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# THE EFFECT OF THE TYPE OF DIETARY SUPPLEMENT ON THE PERFORMANCE OF THE GRAZING DAIRY COW

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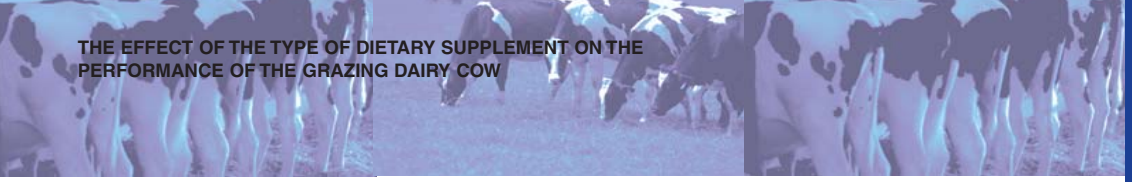

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## AGRISEARCH BOOKLETS

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9 DAIRY DB-16-03
The Influence of Suckler Cow Genetics and Terminal Sire on Performance of the Suckler Herd

10 DAIRY D-13-02
The Effect of the Type of Dietary Supplement on the Performance of the Grazing Dairy Cow



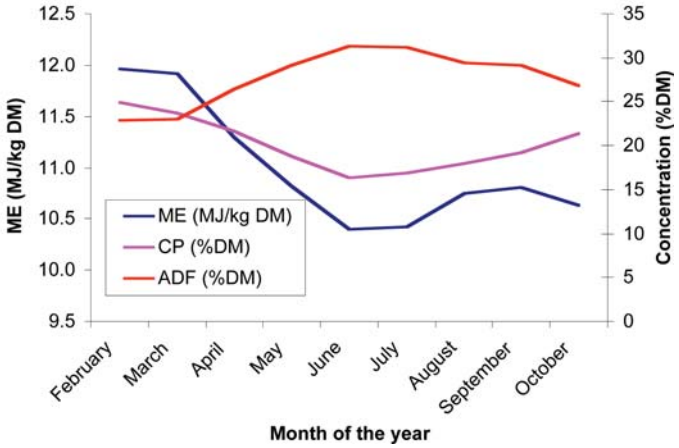
## OVERALL SUMMARY OF PROJECT

- Results from this project indicate that supplementation of grazing dairy cows with forage or concentrate supplements results in increased total dry matter (DM) intake.
- Alternative forage supplements such as fermented whole crop wheat silage or forage maize silage produced a greater feed intake response than grass silage, but the level of supplement intake appears to be dependent on supplement quality, and in particular, DM concentration.
- There was no effect of concentrate energy source (either starch/sugar or fibrous compounds) on milk yield or milk quality, however, the substitution rate was lower for the fibrous concentrate.
- Concentrate supplementation gave the greatest milk yield response of all supplement treatments with an average response of 1.0 l milk/kg fresh concentrate. However, in the first experiment, cows offered maize silage gave a similar daily milk yield to that of cows offered concentrate supplementation.
- While the milk yield response to forage supplementation was generally poor, when compared to concentrate supplementation, milk fat concentration was higher with cows offered maize silage or whole crop wheat silage (increases of up to 0.32%).
- With incoming Nitrates Directives and Water Framework Directives, nutrient management is of critical importance. The efficiency of nitrogen utilisation with grazing dairy cows was improved with maize silage supplementation in both years. This primarily resulted from a reduced nitrogen intake by the animal and consequently a reduced level of nitrogen excretion.
- The lack of milk yield response with forage supplements may result from these cows partitioning a greater proportion of energy to body reserves than unsupplemented cows, or those offered concentrates. This could be beneficial in the longer term in relation to fertility and/or cow longevity.
- In the first study, offering maize silage gave the greatest margin over feed cost (£/day) and could give an increased return over the grazing period of £38 per cow, assuming 150 days grazing. However, in study two there was no major difference in margin over feed cost for forage supplement treatments.

## INTRODUCTION

During the grass growing season, grazed pasture is a primary source of nutrients for the majority of dairy cows across the UK dairy industry. In general, the nutritive value of pasture is relatively high, but as the season progresses the quality can decline in terms of both chemical composition and dry matter (DM) content (Figure 1).

Figure 1 *Grass quality over the season*




In addition to the change in grass quality throughout the season, seasonal fluctuations in grass growth are an important factor, resulting in a surplus or deficiency of available herbage for the grazing animal. With the genetic evolution of the dairy cow, resulting in cows with the potential to produce much higher milk yields, achieving a high nutrient intake for the dairy cow is now of paramount importance to sustain the cow.

