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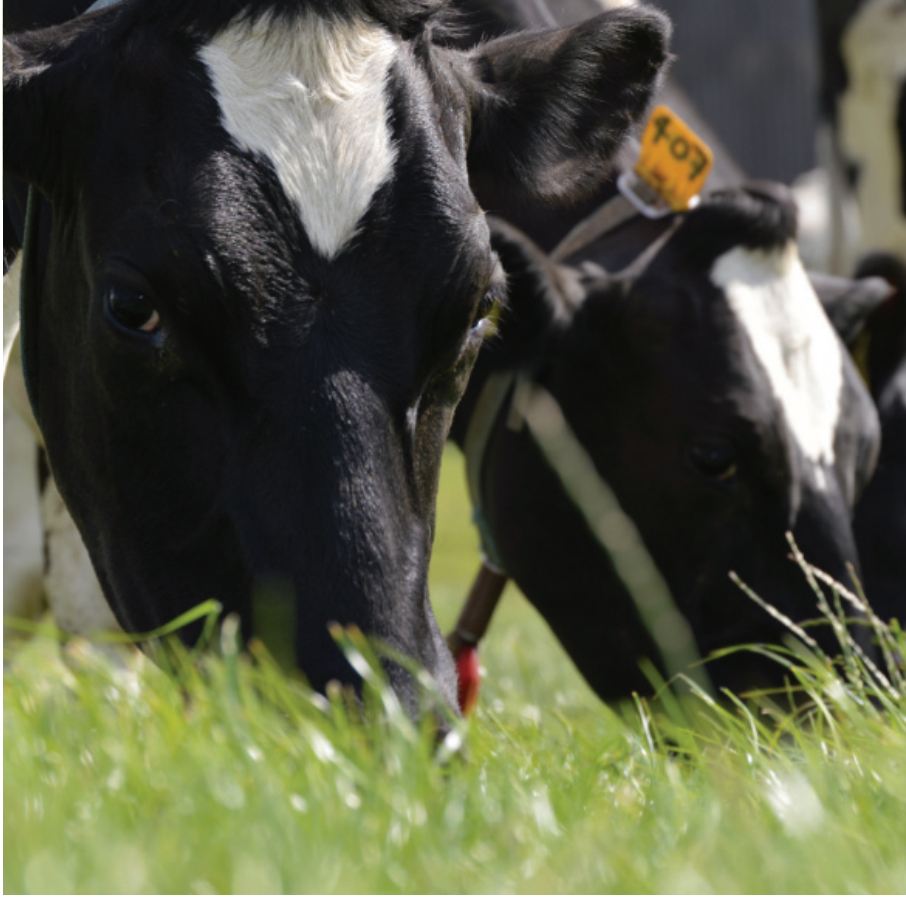

D-47-09

# Developing improved concentrate feeding and grazing strategies for dairy cows

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## SUMMARY


- If efficiently utilised, grazed grass remains the lowest-cost feed for dairy cows in Northern Ireland, and its use has the potential to provide local farmers with a key competitive advantage over many of our global competitors.
- However, the milk-yield potential of most dairy cows in Northern Ireland has increased considerably during the last few decades, and consequently grazed grass as the sole feed is frequently unable to meet the energy requirements of these higher-yielding cows during the grazing season.
- While concentrate feeding is often required, concentrates are expensive. Therefore, it is important that an economic milk-yield response is achieved when concentrates are offered. In addition, spread calving patterns on most farms result in wide ranges in milk yields within herds, meaning that identifying economically optimum concentrate feeding strategies can be a challenge.
- To address these issues, four studies were conducted at the Agri-Food and Biosciences Institute (AFBI) at Hillsborough.

**Study 1: Examining the impact of concentrate feed rate**

- Concentrate feed levels for grazing cows are often determined by assuming that grazed grass will provide the cow with the energy required for 'maintenance', plus a certain level of milk production (the 'Maintenance-Plus' or 'M+' value), with concentrates then offered at a specific feed rate to support milk yields above the Maintenance-Plus value.
- This study examined the impact of adopting three concentrate feed rates (0.25, 0.45 and 0.65 kg of concentrate per litre of milk produced above Maintenance-Plus) for grazing cows within a feed-to-yield system.
- As expected, concentrate intake increased with increasing feed rate. However, while there was a significant milk-yield response when the concentrate feed rate increased from 0.25 to 0.45 kg of concentrate per litre, milk yield did not increase further when the feed rate was increased to 0.65 kg per litre. In addition, total dry matter intakes, live weights and body condition scores were similar between the 0.45 and 0.65 kg per litre feed-rate treatments.
- Both margin-over-concentrates and margin-over-concentrates-plus-forage were greatest at a concentrate feed rate of 0.45 kg per litre. This feed rate was most economically robust across a wide range of milk prices and concentrate costs.





**Study 2: Identifying optimum Maintenance-Plus values**

- Estimating appropriate Maintenance-Plus values to be adopted for dairy cows offered grazed grass supplemented with concentrate feed can be problematic.
- This study examined the effect of adopting three levels of Maintenance-Plus (High, Medium or Low) values on concentrate requirements and cow performance during the grazing season.
- Adopting 'High' Maintenance-Plus values (25 kg/cow/day in late May, decreasing to 14 kg in late September) resulted in less concentrates being offered. However, cows on this treatment produced less milk, were thinner at the end of the study, and had lower margins per cow. The 'High' Maintenance-Plus values adopted in this study were unrealistically high for cows supplemented with concentrates.
- There was little benefit in either production performance (fat-plus-protein yield) or economic performance to be gained when moving from 'Medium' to 'Low' Maintenance-Plus values. Thus, the values adopted for the 'Medium' treatment (ranging from 21 kg per cow per day in late May to 12 kg in late September) appear to be optimal under good grazing conditions where cows are also offered concentrates. However, lower Maintenance-Plus values will need to be adopted if milk yields are to be sustained under difficult grazing conditions.

**Study 3: 'Flat-rate' versus 'Feed-to-yield' concentrate feeding strategies**

- Electronic concentrate-feeding systems exist in most modern milking parlours. These have become increasingly sophisticated, and on many farms it is now possible to allocate concentrates to individual dairy cows with a high degree of precision. However, it is unclear if there are benefits to be gained from 'precision-feeding' systems.
- This study examined the response of grazing dairy cows offered concentrates on either a 'Feed-to-yield' or 'Flat-rate' basis.
- Average daily concentrate intake was 4.0 kg/cow/day for both feeding strategies. However, individual cows within the Feed-to-yield strategy were offered a broad range of concentrate levels (1.0 to 10.0 kg/cow/day).
- Concentrate feeding strategy had no effect on milk yields, milk quality, live weights or body condition scores at the end of the study.

