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Investigation into the effects of feed allowance, duration of feeding level and week of lactation on immediate and carryover dairy cow production

Key external stakeholders:
Scientific, Advisors, Policy makers, Farmers

Practical implications for stakeholders:

- Due to highly variable growth and inconsistent grass supply in early spring strategies to overcome short-term periods of feed deficit were developed
- Short term restrictions of PA up to 25 % of DMI, for up to 6 weeks, can be used as a management strategy to cope with feed deficits in early lactation without impairing total lactation production, normal metabolic function or fertility of the early lactation dairy cow.

Main results:

- When cows are offered more than they require to achieve intake capacity (IC) for a six-week period cumulative milk yield is higher compared to those offered a restricted pasture allowance (PA) for an extended period of time (six-weeks)
- Despite the immediate reduction in milk production, restricting PA for up to 6 weeks may be used as a method of managing short term pasture deficits on farm with minimal effects on total lactation performance.
- Short term restrictions of PA up to 25 % of DMI, for up to 6 weeks, can be used as a management strategy to cope with feed deficits in early lactation without impairing normal metabolic function of the early lactation dairy cow.
- Imposing periods of restricted DHA had no severe effects on oestrous cycle characteristics, oestrous behaviour or overall reproductive performance.

Opportunity / Benefit:

In recent years it has become evident that the climatic conditions experienced during spring can vary greatly from year to year. Consequently it is difficult to predict how much grass will need to be available to meet the demands of the early lactation cow throughout the first and second grazing rotation. The results of this project provide industry stakeholders with knowledge pertaining to feeding the early lactation cow, particularly during periods of grass deficit, when alternative sources of forage may be in short supply. It was important to determine how early lactation cows respond to changes in their grass supply which are likely to occur given the fluctuations in grass growth in early spring.

Collaborating Institutions:

UCD, INRA (France), DairyNZ (New Zealand), Agroscope (Switzerland)

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1. Project background:

Grazed grass is the cheapest feed available to support milk production in intensive pasture based systems (Finneran et al., 2010). However, grass availability in spring can be highly variable due to low growth rates over the winter period of November to February (Hurtado-Uria et al., 2013). Furthermore, PastureBase Ireland data (Hanrahan et al., 2017) have shown large variation in spring growth (February to April) on farm, with year-to-year variation as high as 40%. As a result of this, grass availability can be insufficient at turnout but shortages can also arise at any period in spring due to meteorological influences on the perennial ryegrass plant. This can limit the regrowth potential of the grazed sward in spring (Brereton and McGilloway, 1999) and result in possible feed deficits throughout the course of the first and second grazing rotation. This can make feed-budgeting particularly challenging on farm as feed deficits may arise over a prolonged period, coinciding with early lactation, in spring calving, pasture based systems. This project investigated the effects of offering a range of herbage allowances in early spring for varying durations, and also at different stages of early lactation on production, behavioural and metabolic health responses.

2. Questions addressed by the project:

- What are the production, behavioural and metabolic health responses associated with offering different pasture allowances for different durations of time at different stages in the early lactation period of dairy cows.
- Is there an interaction between feed allowance x feed level duration x stage of lactation
- Are there any carryover effects of treatments imposed during spring observed during the remainder of lactation.

3. The experimental studies:

Three years experimental work were completed, the study completed in year 1 was replicated in year 2 and in year 3 the design was refined to examine the effect of stage of lactation.

Year 1 and 2

The objective of this experiment was to investigate if different pasture allowances offered to early lactation grazing dairy cows for either two or six weeks influenced cumulative milk production produced during the 33-week long experiment. Ninety-six dairy cows were assigned to a randomised complete block design with a 4×2 factorial arrangement of treatments in an experiment which was repeated over two years (March 25 to November 27, 2014 and March 9 to November 23, 2015). Cows were randomly assigned to one of four pasture allowance (PA) (60 %, 80 %, 100 % or 120 % of intake capacity; IC) for either two or six weeks. Once the two- and six-week time durations had elapsed, all cows were offered 100 % of IC. Intake capacity was calculated using the equation of Faverdin et al. (2011) based on age, parity, days in milk, BW, BCS and potential milk yield. Pasture allowance (> 3.5 cm) for the 60 %, 80 % and 120 % treatments were calculated based on the IC of the 100x6 treatment. Treatment groups grazed adjacent to each other to ensure similar herbage mass was offered. Herbage mass (>3.5 cm) was measured twice weekly. As HM was similar between treatments daily area allocations differed. Pre- and post-grazing sward heights were measured daily using a rising plate meter. Fresh pasture areas were offered after each milking while treatments were being imposed and on a 24-hour basis thereafter. Milk yield was recorded daily, individual cows daily yields were summed to calculate cumulative milk yield following the 33-week experimental period. Data were analysed using covariate analysis and mixed models in SAS v9.4. Terms for year, parity, breed, PA, duration and the interaction of PA and duration were included. Pre-experimental values were used as covariates in the model.

Year 3

The objective was to determine the effect of varying PA, allocated for two durations at different stages during early lactation on immediate and total lactation dairy cow production.

