Nutrition for Profitable Pasture-based Dairy Systems

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Introduction

The impending abolition of EU milk quotas presents an exciting opportunity for Irish dairy farmers to significantly grow their businesses for the first time in a generation. Recent supplier surveys by various milk processors have gauged the average potential increase in milk output at 30-50% over the next 7-10 years. This rate of expansion would present huge technical challenges at farm level, particularly in relation to meeting the increased nutrient requirements of the expanded herd. The full impact of increased stocking rate on the total feed bill is frequently underestimated in an expansion scenario, while the marginal value of driving output per cow through extra supplementation is often overestimated. It is important therefore that basic nutrition principles are well understood and then translated correctly into profitable production systems.

Nutrition first principles: energy and protein

Feeds for dairy cows vary greatly in their composition, with concomitant effects on rumen degradability, digestion and animal production (Whelan et al, 2012). Energy is often the first limiting nutrient for dairy cows, particularly in the early lactation phase, due to the relationship between dry matter intake potential limits and the maximal energy density (NRC, 2001) of the total diet. On a net energy (UFL) basis (Jarrige, 1989), the requirements for lactating dairy cows can be summarised as:

1 kg milk = 0.44 UFL (depending on composition)

Maintenance = 1.4 + 0.6*Liveweight/100 (or 5 UFL/d for a 600kg cow)

The UFL value expresses a relative overall net energy content, but energy can be supplied from different sources, in carbohydrate as starch, sugar or fibre, as well as in lipid form. Feeds also vary in the rate at which they degrade, meaning that the energy can be rapidly or slowly degraded. Grass does not contain starch as an energy source, it contains sugars and fibre. Maize silage on the other hand contains starch and fibre, but much lower levels of sugars. Concentrates too vary greatly in their energy composition. Some concentrates are high in starch, such as barley, wheat and maize. Others are high in sugar such as citrus and beet pulp. Yet others are high in fibre such as soya hulls. As mentioned above the feeds can be rapidly or slowly degraded. So, for example, in the category of concentrates high in starch wheat is the most rapidly degraded, followed by barley, followed by maize. Supplementary concentrate feeds should be chosen to complement the base feed forage diet. Rumen synchronisation aims to achieve a balance between the availability of energy and nitrogen in the rumen, maximising microbial protein synthesis (Keim and Anrique, 2011). Milk fat depression can be caused by changes in rumen fermentation patterns, such as a decrease in rumen pH (Plaizier et al., 2008).

The fermentation of rapidly degradable feeds leads to increased concentrations of volatile fatty acids within the rumen, with a consequent reduction in rumen pH; larger than the reduction in pH when slowly degradable feeds are offered (Krause and Oetzel, 2006). Starch-based feeds, and wheat in particular, fed with grazed grass have been shown to give rise to reductions in milk fat % (Reid et al., 2014). This is a result of reduced rumen pH, caused by the rapid degradation of the starch (Meijs, 1986; Terry et al., 1973). Supplementing a grass-based diet with a fibre-based concentrate does not cause a reduction in rumen pH to the extent of supplementing with starch-based concentrates, and can increase the rate of digestion of grass (Bargo et al., 2003). This is due to the fibre-based supplementary concentrates offering more buffering in the rumen than the starch-based concentrates.

Concentrates that are high in fibre such as beet pulp and soya hulls increased grass dry matter intake compared to concentrates that are high in starch (Meijs, 1986; Sayers, 1999). Meijs (1986) and Reid et al. (2014) found that milk production was increased with the use of fibre- compared to starch-based concentrates. Increasing the rate of degradation of supplementary feeds decreased dry matter intake and milk solids yield (Reid et al, 2014).

Several studies (Forster et al., 1983; Kung Jr and Huber, 1983) have shown that increasing dietary crude protein (CP) concentration has a positive impact on milk yield, milk protein concentration and milk solids yield. Continued increases in dietary CP concentration, however, give diminishing returns as regards milk production (Stockdale, 1995). In spring, grass CP concentrations in Ireland tend to be greater than 200 g per kg DM (O'Neill et al., 2013), which is greater than the protein required by cows in early lactation. As a result supplementing grass with feeds high in crude protein does not yield increases in milk production (Reid et al., 2013).

The true protein value of any feedstuff is best measured by the quantity of amino acids that are absorbed by the animal, not what the animal consumes. The amino acids that are absorbed by the animal come from two sources (1) rumen bacteria, which convert energy and Nitrogen into bacterial protein and (2) undegradable protein in the feed, which is not changed in the rumen. The quantity of bacterial protein manufactured by the rumen bacteria is reliant on a supply of Nitrogen and energy. There are potentially two amounts of bacterial protein that the cow can generate, one that relies on there being enough Nitrogen in the rumen and one that relies on there being enough energy in the rumen. If there is a limited supply of Nitrogen the protein value is called PDIN. If there is a limited supply of energy the protein value is called PDIE. Each feed has two values (PDIN and PDIE). The lower of the two is termed PDI, which is the protein which is truly digestible in the intestine. The PDI system is the protein nutrition system utilised in Ireland, and it is based on the French system. As is clear from the description above, feeds can differ in their ratio of rumen degradable to rumen undegradable protein. Grazed grass is high in CP, particularly rumen degradable protein, and therefore PDIN is usually in excess. The PDIE of good quality grass is approximately 105 g per kg DM and the PDIN of good quality grass is approximately 130 g per kg DM. Animals require PDI for maintenance and for milk production.