- Overall, concentrate allocation strategy had little impact on the performance of mid-lactation cows producing moderate milk yields.

**Study 4: Is tight grazing possible when feeding large amounts of concentrates?**

- Research with lower-yielding cows has consistently demonstrated that grass intakes and milk output can be improved by offering cows a greater herbage allowance (i.e. more 'lax' grazing). However, it has been suggested that when higher-yielding cows are offered higher levels of concentrates, it may be possible for them to graze tighter without having a detrimental effect on cow performance.
- This study examined the impact of three 'grazing intensities' (TIGHT, NORMAL and LAX) on the performance of high-yielding dairy cows.
- As grazing intensity increased, post-grazing sward height decreased. However, grass utilisation efficiency and grazing stocking rate increased.
- Even with high levels of concentrate feeding, milk yields per cow were reduced with TIGHT grazing (i.e. a post-grazing sward height of 5.2 cm). However, milk output per ha and margin per ha were maximised with TIGHT grazing. When land is limiting, this approach may be optimal.
- Moving from a NORMAL to a LAX grazing intensity resulted in no significant improvement in animal performance, but a large reduction in grass utilisation efficiency.



## BACKGROUND:

If efficiently utilised, grazed grass remains the lowest-cost feed for dairy cows in Northern Ireland, and its use has the potential to provide local farmers with a key competitive advantage over many of our global competitors. Thus, achieving high levels of cow performance from grazed grass should remain an important target on most dairy farms. Indeed, studies at AFBI Hillsborough have demonstrated that, when offered as the sole feed, grazed grass can sustain daily milk yields of up to 27 kg per cow in late May, with this value declining to 14 kg per cow by late September (Figure 1: solid blue line).

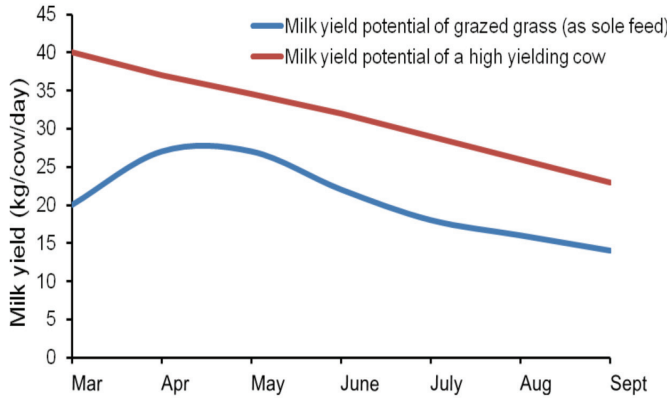


**Figure 1** Milk-yield potential of grazed grass when offered as the sole feed (blue line) compared to the typical milk-yield potential of a high-yielding dairy cow during the grazing season (red line)

However, the milk-yield potentials of most Northern Ireland dairy cows have increased considerably during the last few decades, and consequently grazed grass as the sole feed is frequently unable to meet the energy requirements of these higher-yielding cows during the grazing season. For example, the solid red line in Figure 1 highlights the milk-yield potential of a typical high-yielding cow (producing 40 kg of milk at turnout) over the course of a grazing season. Thus, there is a significant gap between the maximum milk yields that can be supported by grazed grass and the actual milk yields of high-yielding cows. As a consequence, dairy cows are normally offered concentrates to support milk yields above those that can be sustained by grazed grass, with this being necessary to avoid excessive body-tissue losses.

However, since concentrates are expensive, it is important that an economic milk-yield response is achieved when concentrates are offered. Nevertheless, spread calving patterns on most farms result in wide ranges in milk yields within herds, meaning that

identifying economically optimum concentrate feeding strategies can be a challenge. This is made more challenging by the absence of good research evidence across a number of areas.

For example, while Figure 1 presents the potential milk yields sustained by grazed grass when offered as the sole feed, it is known that grass intakes fall when concentrates are also offered to grazing cows (due to 'substitution' of grass with concentrate in the diet). Despite this, there is little information on milk yields that can be sustained from grazed grass (the 'Maintenance-Plus' or M+ value) when it is supplemented with moderate or high levels of concentrates. In addition, while a concentrate feed rate of 0.45 kg per litre of milk produced above Maintenance-Plus is often adopted, this is a theoretical value, with some nutritionists adopting either greater or lower feed rates above Maintenance-Plus. Also, while developments in parlour software and feeding systems now allow individual cows to be offered concentrates with a high degree of precision, it is unclear if benefits arise when concentrates are offered to individual cows according to their milk yields, for example, within 'feed-to-yield' systems.

To address these issues, three studies were conducted at the Agri-Food and Biosciences Institute (AFBI) at Hillsborough, with these studies designed to answer the following questions:

**Study 1:**
What is the impact of adopting different concentrate feed rates when supplementing grazing cows within a feed-to-yield system?

**Study 2:**
How does altering the assumed Maintenance-Plus value influence cow performance and concentrate feed levels within a feed-to-yield system?

**Study 3:**
Do cows respond differently when concentrates are offered on a feed-to-yield basis compared to on a flat-rate basis?

In addition, while it is known that the performance of lower-yielding cows increases with increasing herbage allowance, it is unclear if higher-yielding cows offered high concentrate feed levels are equally as sensitive to changes in herbage allowance. Thus a fourth study was undertaken to address this issue, with this study designed to answer the following question:

**Study 4:**
What impact does grazing intensity have on the performance of high-yielding cows offered high levels of concentrates?

A description of each of these studies, together with their main findings, are presented in this booklet.



