Pre-breeding management of the dairy cow

Excellence in breeding management underpins profitability on Irish dairy farms. However, multiple factors, influenced by nutrition, prior to the commencement of the breeding season will dictate its success. Maeve Regan BSc MSc, Agritech Ireland, discusses how practical nutritional management influences the fertility of Irish dairy cows

ACHIEVING BREEDING SEASON TARGETS

The efficiency of milk production in Irish grass-based systems is hugely influenced by calving pattern, necessitating excellent reproductive performance in a short-breeding season (Butler, 2014). Nationally, only 65% of the Irish dairy herd calves within the first six weeks of the calving season, with an average calving interval of 390 days: the target being 90% calved in the first six weeks and a calving interval of 365 days (Irish Cattle and Beef Federation [ICBF], 2019).

As nutrition underpins the majority of issues in relation to reduced fertility during the breeding season, it is essential to understand the array of causes and proactively manage the herd to avoid such shortcomings on farm.

INFLUENCING FACTORS

- **Negative energy balance**

  In the weeks post-calving, cows will produce more milk than their feed intake can provide for, resulting in body condition loss due to negative energy balance (NEB). A cow will typically reach peak milk output six-eight weeks post-calving but will only reach peak dry matter intake 10-12 weeks after calving (Teagasc, 2016). However, it is limiting the severity and duration of this period of NEB during the weeks post-calving that will increase the cow's chances of being bred successfully (Mulligan and Carty, 2016). Where prolonged, NEB will firstly reduce milk protein levels and, in the more long-term, have detrimental consequences on fertility during the breeding season (Berry et al, 2007; Leroy et al, 2018), effecting metabolic changes which have carry over effects on the resumption and normality of oestrous cyclicity (Wathes et al, 2007). Energy balance with transition cows is typically associated with concentrations of non-esterified fatty acid (NEFA) and β-hydroxybutyrate (BHB). NEFA concentrations reflect the magnitude of fat mobilisation, with BHB concentration linked to the burning of fat in the liver (LeBlanc, 2006), which are both often measured to assess an early lactation cow's energy balance.

- **Body condition score**
  The overall objective is to have an average herd body condition score (BCS) of 3.0 (range 2.75-3.25) at the start of breeding, to achieve optimal fertility. Irish research has shown that where BCS falls below 2.75 in the breeding season, fertility performance is significantly reduced (Buckley et al, 2003).
  Keeping body condition loss to less than 0.5 BCS between calving and breeding has proven to significantly increase the likelihood of conception to first service (Buckley et al, 2003 [see Table 1]). Not only this, but research also conducted on early lactation highlighted that cows that lost <0.5 body condition score between calving and breeding ovulated 15 days sooner, than cows which lost ≥1 BCS (Crowe, 2008).

Table 1: The effect of body condition score loss from calving to breeding on subsequent conception rates (Buckley et al, 2003).

	Body condition score loss between calving and first service		
Body condition score at calving	**<0.25**	**0.25-0.50**	**>0.50**
>3.0	72%	65%	53%
2.75-3.0	64%	55%	44%
<2.75	57%	49%	37%

MEETING THE HERD'S DIETARY ENERGY REQUIREMENT

Dry matter intake typically increases by 0.75-1.0kg/week until peak intake is achieved, highlighting the need for an energy-dense diet for the key transition weeks. Where a herd is only fed to 90% of their UFL requirement over a sustained period of three months, a one-unit loss in BCS should be expected (Mulligan and Carty, 2016 [BCS recorded on a five-point scale]). Energy requirements are largely dependent on cow type/output. For example, a typical 600kg grazing dairy cow will require 6UFL per day for maintenance alone, coupled with approximately 0.42-0.45UFL per kg of milk produced (Mulligan and Carty, 2016). Although early spring calving cows will most likely spend the beginning of the lactation producing milk from a grass silage-based diet, the key aim for a grass-based herd is to meet most of the herd's energy requirements from a mainly grazed-grass diet, supplemented with the required level of concentrates to bridge the UFL gap. For higher output herds (7,000 litres +), more careful transitioning to a grass-based diet is required; research conducted by UCD Lyons Farm has highlighted that providing such cows with a high energy total mixed ration type diet, offered indoors for the first three weeks post-calving, improved metabolic status in early lactation and total grass dry matter intakes six weeks post-calving (Alibrahim et al, 2013). With grazing herds in the period prior to breeding, ensure that the herd is grazing the best quality grass possible (1,400kg covers, two and a half-three leaf stage). Achieving residuals (target 3.5-4cm) is also important to have high quality grass available in the subsequent rotation, however during this important period, the herd's dry matter intake should not be compromised as a result.

