Delivering Nutritional Solutions to Prevent Metabolic Disorders
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Introduction:

The term 'metabolic disorder' describes a complex of production-related diseases that occur at and around the calving event. These disorders are a manifestation of the cow's inability to cope with the metabolic demands of calving and subsequent milk production. A cascade of hormonal and physiological events at calving trigger fat mobilization and while it is inevitable in all cows it is the magnitude and speed of this mobilization that contributes to the effects we see as 'Metabolic Disorders'.

A recent study of trends in the Irish cow population highlighted that on average 24.5% of all cows that die on farm, do so within one month of their last reported calving date (Maher et al. 2008). This highlights the significance of a calving event in the life cycle of the cow and re-emphasises the need for practical dry cow management solutions to reduce this cow wastage.

These events are often viewed as being out of the farmers control and we have been guilty of accepting that higher yielding cows will always be more likely to suffer from diseases such as Milk Fever, Ketosis, Fatty Liver, Ruminal acidosis, Held Cleansings, Displacements and infectious processes such as Metritis and Mastitis. The Holstein often gets the blame. Her genetic potential for high production while creating the demand, doesn't absolve us from poor management of this demand.

Production diseases are a powerful indicator of nutritional performance in a herd. In Fig. 1 there are target incidence rates that give a guideline of where your herd should be performing. It is a useful tool to measure the outcome of any dry cow management system.

As vets we have a tendency to look at the individual cow response to our treatments and recommendations. From the vets, farmers and cows point of view we need to address these disorders on a herd basis. Within a cow group there is huge variation in response to feeding and environmental conditions. The objective of our management systems should be to minimise the variation, stabilise the herd metabolically and create an environment around the cows where they can fulfil their genetic potential.

The calving event and the negative energy balance in early lactation are two major factors affecting subsequent fertility. For optimal reproductive performance, calving difficulty should be minimised and feeding strategies need to be employed that maximise feed intake in the immediate post calving period. Fertility is managed throughout the cows annual cycle on a farm. There are no holiday periods for us or the cow; dry cow nutritional management ultimately establishes the base for the next lactation success.

Fig 1. Target incidence rates for production diseases of dairy cows

Clinical condition	Target Incidence Rate	
Milk Fever	0-5%	Houe et al. (2001),
Downer cow syndrome	(<10% of milk fevers)	
Hypomagnesaemic tetany	0%	
Ketosis	0-5%	Ingvartsen (2006); Heuer et al. (1999)
Left displaced abomasum	0-3%	Heuer (1999); Jordan and Fourdraine (1993)
Right displaced abomasum	<1%	
Low Milk Fat Syndrome	<10%	Nordlund et al. (2004)
Retained Placenta	<10%	Mee (2004c), Heuer et al., (1999)
Lameness	<15%	Ingvartsen (2006), Heuer et al. (1999)
Difficult calvings	<10%	

(Mulligan 2008)

Nutritional Goals for the dry period:

There are three nutritionally-based goals that we need to achieve to help our cows move from dry to calved and milking.

1. Stabilise energy metabolism. Minimise fat mobilisation in the transition cow and maximise her intake post calving reducing the incidence of ketosis, displacements and fatty liver. Also we need to create a rumen environment to help utilise the high energy feeds presented post calving efficiently and without plunging the fresh cow into acidosis within days of calving.
2. Stabilise mineral metabolism. Milk fever, sub clinical hypocalcaemia and udder oedema all result from poor mineral balance in terms of magnesium, calcium, potassium and sodium supply.
3. Stabilise the immune system. Retained cleansings, Mastitis and Metritis are related to the ability of the cow's immune system to function in the early days post calving. The waste products of fat mobilisation and inadequate mineral and vitamin supplies reduce immune system capability.

These goals are inter-related. In order to control these events we need to look at a single approach to incorporate elements of all three.

Delivery of these nutritional goals

Stabilising energy:

Traditionally, the dry period was used to restore lost body condition and though it is a constant recommendation to dry off cows in the condition you want them to calve down in, this recommendation is rarely practised on farm.

Two scenarios arise: firstly cows are dried off in poor condition because of excessive production and inadequate feeding during the lactation. This can happen with high production cows in grass based environments with inconsistent supplement regimes based on guestimates of energy intakes from pasture. Often the diet itself is not at fault rather our measurement of actual intake and response to that measurement being inadequate. These cows are allowed to over consume moderate energy forage base diets ad lib for the dry period and will lay down fat deposits. This is problematic in that the dry cow diet often bears little resemblance to the milkers ration and even with 'steam up' in the final weeks before calving, rumen adaptation is poor, rumen fill is low and acidosis can be a major problem post calving particularly if the cow is introduced rapidly to high volumes of concentrates either in the parlour or in an unbalanced TMR.. Also these cows in better body condition score mobilise this recently laid down fat at the point of calving and the cow is more prone to the metabolic crisis of ketosis and its related diseases.