Milk production g PDI = milk yield kg x milk protein g/kg x 1.5
Maintenance g PDI = 100 + 0.5 x liveweight kg (400g/d for a 600kg cow)

If there is excess Nitrogen in the diet, then large amounts of ammonia are produced in the rumen, which is absorbed into the blood, converted to urea in the liver and ultimately excreted in the urine (Colmenero and Broderick, 2006). Although the majority of urea is excreted in the urine, some diffuses into the milk where it is measured as milk urea Nitrogen (MUN) (Kauffman and St-Pierre, 2001). In the US a negative relationship between MUN and fertility was identified but the majority of this research was conducted with dairy herds fed conserved forages and cereal-based feeds. Such feeding systems contrast markedly with the Irish grass-based diet. Westwood et al. (1998) reviewed the literature from grass-based systems in Australia and New Zealand and concluded that it was "highly unlikely that single or perhaps even serial determinations of milk urea in single cows or bulk vats will have a high predictive value for determining risk of conception in the cow or herd". Reducing MUN is however of benefit from a milk processing perspective, as increasing MUN can adversely affect heat stability, which is an indicator of milk processability. In spring, when grass is in deficit, supplementary feeds low in CP should be offered alongside grazed grass. This will reduce MUN (Reid et al., 2013).

Building a herd feed budget based on nutrition principles

Having characterised the basic structure of energy and protein requirements at the individual cow level, it is essential to incorporate these into a profitable and sustainable farms system. A guiding principle here is that utilising more forage per ha farmed will drive dairy margins (Horan et al, 2012). The grass utilised metric is a function of milk solids yield, maintenance feed requirement, stocking rate and purchased feed inputs. It measures the efficacy with which a dairy farm generates its own feed resource, and then converts this feed into saleable milk product. Due to the significant cost advantage of grazed grass as a nutrient source (Dillon, 2006), this relationship holds true across a wide range of milk payment systems, land type and herd calving patterns.

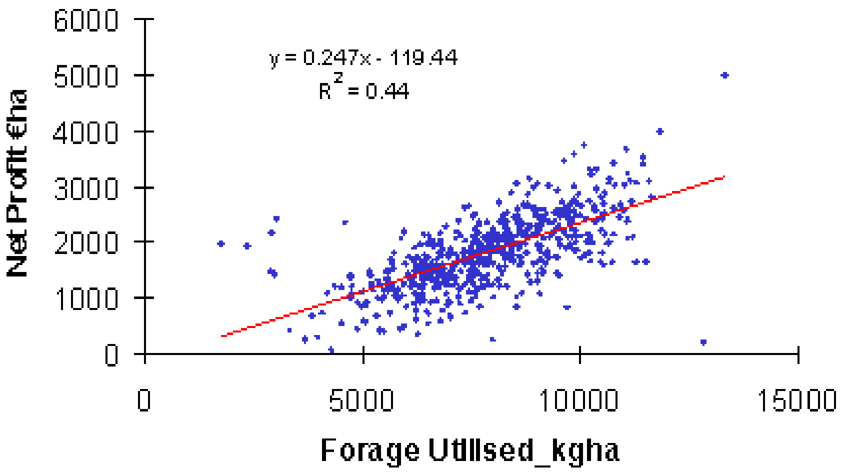


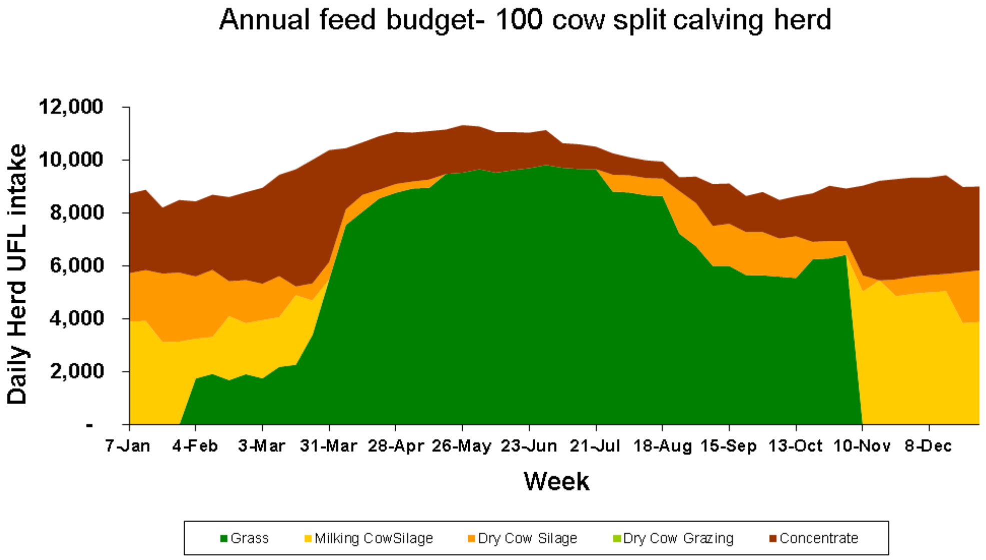
Figure 1 Relationship between forage utilisation and profit per hectare on ROI dairy farms

