Low milk fat in grazing dairy cows

Optimising milk solids output per cow during the lactation period is a key driver of farm profitability, writes Catherine Carty MVB, resident in bovine health management and Dr Finbar Mulligan, BAgrSc, MAgrSc, PhD, senior lecturer, Section of Herd Health and Animal Husbandry, University College Dublin

In 2014, gross agricultural output (GAO) was valued at €7.06bn (DAFM, 2015). The dairy sector accounts for the largest share of GAO at 35.2%. In 2014, total milk output (including imports) was estimated at 6,161 million litres. From this, total milk output, 480 million litres were consumed as liquid milk, 166,000 tonnes of butter were produced in 2014, while 71,000 tonnes of skim milk powder and 215,000 tonnes of cheese were produced in 2014 (CSO, 2015). Thus, the dairy industry is fundamental to Irish agriculture and indeed the Irish economy. With this in mind, it is important to see how farmers are paid for their product. Dairy farms must supply their milk to a processor and get paid according to production. This payment scheme has evolved in recent years, and production, as in litres of milk supplied, is still the key element of some payment schemes for those farmers producing milk for liquid consumption. However, many processors now have dairy farmers on manufacturing milk supply contracts where producers get paid for the milk solids; milk protein and milk fat kilograms (kgs) that are supplied to the processors. Most co-ops now pay on an A + B – C payment system where A is kg of protein, B is kg of fat and C is a reduction for each litre of milk supplied (volume charge). This has to be evaporated off with a major energy cost to the co-op and it costs money to collect and transport large volumes. The fat and protein content of milk will obviously change throughout lactation but are ultimately the main drivers of milk price to the farmer/producer, with other milk quality parameters also having a role. Therefore, Ireland will remain unique within Europe in so far as the predominant systems of milk production will be seasonal calving pasture-based systems. Consequently, optimising milk solids output per cow during the lactation period is a key driver of farm profitability. Therefore, in a seasonal system timing is also important. From CSO statistics, milk fat tends to be lowest during May and June while volume tends to be highest. As a result, any farm suffering milk fat depression (MFD) around this time will suffer economically. Milk fat production is, therefore, very important to Irish dairy farmers.

MILK FAT PRODUCTION

Milk fat is the main energy constituent in milk and is responsible for many of the processing qualities of milk and milk-based products. Milk fat is primarily composed of triglycerides that are composed of different mixtures of fatty acids depending on the free fatty acids (FFAs) in the cow's blood and what is produced in the mammary gland itself. In cows, milk fat is comprised of 98% triglyceride with high amounts of saturated fatty acids. In most species the fatty acid profile of milk fat is strongly related to dietary fatty acids. However, in ruminants dietary lipids are extensively altered by bacterial metabolism in the rumen and one of the main changes of this is the partial or full biohydrogenation in the rumen of monounsaturated and polyunsaturated fatty acids (PUFAs) consumed in the ruminant diet. Since unsaturated fatty acids are toxic to many rumen bacteria, the majority of these dietary lipids undergo biohydrogenation through a series of fatty acid intermediates that ultimately results in saturated fatty acid being produced. The level of milk fat percentage, as well as the composition of that fat in cows, is controlled by a variety of genetic and nutritional influences. Some nutritional influences on milk fat include: the level of unsaturated fat included in the diet; the availability of readily degradable starch; the amount and effectiveness of fibre intake used to buffer the rumen; the management and timing of feeds; and the use of rumen buffering agents, yeasts or the ingestion of moulds.

