energy based feeding budget. Farmlet teaching for veterinary students has involved a comparison of outcomes for farmlets commencing with a common herbage mass on 1 May, stocked at 20 ewes/ha, and running 16, 48 or 72-day grazing rotation lengths until lambing in mid-August. Near the start of lambing, sheep are set-stocked until late September when they are weighed and the

Introduction

The majority of sheep and beef farms in New Zealand manipulate the grazing rotation length to store autumn-grown feed as increased cover for release back to stock during periods of lower growth rates in winter. This winter management practice is often referred to as a ‘controlled grazing system’ (CGS) (Milligan 1981; Sheath et al. 1987). A key component of a CGS is the rationing of herbage intake of stock to levels that provide for body maintenance and pregnancy requirements, while retaining any pasture growth which is surplus to those requirements as standing herbage mass or ‘cover’. Longer rotation lengths are achieved by keeping animals longer on a paddock during a grazing event and result in lower residual herbage mass after grazing. Paradoxically, even though herbage removal (kg DM/ha) is increased when the rotation is lengthened, individual animals consume less feed/head/day. This is because intake per animal is progressively reduced during successive days of a paddock grazing event as herbage height is lowered. Daily herbage intake of animals in a rotational grazing event can be monitored by calculating the herbage remaining during grazing and dividing by the grazing intensity (animal. days/ha) (Matthews et al. 1999). Herbage consumption at a whole farm level (kg DM/ha/day) is thus determined by the stocking rate and rotation length.

The optimal rotation length depends on a range of site factors and so can vary greatly between farms. The key factor to plan rotation length is expected winter pasture growth rate; for a higher growth rate, increased stocking rate and decreased rotation length would be indicated and vice versa. Compared to set-stocked (continuously grazed) systems typically practiced in the middle of last century, a CGS allows more animals to be overwintered, enhancing farm carrying capacity and profitability. Little definitive research exists on the question of whether the higher stocking rate possible in a CGS than in a set-stocked wintering system arises simply from the reconciliation of mismatches in time between when the feed grows and when animals need it, or whether the longer grazing rotations in a CGS actually increase pasture growth rates.

To assist teaching of grazing management theory and practice at Massey University, a series of ‘farmlets’ have been maintained for about 25 years, where final year students working in a group create a small scale CGS on a block of 8 x 0.1 ha paddocks with electric fences for subdivision, running from early-May to late-September. Calculations on a per hectare basis are similar to those for a commercial farm. Typically, there are 5 or 8 student groups, each with their own farmlet. For 13 years (2004-2016), 2nd year veterinary students have also been provided with farmlets for the teaching of grazing management theory and metabolic energy based feeding budget. Farmlet teaching for veterinary students has involved a comparison of outcomes for farmlets commencing with a common herbage mass on 1 May, stocked at 20 ewes/ha, and running 16, 48 or 72-day grazing rotation lengths until lambing in mid-August. Near the start of lambing, sheep are set-stocked until late September when they are weighed and the
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Lolium management in other institutions.

Our primary objective was to present a time series of 6 years data from the veterinary teaching programme farmlets investigating the effect of rotation length on winter pasture growth rate. As animal weights and pasture herbage mass were monitored during the experiments, herbage harvested can be calculated by metabolic energy-based feed budgeting (Nicol & Brooks 2007). A secondary objective was to record herbage harvested can be calculated by metabolic energy-based feed budgeting (Nicol & Brooks 2007).

Methods

Farmlet setup

The farmlets were located at the Massey University Pasture and Crop Research Unit (Lat. 40.38°E), on a flat to gently undulating terrace with a Tokomaru silt loam (Typic Fragiaqualf) soil type, Olsen P-44 mg/kg, and ryegrass-dominant (Lolium perenne) pastures with white clover (Trifolium repens), and a minor presence of some Poa species and herbs such as penny royal (Mentha pulegium). The 8-paddock farmlets were placed on the terrace to make them as similar as possible for factors expected to affect system performance, such as differing pasture botanical composition linked to microenvironment factors where topography or soil factors vary.

A total of 6 farmlets have been used in the experiment from 2011-2016, and the four rotation length treatments were rotated between the 6 farmlets in a semi-random manner, so that in the course of the 6 years of data collection, each rotation length has been trialled on at least 3 different farmlets. Each 0.8 ha farmlet was stocked in the first week of May each year with 16 Romney-cross breeding ewes (weight range 60-65 kg, but in 2014 and 2015, 57-58 kg, following summer drought) and a common target start cover of about 1600 kg DM/ha (ranging from 1450-2030 kg DM/ha) (Figure 1), depending on summer-autumn pasture growth conditions. Ewes were mated from mid-March to early April, using a tupping crayon to detect early and late submission. Farmlet groups of 16 ewes were balanced for bodyweight and mating date each year. Husbandry details such as anthelmintic dosing, crutching, and vaccination followed normal farm practices. Ultrasound scanning was carried out in June each year and dry ewes replaced with a pregnant one. In all 6 years, the experiment included a 48-day rotation length, considered optimal for this site, and 16 and 72-day rotation lengths considered to be ‘deliberate mistakes’ that would overfeed and underfeed ewes, respectively, in early winter. During periods of unusually high rainfall, if treading damage to pasture was about to occur, sheep were moved to the next paddock a day sooner than scheduled. By way of context for the rotation length determination, a pasture growth rate of 1.5-2.0 kg DM/ha/day is typical in June and July, at this site. The rotation was transitioned to set-stocking by spreading sheep between paddocks on about 10 August each year, about a week before the start of lambing. In 2012 and 2014-2016 a second farmlet with a 48-day rotation (designated 48ESS) was included and set-stocked early, in late July, 3 weeks before lambing, to allocate remaining stored cover to sheep in late pregnancy rather than early lactation, as a third ‘deliberate mistake’. Implementation of the four grazing rotation treatments is shown in Figure 2. Lower than normal pasture growth rates in some winters were corrected by application of urea fertiliser (30 kg N/ha in