Table 2: Required supplementation allowance for grazing cows in early lactation (assumed milk fat at 3.8%, milk protein 3.2%; BCS on target) (Mulligan and Carty, 2016).

Grass dry matter intake kg/cow/day	Milk yield kg/day							
	20	**22**	**24**	**26**	**28**	**30**	**32**	**34**
10	5.2	6.3	7.2	8.2	9.3	10.2	11.2	12.2
11	4.1	5.1	6.1	7.1	8.1	9.1	10.1	11.1
12	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
13	1.9	2.9	3.9	4.9	5.9	6.9	7.9	8.9
14	0.8	1.8	2.8	3.8	4.8	5.8	6.8	7.8
15	0.0	0.7	1.7	2.7	3.7	4.7	5.7	6.7
16	0.0	0.0	0.6	1.6	2.6	3.6	4.6	5.6

POST CALVING MINERAL PROVISION

Post-calving mineral status of the herd is also a high priority, especially if alternative feed ingredients are used (eg. feeding maize/beet). Often a cow's post-calving mineral requirement is not being met via concentrates and silage/grass leading to the need for added mineral supplementation. A 2013 study on Irish grazing farms indicated that, on average, grass supplied only 85%, 73%, 52%, 50% and 38% of lactating-cow requirements for key macro and trace elements, phosphorous, copper, iodine, zinc, and selenium (Curran and Butler, 2015). With such elements being strongly linked to fertility performance (NRC, 2001), the correct provision of major minerals and trace elements in early lactation is of paramount importance, especially if a deficiency is highlighted on farm. Deficiencies should be assessed on a farm-by-farm basis ideally.

MILK UREA

High quality grazed grass contains a high level of crude protein (nitrogen). Surplus dietary nitrogen will elevate blood and milk urea levels, and this may give rise to concerns on fertility. Fluctuations in milk urea levels at the point of service has been proven to impair reproductive performance (Butler et al, 1996; Rajala-Schultz et al, 2001; Albaaj et al, 2017).
A sudden increase in milk urea level or consistently high levels can have negative effects on the uterine environment, reducing the chances of embryo survival (Bilodeau-Goeseels and Kastelic, 2003), with sharp increases in urea correlated with decreasing uterine pH (Rhoads et al, 2004).
Applications of chemical nitrogen fertiliser should be little and often during the breeding season, following the cows in rotation ideally, to avoid such occurrences of elevated milk urea. Offering the herd, a low crude protein level concentrate (12-14%) during this time will assist in alleviating the issue also (Whelan et al, 2012).