MILK FAT DEPRESSION

In ruminants, 50% of milk fat is synthesised de novo in the mammary gland. This synthesis of milk fatty acids is carried out by mammary epithelial cells using metabolic precursors such as beta-hydroxybutyrate and acetate. The remaining 50% of milk fat which originates directly from the diet are fatty acids that are absorbed from circulation and result mainly from the intestinal absorption of dietary and microbial fatty acids. Mobilisation of body fat accounts for a small proportion of the fatty acids in milk fat with the exception of when cows are in negative energy

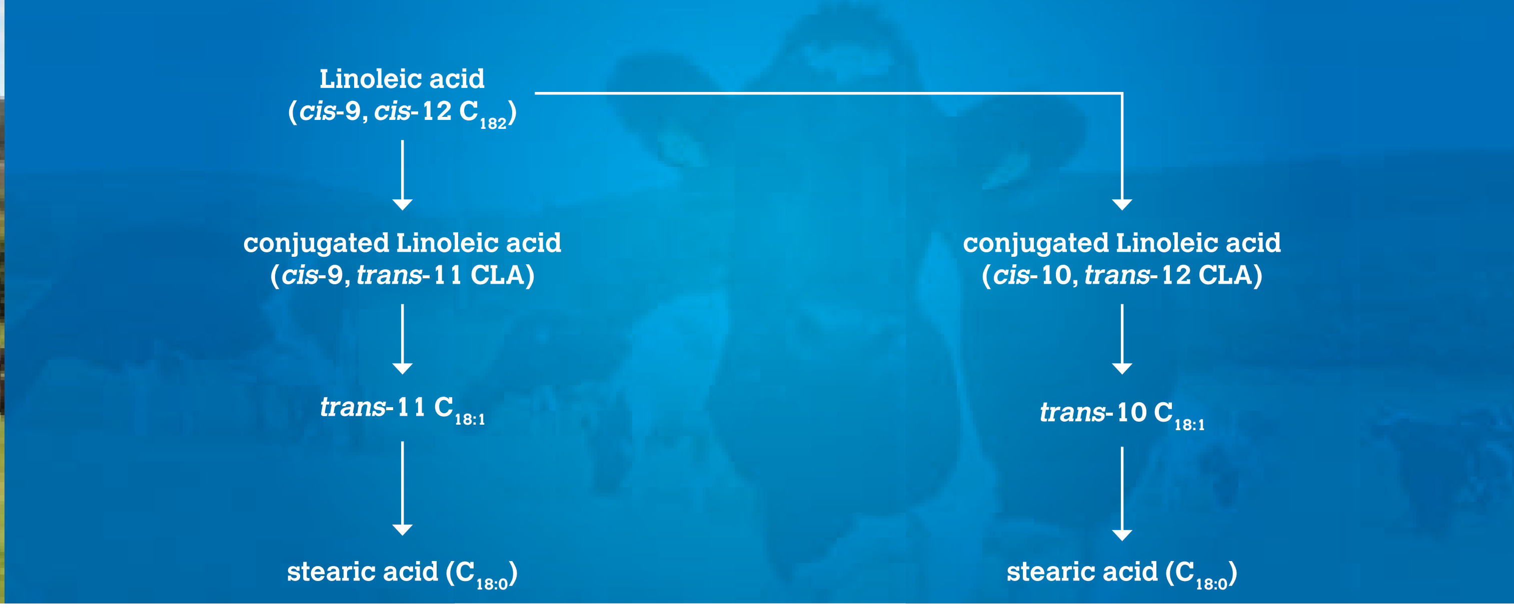

Figure 1: Milk fat synthesis inhibitors.[1]

balance. In this instance, the contribution from mobilised fatty acids increases in direct proportion to the magnitude of the energy deficit.

Milk fat depression (MFD) or low milk fat syndrome typically occurs without evidence of any other obvious clinical disease. It is also a herd level problem as opposed to an individual cow problem. We know there is a subpopulation of Irish herds experiencing the MFD phenomenon, usually in the months of May, June and July, with a herd level milk fat very different from what is expected, even taking the lactation curve and the expected decline into account. Reports from some producers indicate the bulk tank milk fat may reach as low as 3% and below.