Figure 1

Pasture cover trajectories for farmlets with 16, 48 and 72-day rotations in 6 successive years. Different shapes in different years indicate system resilience to compensate for year to year weather variation. Falling cover from a peak in May or June indicates tactical release of stored feed to animals during winter feed deficit.

Figure 2

Aerial view of farmlets in early July 2004. The 16-day rotation was achieved with a 2 day grazing duration in each of the 8 paddocks. Sheep were temporarily spread over two paddocks to avoid treading after rain. The 48-day rotation was achieved with a 3 day grazing duration in each half paddock. The 72-day rotation was achieved with a 3 day grazing duration in each third of a paddock. Grazing intensities were 320, 960, and 1440 sheep.day/ha for 16, 48 and 72-day rotations, respectively. 48ESS was implemented in 2012 and 2014-2016.
2012 on all farmlets; 23 kg N/ha in 2015 on all farmlets; 37.5 kg N/ha in 2013 on the 16-day farmlet only; and 45 kg N/ha in 2016 on 16, 48-day and 48ESS farmlets, but not the 72-day farmlet).

Data collection and metabolic energy budgeting
Sheep were typically weighed about seven times during the experiment, using a Prattey sheep weighing crate fitted with either a TruTest model 702 or model XR3000 indicator. There was no weighing from late July to mid-September to avoid stress on heavily pregnant ewes or ewes with lambs at foot. Pasture cover was measured fortnightly with a standard rising plate meter by an experienced operator alert to potential issues such as the move of shank more deeply into wet soils in winter; the equation “x140 + 400” was used to convert meter reading to kg DM/ha. Net pasture growth was assumed to equal herbage harvested by animals, which was inferred from the energy requirements of the sheep, determined using metabolic energy budget (MEB) feed calculations (Nicol & Brooks 2007; Matthew et al. 2010). In all, there were 18 feed budget calculations for the three rotation length treatments over 6 years and a further four feed budget calculations for the additional farmlet treatment that was set-stocked early in four of the 6 years (spreadsheet available from the authors on request).

Herbage metabolisable energy (ME) was assumed to increase gradually from 11.8 MJ/kg DM in May to 12.5 MJ/kg DM in September (based on occasional near infrared spectroscopy testing and personal communication from M.G. Lambert); pasture communication from M.G. Lambert); pasture was fitted with either a TruTest model 702 or model XR3000.

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Herbage DM (kg/ha)

Growth 1st 5 weeks (May)

Presence of Metabolism (kg/ha)

Growth: total May–September

Herbage consumption

Table 1

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lamb production/ha of the latter equalled that of the former, the herbage accumulation advantage of the 72-day rotation was underestimated in proportion to any loss of herbage quality, and the overall impact on animal performance of this rotation looks more positive than negative (Table 1).

Scientific insights
This pattern of herbage accumulation difference 72–48–16-day, would have been hard to predict from available literature, as alternative logical expectations can be developed from different historical studies. After farmlet setup in May, high residuals after grazing in the 16-day rotation (compared to longer rotation lengths) might have been expected to increase herbage accumulation (Chapman 2016), though in contrast to that there is known to be a period of low accumulation following defoliation (Matthew et al. 1991) and in set-stocked swards at lower herbage mass (Bircham & Hodgson 1983), and there is an old New Zealand farm extension adage “grass grows grass”. Hence the present results support those studies that indicate loss of growth potential in ryegrass after defoliation, so that the more frequent the defoliation, the greater the herbage production loss, even at residual herbage mass after grazing as high as 1500 kg DM/ha. At the high herbage mass end of the spectrum, it is perhaps surprising that there was no evidence of loss of growth to senescence in the 72-day rotation, other than a non-significant trend in June/July growth (860 versus 990 kg DM/ha, Table 1). The leaf appearance interval in Palmerston North in the coldest months of July and August was around 13 days and in a paddock grazing event in order for the animals to eat more/head/day in a short than in a long rotation. It is not uncommon to receive feedback such as: “because of the farmlet practical I understood what the farmer was telling me during my summer vacation practical work.”

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REFERENCES
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