High DM intakes of grass can be achieved by offering cows a greater herbage allowance, but this normally results in a reduced efficiency of utilisation of grassland and hence an increased cost of grass consumed. Recent costing of forages in Northern Ireland demonstrated that the actual cost of grazed grass was primarily related to the yield of utilised DM and that a reduction in this yield could almost double the cost of grazed grass.

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Grassland occupies 838,486 ha of all land in Northern Ireland and is the primary feed used in ruminant agriculture (DARDNI, 2005). However, the area of land for arable silage, which would include whole crop cereals, and maize silage, has increased by 54% over the past ten years to 2788 ha (DARDNI, 2005). The majority of this arable silage is used for indoor winter feeding as a component of a total mixed ration. A secondary use of arable silage could be as a supplement for grazing dairy cows.

Standard dairy concentrates provide a compact concentrated package of nutrients during the grazing season and minimise any substitution rate for grazed grass, and maintain or lift animal performance. However, with increased financial pressure to reduce input costs in modern farming practices, and a requirement for increased efficiencies of production of a traceable milk product to the consumer, the provision of home-grown arable silages as supplements requires investigation.

Maize silage and wholecrop wheat silage are potentially lower cost feeds, compared to concentrates, with high intake characteristics that could potentially provide a source of starch and effective fibre to the grazing dairy cow. This could help to maintain or improve animal performance and improve efficiencies of production during the grazing season. Dairy cows normally have a poor efficiency of dietary N utilisation at grass, which is often related to the poor synchrony between pasture protein and carbohydrate release in the rumen. Furthermore, there is evidence that by combining dietary ingredients with different rates of ruminal degradability, it is possible to improve the efficiency of microbial protein synthesis in the rumen. Therefore, a further objective of this research programme was to examine the effect of offering dairy cows a slowly degradable versus a rapidly degradable concentrate and to assess any potential effect on rumen synchrony. Furthermore, as the maize silage and wholecrop wheat silage were high starch feeds with low protein content, the contribution of the starch components of these forages to rumen synchrony was also investigated.

With the incoming legislation from the European Union, incorporating both the Nitrates Directive and The Water Framework Directive, improving the efficiency of utilisation of nitrogen (N) and phosphorus (P), will be of foremost importance in dairy cow feeding systems, both presently and in the future. There is considerable potential to reduce, and indeed to control, specific nutrient inputs on farm by offering home-grown forages as an alternative to concentrates.

Therefore, data demonstrating the efficiency of utilisation of N from cows offered supplementary concentrate, grass silage, maize silage and wholecrop wheat silage are required. Such investigations would allow for N outputs in milk to be determined for these diets and hence, N not captured by the grazing animal, which is subsequently released on farm (ignoring tissue gain or loss of N), can be quantified.

Consequently, the overall objective of this research programme was to examine the effects of supplementation, herbage allowance and type of supplement on animal performance, milk quality and the efficiency of production and nutrient utilisation.

## SERIES OF EXPERIMENTS

The research programme involved two separate experimental studies, which are outlined briefly as follows:

### Experiment 1 Effect of offering a range of forage and concentrate supplements to grazing dairy cows

The first grazing study involved 24 late winter/spring calving dairy cows offered either ***no supplement*** or one of the following supplements: (1) **grass silage,** (2) **forage maize silage,** (3) **fermented whole crop wheat silage,** (4) **rapidly degradable concentrate** 4.5 kg/cow/day or (5) **slowly degradable concentrate** 4.5 kg/cow/day. All forage supplements were offered *ad libitum* for a 2-hour period immediately after the morning milking only. Concentrate supplements were offered in parlour during each milking for cows offered both concentrate types.

### Experiment 2 Effect of inclusion of a range of different forage supplements at two different grazing allowances to grazing dairy cows

The second grazing study involved 30 late winter/spring calving dairy cows offered either **no supplement, grass silage, maize silage, whole crop wheat** or a **standard dairy concentrate** at either **low** or **high** grass allowances (15 and 30 kg DM/day respectively measured above 4 cm). All forage supplements were offered *ad libitum* for a 2-hour period immediately after the morning milking only.

