Is it time for a re-think on the sustainability of cattle management?

The economic realities facing today's dairy producers wishing to grow are complex as the market price for milk is not favourable. Input costs are unlikely to diminish to any meaningful degree, and all manner of regulations are constraining growth potential.

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Working one's way through this maze is possible but increased production efficiency is perhaps the only realistic option, and to do so biological variation must be reduced.

One need only open a dairying trade journal to realise the myriad of technologies that offer to lead producers to profitable sustainability but, prior to investing in any of these, producers should take a long look at the implications of some choices.

It is no secret that technology is advancing at a rapid pace but it is all too easy to fall into the depreciation trap where investments are out of date long before being paid for, or when decisions are made without really appreciating the actual problem let alone if it can be addressed. The topic of dairy nutrition is a good example.

Designing a cost effective dairy diet

Designing a cost effective dairy diet is certainly not easy as one needs to know the value of the various ingredients used. Unfortunately defining value is the sticking point as economic value and biological value are not always the same.

Great strides have be made to narrow this gap but the reality is that the majority of feed analysis techniques offer chemical accuracy but the values are then used as biological proxies to derive energy and protein estimates.

Unfortunately when these values are used to predict the all important dry matter intake, errors are easily made.

A more logical approach would be to consider the whole question in an integrative manner (Fig. 1).

By following this form of logic one takes a systems approach rather than isolating any one factor and you are in effect minimising biological variance.

This path requires new approaches to data acquisition, but as may be seen from Table 1 the expectation that there is an average cow eating an average intake is just not realistic.

First lactation and mature cows obviously do not react equally to similar feeding characteristics and yet many dietary formulation programs assume that they do.

There are many other environmental factors such as housing design, stocking rate, and days in milk that effect intake so the question then becomes how does one account for these variables?

Cow behavioural approach

Fermentrics and Cainthus, an Irish agriculture AI company, are currently investigating the visual measurement of cow ethology rather than to try and predict it.

The goal is to use machine learning to create a visual monitoring system for cattle. This would enable us to use affordable cameras to monitor cows on an individual basis in real time, 24 hours a day.

Table 1. Effect of eating characteristics on production (+/- represent a correlation $p<0.05$, while NS represents non-significance).

Measurement	First lactation	Mature cows
Prod x DMI	+	+
Prod x water intake	+	+
Prod x meal size	NS	+
Prod x meal rate	+	NS
Prod x meal number	+	NS
Prod x eating bouts	NS	+
Prod x length of eating bouts	NS	NS
Prod x rumination	-	-
Prod x chewing of DMI	-	-

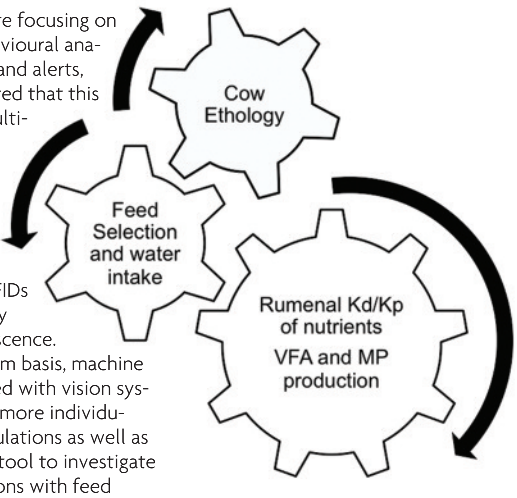

Fig. 1. An integrative approach to estimate dry matter Intake.

Currently we are focusing on feed intake, behavioural analytics, lameness, and alerts, and it is anticipated that this technology will ultimately replace many devices on a dairy farm as well as reduce labour requirements. Ear tags, wearables and RFIDs are all in the early stages of obsolescence.

On a longer term basis, machine learning combined with vision systems will enable more individualised feed formulations as well as offering a viable tool to investigate genetic interactions with feed intake

The system utilises 4K cameras located in a manner which captures movements in sufficient detail that machine learning algorithms can be used to generate facial recognition data. When combined with measurement of time spent actually eating, as opposed to GPS systems which simply log the cow being at the bunk, the successful application of a systems approach can become reality.

