



Best Practice Guide on Nutrition in European Dairy Farms and the Use of Technology to Improve Feed Management

Last update: September, 2018 - Authors: Janine Roemen

This guide aims to assist dairy farmers on the use of automatic feeding systems and new technologies to improve feed management. It outlines the different technologies available for monitoring feed management, and offers some general advice on maintaining a good feed efficiency.

Feed management in dairy cattle

Feed is an essential part of management on every dairy farm. From an economic point of view it is essential that the production per kilogram of dry matter is as high as possible. Efficient feeding also has a positive effect on cow health and milk yield. Feed is the largest cost in milk production and directly influences animal performance and health status. Monitoring of feed intake is more than just monitoring the dietary health of the individual cow. Individual feed monitoring helps to evaluate the productivity of each cow in relation to the quantity of feed being consumed.

In this guide we focus on automatic feeding systems and on group based feeding with partly mixed ratio (PMR). PMR is a feeding regime that combines Total Mixed Ration (TMR) and individual feeding of concentrates. A robotic feeding system (Photo 1) provides a continuous availability of fresh feed, which results in increased dry matter intake and increased milk production.



Photo 1. Robotic feeder. Source: Lely

In addition, frequent feeding has a positive impact on general animal health. Mixing the right ingredients in the right quantities and feeding them at the right timings will improve feed management and efficiency. With automatic feeding systems, each group within the herd receives the correct quantities of feed for the cow's age and phase of lactation cycle. When feed efficiency (kilograms milk yield/ kilograms dry matter intake) increases with 0,1 point, this will lead to **€250** extra profit per cow per year (Table 1.). There is a strong relationship (Photo 2.) between feed efficiency and feed balance (money of milk – feed costs). When the feed efficiency increased from 1,3 to 1,5 net feed balance increased from €4,50 to €6,35 per cow per day.

Table 1. Example of how feed efficiency can be calculated. Source: Agrifirm feed

Measurement feed efficiency dairy farm with 100 cows
<ul style="list-style-type: none"> • 100 cows * 9000 kg = 900.000 kg milk per year • 900.000/ 365 days= 2465 kg/day • Total amount of feed per 100 cows = 1900 kg DM per day • Feed efficiency = 2465/ 1900 = 1,3
<ul style="list-style-type: none"> • When Feed efficiency 1,3 -> 1,4 • From 1900 kg dry matter: 1900*1,4= 2660 kg milk • Per year: 2660 *365= 970.900 liter milk -> 70.900 kg extra • 70900 * 0,38 = €26.942 • 26942/100= 269,42 per cow

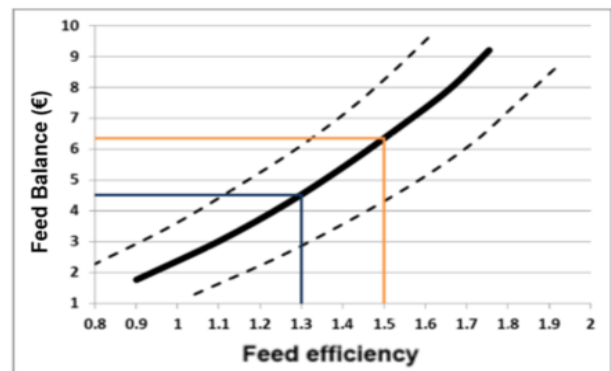


Photo 2. Relation between feed efficiency and feed balance per cow per day. Source: WUR Wageningen

How to monitor feed management

Automatic feeding systems combine a number of different types of sensors and technologies to improve feed management and efficiency.



An evaluation of a farm's feed management, efficiency and milk production can be achieved by using key performance indicators (KPIs) (**Table 2**). Remember that not all of these KPIs are carved in stone, and that they will vary with different farm systems.

Table 2. General key performance indicators (KPIs) of feed management and efficiency.

KPI	Target
Dry matter intake	3-4% of body weight
Water intake	150-200 liters/cow/day
Body condition score	2.75-3.5
pH rumen	5.8-7.0 pH ²
Urea	4-6 mmol/L
Rumination time	470-490 min/ day
Feed efficiency	1,35-1,55 ¹
Feeding frequency	>7 portion/cow/day ³

¹Knook, R (2011), ²Talsma, L (2014), ³DeVries, T. (2003)

Most automatic feeding systems have sensors to measure the weight of the ration. Some robotic feeding systems brands, also have a feed-height sensor for measuring the amount of feed at the feed fence. Other technologies that improve feed management are; rumination sensor, body condition score camera, pH bolus and urea meter. Specific details on the technologies are outlined below.