## IMPLICATIONS OF THE FINDINGS OF THE PROJECT

- For all the home-grown forages used in this study, total DM intake increased and maize silage and whole crop wheat gave the greatest increase. Although substantial increases in milk yield were obtained, particularly in year 1, the milk yield response was modest with forage supplements. However, the additional energy supplied by the increased DM intake with maize silage and whole crop wheat supplemented cows may result in improved body condition, which may have beneficial implications for cow fertility and longevity.
- Milk fat concentration was generally reduced with concentrate supplements but maintained with forage supplements at a similar level to cows offered fresh grass only.
- Of all the forage supplements offered the inclusion of maize silage in the diet of grazing dairy cattle does appear to offer financial benefits but financial returns will be dependent on good grass utilisation and are likely to be greatest when grass supplies are limited.
- The available evidence suggests that fibrous concentrates are superior to starch based concentrates for grazing dairy cattle. Concentrates which have a high fibre content are normally slowly degradable (slow energy release), however, the results from this study indicate that the rate of energy release (slow or rapid) had no effect on the performance of the grazing dairy cow.
- Increasing the grass allowance reduced efficiency of grassland utilisation with increased wastage, which if left unmanaged without intervention would lead to sward deterioration. Additionally, poor efficiency of utilisation will increase the cost of grazed grass and therefore impact on the profitability of the dairying system. Although maximal individual animal performance was achieved at the higher herbage allowance (+ 7% in milk yield compared to low herbage allowance), milk production per hectare was markedly reduced by 47%.
- With incoming Nitrates Directives and Water Framework Directives, nutrient management is of critical importance. The efficiency of nitrogen utilisation with grazing dairy cows was improved with maize silage supplementation in both years. This primarily resulted from a reduced nitrogen intake by the animal and consequently a reduced level of nitrogen excretion.

## Financial results

The financial effects of the supplement treatments are shown below:[1]

| | Supplement | | | | |
|---|---|---|---|---|---|
| | No supplement | Grass silage | Maize silage | Whole crop wheat | Conc. |
| Milk value (£/day) | 4.10 | 4.07 | 4.22 | 4.17 | 4.66 |
| Total feed cost (£/day) | 0.84 | 0.90 | 1.00 | 1.09 | 1.55 |
| Margin over feed costs £/cow/day) | 3.26 | 3.17 | 3.22 | 3.08 | 3.11 |
| Margin over feed costs (ppl) | 14.4 | 14.1 | 13.8 | 13.4 | 12.1 |
| Margin over feed per cow over grazing period (£)[2] | 489 | 476 | 483 | 462 | 467 |

1 Assumed costs: grazed grass £37.10/t DM, grass silage £59.50/t DM, maize silage £63.00/t DM, whole crop wheat £59.50/t DM and concentrate £189/t DM (Kilpatrick et al., 2002). Base milk price of 18.1 pence/l, with a bonus of 0.018 and 0.032 pence/0.01% for additional increases in milk protein and fat above the base (4.0 and 3.18% respectively).

2 Assumes a 150-day grazing period.

- Margin over feed (£/day) indicates that unsupplemented cows gave the greatest margin, which was 18 pence/day greater than the poorest performing treatment. However, the effect of supplement on grass utilisation and hence subsequent cost of grazed grass has not been factored into the margin calculation, therefore making interpretation of the financial results difficult.

# REVIEW OF FINDINGS

## Experiment 1 Effect of offering a range of forage and concentrate supplements to grazing dairy cows

## Intake

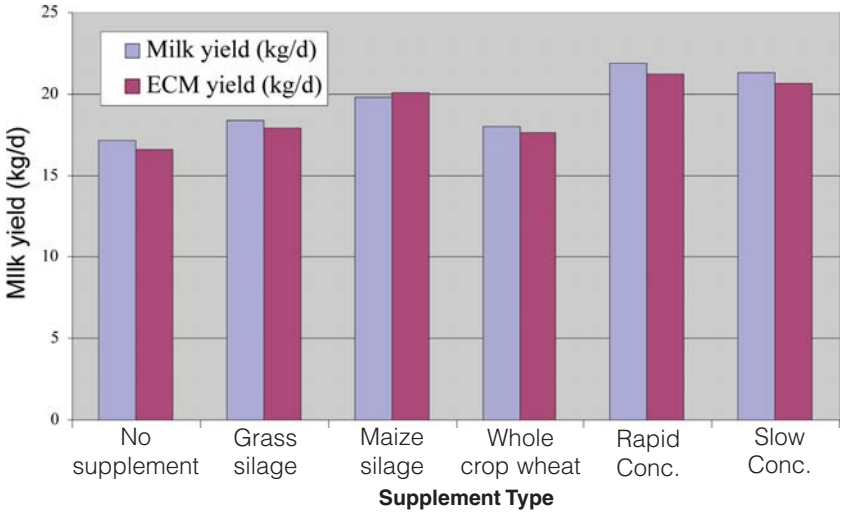
The mean supplement, grass and total dry matter intakes are shown below:

