THE RESPONSE BY GRAZING DAIRY COWS TO SUPPLEMENTARY FEEDS

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This thesis is dedicated to my Grandparents

William James and Nancie Julia Penno

ABSTRACT

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Many experiments have measured the responses of grazing dairy cows to various forms of supplementary feed, but few have studied the reasons for the large differences in responses between experiments. Two short-term, and one long-term supplementary feeding trials were designed to help understand the reasons for wide variation in responses that have been reported, and to develop a biophysical framework to improve the prediction of the response by grazing cows to supplementary feeds.

Two grazing trials (trial 1 in year 1; trial 2 in year 2) were conducted with groups of cows in early, mid and late lactation in spring, summer, autumn and winter, in a partially complete Latin Square arrangement. At each stage of lactation, and in each season of the year, cows were offered either a restricted pasture allowance (25 to 35 kg DM/cow/day), or the restricted pasture allowance plus supplements offered at 50 MJME/cow/day in trial 1 and 80 MJME/cow/day in trial 2. The supplements were either rolled maize grain (MG) or a mixture of feeds formulated to nutritionally balance the diet (BR). Supplemented cows at each stage of lactation and during each season of the year were compared to their respective control groups, which received only the restricted pasture allowance.

In both trials 1 and 2, offering MG and BR supplements resulted in large increases in DMI. At a restricted metabolisable energy (ME) allowance, offering supplementary feeds increased ME intake by 0.65 MJME/MJME offered. This highly significant linear relationship was consistent across the different seasons and did not diminish at higher ME allowance. Between stages of lactation, substitution rates (SR) ranged from 0.1 to 0.3 ($\pm$0.1) during trial 1, and 0.1 to 0.5 ($\pm$0.1) during trial 2, however differences were not closely associated with either stage of lactation, season of the year or type of supplement offered. The pasture dry matter intake of the unsupplemented

cows (PDMI) was closely associated with SR, with SR increasing from 0.0 to 0.6 kg as the PDMI increased from 1.5 to 3.5% of liveweight.

In trial 1, the immediate responses ranged from 2.0 to 5.6g milksolids (MS)/MJME and from 0.3 to 11.1g liveweight/MJME. In trial 2, the immediate responses ranged from 0.3 to 3.3g MS/MJME and from 1.9 to 6.4g liveweight/MJME. The immediate MS responses were consistently smaller during spring than in other seasons of the year. The carryover responses (measured during the four weeks following supplementary feeding) were about 0.5 times the immediate effects in both trials 1 and 2. In trial 1 there was no difference ($P>0.10$) between the total milksolids responses (immediate plus carryover responses) of early and mid lactation cows, whereas in trial 2 mid lactation cows demonstrated larger ($P<0.05$) total milksolids responses than early lactation cows. In trial 1 the total milksolids responses measured in spring, summer autumn and winter were 6.4, 6.9, 3.6 and 7.5 (±1.17) g MS/MJME, respectively. During trial 2 the total milksolids responses measured in spring, summer autumn and winter were –0.1, 3.4, 3.6 and 4.7 (±0.74) g MS/MJME, respectively. There was no difference in the total milksolids response resulting from MG or BR in trial 1, whereas during trial 2 the milksolids response from MG and BR were 1.9 and 3.9 (±0.52) g MS/MJME, respectively.

Stage of lactation and season of the year accounted for little of the variation in the magnitude of the marginal milksolids response from feeding supplementary feeds. The factor that was of greatest importance was the relative feed deficit (RFD) measured by the reduction in milksolids yield (kg MS/cow/day) of the respective control groups that had occurred when the feeding treatments had been imposed. Total marginal milksolids responses were greatest when severe feed restrictions, relative to the current feed demand, resulted in large reductions in milksolids yield of the control groups. Total marginal milksolids response increased ($P<0.01$) by 0.9g MS/MJME offered as supplement per 0.1 kg MS/cow/day RFD. Total marginal milksolids responses also declined ($P<0.01$) by 0.2g MS/MJME offered as supplement as pasture allowance increased by 10 MJME/cow/day.

In the long-term trial, five spring-calving pasture-based farmlet systems were compared with the objective of measuring the long-term effects of offering large quantities of three types of supplementary feed within dairying systems. Four of five farmlets (5.67 ha) were stocked with 25 high genetic merit Friesian cows (4.41 cows/ha) and one farmlet was stocked with 19 cows (3.35 cows/ha) calving between 12 July and 31 August in each year, for three complete years. Herds on the higher stocked (HS) farmlets were offered either no supplementary feed from off farm sources (Control), or supplementary feeds of rolled maize grain (MG), or whole maize crop silage (WCS), or a nutritionally balancing ration (BR). The herd grazing the lower stocked farmlet (LS) was offered supplementary feed of pasture silage that had been conserved on that farmlet from surplus spring pasture.

The high stocking rate and early calving date of the supplemented herds resulted in low pasture allowances at most times of the year, requiring the use of 1.1 to 1.7 t DM/cow/year as supplementary feed. While some pasture substitution may have occurred, there was no difference between the annual pasture dry matter intake (DMI) of the supplemented and control herds. Feeding treatments of MG, WCS, BR and LS increased annual milksolids (MS) yield from 269 (Control herd) to 400, 363, 408 and 361 (±15.8) kg/cow, respectively. Differences in total dry matter and metabolisable energy intake per cow explained most of the differences in MS yield per cow between the five farmlets. Marginal responses from the MG, WCS, BR, and LS treatments averaged 7.3, 7.6, 7.8, and 6.6g MS/MJME over the three years of the experiment. Cows in the HS supplementary feeding herds and the LS herd calved in fatter condition and maintained higher DMI in early spring, and had shorter post partum anoestrous interval and a lower incidence of anoestrous than those in the HS control herd.

A model based on the data derived from the two short-term trials used RDF, pasture allowance, supplement intake and stage of lactation to predict much of the variability between some published short-term experiments, and closely agreed with the milksolids responses measured during the long-term trial.

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LIST OF ABBREVIATIONS

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AA	Amino acids
ADF	Acid detergent fibre
ADFIP	Acid detergent fibre insoluble protein
AP	*Ad libitum* pasture
ARDOM	Apparently rumen digested organic matter
ATP	Adenosine triphosphate
BOH	Beta hydroxy butyrate
BR	Nutritionally balancing ration
CNCPS	Cornell Net Carbohydrate and Protein System
CP	Crude protein
DIM	Days in milk
DM	Dry matter
DMI	Dry matter intake
DOMD	Digestible organic matter in dry matter
eNDF	Effective neutral detergent fibre
FCM	Fat corrected milk (4%)
HS	High stocking rate
LCFA	Long chain fatty acids
LS	Low stocking rate
ME	Metabolisable energy
MEA	Metabolisable energy allowance
MEI	Metabolisable energy intake
MF	Milkfat
MG	Maize grain
MP	Milk protein
MR	Milk yield response
MS	Milksolids
MY	Milk yield
NDF	Neutral detergent fibre

NDFIP	Neutral detergent fibre insoluble protein
NEFA	Non-esterified fatty acids
NPN	Non protein nitrogen
OM	Organic matter
OMD	Organic matter digestibility
PDMI	Pasture dry matter intake of unsupplemented cows
r.s.d.	Residual standard deviation
RDP	Rumen degradable protein
REML	Residual maximum likelihood
RFD	Relative feed deficit
s.e.d.	Standard error of the difference
SOLCHO	Soluble carbohydrate
SR	Substitution rate
UDP	Rumen undegradable protein
VFA	Volatile fatty acids
WCS	Whole crop silage (Maize silage)