Data generated to date (Table 2) has shown some interesting results. The initial assumption was that the TMRs fed the cows were essentially equal hence any intake variance would be caused by parity, grouping, housing etc. So far this assumption has proven inaccurate as may be seen in Table 2. The values were generated when a free stall barn was divided into quadrants with representative samples being taken from the same location on three successive days.

While we did not expect the results to be totally similar, given that nutrient values do change across the face of a bunk, we never anticipated a range as wide as this.

The TMR was fed in two batches with quadrants 1 and 2 being from the first load and quadrants 3 and 4 from the second load.

By way of explanation MBP (microbial biomass production) represents a value generated from an In Vitro gas fermentation system and there is a strong correlation between this value and the milk potential of the ration.

Gas fermentation systems allow for a dynamic analysis of ingredients, or TMRs, and offer valuable insight into how the carbohydrate fractions are fermenting. The value of this approach is that as one can obtain moving rates and extents of fermentation the data allows for more accurate diet formulation.

The system developed by Fermentrics measures CO_2 , CH_4, and pressure on a live basis hence inferences as to how much energy is being produced at any point in the process can be drawn. Alternative

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systems measure terminal, or set hour points, to calculate rates but this approach is not live and one needs to ensure that the selected measurements are reflective of the actual fermentation.

The intriguing results of analysing diets in this fashion is that one quickly sees that the nutritive value of the TMR is not simply an additive function of the various ingredients used. The final results can, in fact, be either better or worse than expected.

Positive associative effects arise from such things as synchronisation of diets, and the addition of enzymes, while negative effects can arise from excess fermentable carbohydrate, fat additions, or the presence of anti-nutritional factors. Capturing positive effects, while avoiding negative ones, offers a tremendous opportunity to reduce diet costs.

Recently published data has shown that diets that were theoretically equal in metabolisable energy actually produced vastly different amounts of MBP depending on how the diets were designed.

Forage and protein levels were left constant while high energy starch and sugar ingredients were varied. Despite the assumed equality between the TMRs the theoretical milk yield difference was as much as 2.5 litres per cow.

Conclusion

The bottom line is that sustainability, let alone expansion, in the present dairying environment requires a re-think as to how cattle are managed. Economies of scale are a logical goal but by following this route one is exchanging labour for capital hence any investments need to be made with a view to long term usefulness. The consideration of cow ethology offers tremendous opportunity to manage costs if technologies such as AI and machine learning are utilised. The further inclusion of live fermentation metrics in diet formulation magnifies the potential cost savings. ■

References are available from the author on request

Table 2. Nutrient analysis from locations within a free stall barn (*p<0.05 within a quadrant).

	Day 1	Day 2	Day 3
Quadrant 1			
MBP (mg/g)	165	118*	144
Protein (%)	17.2	16.6*	17.6
Starch (%)	17.0	14.7*	18.3
NDF (%)	37.9	31.6*	35.9
Sodium (%)	0.2	0.22*	0.2
Quadrant 2			
MBP (mg/g)	160	153	159
Protein (%)	18.0	17.8	16.4*
Starch (%)	19.4	17.4	16.5
NDF (%)	33.8*	36.8	37.1
Sodium (%)	0.2	0.2	0.17*
Quadrant 3			
MBP (mg/g)	157*	164*	139*
Protein (%)	18.5*	16.4*	17.6
Starch (%)	20.0*	16.8*	15.1*
NDF (%)	36.8*	38.1	39.1*
Sodium (%)	0.2	0.17*	0.2
Quadrant 4			
MBP (mg/g)	160	153	159
Protein (%)	18.0	17.8	16.4*
Starch (%)	19.4	17.4	16.5
NDF (%)	33.8*	36.8	38.1
Sodium (%)	0.2	0.2	0.17*