| | | Forage | | | Concentrate | |
|---|---|---|---|---|---|---|
| Supplement | No supple-ment | Grass silage | Maize silage | Whole crop wheat | Rapidly degradable | Slowly degradable |
| Grass intake (kg DM/cow/day) | 12.9 | 11.2 | 8.9 | 11.0 | 11.8 | 12.2 |
| Supplement intake (kg DM/cow/day) | - | 3.0 | 6.3 | 3.6 | 3.9 | 3.9 |
| Total intake (kg DM/cow/day) | 12.9 | 14.2 | 15.3 | 14.7 | 15.7 | 16.1 |
| Substitution rate (kg DM/kg DM) | - | 0.56 | 0.63 | 0.53 | 0.28 | 0.18 |

- Supplementation with either forage or concentrates increased total DM intake and the greatest forage supplement intake was obtained with maize silage (6.3 kg DM/day). However, grass intake decreased with supplementation therefore incurring a substitution rate which was 0.56, 0.63, 0.53, 0.28 and 0.18 (DM basis) for cows offered grass silage, maize silage, whole crop wheat, rapidly degradable and slowly degradable concentrates respectively.

## Milk Performance

The average milk and energy corrected (ECM) milk yields are shown below:




- Of the cows offered forage supplements, only cows offered maize silage had a higher average milk yield than unsupplemented cows, which was also associated with improved milk compositional quality. The compounded effect of these two responses obtained with maize silage produced an energy corrected milk (ECM) yield similar to that of concentrate supplemented cows.

- Cows offered concentrates produced a higher milk and ECM yield than cows offered any other treatment. However milk fat concentration was noticeably lower with cows offered concentrates
- Cows offered no supplement had similar ECM yield to cows offered any of the alternative forages.
- Cows offered maize silage had a higher dietary nitrogen utilisation efficiency for milk production compared to cows, which were unsupplemented or offered concentrates. Blood and milk urea-N concentrations were lower with cows offered maize silage and whole crop wheat than any other treatment, indicating improvements in efficiency of nitrogen utilisation within the rumen as presented below:

| | | Supplement | | | | Grazing | |
|---|---|---|---|---|---|---|---|
| | No supplement | Grass silage | Maize silage | Whole crop wheat | Conc. | Low allowance | High allowance |
| Milk urea-N (mg/kg)† | 187 | 174 | 138 | 130 | 173 | 148 | 173 |
| Blood urea (mmol/l) | 8.0 | 8.0 | 5.8 | 5.9 | 7.3 | 6.7 | 7.3 |
| N intake (g/cow/day) | 581 | 558 | 527 | 569 | 701 | 542 | 633 |
| Milk N output (g/cow/day) | 106 | 108 | 111 | 111 | 126 | 105 | 120 |
| Efficiency of N utilisation* | 0.19 | 0.20 | 0.22 | 0.20 | 0.18 | 0.20 | 0.20 |

† Average of am plus pm milk samples * N output in milk/N intake in feed

- Cows on the high herbage allowance had a higher herbage intake and lower voluntary intake of forage supplement but had a considerably lower efficiency of grass utilisation than cows offered the low herbage allowance (0.46 vs. 0.74 kg grass DM consumed/kg grass DM offered respectively).
- Forage supplement intake was higher with cows offered whole crop wheat than maize silage or grass silage (5.4, 4.3 and 2.8 kg DM/cow/day respectively), resulting in a total DM intake which was higher with whole crop wheat and concentrate supplemented cows, compared to cows offered no supplement, grass silage or maize silage.
- Cows offered no supplement or the concentrate supplement treatments grazed for longer than cows offered forage supplements, resulting in cows offered these treatments having the highest herbage DM intake.

## Milk Performance

The responses to supplement treatment are presented below:

| | | Supplement | | | | Grazing | |
|---|---|---|---|---|---|---|---|
| | No supplement | Grass silage | Maize silage | Whole crop wheat | Conc. | Low allowance | High allowance |
| Milk yield (kg/day) | 22.6 | 22.5 | 23.3 | 23.0 | 25.8 | 22.7 | 24.2 |
| Butterfat (%) | 3.98 | 3.94 | 3.91 | 3.96 | 3.71 | 3.94 | 3.86 |
| Protein (%) | 3.26 | 3.16 | 3.21 | 3.28 | 3.24 | 3.18 | 3.28 |
| Lactose (%) | 4.78 | 4.80 | 4.83 | 4.77 | 4.83 | 4.80 | 4.80 |