The second scenario is even more common in the higher production herds. Cows are too fat entering the dry period and allowed to over consume. These cows are often cows finishing extended lactations or fed a high starch diet particularly in the late lactation phase in a misguided attempt to hold milk production or they are cows that are 'rolled around' – with a calving interval of > 450 days. Many herds contain a combination of all three, allowing the cows to control the dry off policy not the farmer. While it is acceptable to have longer calving intervals in higher producing cows the economics of extending lactations needs to be appraised properly for an individual farm particularly if the system is contributing to fat cows at dry off and subsequent problems post calving.

Seasonal grass-based environments can magnify this problem by having dry off policies where some late calving cows are dried early to fit the system and can spend up to 4 months in the dry group gaining weight and condition.

The modern Holstein creates a challenge in terms of Body Condition scoring. Field experience has shown that small changes in Body Scores may poorly reflect larger changes in internal fat depots. Unlike traditional Friesian breeds where ' what you see is what you get', with the Holstein we need to be cognisant that cows allowed to over consume in the dry period may not show significant BCS change yet carry large quantities of internal fat depots. This can also apply to Jersey type breeds.

The body condition score message should be reviewed for an individual herd and the most important element is the herdsman recognising change between management groups. Scoring the cows at dry off, calving and one month into lactation and recognising change focuses the mind on the level of change occurring in your system.

The goal of a nutrition system is to reduce these change events – stabilise the energy metabolism of the cow. A dry cow system should control the cows' energy intake particularly in the early dry period to prevent excessive fat deposition. Also by controlling the energy intake in the dry period, there is a better adjustment to the demands of increased glucose production in early lactation. The cow can stabilise her metabolic processes more quickly and combined with a better dry matter intake make the transition smoother.

An important element of the dry cow strategy is to constantly present the cow with a sample of the diet that she will consume in early lactation. Rather than building rumen adaptation to the diet in the last weeks of the dry period a small quantity of the lactation forage and concentrate should be included throughout the dry period so the rumen doesn't lose its absorptive capacity for the acids produced during digestion in early lactation. Dry cow diets using the lactation TMR diluted with low energy forage allow for this constant supply to occour and so reduce the incidence of acidosis.

Displacements have a commonality of cause; high BCS at calving, excessive weight loss and ketosis. Poor rumen fill after calving particularly in high risk groups such as shy feeding heifers or in environments where low dry matter intakes can occour, is a major contributory factor. It can also occur where concentrate fed in the first days exceeds forage intake, promoting acidosis and poor rumen fill – classically seen in parlour feed systems.

It is argued that the presence of the calf in the last trimester of pregnancy interferes with rumen fill and while the space occupied by the calf can't be reduced it is sensible to maximise the capacity of the rumen in this period. In order to do so we need to fill the rumen with material that doesn't compromise energy intake and stimulates rumen function. The use of straw in dry cow diets is promoted for its low energy properties and its rumen functionality. But it must be balanced correctly with energy, protein, minerals and vitamins and more importantly every cow must be able to consume a correct amount of the overall diet every day consistently over the dry period. Including straw without creating optimum conditions for its consumption in a balanced ration will create more problems than it can solve.

Stabilising Mineral Metabolism:

Milk fever and sub clinical hypocalcaemia have major impacts on individual cow's production, immune system and survivability in the herd. The demand for calcium at calving is enormous and the cow must have the ability to switch on its calcium mobilisation mechanisms to cope with this demand. It is the

most obvious metabolic disease and is familiar to every farmer and herdsman regardless of the dairy system employed. It is termed a 'gateway' disease and is linked to conditions such as retained cleansings, displacements, ketosis and mastitis.

When trying to determine the incidence of milk fever on a farm, while cases of down cows are remembered, the fact that cows may receive a treatment routinely at the point of calving is not viewed as an 'incident'. The ambition in a milk fever control strategy is to eliminate the need for any treatment protocol and create the environment where the cow stabilises her own blood calcium.

Magnesium deficiency in the run up to calving is a major cause of milk fever in both housed and grazing environments and must be dealt with by additions of magnesium to the diet.

The presence of high concentrations of potassium (K+) particularly in our grass based forages contributes to a positive Dietary Cation Anion balance and is a factor in low blood calcium at the point of calving. High calcium levels in the diet precalving contribute to this effect. We can't remove these minerals from the forages but we can dilute the effect by using less of these forages in the dry cow diet. By using a straw based dry cow diet for the whole dry period we can reduce the incidence of milk fever significantly (fig.2).

Overfat cows are more prone to milk fever and the energy control principles apply. Reduce the fat deposition and disease incidence reduces.

Stabilising the immune system:

From our field experience, by controlling the energy intake of the dry cow, fat deposition and mineral balance, the calving event occurs more smoothly and overall health of the herd improves. By improving calcium metabolism, reducing the potential for fat deposition in the liver and decreasing the levels of ketones more rapidly post calving there appears to be a cumulative response in terms of the cow's ability to deal with production related infectious disease such as mastitis and metritis. Retained cleansings are also reduced. Ease of calving is the feature most noted by farmers using the controlled energy dry cow system and this improvement alone may assist in increasing dry matter intakes after calving and improving overall health and well being.