- **Weight sensor**

The weight sensor makes it easier to put an accurate ration into the feeder. This measures the weight of the feed and sends the results to the user's screen. The weight sensor works with an elastic deformation of a spring which is deformed by the weight. The weight is then read out on a scale. The benefits are having confidence that the ration is consistent regardless of whom is feeding, and keeping a record of what was fed. Such sensors are commonly integrated into commercially available diet feeding systems.

- **Feed height sensor**

Some feeding robots have a [feed height sensor](#) which identifies the quantity of feed at the feed fence. This sensor quantifies the feed and tops it up if necessary. The only thing that needs to be configured manually is the height of the feed at the feed fence. With this sensor there is always feed within the cow's reach. Regular pushing of the forage

reduces the amount of waste feed with an average of 75% (Lely, 2017). At the same time, it maximizes the capacity of the feeding fence, because feed is always within reach.

- **Feeding time sensors**

The further development of activity sensors measuring feeding is increasing rapidly. The advantage of individual feed intake monitoring is that a farmer can see when an individual cow is consuming less feed. Which can indicate that the cow has a health disorder (Bareille et al., 2003).

Several sensors are already monitoring feeding time; such as an ear sensor, neck sensor and a leg tag. An ear sensor determines feeding time using an accelerometer, by recognizing specific movement which indicate feeding behaviour. A neck sensor works similarly. One system available determines feeding time by using a pedometer and tracking the location of the cow.

- **Concentrate feeder**

Automatic concentrate dispensing equipment is available for use in stanchion or comfort-stall barns (**Photo 3**). Concentrate feeders can identify individual cows. Each cow wears an identification device around its neck or ear and receives the correct portion in relation to her individual milk production, age, condition score and stage of lactation.

Concentrate feeders provide insights into the concentrate intake and also have the benefit of spreading concentrate intake over time and hence reducing acidity in the rumen. Decreased feed intake is also detected in the feeding stations. This can be an early sign of health disturbances.



Photo 3. Concentrate feeder with a sensor for cow identification. Source: Delaval

- **Cow Weight sensor**

Often combined with concentrate feeders; a weight sensor measures the weight of individual cows. The individual weight is important basic information which is used when formulation rations. When the weight of the cow changes, the concentrates



quantities available to the cow are automatically adapted.

There is also a walk over scale available to monitor individual trends in weight loss/gain. A walk over weight scale is placed in a walk way or sort gate combined with identification. Such scale is often used on group level to manage feeding and is very popular in grassland conditions to manage pasture planning and if additional concentrate is needed as a supplement to grass.

- **Rumination sensor**

Most dairy farmers don't know if all of their cows are getting a full ration every day. The rumination sensor records the number of minutes each cow spends eating, rumination and grazing by listening for sounds of rumination and cud chewing, or by monitoring the movements of the head with an accelerometer. The sensors are placed on the neck or ear. The rumination sensor is useful indicator for individual health changes. Using the rumination sensor on group level it is an useful indicator for feeding changes. When cows will decreased rumination and less eating, the ration must be changed.

- **Body condition score camera (BCS camera)**

Body condition scores are often used as a critical measure of how effective feeding is on a farm. Knowing the body condition helps you fine tuning the diet to prevent weight loss in early lactation as well as during late lactation to prevent too fat cows. BCS is a more useful indicator for managing the feeding strategy compared to measuring the weight of the cow. The importance of having an optimal body condition score in the beginning and end of lactation to:

- Optimize milk production;
- Minimize fertility disorders;
- Minimize health disorders;
- Maximize economic return.

At calving = < 3.25 Too little energy provided in late lactation and dry period. Risk of low milk production and poor reproduction

At calving = > 3.75 Too much energy in late lactation and dry period. Risk of metabolic disorders.

Peak lactation = high producers might drop below 2.75 but that must be regained later to avoid reproductive problems.

At dry off = > 3.75 problems with calving and reproduction in next lactation like uterine infection,

retained placenta etc. Can be due to too much energy in the feed but also to prolonged calving intervals.

The [BCS camera](#) takes a 3D image of the cow's lower back every time they pass under the camera. It then calculates the body condition score of each cow and sends it to the computer. **(Photo 4).**

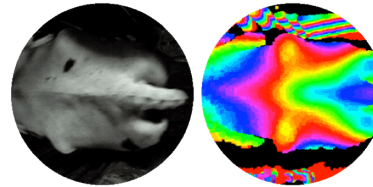


Photo 4. Body condition score camera to measure the condition of the cow with 3D technology.