The experiment was undertaken from March 14 to October 31, 2016. The experiment was a randomised block design that consisted of seven grazing treatments. A total of 105 cows (30 primiparous) were randomly assigned to each of the treatments. Cows were balanced on breed, calving date, parity, days in milk (DIM), pre-experimental milk production, BW and BCS gathered during the two weeks prior to commencement of the experiment. The control group (C) were allocated a PA representing 100% of their intake capacity. The remaining treatments were allocated 60% of the PA offered to the C treatment for a period of either two or six weeks from week one (ELS), three (MLS) or five (LLS) of the experiment. Once their respective 60% PA durations had finished, all treatments received 100% of IC. From week eleven all cows grazed as a single herd. All PA were offered above 3.5cm; post grazing sward height was not restricted. While treatments were imposed herds grazed separately but adjacent to one another, separated by temporary electric fences. All cows received a fresh PA after each milking until all treatments had ceased in week eleven. Herbage mass (HM; > 3.5 cm) was measured twice weekly by cutting eight 10 m strips from the grazing area. Pre- and post-grazing sward height was measured on a daily basis using a rising plate meter (Jenquip Rising Plate Meter, New Zealand). Milk yield (MY) was recorded on a daily basis. Milk composition was determined weekly from

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one successive evening and morning milking. Fat and protein concentrations were measured using MilkoScan 203 (DK-3400, Foss Electric, Hillerød, Denmark). Bodyweight and BCS (1 to 5 scale (1 = emaciated, 5 = extremely fat) in increments of 0.25; (Lowman et al., 1976) were also measured by a trained independent observer on a weekly basis. Milk and milk solids yield (MSY) were summed following the first ten weeks of the experiment and also at the end of the experiment (week 33). Bodyweight and BCS at the end of each period were also analysed. Variables associated with production were analysed using PROC MIXED models in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). The models contained terms for treatment, breed, parity, DIM and pre-experimental production covariates. These covariates were centred within breed and parity.

4. Main results:

Milk production

Cows assigned to the 120x6 treatment had a higher cumulative milk yield (4,270 kg/cow) than the 80x2, 100x2, 60x6 and 80x6 treatments. All cows other than the 120x6 were similar (3,957 kg/cow). Following the first 10-weeks of the experiment (six weeks when different PA were imposed and four weeks when 100 % IC was offered) the 120x6 treatment produced more milk (+ 44 kg/cow) than all other treatments during this period. This was due to their higher dry matter intake. However, a six-week period is relatively short in the context of a 33-week long experiment; consequently it gave the other treatments an opportunity to increase their milk production when IC was restored to 100 %. Nevertheless, a six-week PA restriction (60x6 and 80x6) in early lactation did reduce cumulative milk yield in comparison to offering 120% IC however, cumulative milk yield of these treatments was similar to the control treatment (100x6). As the 100x6 and 120x6 treatments were similar it suggests that there was no advantage in offering additional grass over and above cows IC in early lactation. There was no effect of PA or duration on 33-week average milk fat (4.75%), protein (3.61%) and lactose (4.71%) content. The results of this experiment suggest that when cows are offered more than they require to achieve IC for a six-week period (120x6) cumulative milk yield is higher compared to those offered a restricted PA for an extended period of time (six-weeks).

Restricting PA for 2 weeks and 6 weeks reduced daily milk yield (- 1.55 and - 2.54 kg/cow per day, respectively), cumulative milk protein yield (- 4.3 and - 7.6 kg/cow, respectively), and cumulative milk solids yield (- 6.6 and - 11 kg/cow, respectively) in the first 10 weeks of the experiment. There was no effect of grazing treatment on cumulative production at the end of the 33 week period. Cows in the MLS and LLS treatment produced less milk over the first 10 weeks of the experiment (- 2.4 kg/cow per day) compared to the ELS animals (22.7 kg/cow per day), however, bodyweight was greater (+ 23 kg/cow) in the LLS animals compared to the ELS and body condition score was greater in the LLS animals (+ 0.1) respectively) compared to both the ELS and MLS treatment. This indicates that animals that are restricted later in early lactation partition a greater proportion of available energy to maintenance, resulting in greater losses in milk production. This study suggests that despite the immediate reduction in milk production, restricting PA for up to 6 weeks may be used as a method of managing short term pasture deficits on farm with minimal effects on total lactation performance.

Dry matter intake and metabolic function

Restricting PA in early lactation (34-88 DIM) resulted in a mean reduction in DMI of 25 %, however, DMI as a proportion of the control treatment declined when imposed in mid-March for 6-weeks (75 % of control DMI achieved) and mid-April for 6-weeks (65 %) compared to mid-March for 6-weeks (78 %), which may be attributable to changes in the sward, as the plant changes from the vegetative to reproductive phase during this period. The reduction in milk production, relative to the control treatment, was similar between all restricted treatments (18 %), resulting in a 1.1 kg reduction in milk output per kg reduction in DMI. However, there was no effect of PA restriction or duration on body condition score, energy balance or blood metabolites, suggesting that the animals used in the study made sufficient physiological adaptions to partition energy for the maintenance of body reserves. In conclusion, short term restrictions of PA up to 25 % of DMI, for up to 6 weeks, can be used as a management strategy to cope with feed deficits in early lactation without impairing normal metabolic function of the early lactation dairy cow.