- Cows on the high herbage allowance produced a higher milk yield than cows offered the low herbage allowance

| Supplement | No supplement | Forage | | | Concentrate | |
|---|---|---|---|---|---|---|
| | | Grass silage | Maize silage | Whole crop wheat | Rapidly degradable | Slowly degradable |
| Milk yield (kg/day) | 17.1 | 18.4 | 19.8 | 18.0 | 21.9 | 21.3 |
| Butterfat (%) | 3.98 | 3.99 | 4.15 | 4.02 | 3.83 | 3.86 |
| Protein (%) | 3.21 | 3.14 | 3.28 | 3.17 | 3.22 | 3.24 |
| Lactose (%) | 4.60 | 4.70 | 4.71 | 4.69 | 4.79 | 4.70 |
| Efficiency of N utilisation* | 0.17 | 0.17 | 0.23 | 0.17 | 0.18 | 0.17 |
| Milk urea-N (mg/kg) | 224 | 196 | 151 | 206 | 213 | 212 |
| Blood plasma urea-N (mmol/l) | 7.6 | 6.6 | 4.9 | 6.9 | 7.6 | 7.5 |

*N output in milk/N intake in feed

- Cows offered concentrate supplements produced a significantly higher milk yield than any other treatment, but concentrate type had no effect on milk yield or milk composition.
- Animals offered maize silage had an improved N efficiency compared to any other treatment, primarily as a result of the combined effects of a reduced N input, coupled with an increased yield of milk protein. In addition, cows offered maize silage had a reduced blood plasma urea N and milk urea N concentration as shown in the table above.

## Financial returns

The financial effects of the supplement treatments are shown below[1].

| Supplement | No supplement | Forage | | | Concentrate | |
|---|---|---|---|---|---|---|
| | | Grass silage | Maize silage | Whole crop wheat | Rapidly degradable | Slowly degradable |
| Milk value (£/day) | 3.10 | 3.33 | 3.60 | 3.26 | 3.96 | 3.85 |
| Total feed cost (£/day) | 0.48 | 0.59 | 0.73 | 0.62 | 1.45 | 1.19 |
| Margin over feed costs (£/cow/day) | 2.62 | 2.73 | 2.87 | 2.64 | 2.51 | 2.66 |
| Margin over feed costs (ppl) | 15.3 | 14.8 | 14.5 | 14.7 | 11.5 | 12.5 |
| Margin over feed over grazing period (£/cow)[2] | 393 | 410 | 431 | 396 | 377 | 399 |

1 Assumed costs: grazed grass £37.10/t DM, grass silage £59.50/t DM, maize £63.00/t DM, whole crop wheat £59.50/t DM and slowly degradable concentrate £189/t DM (Kilpatrick et al., 2002). Rapidly degradable concentrate £259/t DM. Base milk price of 18.1 pence/l, with a bonus of 0.018 and 0.032 pence/0.01% for additional increases in milk fat and protein above the base (4.0 and 3.18% respectively).

2 Assumes 150-day grazing period.

- Cows offered maize silage had the greatest margin over feed cost per day, 25 pence per day greater than unsupplemented cows. Rapidly degradable concentrate is a non-commercial ration formulated for experimental purposes and was approximately £70/t DM more expensive than the slowly degradable concentrate. This additional feed cost, without a compensatory increase in milk value, results in cows offered rapidly degradable concentrates giving the lowest margin over feed cost.

## Experiment 2 Effect of inclusion of a range of different forage supplements at two different grazing allowances to dairy cows

## Intake

The mean supplement, grass and total dry matter intakes are shown below:

| | No supplement | Supplement | | | | Grazing | |
|---|---|---|---|---|---|---|---|
| | | Grass silage | Maize silage | Whole crop wheat | Conc. | Low allowance | High allowance |
| Grass intake (kg DM/cow/day) | 14.0 | 11.2 | 11.0 | 12.1 | 13.9 | 11.1 | 13.8 |
| Supplement intake (kg DM/cow/day) | - | 2.8 | 4.3 | 5.4 | 3.8 | 4.8 | 3.5 |
| Total intake (kg DM/cow/day) | 15.8 | 16.1 | 17.2 | 19.2 | 19.6 | 16.6 | 18.6 |
| Substitution rate (kg DM/kg DM) | - | 1.00 | 0.70 | 0.35 | 0.05 | - | - |
| Grazing time (min/day) | 507 | 406 | 395 | 376 | 479 | 453 | 413 |
| Ruminating time (min/day) | 381 | 444 | 443 | 444 | 392 | 428 | 414 |