## STUDY 1:

**What is the impact of adopting different concentrate feed rates when supplementing grazing cows within a feed-to-yield system?**

## BACKGROUND:

Concentrate feed levels for grazing cows are often determined by assuming that grazed grass will provide the cow with energy required for 'maintenance,' plus a certain level of milk production (the Maintenance-Plus or M+ value), with concentrates then offered to support milk yields above the Maintenance-Plus value. When calculating the quantity of concentrates required to support milk produced above the Maintenance-Plus value, a feed rate of 0.45 kg concentrate per litre of milk is often used. This value is based on the assumption that the production of one litre of milk requires approximately 5.1 megajoules (MJ) of metabolisable energy (ME), and that one kilogramme of concentrate contains approximately 11.5 MJ of ME. By dividing 5.1 by 11.5, we arrive at the feed rate of 0.45 kg of concentrate per litre of milk. However, this is a 'theoretical' value, and takes no account of 'substitution', the process by which grass intakes decrease as concentrate feed levels increase. For this reason, some nutritionists have adopted alternative feed rates that are either greater or lower than the value of 0.45 kg per litre. However, there is little information on the impact of adopting different concentrate feed rates when supplementing grazing cows.

Thus, the objective of this study was to examine the effect of adopting three different concentrate feed rates (0.25, 0.45 and 0.65 kg of concentrate per litre of milk), on the performance of grazing dairy cows.

## THE STUDY:

- This study involved 138 Holstein-Friesian dairy cows, 54 of which were in their first lactation. The study started on 8 June and finished on 3 October, with the late start date due to the very wet spring during 2012.
- Cows were a mean of 169 days calved at the start of the study and had an average daily milk yield of 28 kg per cow.
- For cows in their second or greater lactation, grazed grass was assumed to sustain daily milk yields of 21 kg per cow in early June, with this value decreasing to 12 kg per cow in mid-September (the Maintenance-Plus values). Maintenance-Plus values

adopted for first-lactation animals were 20% lower. Concentrates were then offered to individual cows to support milk yields above these Maintenance-Plus values, with concentrates offered at one of three feed rates, namely:

- 0.25 kg of concentrate per litre of milk produced above Maintenance-Plus
- 0.45 kg of concentrate per litre of milk produced above Maintenance-Plus
- 0.65 kg of concentrate per litre of milk produced above Maintenance-Plus

- Concentrate allocations were adjusted fortnightly during the study to take account of the declining Maintenance-Plus value adopted for grazed grass and changes in milk yields of individual cows. A minimum daily concentrate allocation of 1.0 kg/cow was adopted even if the milk yields fell below the Maintenance-Plus value, while the daily concentrate allocation was 'capped' at 10.0 kg/cow.

- Average concentrate feed levels throughout the study for each treatment are shown in Figure 2, although concentrate feed levels for individual cows on each treatment varied considerably around these averages.
- Each of the three treatment groups grazed separately, while cows were given access to a new paddock daily following evening milking.



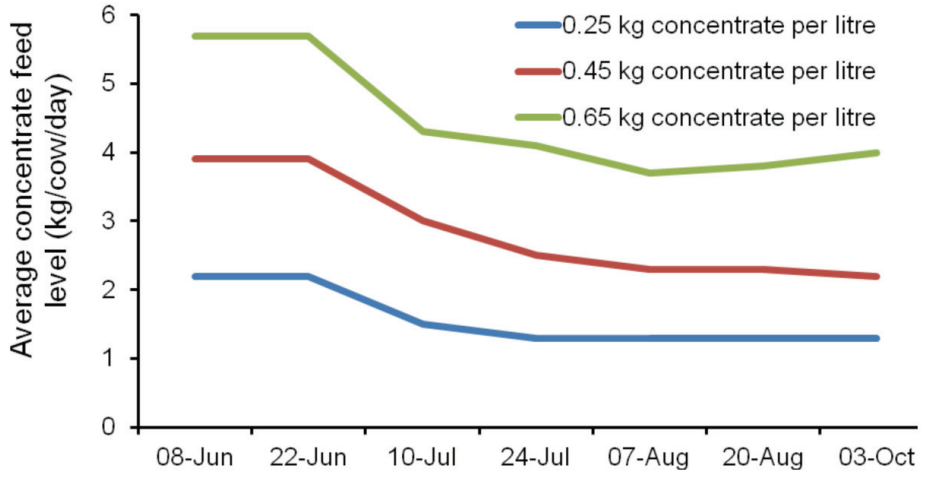


**Figure 2** Average concentrate feed levels for each treatment throughout the study (actual feed levels for individual cows varied considerably around these values)

## OUTCOMES AND PRACTICAL IMPLICATIONS

**Cow performance**

- 2012 was a very wet and difficult summer, and consequently cows had to be housed on a number of occasions. As a result, milk yields were substantially lower than expected.
- As expected, concentrate intakes increased as feed rate was increased from 0.25 to 0.65 kg of concentrate per litre of milk (Table 1).
- Although total dry matter intakes tended to be highest for cows on the highest concentrate feed rate treatment (0.65 kg of concentrate per litre of milk), these cows had the lowest grass intake due to 'substitution' of grass by concentrates in the diet.
- Increasing concentrate feed rate from 0.25 to 0.45 kg of concentrates per litre of milk resulted in a 2.5 kg/cow/day increase in milk yield. However, a further increase in concentrate feed rate to 0.65 kg per litre of milk resulted in only a small (and not statistically significant) increase in milk yield.

**Table 1** Effects of concentrate feed rate on cow performance

| | Concentrate feed rate (kg per litre of milk produced above the Maintenance-Plus value) | | |
|---|---|---|---|
| | **0.25** | **0.45** | **0.65** |
| Concentrate intake (kg/cow/day) | 1.6 | 3.0 | 4.5 |
| Grass dry matter intake (kg/cow/day) | 11.9 | 12.3 | 10.9 |
| Total dry matter intake (kg/cow/day) | 13.6 | 15.5 | 15.9 |
| Milk yield (kg/cow/day) | 17.3 | 19.8 | 20.4 |
| Milk fat (%) | 4.15 | 4.03 | 4.04 |
| Milk protein (%) | 3.33 | 3.29 | 3.30 |
| Milk fat-plus-protein yield (kg/cow/day) | 1.27 | 1.43 | 1.48 |
| Live weight at end of study | 568 | 560 | 573 |
| Body condition score at end of study | 2.3 | 2.2 | 2.3 |

- Concentrate feed rate had no effect on milk composition.
- Concentrate feed rate had relatively little effect on either the live weight or condition scores of cows at the end of the study.
- Average stocking rates during the study were 4.5, 5.1 and 5.5 cows per hectare with the 0.25, 0.45 and 0.65 concentrate feed rates, respectively.