MILK FAT PRODUCTION THEORIES

There are several theories as to why milk fat production drops, all of which are in some part related to rumen microbial processes. One such theory was that volatile fatty acid production in the rumen would have a direct effect on milk fat production; it proposed that decreased rumen production or absorption of acetate and butyrate would limit milk fat synthesis, this has been strongly over-ruled now due to controlled trials where acetate was infused into the abomasum in milk fat depressed cows with little increase in milk fat percentage. The second theory of MFD was that in cows fed starch-rich diets there is increased production of propionate and as a result, increased glucose and, in turn, insulin and that insulin would act to divert nutrients away from the amammary gland and towards body fat reserves. This theory has also been refuted in trials where cows were experimentally infused with propionate and glucose and the results of MFD were very variable and unpredictable and offered little evidence for the glucogenic-insulin theory as the basis of MFD. The third theory of MFD and now most widely accepted is 'the biohydrogenation theory'. The biohydrogenation theory represents a combining concept to explain the basis for diet-induced MFD where under certain dietary influences and, thus, rumen conditions, typical pathways of rumen biohydrogenation of PUFAs are altered to produce fatty acid intermediates. These intermediates of rumen fatty acid biohydrogenation then escape the rumen, are absorbed, and travel via the blood

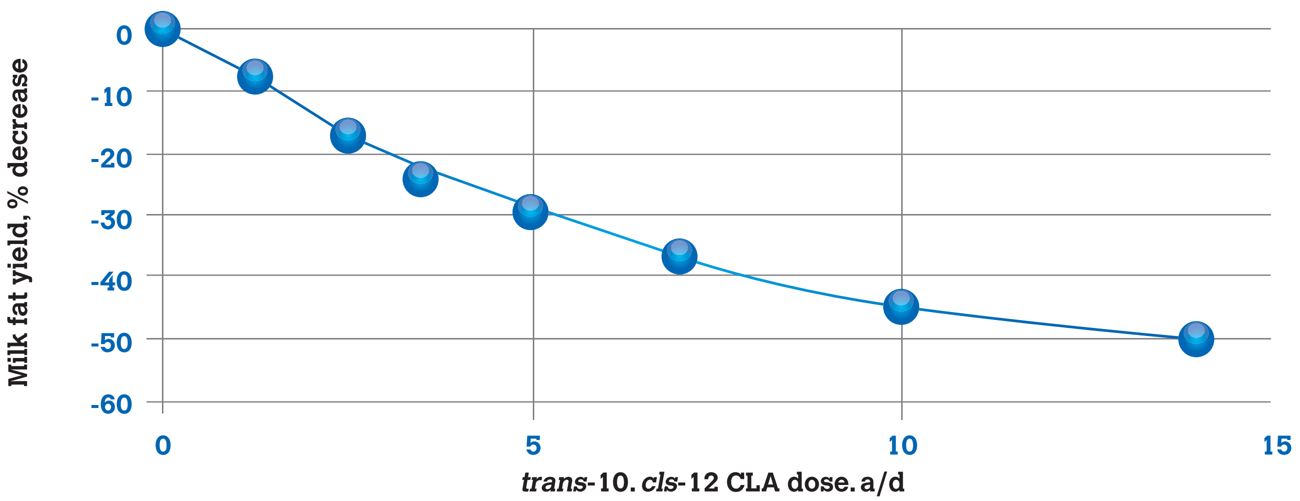

Figure 2: Milk fat yield percentage decrease.[1]

to the mammary gland where they signal a decreased expression of key mammary lipogenic enzymes that are necessary for milk fat production in the mammary gland. These intermediates of PUFA metabolism in the rumen are isomers of conjugated linoleic acid (CLA) which is a necessary intermediate in the biohydrogenation of PUFA to give a saturated fatty acid end product that is of use to the cow. However, three specific types of these CLA isomers have been found to be potent at inhibiting milk fat synthesis. The CLA isomer most noted for reducing milk fat is known as trans-10, cis-12 CLA.

A common misconception, however, is that acidosis is a prerequisite for MFD to occur. This is not the case, and in most situations, rumen health appears excellent and there are no overt signs of ruminal acidosis (Overton et al, 2006).

