

## Milk MIR– a case study from NMR in the UK

**Milk MIR** has been a commercial service available to dairy farmers in the UK since 2012, through NMR, the country's biggest herd recording organisation.

The UK service is underpinned by two research projects which involve collaborating with Scotland's Rural University College (SRUC). This case study gives some insight in the UK experience which may be useful in considering the application of MIR technology by Australian herd test centres.

### Milk MIR, a commercial service

NMR has 15 CombiFoss machines located in three labs across the UK; of these, 10 have been standardised for MIR analysis.

Farmers don't pay for the analysis as such, but for the reports. Marketed as 'Milk MIR,' NMR charges 20p (~40 cents) per result which is equivalent to about \$80/month for a 200 cow herd.

All milk samples processed through the standardised machines (about 400,000/month) undergo MIR testing, regardless of whether the farmer pays for reports. The results are used for research purposes, in collaboration with SRUC (see later) as well as providing national data to use for benchmarking.

NMR routinely analyses milk samples for 32 different fatty acids, three indicators of energy balance and will soon also report on indicators of ketosis.

The service is not marketed direct to farmers due to the numerous different ways results could be interpreted. Instead nutritionists are the main target users, followed by other farm advisers and vets. NMR's strategy has been for a slow and sustainable roll out to ensure the results are interpreted correctly once advisers have been trained and can promote and use the service with their clients.

### Implementation process

Now that the process is routine there's very little difference in the lab to the way milk samples are treated for MIR analysis, however the implementation process did involve significant investment in time and money. Two of the key challenges were the standardisation process and IT infrastructure.

NMR's initial MIR work was done on unstandardized machines, but the company now only uses machines standardised to the same master spectra. A European network means that the results for samples tested on standardised machines will be repeatable and comparable across all sites, companies (not just NMR's) and countries in the network.

The standardisation routine is similar to that used for other herd test processes. Monthly ring test samples are dispatched to each lab from the European network for testing and the MIR is reported back to calculate coefficients and intercepts that can be applied to raw spectra going forward.

The sheer scale of data generated by MIR analysis had major implications for NMR's IT systems. Implementing MIR services required upgrading the IT infrastructure and training for IT personnel. Some of the IT challenges faced by NMR included unexpected complications with software upgrades, name differences between computers, loss of



connectivity (between FOSS machine and the company PC resulting in loss of data) and the implications of human error in sample positions in racks.

Another challenge was translating analyses and reports developed in SRUC's research environment into processes that were commercially feasible. While SRUC can comfortably run analyses over many hours, NMR deals with a much bigger scale of samples and needs processes with a much faster turnaround. For example, each day NMR processes 8-20 million rows of data in about 20-50 minutes. If the process takes any longer than an hour and half it has an unsustainable impact on testing in the labs.

## Uses of MIR results

Initially NMR focussed on MIR analysis for different fatty acids (which influence the qualities of milk for processing into specialist products such as the crumbliness of stilton cheese). However, there was limited commercial value in this because farmers were not paid by processors for different fatty acid composition in milk. EU labelling laws meant milk could not be marketed based on its different fatty acid composition.

To date the two most useful applications of MIR results have been for dairy herd nutritional management (energy balance) and the development of breeding values for new traits.

## Plans for the future

NMR recognises that the number of dairy farmers in the UK is unlikely to increase, so business growth is more likely to be achieved by providing more and better-valued services to its customers. MIR presents opportunities to do this.

It is investigating opportunities to improve the standardisation process, refine ketosis predictions and use of MIR results to develop breeding values for new traits (in collaboration with SRUC).

Working with third party advisers to enhance the use of energy balance reports continues to be a high priority.

## Managing energy balance

Currently the main service to dairy farmers from milk MIR is to provide energy balance reports from herd recording samples. At this stage, it is seen as a better way of monitoring ketosis risk than fat to protein ratios. However the reports have the potential for expanded use to herd managers. In collaboration with SRUC, NMR has developed energy reports for individual cows and at the herd level (see reporting, below). NMR supplies MIR reports online only; paper reports are not provided but can be downloaded from the web.