**Responses of higher- and lower-yielding cows to concentrate feed rate**

- Although the overall treatment effects indicate that there was only a small milk-yield response to a concentrate feed rate above 0.45 kg per litre, this study was designed to identify if this response was similar for both high- and low-yielding cows.
- To examine this, cows within each treatment were ranked according to average daily milk yield (lowest-yielding to highest-yielding), with the results from the lower- and higher-yielding cows on each treatment examined (Figure 3).



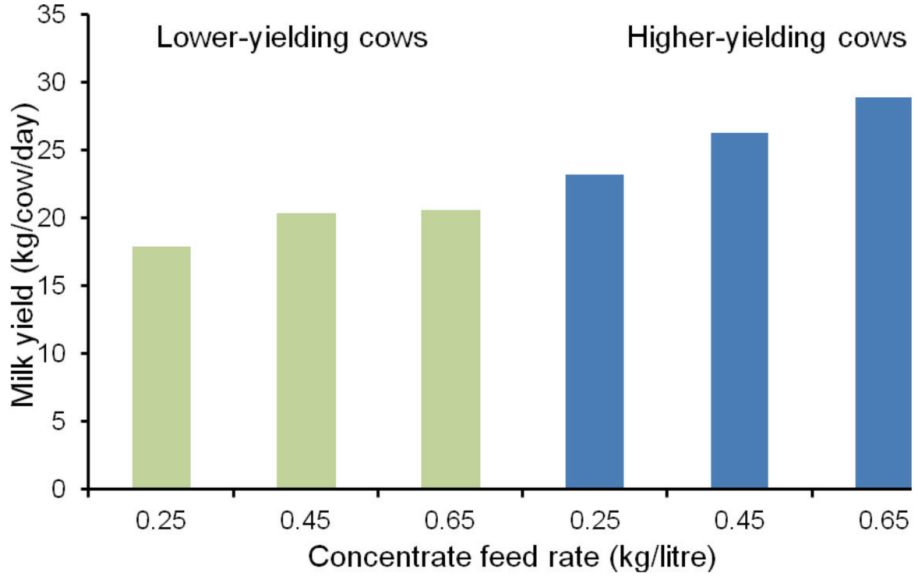


**Figure 3**: The milk-yield response to increasing concentrate feed rate of the lower-yielding cows (green bars) and the higher-yielding cows (blue bars) within each treatment.

- Figure 3 demonstrates that the higher-yielding cows on each treatment (blue bars) had a greater milk-yield response to increasing concentrate feed rate than the lower-yielding cows on each treatment.
- The response of very high-yielding cows to concentrate feed rates requires additional research.

**Economics**

- The financial impact of each of the three feed rates was examined at a base milk price of 30 pence per litre (adjusted for compositional bonuses for fat and protein) and a concentrate cost of £250 per tonne (Table 2).
- Both margin-over-concentrates and margin-over-concentrates-plus-forage were highest at a concentrate feed rate of 0.45 kg concentrate/litre. In addition, when margins were examined under a wide range of milk price (22 to 35 pence per litre)

and concentrate cost (£200 to £300 per tonne) scenarios, margins remained highest with the 0.45 kg feed rate treatment.

- Thus, on a herd basis, a feed rate of 0.45 kg of concentrate per litre of milk would appear to be economically robust under a wide range of milk price and concentrate cost scenarios.

**Table 2** Effect of concentrate feed rate on economic performance

| | Concentrate feed rate (kg/litre of milk produced above the Maintenance-Plus value) | | |
|---|---|---|---|
| | **0.25** | **0.45** | **0.65** |
| Margin over concentrates (£/cow/day) | 4.44 | 4.69 | 4.50 |
| Margin over concentrates plus forage (£/cow/day) | 3.63 | 3.95 | 3.82 |

Forage costs included sward establishment, variable, contractor and infrastructure costs, and a land charge (adjusted according to the length of the study)

## CONCLUSIONS:

- There was a significant milk-yield response when the concentrate feed rate increased from 0.25 to 0.45 kg of concentrate per litre of milk above the Maintenance-Plus value. However, milk yields did not increase further when the feed rate was increased to 0.65 kg of concentrate per litre of milk.
- A feed rate of 0.45 kg of concentrate per litre of milk was most robust across a wide range of milk prices and concentrate costs.



## STUDY 2:

**How does altering the assumed Maintenance-Plus value influence cow performance and concentrate feed level within a feed-to-yield system?**

## BACKGROUND

Concentrate feed levels for grazing cows are often determined by assuming that grazed grass will provide the energy required by the cow for 'maintenance' plus a certain level of milk production (the 'Maintenance-Plus' or 'M+' value), with concentrates then offered to support milk produced above this Maintenance-Plus value. While research has demonstrated that daily milk yields of up to 27 kg per cow can be supported by grazed grass when offered as the sole feed in spring, with this value declining to 14 kg in the autumn, grazed grass is unlikely to sustain these milk yields when concentrates are also offered due to the 'substitution' of grass with concentrates in the cow's diet. However, there is relatively little research information available on appropriate Maintenance-Plus values that should be adopted when cows are offered concentrates. Nevertheless, there is a tendency for farmers to adopt unnecessarily low Maintenance-Plus values, resulting in excessive concentrate feeding during the grazing season. Thus, the objective of the current study was to examine the effect of adopting high, medium or low Maintenance-plus values on concentrate requirements and cow performance within a feed-to-yield system throughout the grazing season.

## THE STUDY:

- This study involved 72 Holstein-Friesian cows, 24 of which were in their first lactation.
- The study started on 24 May and finished on 2 October. The late start date was due to the exceptionally poor weather during spring in 2013.
- Cows were an average of 159 days calved, and had an average daily milk yield of 32 kg per cow, at the start of the study.
- The study examined three treatments, which involved the adoption of either 'Low', 'Medium', or 'High' Maintenance-Plus values throughout the grazing season. The values adopted for cows in their second or subsequent lactations are presented in Figure 4, while the values adopted for the first-lactation heifers were reduced by 20% compared to these values.
- Cows on the 'Low', 'Medium' and 'High' treatments were kept in separate groups and

managed within a rotational-grazing system throughout the study.