Increasing grass utilised in practice requires implementation of strategies to a) maximise herbage production per hectare and b) manage allocation of forage for efficient conversion to milk. For the latter, the competing aims of efficiently harvesting available feed and meeting the nutrient requirements of the herd must be balanced.

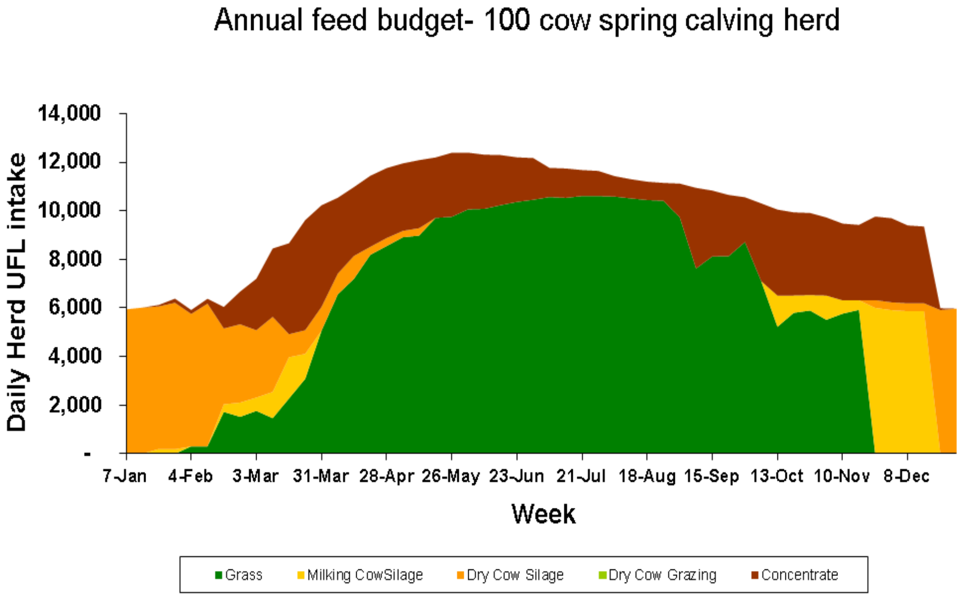
Table 1. Framework for seasonal grass management across different production systems

	Curtins **100% Spring calving herd** **450kg milk solids @ 600kg conc. per cow**	**Johnstown** **60% Autumn calving herd** **540kg milk solids @ 1200kg conc. per cow**
Spring	Spring rotation planner	Spring rotation planner
Summer	Grass Wedge *70 DMD silage*	Grass wedge *High quality silage*
Autumn	Autumn grass budget	Autumn grass budget
Winter	Teagasc ration program -Dry cow diet	Teagasc ration program -Lactating cow diet/dry cow diet

Better utilisation of available herbage can be achieved through use of proven pasture management technologies- spring rotation planner, mid-season grass wedge, autumn grass budget- these are equally applicable in low and higher input systems alike (Table 1).



a)



b)

Figure 2. Feed energy budgets for 100-cow herds in spring or split calving systems

Some tailoring of specific targets within this framework may be necessary for particular fixed farm circumstances e.g. heavy land, winter milk, fragmented farms, high stocking rate (Figure 2). However, such adjustments should be made with the core objective of increasing forage utilised in mind e.g. provision for excellent quality silage for milking cows in a winter milk scenario.

Increasing farm stocking rate post quota- what are the implications for nutrition management?