PRE-BREEDING MANAGEMENT ON FARM – KEY RECOMMENDATIONS

- **Feed space**
  In many Irish systems, feed space is restrictive relative to herd size (one feed space per cow is not available). In an ad-lib feeding/TMR scenario feed space required per head equates to 300mm per cow. However, where meal feeding occurs at the barrier or in the situation where a small inclusion of the overall diet is offered via a forage buffer in early lactation, 600mm per cow is required (Teagasc). Where feed space is limited, access to a buffer may not be possible for the entire herd, leading to underfeeding. Fresh feed should be always offered, and refusals removed regularly. These issues must be addressed for an optimal nutritional status within a herd.
- **Optimising the percentage of grazed grass in the diet**
  Diets that contain a high proportion of grazed grass will contain a high energy density, which is extremely beneficial in early lactation. Energy content of grazed grass varies from 1.05UFL per kg dry matter for leafy fresh spring grass, to 0.85UFL per kg dry matter for very stemmy grass in the Autumn. However, relative to grass silage (72-77% dry matter digestibility silage varying from 0.81-0.86 UFL) grazed grass has a significantly higher energy content. Grassland management is the most influential parameter when trying to increase the proportion of grazed grass within the diets, with rotation length, pre-grazing herbage mass and post-grazing sward height affecting both sward quality and supply.
  Grazing infrastucture (eg. roadways, multiple access points, trough placement) will also be a dictating factor on farm during early spring.
- **Youngstock management pre-breeding**
  A key performance indicator in Irish dairy systems is calving replacement heifers at 24 months of age (Berry and Cromie, 2009). At the onset of breeding, fifteen-month-old replacement heifers should be 60% of their predicted mature bodyweight (e.g., 600kg average mature herd weight, target 360kg at breeding). To reach such targets, replacement heifers need to achieve a steady gain of approximately 0.75kg/day from birth. Heifers that are below target weight should be prioritised and grouped, whereby lightest heifers are supplemented to achieve such target weights.
- **Once-a-day milking under-conditioned cows**
  In the situation where several cows within the herd are below target BCS taking corrective action early to ensure fertility/breeding is not compromised must be considered. Energy from feeding additional concentrates during lactation is preferentially partitioned towards extra milk production rather than rebuilding body condition (Butler, 2014). Therefore, once-a-day milking is one strategy that may be considered to build condition on these cows (Teagasc, 2020). By milking the cow once a day, the energy requirement for milk production drops significantly, affording the cow the opportunity to increase body condition. This is especially the case when the cow is fed at the same rate as if she were milked twice a day. This practise should be considered three-to-five weeks pre-breeding depending on the extent of body condition loss, and continued for a further few weeks after submission, in order to allow such cows, the best chance of maintaining their pregnancy. However, this strategy should only ever be considered where the herd's cell-count allows.
- **Pre-breeding heat detection**
  Target submission rates of 80% should be achieved in the first 21 days of breeding. Where submission rates are below target it can often be associated with poor detection of heats. Heat detection aids can be extremely useful over the breeding season, including the use of tail paint, vasectomised bulls, pressure activated heat mount detectors, or activity monitoring technologies.
  Ideally, heat detection should commence at least three weeks before the planned onset of the breeding season (Diskin and Sreenan, 2000). All cows calved three weeks before the planned onset of the breeding season should be tail-painted and checked daily until breeding commences. Cows during this time that are not observed in heat, and that are more than 42 days calved should be selected for further examination and preferably scanned by a veterinarian to identify the cause of non-cyclicity (Diskin and Sreenan, 2000). The objective being, to identify and treat potential problem cases early in the season and enhance their chances of pregnancy within a 12-week breeding season.
- **Milk fat to protein ratio, a nutritional aid**
  While BCS loss is a result of NEB, the change in BCS happens over a period of weeks, therefore, it is difficult to monitor the nutrition of the herd using this on a daily or weekly basis. Milk production and constituents' data are also a valuable tool for monitoring the current nutritional status of the herd (Toni et al, 2011). In Irish scenarios, a falling milk protein concentration in the post-calving period is an indicator of reduced energy/dry matter intake (protein is also heavily correlated to genetic potential). A high butterfat concentration in early lactation may be a sign of BCS loss, but again variances will occur here between breeds eg. Jersey vs. Holstein. A cow's fat to protein ratio (calculated by dividing the butterfat percentage by protein percentage) in early lactation can be used to signal poor energy balance. Ideally this would be calculated on an individual cow basis, following an early milk recording. A ratio of >1.4 has been shown to indicate excessive negative energy balance with Holstein/Friesian cows (A slightly higher ratio than this will be tolerable with Jersey or Jersey cross cows). The target is to have this ratio between 1.2 and 1.4.

REFERENCES

- Albaaj A, Foucras G, Raboisson D. Changes in milk urea around insemination are negatively associated with conception success in dairy cows. Journal of Dairy Science 2017; 100: 3257-3265
- Alibrahim RM, Whelan SJ, Pierce KM et al. Effect of timing of post-partum introduction to pasture and

supplementation with Saccharomyces cerevisiae on milk production, metabolic status, energy balance and some reproductive parameters in early lactation dairy cows. Journal of Animal Physiology and Animal Nutrition 2013; 97:105-114