- Grazing was managed so that post-grazing sward heights were similar with all three treatments.
- Concentrates were offered to all cows on a 'feed-to-yield' basis. The allocation for each cow was adjusted fortnightly during the study to account for the changing 'Maintenance-Plus' values for each treatment and the changing milk yield of each individual cow. Concentrates were allocated to individual cows at a rate of 0.45 kg for every litre of milk produced above their assigned Maintenance-Plus value. This was the optimal rate identified in Study 1.

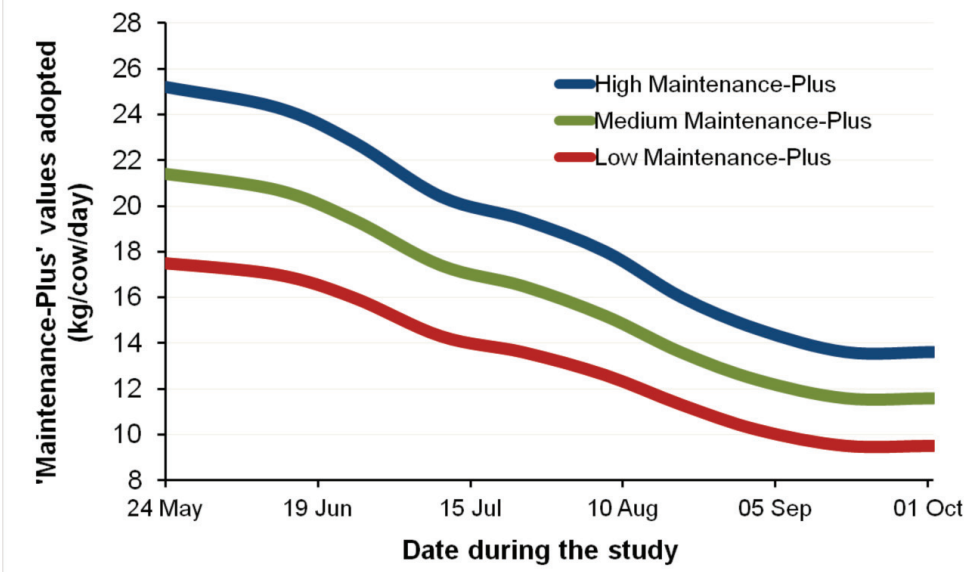


**Figure 4** Maintenance-Plus values assigned to each of the three treatments throughout the study (values for first-lactation cows were assumed to be 20% lower)



## OUTCOMES AND PRACTICAL IMPLICATIONS

### Cow performance

- Placing a lower reliance on grazed grass through the adoption of lower Maintenance-Plus values resulted in increased concentrate intakes (Table 3).
- Total concentrates offered during the study were 242, 408 and 645 kg per cow for the 'High', 'Medium' and 'Low' treatments, respectively.

**Table 3** Effect of Maintenance-Plus ('High', 'Medium' or 'Low') on concentrate intakes and cow performance

| | Maintenance-Plus values adopted | | |
|---|---|---|---|
| | 'High' | 'Medium' | 'Low' |
| Concentrate intake (kg/cow/day) | 1.8 | 3.2 | 4.9 |
| Milk yield (kg/cow/day) | 19.0 | 21.8 | 23.8 |
| Milk fat (%) | 4.49 | 4.41 | 4.36 |
| Milk protein (%) | 3.50 | 3.41 | 3.42 |
| Milk fat-plus-protein yield (kg/cow/day) | 1.51 | 1.70 | 1.84 |
| Body condition score at end of study | 2.2 | 2.2 | 2.3 |
| Live weight at end of study (kg) | 547 | 556 | 579 |

- Milk yields increased as concentrate intakes increased, with the greatest milk yield observed with the treatment involving the lowest reliance on grazed grass (i.e. the 'Low' Maintenance-Plus values).
- Altering the Maintenance-Plus values had no effect on milk fat or protein content of the milk produced.
- Reducing the Maintenance-Plus values from 'High' to 'Medium' resulted in a significant increase in milk fat-plus-protein yield. However, when the Maintenance-Plus values were reduced from 'Medium' to 'Low', there was no further significant increase in milk fat-plus-protein yield.
- Thus, caution is required when adopting very low Maintenance-Plus values, as

the additional concentrates required may not necessarily result in an increase in cow performance.

- Cows in the 'Low' Maintenance-Plus treatment group had greater body condition scores and live weights at the end of the study, compared to those in the 'Medium' or 'High' groups. Thus, cows with the greatest reliance on grazed grass ('High' Maintenance-Plus) were thinner and lighter at the end of the study than cows with the lowest reliance on grass ('Low'). If the body-tissue reserves of these thinner cows cannot be restored during the late-lactation period, they may have an increased risk of health and fertility problems during their next lactations.
- Average stocking rates during the grazing period were 6.5, 7.0 and 7.7 cows per hectare for the 'High', 'Medium' and 'Low' treatments, respectively.

**Economics**

- Financial performance associated with each of the three Maintenance-Plus treatments was examined at a base milk price of 30 pence per litre (adjusted for compositional bonuses for fat and protein) and a concentrate cost of £250 per tonne (Table 4).
- Both margin-over-concentrates and margin-over-concentrates-plus-forage were lowest with the 'High' Maintenance-Plus treatment.
- There was only a small increase in margins when moving from the 'Medium' to the 'Low' Maintenance-Plus treatments. However, this difference decreased as milk price decreased or as concentrate cost increased.
- When examined on a margin per hectare basis, margins were lowest with the 'High' treatment due to the 'margin' being spread over a larger land area.



**Table 4** Effect of Maintenance-Plus ('High', 'Medium' or 'Low') on economic performance

| | Maintenance-Plus values adopted | | |
|---|---|---|---|
| | 'High' | 'Medium' | 'Low' |
| Margin over concentrates (£/cow/day) | 5.76 | 6.22 | 6.41 |
| Margin over concentrates plus forage (£/cow/day) | 5.23 | 5.73 | 5.96 |

Forage costs included sward establishment, variable, contractor and infrastructure costs, and a land charge (adjusted according to the length of the study).

## CONCLUSIONS:

- Adopting 'High' Maintenance-Plus values (i.e. increased reliance on grazed grass) resulted in less concentrates being offered, but also lower milk outputs and thinner cows. Therefore, it is likely that these 'High' values were overly optimistic.
- Adopting 'Medium' Maintenance-Plus values (the green line in Figure 4) seems to be more appropriate when weather and grazing conditions are good, and will allow the use of grazed grass to be optimised. However, lower Maintenance-Plus values will need to be adopted if milk yields are to be maintained under difficult grazing conditions.