Stocking rate, classically defined as cows per unit land area, is a primary determinant of herbage utilisation efficiency, and milk output per cow and per ha, in grazing systems (McCarthy et al, 2011). A curvilinear relationship is typically observed between stocking rate and milk output per ha in 'closed' feed systems (Penno, 1999). Initially where pasture supply is not limiting, milk yield per cow and per ha rise due to improved pasture quality and greater stocking rate. Individual pasture intake and consequently milk yield become constrained as stocking rate increases further, however this is offset by increased herbage utilisation such that milk output per ha continues to rise due to the multiplicative effect of stocking rate. Milk yield per cow and per ha ultimately decline where stocking rate moves beyond the point at which pasture utilisation is maximised, due to increased maintenance energy requirements as a proportion of a fixed nutrient supply. This be expressed as reduced feed conversion efficiency (FCE) i.e. energy corrected milk volume per kg dry matter consumed (Beever and Doyle, 2006). Restricted feed energy allowances in the high stocking rate scenario may also have genotype-dependent negative effects on BCS, reproductive function and health (Roche et al, 2011). The negative effects of a high grazing stocking rate on milk yield per cow and FCE could be at least partially moderated by feeding supplements to compensate for the reduction pasture allowance (Kolver 2003), creating though an 'open' feed system that relies on external feed sources.

It is difficult to define a biologically optimum system using the simple definition of stocking rate alone, due to variation in cow milk yield and bodyweight, but also herbage production per ha (McCarthy et al, 2011). A survey project by Creighton et al (2011) reported a large range in grass growth and utilisation and management practices among Irish dairy farms. This study highlighted the significant latent capacity that exists at farm level for increased grass production to support herd expansion, in advance of any change to supplement feeding strategy.

Table 2. Effect of annual pasture production (t DM/ha) on cost of feed for an expanding dairy herd

	Current	Expanded No change pasture	Expanded Improved pasture
Cows	100	130	130
Farm ha	63	63	63
Total Farm SR[1]	1.96	2.50	2.50
Annual grass tDM	10.0	10.0	13.0
Purchased Feed - *Concentrate* - *Forage* Total	 *€32,569* - €32,569	 *€53,859* *€15,144* €69,004	 *€40,855* *€1,718* €39,137
Milk receipts (32cpl)	€178,069	€229,858	229,858
Change in margin over feed and direct costs[2]	-	€3,354	€33,221

[1]Includes a 25% replacement heifers

[2] Direct per cow costs of vet, AI, parlour etc. does not include capital/expansion or extra labour

Securing this increase in pasture output will be the critical determinant of successful post-quota expansion for farms currently operating at lower efficiency levels. Otherwise there is a risk of dairy farms moving to a structural dependency on external feed even at seemingly feasible stocking rates (Table 2). This typical example shows that where pasture growth is currently moderate to low, increasing cow numbers by 30% leads to a >100% increase in total annual feed costs, as a combination of extra concentrate and purchased forage (direct or as rented silage ground). When standard overheads per extra cow are deducted, there is little to no margin remaining from the increased milk revenue to pay extra capital costs or labour. On the other hand, investment in improved pasture production on a whole farm basis yields a promising financial margin to cover extra capital costs plus generate an increased farm profit.

Nutrition for higher yielding herds- do high forage diets fit the bill?

The benefit of increasing forage utilisation for profit in pasture based systems is clear, however a somewhat vexed issue remains in relation to nutrition, or more specifically supplementation, of higher yielding herds. How vaild is the high forage message for herds operating at milk yields of e.g. 8000+ litres; how can grazing diets meet the increased nutrient demands of high yielding cows in these systems?

The nutritional limitations of grazed grass for milk production have been extensively studied, and the general consensus is that grass can support a maximum yield of 26-28kg/day where grazing high quality pasture to standard residuals (4.5-5cm) under ideal conditions (Bargo et al, 2003). Comparing un-supplemented Holstein cows at pasture to a total mixed ration control, Kolver and Mulller (1998) identified a 15.3kg (43 vs. 27.6) reduction in daily milk yield for grazing cows; feed energy was first limiting as sufficient amino acids for approximately 35kg were derived from the grazing diet. Characterising the energy dynamics further, it was shown that 61% of the milk output differential between diets was due to dry matter intake, 24% to increased physical activity, with the remainder accounted for by differences in milk composition, bodyweight and energy costs associated with urea excretion. Physical intake was the principal constraint on total nutrient intake rather than energy density per kg dry matter of feed.

Given this underlying limitation, feeding energy-dense supplements that increase overall dry matter intake is in theory the primary strategy for closing a nutrient gap on pasture diets. However, pasture substitution rate (SR), i.e. reduction in pasture DMI per kg supplement offered, reduces the capacity to bridge energy deficits by supplementation. A low SR (e.g. 0.5) means that total DMI increases with supplement feeding while a SR close to 1.0 means no additional DMI is achieved by extra feeding; SR is consequently a key determinant of milk yield response to supplements. Substitution rate varies with sward type, herbage allowance, genotype, stage of lactation, and is generally lower where the degree of dietary energy deficit is greater e.g. cows fed a restricted allowance of poor quality pasture will have a lower SR compared to cows on full allowance good quality grass (Bargo et al, 2003). Thus a high milk response to concentrate should not be assumed to be a 'good thing' in the feed system.