### Example reports

To view a demonstration of the NMR's MIR reports (based on real herd results) visit [www.nmr.co.uk](http://www.nmr.co.uk) and click on Herd Companion.

username: demo

password: Demo

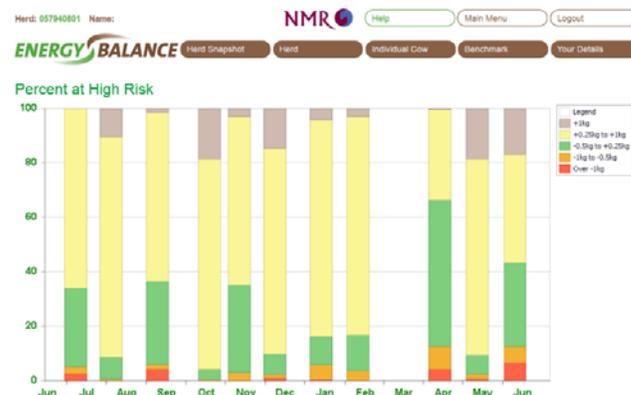
### Whole herd reports

One of NMR's MIR reports shows the proportion of cows at risk of negative energy balance reported in five bands from low to high risk (based on amount of body condition they are losing/gaining on a daily basis):

- Grey: gaining >1kg/week (getting fat)
- Yellow: gaining 0.25 - 1kg
- Green: losing 0.25 - 0.5kg
- Orange: losing 0.5 - 1kg
- Red: losing > 1kg (risk of ketosis)

### Reporting individual cow energy balance

Herds also receive a report of energy balance status of individual cows. This is useful for tracking those going into negative energy balance (expected in early lactation) or if they are coming out of it (which is important for return to fertility after calving). Cows that stay red or go from green to red require further investigation.



**ENERGY BALANCE** Herd Snapshot Herd Individual Cow Benchmark Your Details

Individual Cow Data

■ Losing 1kg+ 
 ■ Losing 0.5kg to 1kg 
 ■ -0.5kg to +0.25kg 
 ■ Gaining 0.25kg to 1kg 
 ■ Gaining 1kg+

Line No	Name	Earlag	Lactation Number	Calving Date	DIM ▲	Fertility Status 09/06/2016	Milk Yield 09/06/2016	Energy Balance 12/04/2016	Energy Balance 11/05/2016	Energy Balance 09/06/2016
0360	M MAXI JENNIFER	UK305856602360	01	05/06/2016	4	Calved	29.80			
0079	M CANVAS KIM	UK305856502079	02	04/06/2016	5	Calved	37.60			
0385	M PLEASURE BRENDA	UK305856302385	01	03/06/2016	6	Calved	21.00			
0652	M ROY MILDRED	UK305856501652	04	03/06/2016	6	Calved	53.60			
0133	M DRAYMAN BRENDA	UK305856302133	02	02/06/2016	7	Calved	33.80			
0124	M BLUESKY BEATRIX	UK305856102124	02	30/05/2016	10	Calved	45.80			
0040	M CANVAS AMBER 2	UK305856602080	02	27/05/2016	13	Calved	42.60			

Using the reports in the UK

Designed to be used in conjunction with a vet, nutritionist or farm advisor, these reports can be used to fine-tune management of nutrition for fertility, feed efficiency, milk production and animal health.

**Fertility:** Poor energy balance affects the quality of egg cells (oocytes) and therefore the viability of embryos. With egg cells taking between 60 to 80 days to develop, negative energy before and after calving affects egg quality. It is important to minimise both the depth and also the duration of any negative energy balance. Cows that are losing body condition due to negative energy balance, may also produce Non-Esterified Fatty Acids (NEFAs) as a result of breaking down body tissue to meet their energy shortfall. These NEFAs are toxic to the follicular environment and reduce conception rates by contributing to loss of pregnancy in the very early stage. The report provides the ability to identify whether energy balance is affecting the cow fertility today or because of what happened two months earlier.