## STUDY 3:

**Do cows respond differently when concentrates are offered on a feed-to-yield basis compared to a flat-rate basis?**

## BACKGROUND

Electronic concentrate feeding systems in most modern milking parlours have become increasingly sophisticated, and on many farms it is now possible to allocate concentrates to individual dairy cows with a high degree of precision. Indeed, 'feed-to-yield' concentrate allocation strategies were adopted within Studies 1 and 2 of this booklet. However, it is unclear if these 'precision feeding' systems, which normally adopt a 'feed-to-yield' approach, actually result in improved levels of cow performance compared to 'flat-rate' feeding systems.

Thus, the objective of this study was to compare the impact of two concentrate allocation strategies ('Feed-to-yield' versus 'Flat-rate') on the performance of grazing dairy cows.

## THE STUDY:

- This study involved 56 Holstein-Friesian cows. Cows were an average of 150 days calved at the start of the study and had an average daily milk yield of 31 kg per cow (range: 20 to 48 kg per cow).
- The study started on 12 May and finished on 11 September (122 days).
- Two treatments were examined in this study, with treatments comprising two concentrate allocation strategies:
  - 'Flat-rate'
  - 'Feed-to-yield'

**Description of the Flat-rate treatment**

- Within this treatment grazed grass was assumed to sustain daily milk yields of 25 kg per cow on 12 May, decreasing to 12 kg per cow on 3 September (the Maintenance-Plus values).
- The difference between the assumed Maintenance-Plus value and the average milk yield of cows on this treatment was determined each month, and this value was used to identify the appropriate concentrate feed-level for the treatment based on a constant feed rate per litre of milk. All cows on this treatment were then offered concentrates on a flat-rate basis at this feed level.
- The quantity of concentrates offered to all cows on this treatment decreased from 5.3 to 2.5 kg/cow/day from early May to early September.

**Description of the Feed-to-yield treatment**

- Each cow within the Feed-to-yield treatment had a different daily concentrate allocation, with these being determined by the milk yield of each individual cow.
- Feed levels for each cow were determined by taking the total quantity of concentrates offered to all cows within the 'Flat-rate' treatment, and dividing it among the cows on the 'Feed-to-yield' treatment, according to their individual milk yields. Thus, higher-yielding cows received more concentrates than lower-yielding cows.
- Daily concentrate feed levels for cows on the Feed-to-yield treatment ranged from 1.0 to 10.0 kg/cow in May, and from 1.0 to 7.9 kg/cow in early September (Table 5). However, throughout the study the average daily concentrate intake for cows on this treatment was identical to the feed level used with the 'Flat-rate' treatment.

**Table 5** Concentrate feed levels throughout the study with the Flat-rate and Feed-to-yield treatments.

| | Concentrate allocation strategy (kg concentrate/cow/day) | | |
|---|---|---|---|
| | Flat-rate | Feed-to-yield | |
| | | Minimum | Maximum |
| 12 May to 12 June | 5.3 | 1.0 | 10.0 |
| 13 June to 9 July | 4.0 | 1.0 | 8.9 |
| 10 July to 3 Aug. | 3.8 | 1.0 | 8.0 |
| 4 Aug. to 2 Sept. | 3.2 | 1.0 | 8.0 |
| 3 Sept. to 11 Sept. | 2.5 | 1.0 | 7.9 |

## OUTCOMES AND PRACTICAL IMPLICATIONS

- With both the Flat-rate and Feed-to-yield treatments, the total quantity of concentrates consumed during the study was 480 kg per cow, which corresponds to an average daily intake of 4.0 kg per cow.
- Allocating concentrates to individual animals based on their individual milk yields (Feed-to-yield basis) had no effect on the average milk yield, milk composition or fat-plus-protein yields of cows on this treatment compared to offering concentrates using a simple Flat-rate system (Table 6).
- Similarly, neither live weights nor condition score at the end of the study were affected by concentrate allocation strategy.

**Table 6** The effect of concentrate allocation strategy on cow performance.

| | Concentrate allocation strategy | |
|---|---|---|
| | Flat-rate | Feed-to-yield |
| Milk yield (kg/cow/day) | 22.3 | 22.9 |
| Milk fat (%) | 3.96 | 4.01 |
| Milk protein (%) | 3.32 | 3.36 |
| Milk fat-plus-protein yield (kg/cow/day) | 1.62 | 1.65 |
| Live weight at end of study | 560 | 560 |
| Body condition score at end of study | 2.3 | 2.3 |

- While feeding system did not affect performance at a 'herd' level, it is important to examine how individual animals responded when managed on these two feeding systems. In particular, it is important to identify if 'higher' yielding cows responded differently from 'lower' yielding cows.
- To examine this, cows managed on each of the two treatments were ranked on the basis of milk yields into 'higher' and 'lower' yielders (top and bottom 50% of cows), with the results presented in Figure 5.
- When we examine the lower-yielding group, cows on the Feed-to-yield treatment had a lower milk yield than those on the Flat-rate treatment, whereas the opposite effect was observed with the higher-yielding cows.



- Thus, there was a greater range of milk yields with the Feed-to-yield system compared to the Flat-rate system, with the Feed-to-yield cows having 'more extreme' yields.
- These effects are due to differences in concentrate intakes with individual cows on each treatment. For example, all cows (both higher and lower yielding) on the Flat-rate system had an average concentrate intake of 4.0 kg per day. However, lower-yielding cows on the Feed-to-yield system had an average concentrate intake of 2.5 kg per day, while higher-yielding cows on the Feed-to-yield system had an average concentrate intake of 5.3 kg per day.
- Despite these differences in milk yield between higher- and lower-yielding cows on the two feeding systems, there was no evidence that concentrate feeding system had an effect on either live weight or body condition scores of high- and low-yielding cows.