Supplement type also influences SR. In terms of concentrate type, there is consistent evidence to show that feeding rapidly fermentable carbohydrate reduces pasture fibre digestion and increases SR compared to more slowly degradable/digestible fibre sources (Reid et al, 2014). Forage supplements have a greater negative effect on pasture intake compared to concentrates. This is particularly evident where grass allowance is high and the forage supplement contains high levels of NDF, e.g. straw or low DMD grass silage (Bargo et al, 2003). The net effect may be a reduction in overall energy intake so supplementing forage in practice should be limited to meeting forage deficits.

In addition to SR, the practicality of bridging the theoretical energy gap for high yielding cows at pasture is further complicated by maximum in-parlour concentrate feeding rates, and a minimum dietary NDF requirement of 32-35% which effectively caps inclusion of non-fibre energy sources. A move to a buffer-feeding/partial housing system would seem to address these issues, but there are more fundamental system-level issues to be addressed.

Firstly, it is quite clear from Teagasc eProfit monitor data that while grass utilised per ha is a key driver of profit, milk yield per cow explains only 3% of the farm-to-farm variation in net margin. This lack of relationship between yield and net margin is not unique to the Irish grass based system, as UK benchmarking data (DairyCo, 2012) shows a very similar trend for high-input herds (Figure 3). Collectively, these data demonstrate that achieving a particular level of output *per se* does not guarantee a financial margin- increasing the proportion of total yield achieved from forage on the other hand is a more relevant objective.

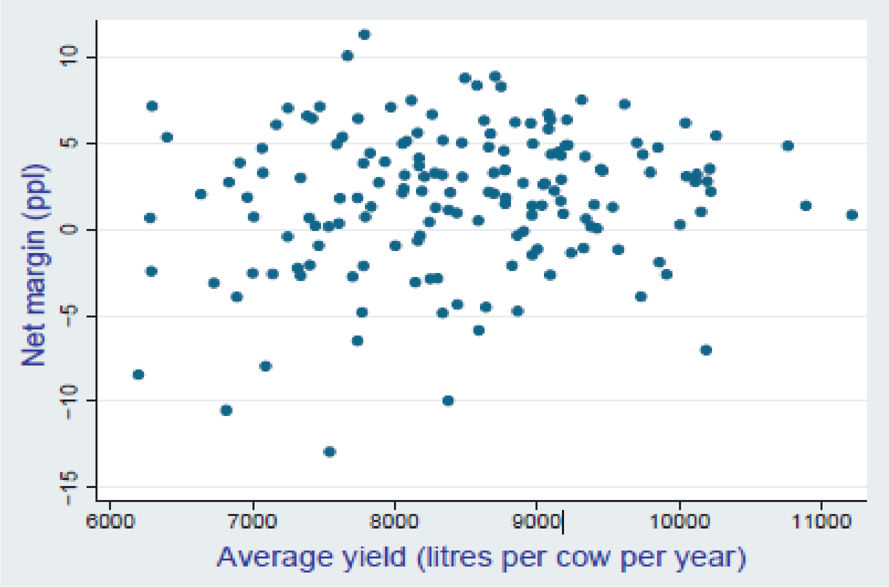


Figure 3. Relationship between milk yield and net margin per litre in high input UK dairy herds (DairyCo, 2013)

Secondly, there is a requirement to draw a distinction between the high yielding cow and the high yielding herd. In 2013 the average yield per cow for 230 benchmarked winter milk herds was approximately 5900 litres per cow, with <1% of herds delivering over 8000 litres. Milk recording and genetic merit data does show high peak yield potential of cows in these herds, yet annual average yields indicates a majority of cows are at comparatively moderate to low yield for much of the year. Given the relatively high level of feed inputs recorded, this is more a calving pattern/lactation structure issue than an 'under-feeding' issue; nonetheless there are real implications for feeding management strategy.

To illustrate by example, Figure 4 plots the distribution of daily milk yield within a high output split calving herd during the indoor feeding period (January) and at grazing (May). The fresh calved group was approximately 80 days in milk at each recording. The 305-day recorded production average for this 280-cow herd was 8192 litres (7023 litres delivered) in 2013, placing it in the top 8% of Glanbia herds for volume per cow.

Note the similar range and shape of yield distribution at both time points. The key point however is the proportion of cows in the notional 'high yield' bracket. Around 7.5% of the total cows in milk were yielding in excess of 35 litres at either time point- or 19/257 cows in May and 10/138 cows in January for this farm. Fewer than 5% of cows were breaking the 40 litre threshold. The marginal milk production (in excess of 35 litres) of some individual cows is impressive and poses some interesting theoretical challenges, but it accounts for less than 1.3% of total daily daily milk production.