Fertility

Imposing short periods (2 weeks) of restricted DHA had no effects on metabolic health in early lactation dairy cows. After 6 weeks of low DHA a more pronounced effect was observed, but even at the most restricted DHA treatment, the cows displayed co-ordinated adaptation to cope with reduced feed intake.

There was little effect of DHA on any of the variables measured in P4. The 120% DHA treatment resulted in more luteal phases before 60 days postpartum than the 80% DHA treatment. Neither intensity nor duration of oestrus were affected by acute or chronic restrictions in DHA There was no significant effect of DHA on incidence of silent heats or heats without ovulation. From phenotypic fertility measures, there was little effect of DHA on reproductive performance, although, the 6-week 80% DHA treatment resulted in a tendency for shorter mating start date to conception interval than the 6-week 100% DHA treatment. A significant effect of DHA for the 6 week duration on calving interval was also detected. The 80% DHA cows had a significantly

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shorter calving interval than the 100% DHA. Based on the conditions of this study, we conclude that imposing periods of restricted DHA had no severe effects on oestrous cycle characteristics, oestrous behaviour or overall reproductive performance.

Animal Behaviour and Welfare

Although there was an effect of treatment on daily lying time, with the 60% cows spending less time lying than the 120%, cows in all treatments spent at least 9 h lying per day throughout the experiment. Daily lying time increased as the grazing season progressed. Feed allowance affected both lying bout duration and number, with cows on the highest feed allowance having the highest values for both. There was an effect of feed allowance on the time that cows first lay down after both morning and afternoon milking, with a similar pattern for both times; the lower the feed allowance, the longer it took. During the POST period, this pattern was no longer evident in the afternoon, but still present in the morning. None of the treatments imposed resulted in daily lying times lower than those reported in other studies at pasture. However, the significant differences in patterns of lying during the day could be reflective of satiety level; the patterns of lying in cows with a low feed allowance compared to those with an allowance aligned with intake capacity are in agreement with previous research. Herd level recording of lying behaviour, relative to time since milking and/or fresh feed allocation, has potential for use as an animal welfare indicator for cows at pasture.

There was no effect of DHA on locomotory ability for either 2 week or 6 week cows. However, in the 2 week treatment, cows on the 120% DHA had the best spine arch scores, and cows in the 60% treatment had the worst tracking. Likewise in the 6 week treatment cows on the 60% DHA had the worst spine arch scores, yet cows allocated a higher DHA tended to have worse ab/adduction scores. There was no effect of DHA on hoof health.

5. Opportunity/Benefit:

In recent years it has become evident that the climatic conditions experienced during spring can vary greatly from year to year. Consequently it is difficult to predict how much grass will need to be available to meet the demands of the early lactation cow throughout the first and second grazing rotation. The results of this project provide industry stakeholders with knowledge pertaining to feeding the early lactation cow, particularly during periods of grass deficit, when alternative sources of forage may be in short supply. It was important to determine how early lactation cows respond to changes in their grass supply which are likely to occur given the fluctuations in grass growth in early spring.

The results of the experiment also provided data for other projects

6. Dissemination:

An overview of the project was given at the Moorepark Open Day in 2015 and 2017. Visitors to Moorepark, both national and international, received presentations on the project and many interesting discussions took place. Poster and oral presentations were made at the EGF, BSAS, ISNH and IDF Conferences.

Main publications:

A. Claffey, L. Delaby, E. Lewis, T.M. Boland, E. Kennedy (2019) Pasture allowance, duration, and stage of lactation—Effects on early and total lactation animal performance. Journal of Dairy Science 102, 8986–8998

K. O'Driscoll, E. Lewis and E. Kennedy (2019) Effect of feed allowance at pasture on the lying behaviour of dairy cows. Applied Animal Behaviour Science 213, 40-46

J. Werner, C. Umstatter, E. Kennedy, J. Grant, L. Leso, A. Geoghegan, L. Shalloo, M. Schick, B. O'Brien (2019) Identification of possible cow grazing behaviour indicators for restricted grass availability in a pasture-based spring calving dairy system. Livestock Science 220, 74-82

Popular publications:

Kennedy E., Delaby L., Roche J.R., Horan B. and Lewis E. (2018) Interaction of early lactation pasture allowance and duration on cumulative milk production. Sustainable meat and milk production from grasslands. Proceedings of the 27th General Meeting of the European Grassland Federation p.461-463

E Kennedy, L Delaby, J Roche, B Horan, E Lewis (2016) Early lactation pasture allowance and duration: the effect on yield of milk fat and protein. The multiple roles of grassland in the European bioeconomy 2016 Proceedings of the 26th General Meeting of the European Grassland Federation. p 403-405

E Kennedy, L Delaby, B Horan, J Roche, E Lewis (2015) Duration is important in the effect of pasture allowance restriction on subsequent milk. Grassland and forages in high output dairy farming systems.(Symposium of the European grassland federation, p. 110-112

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