Mineral and vitamin balances often need revision in the higher production cow environment. Particularly where grass silages are the base forage there can be considerable variation in the mineral and vitamin content. Vitamin and trace element deficiencies can be compounded by using high volumes of straw in the dry cow diet and mineral and vitamin supplements have to be increased using this strategy.

The solution

Keenan have developed and employed a dry cow strategy based on the above principles using the unique capabilities of the Keenan Klassik mixer wagon to process large volumes of straw while retaining its functional characteristics. The straw acts as an energy diluent allowing high quality concentrate and forage to be fed as part of the dry cow diet. Also the straw volume dilutes the negative effects of high potassium, sodium and calcium in the dry cow diet. The chopped straw, when processed through the Klassik provides a source of Keenan Mech FiberTM, fibre that creates rumen fill and has a function in maintaining the ability of the rumen to digest large volumes of forage and concentrate during the lactation.

The energy diluting effects have a profound effect on the metabolism of the cow acting through the hormonal and physiological responses of fat tissue and the liver of the cow at the point of calving.

The rumen fill effects allow for greater feed volumes to be consumed by the cow earlier in lactation and the presence of a portion of the lactation ration throughout the dry period promotes successful adaptation of the rumen to the high concentrate and starch rich forages of the early lactation feeding programme.

Fig 2. Animal Health Controlled Energy: Hi Fibre Survey 2008 – Production Disease Incidence in Irish Customer Herds

Hi Fibre	# herds (# cows)	Held cleanings	Assisted calvings	Milk Fever	Stomach problems	Lameness
No	30 (2814)	7.8%	17.3%	9.9%	2.5%	8.4%
Yes	51 (4753)	5.7%	14.0%	2.4%	1.5%	7.3%

(Kavanagh 2008)

Delivering the Keenan Controlled Energy: HiFibre Diet solution

Solutions are only as good as the responsibility and commitment taken to delivery. There are a number of 'rules' to employing the Keenan Controlled Energy: Hi Fibre diet.

They can be broadly categorised into

1. Nutrition principles
2. Machine delivery
3. Cow environment and feed management
4. Monitoring

Nutrition principles

The diet is constructed using a minimum of 5 kg fresh weight chopped straw as the base forage and adding available ensiled forages combined with a protein source and a source of energy e.g. grain that reflects the energy feed supplied in the lactating cow diet. Alternatively 50% of the DM volume is made up from the lactating cow TMR with the balance provided as cereal straw. Minerals and vitamins are included. The formulation of the diet sets out to achieve an energy level of 9 MJ ME/kg DM, 13% CP at 40-45 % DM content with a daily allowance of 10-12kg DM per cow per day. This quantity is offered daily free choice. If the dry cow group contains significant numbers of heifers a CP of 14% is recommended.

The diet is fed for the duration of the dry period.

Machine Delivery

A Standard Operating Procedure for loading and using the machine is employed to ensure consistency in mix quality and to ensure there is no over or under processing of ingredients. This is vital to the overall success of the diet. If the mix or process is poor the cows will either sort the diet or over consume the diet and the farmer loses control of their intake. Either situation will lead to problems with individual cows. The machine must have the ability not to degrade the quality of the ingredients added, the fibre must retain its functionality and the forages must not be processed excessively to encourage higher intakes. The machine must also have the ability to hold water if required to reduce the overall dry matter of the diet as necessary.

Cow environment and feed management

Adequate space for all the cows to eat at once – 22-28in per cow of feed barrier length or 1 headstall per cow – should be provided. With the seasonal herd the demand for feed space can be problematic in large groups of dry cows. Access should be continuous to ensure consistent intakes and regular push ups are required. Refusals should be removed daily.

The housing environment needs to be monitored for cow comfort to ensure adequate rumination. Water supply must be potable and readily available. Light (200 lux) should be provided for an 8 hour minimum in the dry cow house to ensure activity at the feed area. Light levels may need to be higher if there are high numbers of heifers in the group.

If heifers are included in the dry cow group care should be taken that they can achieve adequate intakes. Rumen fill and body condition should be assessed regularly to ensure bullying

is not interfering with intakes. This is common in herds where the heifer rearing programme doesn't grow the young stock well and they enter the adult herd undersized.

Monitoring

The cows embarking on this dry cow programme need to have adequate body condition before dry off but be aware that it should not be excessive. It is not a weight reducing diet and the overall ambition of the Keenan dietary system is to stabilise the herd, not to contribute to the cycle of weight fluctuation.

The cows need to be observed frequently by the herdsman for rumination, rumen fill, change in body condition or health status that may indicate management failures or forage variables in the diet. We need to be aware of variation in forage quality that may affect the process as well as the end result. Understanding and recognising the principles of the approach will lead to success.

Conclusion:

The Keenan Controlled energy: High Fibre diet is an effective on farm strategy to reduce the incidence of metabolic disease at farm level. The system is reliant on a disciplined approach and a grasp of the principles outlined above.
The machine has a central role to play in the correct processing of the diet to ensure controlled intakes. The cow's environment can have a negative impact on any system and needs to be optimised. Monitoring the outcome of the system is important and disease incidence rates are a useful tool. The system gives control back to the farmer and removes it from the cow.

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