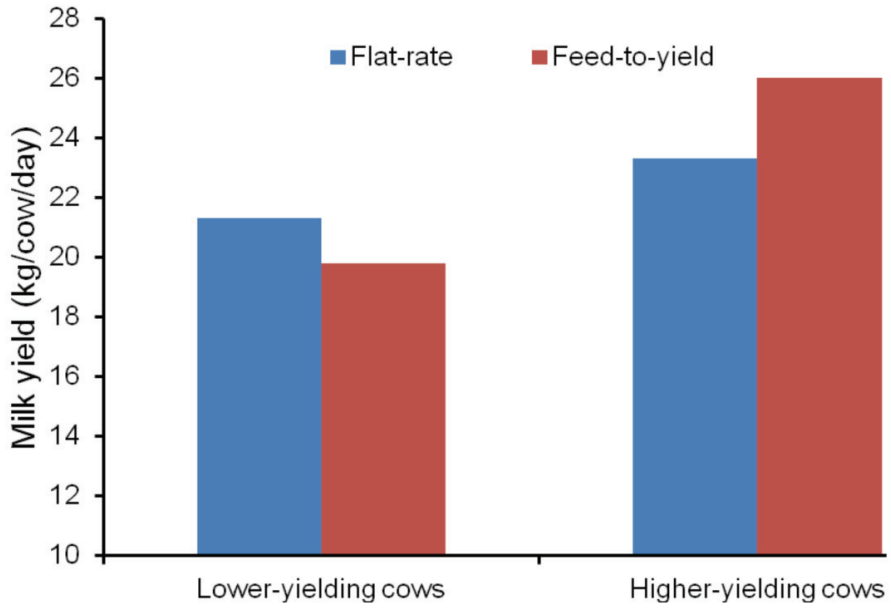


**Figure 5** The milk yields of the highest- and lowest-yielding cows within the Flat-rate (blue bars) and Feed-to-yield (red bars) treatment groups

## CONCLUSIONS:

- With moderate-yielding cows in mid-lactation, offering the same quantity of concentrates using either a Flat-rate or Feed-to-yield system is unlikely to have a large effect on herd performance.
- However, the use of a Feed-to-yield system will result in cows having a greater range of milk yields than a Flat-rate system. This did not appear to have an effect on cow condition score in the current study.
- It is uncertain if a similar effect would be observed in herds with a greater spread in calving dates.



## STUDY 4:

**What impact does grazing intensity have on the performance of high-yielding cows offered high levels of concentrates?**

## BACKGROUND:

Research with lower-yielding cows has consistently demonstrated that grass intakes and milk output can be improved by offering cows a greater herbage allowance. Nevertheless, offering more grass is normally associated with lower grass utilisation efficiency, and this may result in lower herbage quality later in the grazing season. However, the effect of herbage allowance on the performance of higher-yielding cows has received much less attention. Indeed, it has been suggested that when cows are offered higher levels of concentrates it may be possible for them to graze tighter without having a detrimental effect on cow performance.

Thus, the objective of this study was to assess the impact of grazing intensity on the performance of high-yielding dairy cows, when offered 'high' levels of concentrates.

## THE STUDY:

- This study involved 63 Holstein-Friesian dairy cows (including 21 cows in their first lactation). At the start of the study cows had an average daily milk yield of 36 kg per day and were an average of 65 days calved.
- The study started on 29 April and finished on 17 September (141 days).
- Three treatments were examined in this study, with treatments comprising three 'grazing intensities':
  - o 'TIGHT'
  - o 'NORMAL'
  - o 'LAX'
- Cows on each of the three treatments grazed in separate groups within a paddock grazing system, with the three different grazing intensities imposed by altering the size of the paddocks being grazed (0.14, 0.17 and 0.20 hectare paddocks for the TIGHT, NORMAL and LAX treatments, respectively).
- Concentrate feed levels were constant across the three treatments, with cows offered 9.0 kg of concentrate per day and heifers 6.0 kg per day.
- All paddocks across all treatments were topped once (to approximately 4.0 cm) mid-

season using a disc mower.

## OUTCOMES AND PRACTICAL IMPLICATIONS:

### Herbage utilisation and quality

- As expected, as grazing intensity increased, post-grazing sward height decreased (Table 7).
- As a consequence, grass utilisation efficiency (the proportion of grass above 4.0 cm that was removed by the cow) increased with increasing grazing intensity, with over 80% of grass offered with the TIGHT grazing treatment being consumed by the cows.
- Herbage quality tended to be higher with the TIGHT grazing treatment.

**Table 7** Effect of grazing intensity on sward height, grass utilisation efficiency and grass quality

| | Grazing intensity | | |
|---|---|---|---|
| | TIGHT | NORMAL | LAX |
| Post-grazing sward height (cm) | 5.2 | 6.1 | 6.8 |
| Grass utilisation efficiency (%) | 81 | 69 | 62 |
| Grass metabolisable energy content (MJ/kg DM) | 11.9 | 11.7 | 11.7 |
| Grass crude protein content (% DM) | 23 | 22 | 21 |

### Cow performance

- The excellent cow performance in this study (Table 8) was due in part to the excellent weather conditions during the 2010 grazing season.
- Grass intakes and total dry matter intakes were highest with the LAX grazing treatment. This confirms that grass intakes can be increased by offering more grass, even when cows are offered high levels of concentrates.
- Moving from the LAX to the NORMAL grazing intensity resulted in only a small, but not statistically significant, reduction in milk yield and fat-plus-protein yield.



However, increasing grazing intensity further (from NORMAL to TIGHT) resulted in a large reduction in milk yield and fat-plus-protein yield.

- The low milk fat contents reflect the high concentrate feed levels adopted.
- Grazing intensity had no effect on live weights or body condition scores at the end of the study (Table 8).
- This study demonstrates that, even with high concentrate feed levels, the performance of high-yielding cows was reduced with tight grazing (residual sward height of 5.2 cm). However, moving from a system with a post-grazing height of 6.1 cm (NORMAL) to one with a post-grazing height of 6.8 cm (LAX) resulted in no improvement in performance, but a large reduction in grass utilisation.

**Table 8** Effect of grazing intensity on cow performance

| | Grazing intensity | | |
|---|---|---|---|
| | TIGHT | NORMAL | LAX |
| Concentrate intake (kg/cow/day) | 8.1 | 8.1 | 8.1 |
| Grass dry matter intake (kg/cow/day) | 8.8 | 9.0 | 10.4 |
| Total dry matter intake (kg/cow/day) | 15.9 | 16.1 | 17.5 |
| Milk yield (kg/cow/day) | 30.5 | 32.2 | 33.2 |
| Milk fat (%) | 3.39 | 3.35 | 3.46 |
| Milk protein (%) | 3.24 | 3.27 | 3.32 |
| Milk fat-plus-protein yield (kg/cow/day) | 2.02 | 2.16 | 2.23 |
| Live weight at end of study | 545 | 555 | 561 |
| Body condition score at end of study | 2.4 | 2.3 | 2.4 |

### Cow performance per hectare

- While milk production per cow can be a major driver of efficiency within dairy systems, land availability is a limiting factor on many local dairy farms. Thus, it is important to consider the effect of grazing intensity on milk output per hectare.
- This study clearly demonstrated that tighter grazing resulted in increased stocking rates (Table 9). As a result, total milk output per ha and total solids output per ha increased with increasing grazing intensity.