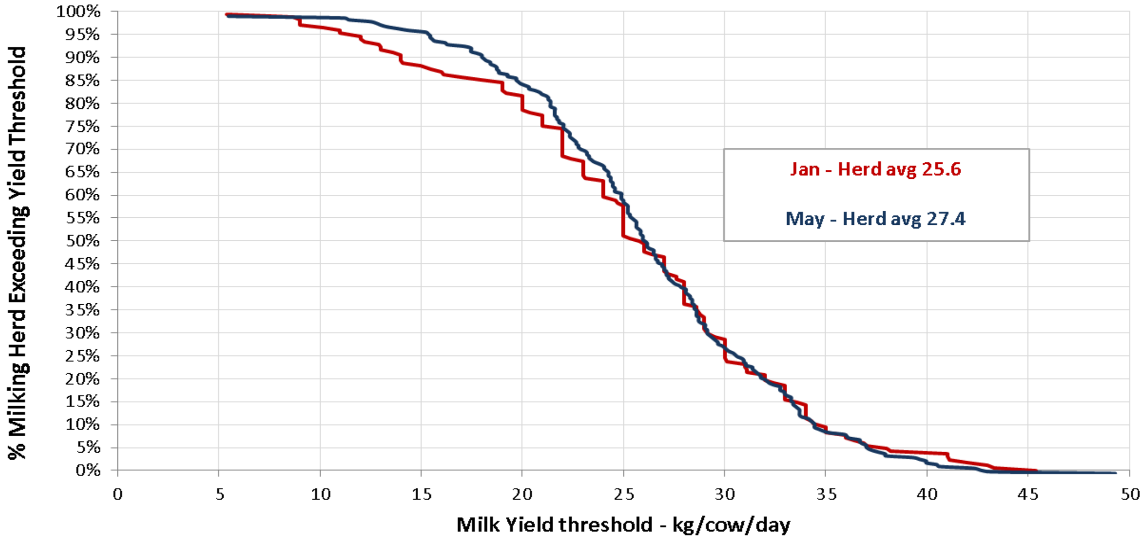


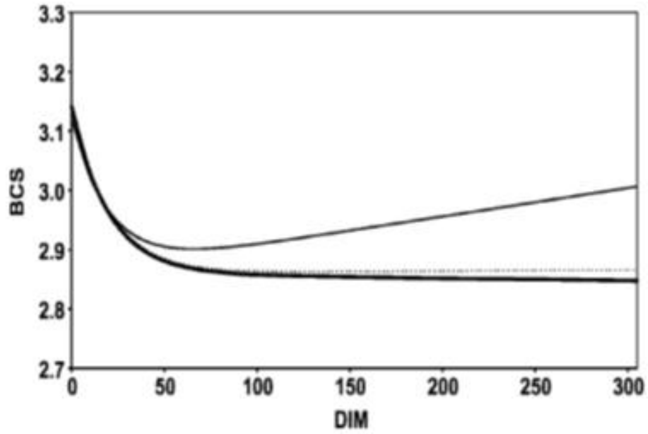
Figure 4. Distribution of milk yield per cow for a 8100-litre herd recorded in January and May

This yield pattern is repeatable across many herds of similar structure and milk yield. It should be taken into account in order to maximize feeding efficiency at the system level. Placing too much emphaisis on meeting the nutrient demands of a small cohort of higher yielding cow can lead to inflated total feed costs particularly with complete diet feeding systems (Cushnahan, 2009). Rather, improved global feed efficiency in these herds can be achieved by improvements in grass utilistion and grass silage quality, targeted concentrate feeding through the milking parlour, plus closer balancing of PDI/UFL ratios. A structured calving pattern with shorter calving intervals is also very benefical.

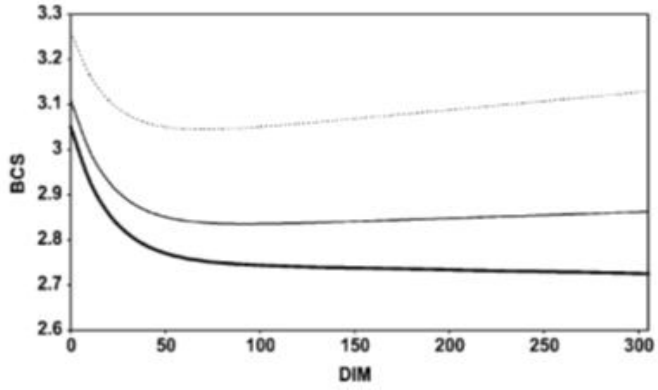
Nutrition for improved herd fertility

Achieving excellent herd fertility is a cornerstone of profitable dairy production across a range of production systems (Inchaisri et al, 2010). The components are easy calving, prompt resumption of ovarian cyclicity, strong oestrus expression, a high conception rate to first insemination, low embryo mortality, plus a 365-day calving interval and multiple lactations to drive high lifetime yield (Lucy 2001). It is generally accepted that energy balance i.e. the difference between feed energy intake and the combined requirements for maintenance and lactation, is a key regulator of reproductive function. A more severe negative energy balance in early lactation has been associated with deleterious effects on various reproductive functions including resumption of ovarian cyclicity, follicular development, corpus luteum functionality, and oocyte quality (Lucy, 2001). Energy balance at the gross level is expressed as change in body condition score (BCS), so it is logical that greater rates of BCS loss in early lactation are associated with poorer fertility outcomes. This was demonstrated in a large-scale study by Buckley et al (2003), who showed improved submission and conception rates for cows at BCS 2.75+ at breeding, and/or losing <0.5 BCS units between calving and breeding.