**Feed efficiency:** At certain times of the year it will be more efficient to adjust body condition depending on feed costs. It is more efficient to hold body condition leading into the dry off period than allowing cows to lose condition late in lactation and regain it in the dry period. Aim for no changes in body condition during the dry period. The reports can be used to monitor status throughout lactation and adjust diets accordingly to prevent weight loss or gain in late lactation. The principles of managing body condition still apply but this tool gives a proactive opportunity to manage cow condition before any visible changes are seen, by which time it is often too late and the damage has been done.

**Production:** Reviewing energy balance results in the context of production helps determine whether the right cows are being fed the right amount of energy at the right time.

**Health:** Knowing which cows are in negative energy balance in early lactation means they can be monitored more closely as they are at increased risk of ketosis, metritis, displaced abomasum and retained foetal membranes. However these diseases often involve multiple causes/contributing factors.

When to monitor energy balance

The most obvious time to monitor energy balance is in early lactation when the risk of ketosis is highest. However UK research suggests it is useful to monitor energy balance throughout the whole lactation in feeding systems that involve cows being fed a total mixed ration indoors through the winter and pasture in the summer. In this situation it is easy to over-estimate the nutritional value of pasture or underestimate the needs of late lactation cows resulting in negative energy balance which can reduce fertility in the coming lactation.

It may be worth monitoring energy balance of specific groups of cows such as heifers or second calvers as these animals will still be growing. UK research shows that on average, heifers take a week longer to return to positive energy after calving. Some herds in the UK run a separate heifer group to allow them to adjust their diets accordingly and reduce bullying by older herdmates.

MIR and genetics

MIR analysis of herd recording samples presents opportunities to develop breeding values for traits that are otherwise difficult to measure such as methane production, energy balance and therefore resistance to metabolic diseases.

Scotland's Rural University College (SRUC) has analysed MIR from a vast dataset from herd test samples collected since 2012 in addition to the genotypes for 1200 animals in this data set. This has allowed the team to identify rapid, cost effective biomarkers for new traits.

Research has shown that within bulls with the same economic index (eg BPI in Australia), there's a big variation between their breeding value for energy balance and therefore the opportunity to select for improved energy balance. The heritability for negative energy balance is 0.11-0.2 which is similar to the heritability of fertility. Trends around the world have shown that selection for fertility has resulted in significant improvements in the genetic merit of fertility in Holstein cows. This suggests there's the potential for similar gains from an energy balance breeding value.

Although it is some time before a breeding value for energy balance will be available in the UK, research has found that energy balance is favourably correlated with milk protein content and calving interval. This means that selecting for improved energy balance will result in increased milk protein content and a shorter calving interval.

### Options for monitoring energy balance

MIR is a new tool for monitoring energy balance in collaboration with a nutritionist/advisor. In the UK it has some advantages over other methods of monitoring energy balance, such as monitoring dry matter intakes and diet metabolisable energy (ME) levels, body condition scoring, monitoring blood metabolites, milk fat to protein ratios or milk urea or proteins. This is due to the ease, availability and low cost of MIR data from milk recording samples. While it is useful to monitor individual or group dry matter intakes and diet ME values, it can be challenging to routinely record this data on-farm due to the time and logistics involved.

Body condition scoring is subjective and not always done routinely. Additionally it only monitors subcutaneous fat not visceral fat and by the time a difference is detected, it's too late to prevent an impact on production or fertility. Monitoring blood metabolites is the gold standard diagnostic tool for ketosis but it is impractical for routine whole-of-herd monitoring. MIR will never replace blood sampling as a diagnostic tool but is a good monitoring tool to flag when to investigate further.

There has been interest in monitoring fat:protein ratios from herd test samples but published research shows that the accuracy is only slightly above 50% (the same as flipping a coin) for detecting ketosis. Proteins on their own are more accurate, but it is unclear whether slight changes in protein percentage can be relied upon to guide on-farm decisions. The MIR tool is derived from the same data as fat:protein ratio but includes much more information from the milk sample, taking the process a step further to achieve more reliable results.

The reliability of monitoring urea in milk samples from individual cows is questionable due to the low quantity in milk. Reliability from bulk milk is better but the results don't indicate whether the diet has the correct balance between rumen degradable protein and rumen fermentable energy.

### More information

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