**Table 9** Effect of grazing intensity on stocking rate during the grazing period and on milk output and milk solids output per hectare.

| | Grazing intensity | | |
|---|---|---|---|
| | TIGHT | NORMAL | LAX |
| Grazing stocking rate (cows/hectare) | 7.8 | 6.7 | 5.6 |
| Total milk output per hectare (kg) | 33,178 | 30,229 | 25,558 |
| Total milk fat plus protein output per hectare (kg) | 2,197 | 1,992 | 1,738 |

**Economics**

- The financial impact of each of the three feed rates were examined at a base milk price of 30 pence per litre (adjusted for compositional bonuses for fat and protein) and a concentrate cost of £250 per tonne (Table 10).
- Both margin-over-concentrates and margin-over-concentrates-plus-forage were highest with the LAX treatment and lowest within the TIGHT treatment. This trend remained unchanged across a wide range of milk price (22 to 35 pence per litre) and concentrate cost (£200 to £300 per tonne) scenarios.
- Margin per hectare was highest within the TIGHT treatment and lowest with the LAX grazing treatment. This is due to the 'margin' being spread over a greater number of hectares with the LAX treatment.

**Table 10** Effect of grazing intensity on economic performance

| | Grazing intensity | | |
|---|---|---|---|
| | TIGHT | NORMAL | LAX |
| Margin over concentrates (£/cow/day) | 6.75 | 7.32 | 7.71 |
| Margin over concentrates plus forage (£/cow/day) | 6.27 | 6.76 | 7.04 |

Forage costs included sward establishment, variable, contractor and infrastructure costs, and a land charge (adjusted according to the length of the study)



## CONCLUSIONS:

- Even with high levels of concentrate feeding, milk yield per cow was reduced with TIGHT grazing (i.e. a post grazing sward height of 5.2 cm). However, milk output per ha and margin per ha were maximised with TIGHT grazing. When land is limiting, this approach may be optimal.
- Moving from a system with a post-grazing height of 6.1 cm (NORMAL) to one with a post-grazing height of 6.8 cm (LAX) resulted in no improvement in animal performance, but a large reduction in grass utilisation efficiency.

## AGRISEARCH BOOKLETS

**1 SHEEP**
The Effects of Genetics of Lowland Cross-Bred Ewes and Terminal Sires on Lamb Output and Carcass Quality

**2 DAIRY**
A Comparison of Four Grassland-Based Systems of Milk Production for Winter Calving High Genetic Merit Dairy Cows

**3 DAIRY**
Dairy Herd Fertility - Examination of Effects of Increasing Genetic Merit and other Herd Factors on Reproductive Performance

**4 SHEEP**
Developing Low Cost 'Natural-Care' Systems of Sheep Production

**5 BEEF**
An Examination of Factors affecting the Cleanliness of Housed Beef Cattle

**6 BEEF**
The Effects of Housing System on Performance, Behaviour and Welfare of Beef Cattle

**7 DAIRY**
Developing Improved Heifer Rearing Systems

**8 BEEF**
The Influence of Suckler Cow Genetics and Terminal Sire on Performance of the Suckler Herd

**9 DAIRY/ BEEF**
Reducing Organic Nitrogen Outputs from Dairy Cows and Beef Cattle in Nitrate Vulnerable Zones

**10 DAIRY**
The Effect of the Type of Dietary Supplement on the Performance of the Grazing Dairy Cow

**11 DAIRY**
Are International Dairy Sire Genetic Evaluations Relevant to Milk Production Systems in Northern Ireland?

**12 DAIRY/ BEEF**
Holstein Bull Beef

**13 DAIRY**
Effective Footbathing of Dairy Cows

**14 DAIRY**
Effects of Feeding Forage Maize and Whole Crop Silages on the Performance of Dairy Cows Offered Two Qualities of Grass silage

**15 BEEF**
Maximising Beef Output from the Suckler Herd Through the Production of Heavy Bulls

**16 DAIRY**
The Effect of Reducing the Protein Content of the Diet on the Performance of Dairy Cows

**17 DAIRY**
Comparisons of Dairy Cow Management Strategies which Differ in Labour Inputs

**18 DAIRY**
Reducing Phosphorous Levels in Dairy Cow Diets

**19 DAIRY**
The Effect of Applying Slurry During the Grazing Season on Dairy Cow Performance

**20 BEEF**
Contribution of Meat (Beef and Lamb) from Grass-Fed Ruminants to the Total Human Dietary Intake of Long Chain N-3 Polyunsaturated Fatty Acids.

**21 BEEF**
Maximising Returns from Beef Sourced from the Dairy Herd

**22 DAIRY**
A Comparison of the Performance of Holstein-Friesian and Norwegian Red cows on Northern Ireland Dairy Farms

**23 DAIRY**
The Effect of a Number of Novel Supplementation Strategies on Milk Production and Fertility of High Yielding Dairy Cows

**24 DAIRY**
A Comparison of the Performance of Holstein-Friesian and Jersey Crossbred Cows across a Range of Northern Ireland Production Systems

**25 DAIRY**
The Effect of Applying Cattle Slurry as the Sole Source of Nutrients over a Four Year Period on the Yield and Persistency of Seven Perennial Forage Crops

**26 DAIRY**
Grassland performance and its relationship with profitability on 10 Northern Ireland dairy farms

**27 DAIRY**
The Effect of offering concentrates during the dry period on dairy cow performance

**28 DAIRY / BEEF**
Prevalence of BVD in Northern Ireland Dairy and Suckler Herds

**OTHER PUBLICATIONS:**
- BovIS User Guide (Carcass Benchmarking Application)
- Diagnosis and Treatment of Lameness in Sheep

*For further information or to request a copy of the the full scientific report detailing the experimental tests and statistical analysis contact*

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