Calving at the appropriate BCS and minimizing losses postpartum are therefore key objectives for nutritional management of fertility outcomes. Meeting the BCS targets for calving (discussed below) is relatively straightforward because cows are in an anabolic endocrine state at this point of the lactation cycle. Minimizing the degree of BCS loss post-calving through nutritional means is another matter entirely, as cows have inevitably shifted to a catabolic state in support of lactation. This shift is essentially due to a change in the balance between insulin (anabolic) and somatotropin (catabolic), with cows of increased genetic merit for peak milk yield having a greater and more prolonged reduction in insulin relative to somatotropin (Bauman, 2000). Thus a simple increase in concentrate supplementation may not be effective to elicit a BCS improvement response in the early post-calving period. This is illustrated by BCS data from a genetic strain/feeding interaction trial (Figure 5, Horan et al, 2005). It shows that a high concentrate feeding system (1500kg/cow) resulted in greater BCS gain from mid-lactation compared to systems at 500kg/cow, but rate of BCS change in the critical time for fertility (0-70 days) was unaffected by concentrate feeding.



a) Body condition score lactation profile for the high stocking rate (—), Moorepark (▬), and high concentrate (——) feed systems.



b) Body condition score lactation profile for the New Zealand (—), high durability (——), and high production (▬) strains.

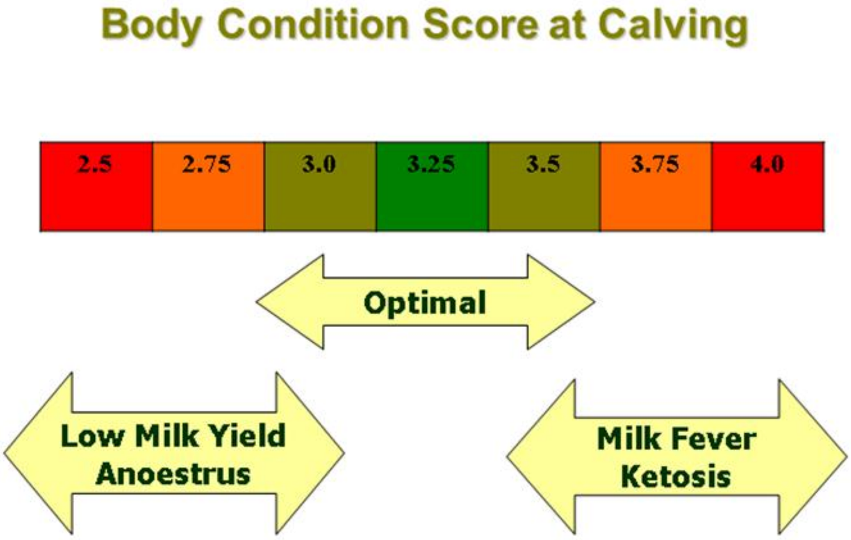
Figure 5. Effect of a) feed system and b) genetic strain on lactation BCS profiles (Horan et al, 2005)

On the other hand, the same study showed that cows of improved genetic merit for fertility traits demonstrated a capacity to retain BCS (higher nadir, early resumption of BCS gain) compared to strains selected entirely for milk production. Cummins et al (2012) also observed a better capacity to retain BCS in high fertility-index (FERT+)

Holstein cows compared to low fertility-index (FERT-) counterparts, despite similar genetic potential for milk yield. Interestingly, the same study reported higher circulating concentrations of IGF-1 throughout lactation for the FERT+ strain. IGF-1 is closely linked to insulin and energy balance, and plays a key role in stimulating ovarian follicular growth, maturation of the dominant follicle and expression of oestrus; it is also positively associated with likelihood of conception (Butler, 2014). Given the mechanism described, it is perhaps unsurprising that a range of genotype* feeding experiments have consistently shown genetic selection for fertility traits to be a much more effective means of improving herd performance than extra concentrate feeding in early lactation (Dillon et al, 2004, Horan et al, 2005, Vance et al,2013).