- Berry DP, Buckley F, Dillon P. Body condition score and live-weight effects on milk production in Irish Holstein-Friesian dairy cows. Animal 2007; 1: 1351-1359.
- Berry DP, Cromie AR. Associations between age at first calving and subsequent performance in Irish spring calving Holstein–Friesian dairy cows. Livestock Science 2009 Jul 1;123(1):44-54.
- Bilodeau-Goeseels S, Kastelic JP. Factors affecting embryo survival and strategies to reduce embryonic mortality in cattle. Canadian Journal of Animal Science, 2003; 83: 659–671.
- Buckley F, O'Sullivan K, Mee JF et al. Relationships among milk yield, body condition, cow weight, and reproduction in spring-calved Holstein-Friesians. Journal of dairy science 2003; 86: 2308-2319.
- Butler, W. R., J. J. Calaman, and S. W. Beam. 1996. Plasma and milk urea nitrogen in relation to pregnancy rate in lactating dairy cattle. J. Anim. Sci. 74:858–865.
- Butler ST. Nutritional management to optimize fertility of dairy cows in pasture-based systems. Animal 2014; 8: 15-26.
- Crowe MA. Resumption of ovarian cyclicity in post-partum beef and dairy cows. Reproduction in Domestic Animals 2008; 43:20-8.
- Curran F, Butler S. Mineral nutrition in pasture-based systems. Irish dairying: sustainable expansion, 2016.
- Diskin MG, Sreenan, JM. Expression and detection of oestrus in cattle. Reproduction Nutrition Development 2000; 40: 481-491.
- ICBF (Irish Cattle Breeding Federation). HerdPlus Dairy Calving Statistics 2019.
- LeBlanc S. Monitoring programs for transition dairy cows. World Buiatrics Congress, 2006.
- Leroy JL, de Bie J, Jordaens L, et al. Negative energy balance and metabolic stress in relation to oocyte and embryo quality: an update on possible pathways reducing fertility in dairy cows. Animal Reproduction 2018; 14: 497-506.
- Mulligan F and Carty C MVB. Dry and transition cow nutrition for the grazing Irish dairy herd. Irish Grassland Association, 2016.
- NRC, (2001) National Research Council. Nutrient requirements of dairy cattle. 7th Revised Edition. National Academy Press. Washington, D.C.NRC
- Rajala-Schultz PJ, Saville WJA, Frazer GS, Wittum TE. Association Between Milk Urea Nitrogen and Fertility in Ohio Dairy Cows. Journal of Dairy Science 2001; 84: 482-489
- Rhoads ML, Gilbert RO, Lucy MC, Butler WR. Effects of Urea Infusion on the Uterine Luminal Environment of Dairy Cows. Journal of Dairy Science,2004; 87: 2896-2901.
- Teagasc. Body condition score cows to identify ones for extra care, 2020. https://www.teagasc.ie/publications/2020/body-condition-score-cows-to-identify-ones-for-extra-care-.php
- Teagasc, Dairy Manual. Winter facilities, 2016; 24: 151-152
- Teagasc, Dairy Manual. Feeding the dairy cow, 2016:
- Toni F, Vincenti L, Grigoletto L, et al. Early lactation ratio of fat and protein percentage in milk is associated with health, milk production, and survival. Journal of Dairy Science 2011; 94: 1772-1783
- Wathes DC, Fenwick M, Cheng Z et al. Influence of negative energy balance on cyclicity and fertility in the high producing dairy cow. Theriogenology, 2007; 68: S232-41.
- Whelan SJ, Mulligan FJ, Gath VP et al. Effect of dietary manipulation of crude protein content and nonfibrous-to-fibrous-carbohydrate ratio on energy balance in early-lactation dairy cows. Journal of Dairy Science 2014; 97:7220-7224

READER QUESTIONS AND ANSWERS

1. WHEN ARE COWS AT RISK OF SUFFERING FROM NEGATIVE ENERGY BALANCE?

A. Pre-calving
B. Post-calving
C. Pre-breeding

2. WHAT IS THE TARGET SIX-WEEK CALVING RATE IN IRISH GRASS-BASED DAIRY SYSTEMS?

A. 70%
B. 90%
C. 80%

3. WHAT IS THE TARGET BODY CONDITION SCORE FOR COWS AT THE POINT OF FIRST SERVICE?

A. 3.0
B. 2.5
C. 3.5

4. AT THE ONSET OF BREEDING, REPLACEMENT HEIFERS SHOULD BE WHAT PERCENTAGE OF THEIR MATURE WEIGHT?

A. 50%
B. 70%
C. 60%

ANSWERS: 1B; 2B; 3A; 4C.