Lock et al, 2013, presented an abstract to the American Dairy Science Association (ADSA) where they concluded from an in vitro experiment to prove that the pH from 6.2 to 5.8 caused a large shift in the trans-fatty acid isomers from trans-11 isomers to trans-10 intermediates.

Lock et al, 2010, in the Tri-state Dairy Nutrition Conference, US, stated that changes in ruminal microbial processes are key to the development of MFD and occur as both an altered rumen environment and an alternative pathway of rumen biohydrogenation of polyunsaturated fatty acids. Dietary components can increase the risk of MFD by increasing substrate supply, altering rumen biohydrogenation pathways and altering the rate of biohydrogenation. These authors concluded that no single dietary factor is responsible for MFD but rather an interaction between various dietary components that can influence the rumen outflow of these intermediates of biohydrogenation that are associated with MFD. These authors also stated that as little as 1-2g per day of rumen outflow of the suspect biohydrogenation intermediates, such as trans-10, cis-12 CLA, is enough to reduce milk fat output by the cow by 0.4%.

IMPORTANCE OF PASTURE CONTENT

In most forage species, linolenic acid is the most predominant PUFA, linoleic being the second-most abundant PUFA in grass or forage. Depending on the grass species, stage of maturity and the environment, the fatty acid content of pasture varies but can potentially be in excess of 5% of forage dry matter.

Thus, cattle on young, fresh, immature pastures can be consuming a diet high in fat. In Ireland, we have many herds on a full grazing diet and, thus, the potential to be feeding a diet high in fat, especially in PUFA. The substrate is provided for the rumen microbes, coupled with the fact that this grass may be highly fermentable and may change rumen conditions (mildly depress rumen pH) to favour this alternative pathway of biohydrogenation to production of the detrimental isomers of CLA or trans-10, cis-12 CLA these conditions are thus ideal to cause a drop in milk fat production. Feed management and timing of feed delivery, as well as the supplements involved, can have a role in inducing and indeed preventing MFD.

However, it appears the young, fresh, immature, pasture fed to some Irish grazing dairy cows in early summer can unfortunately be associated on some farms with a large decline in milk fat production, that can in some cases be difficult to recover from for the remainder of the grazing season. The reality is that on some farms, the grass-only system can be 'the perfect storm' for causing milk fat depression.

There are many questions around the MFD phenomenon that have been observed on some Irish dairy farms such as firstly quantifying the problem, how much of this problem actually exists, is it the economic and management problem that it sounds like? There is some variety in processor price for what is an acceptable base price for the butterfat constituent in milk payment contracts. Do we have an industry standard as acceptable for butterfat or likewise, do we have a physiological accepted 'target' for butterfat on Irish dairy farms?

Research from G Oetzel in Wisconsin presented at American Association of Bovine Practitioners (AABP) in 2007, states a normal milk-fat percentage for Holstein herds should be between 3.4 and 4.0% and between 4.2 and 5.0% for Jersey herds with some seasonal variation. In his opinion, milk fat should never drop below 3.2% in Holstein herds.

Looking at an industry standard in Ireland, for some of the processors at least, base price for butterfat starts at 3.6%. If we take the currently unquantified but widely reported problem of MFD in grazing Irish dairy herds, we need to address why this phenomenon occurs in some parts of the country and not others.

Perhaps it is merely not addressed and if there are certain herd-level risk factors that could be identified to help avoid the problem. Is it acceptable to expect and accept a crash in butterfat in the summer months beyond that of the normal lactation curve and accept the lost return on product? There are a variety of options to address the nutritional-related implications on milk fat to enhance milk fat production but are they proven or indeed cost sensible?

In an era where Ireland is expected to increase milk output by 50% in the next five years, and where most farmers get paid on milk solids, then it is essential that cow production and in turn farm profitability is maximised. Although MFD is not an issue for every dairy farmer, it is an area where further investigation is warranted.

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