Dry cow nutrition- energy and protein guidelines

The dry period is a vital but often overlooked stage of the lactation cycle. It allows for regeneration of mammary tissue in preparation for next lactation, late stage foetal development, and importantly, correction of body condition score (BCS) to achieve the target 3.25 at calving. Large-scale studies in pasture-fed herds have demonstrated that meeting this target improves subsequent herd fertility through lower incidence of metabolic disease/retained placenta, earlier resumption of ovarian cyclicity and improved non-return rates (Buckley et al, 2003, Roche et al 2011). There is some evidence from UK studies to suggest slightly lower BCS at calving (3.0) may be more appropriate for higher yielding genotypes, particularly in an autumn-calving context (Jones and Garnsworthy, 1987). Interestingly, several experiments have concluded that the type of dry cow diet offered (e.g. restricted feeding of high quality silage, ad-lib feeding lower DMD silage, dilution with straw etc.) makes little difference to subsequent performance provided that BCS and mineral status are correct at calving (Butler et al 2011, Dann, 2004).



Achieving the correct BCS at calving is essentially a function of dietary energy density, dry matter intake and dry period duration. Some rules of thumb (Jarrige, 1989) for calculating dry cow requirements are:

- A 600kg cow requires 5.0 UFL per day for maintenance rising to
    - 5.9 UFL per day in the 7th month of gestation
    - 6.9 UFL per day in the 8th month of gestation
    - 7.9 UFL per day in the 9th month of gestation

- 1kg of weight gain requires 4.5 UFL energy intake above maintenance
    - 1 BCS unit is equivalent to 50kg bodyweight
    - A gain of 0.5 BCS units requires around 112 UFL intake in excess of maintenance
    - In a 70 day dry period, this equates to 112/70 = 1.6 UFL per day in excess of maintenance

- The PDI requirements for the dry period are 420g per day rising to 480, 560 and 620g for the 7th, 8th and 9th month of gestation respectively.

Total PDI requirements are readily met in most circumstances but should be checked where poor quality silage, straw and/or low protein straights are fed. Meeting UFL intake targets should be quite straightforward in a pasture-based system where grass silage is of requisite quality (68-72 DMD) and cows are in reasonable condition (2.75+) in late lactation. However, corrective action will be needed where UFL intake is likely to be too high or too low- forage testing is a vital first step.

Herd average BCS is a somewhat irrelevant number from a management point of view. The focus should instead be on using individual BCS measures to make decisions on a cow-by-cow basis. This requires proper BCS recording of cows at key times e.g. late September, drying off, calving and mid-March in a spring calving context.

Assuming an adequate plane of nutrition at the herd level, the principal mechanisms for correcting individual BCS pre-calving are i) extra days dry, ii) once daily milking in late lactation where SCC allows and iii) supplementation during the dry period. The necessity for implementing these corrective actions depends on quality of silage and target BCS change, summarised in Table 3. For example, a net loss of 0.15 BCS units would be expected over the dry period where silage DMD is 62%. However, offering 2kg soya hulls/maize gluten or equivalent for 7 weeks would offset this loss and result in a moderate net gain of BCS 0.15 units (-0.15 + 0.30). On the other hand an extra 6 weeks dry on 72 DMD silage is projected to increase BCS by 1.0 unit (0.50 + 0.50). Decisions on the most workable option vary between farms, but the end result should always be >90% of cows in the correct BCS range at calving.

Table 3 Effect of silage DMD and different management options on dry period BCS change

	Dry Period Silage DMD		
	62%	***68%***	***72%***
8 week dry period			
Daily UFL balance [A]	-0.60	0.90	1.90
Projected BCS change	***-0.15***	***0.20***	***0.50***
Management options for BCS	**BCS Effect (additive)**		
Extra 6 weeks dry [B]	+0.20	+0.45	+0.50
OAD milking for 7 weeks [C]	+0.18	+0.18	+0.18
2kg soya hulls/gluten for 7 weeks [D]	+0.30	+0.25	+0.22

A Energy demand versus intake on 62, 68 or 72 DMD silage. Assumes ad lib silage offered.
B 6 weeks extra dry period on same silage ad lib
C Assuming 20% reduction in milk yield in final 7 weeks of lactation, diet unchanged
D 2kg soya hulls or equivalent on ad lib silage, 0.4kg DM per kg substitution rate assumed.

Summary

Achieving high pasture utilisation is the single most important driver of dairy farm profit and should be central to strategic feeding decisions in the post-quota environment. Balancing this objective with good herd nutrition status is a complex management task requiring forage management skills, knowledge of the cow's specific nutrient demands, and a good understanding of the interactions between forage and supplmentary feeds. Feed energy intake is the first limiting nutrient, however pasture substitution effects and minimum fibre requirements are the primary constraints for energy supplementation. Moreover, maintaning good energy status and body condition score is essential for reproductive function but this is made more difficult by genetic selection for cows that are predisposed to mobilization of body reserves. Genetic selection for genotypes that have have improved BCS and IGF-1 profiles simplifies feeding decisions to a large degree, as does control of herd calving pattern. Dry cow nutrition is relatively straightforward but requires planning to ensure the key BCS targets around calving and breeding are met.

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