Source: Delaval

- **pH bolus**

The pH-bolus **(Photo 5)** is designed to provide a continuous measurement of cows' ruminal pH. On farm, the boluses are often used in sentinel cows to monitor and optimise feeding regimes. The bolus can be inserted with a special gun into the rumen and contains several sensors. If the rumen pH is too low, the feed can't be digested well. High concentrate levels are not good for rumen health and will decrease the rumen pH. The pH bolus will give you an alert, so you can take action. Depending on the manufacturer, bolus life spans can range from 2 months to 4 years.



Photo 5. pH-bolus. Source: Smaxtec

- **Urea**

The urea values given an indication of the balance between protein and fat in the diet and monitor feeding efficiency. It is therefore a useful indicator for feeding changes. Urea is not used so much on individual level but rather on herd and group level. It is essential to both look at high and low values. And it is also very different information if you look at tank-milk or at individual cows. When the milk urea is too high or too low, you can alter the rations available to the cow.

The concentration of urea can be measured by an analysis device **(Photo 6).**



Photo 6. Urea meter. Source: Veeteelt.nl

Advantages to monitoring feed management and efficiency

- Better feed efficiency
 - Efficient use of ration and ingredients.
 - Healthy cows with a good body condition score.
- If you can quantify feed intake you can calculate the efficiency of milk production, and use the information for fine tuning the diets. In the long term this type of data may also be useful for selecting more efficient cows.
- Decreased feed intake can be a sign of ill health, or problems with management systems.
- Decreased rumination can also be a sign of heat and is therefore used in some systems combined with activity data to detect heat.
- More control to monitor milk production performance of individual cows.
- Increased income and reduced costs.
 - Increased milk production because cows receive a better ration.
 - Better diagnosis of health status the individual data provided.
 - Reduced medicine use.
- Reduced labour costs with less time spent on:
 - Observing sick cows
 - Administering drugs
 - Identifying cows

Which technology should I buy?

Before purchasing an automatic feeding system or other technology to improve feed management and efficiency, you should make sure it is appropriate for your herd management practices. Guidance from your veterinarian or other professional advisors is recommended.

Before finally committing to a technology investment here are some questions you might like to ask the supplier:

- Which system or sensor suits my farm?
- What are the full costs (hardware, devices, maintenance, data storage)?
- How easy is it to use the system?
- How long will the system last?
- How reliable are the alerts?
- What is your warranty policy?
- What percentage of devices fail per year?
- What support is available?
- What is the longevity of the battery?
- What is your policy for upgrading to new versions?
- Can my farm advisors or veterinary access the information?
- Who owns the data generated from the sensors?

Best practice tips

It is important that technology is seen as a way of improving stockmanship skills by providing an extra tool, and not as a replacement for good stockmanship.

- Fresh and appetizing feed results in a high dry matter intake. With automatic feeding systems, each group receives the appropriate ration and fresh feed several times a day.
- Keep ration changes to a minimum and evaluate the data results with your veterinarian or nutritionist.
- The BCS camera is very sensitive and detects even very small changes in body condition. This allows the farmer to act upon a change in efficiency very rapidly to ensure the health of the cow.
- The concentrate feeder is designed in such a way that even very small quantities of concentrate can be provided in the feed box.
- Before buying a system or sensor look at the other functionalities that would best suit your farm needs.
- Combining sensors is more reliable than using data from one sensor.
- In conjunction with your nutritionist, use the data on individual cows to improve feed efficiency.



- Don't use the pH Bolus in heifer <18 months and in cows with a bodyweight < 450 kg.
- High concentrate levels will decrease the rumen pH, but they are only one cause. We also see very low pH when cows are let out on pasture in early lactation, which is something we cannot easily prevent.
- Not all cows need a pH Bolus. One cow with pH Bolus in a group of 10 cows, which is in the same lactation stage, is enough. This cow is representative of the whole group and in this way you save money, because boluses are very expensive.
- The early identification of potential management challenges helps maximize efficiency and productivity, reducing potential milk production losses and improving animal health.
- The basic for healthy cows is always a good feed management in [drying-off period](#).

Disclaimer. While all reasonable efforts have been taken by the author to ensure the validity of this Best Practice Guide, the author, 4D4F and the funding agency accept no liability for any loss or damage stemming from reliance upon this document. Use this document at your own risk, and please consult your veterinarian or advisor to ensure that the actions suit your farm.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 696367



Reference

- Bareille, N., Beaudeau, F., Billon, S., Robert, A., Faverdin, P. 2003. Effects of health disorders on feed intake and milk production in dairy cows. *Livestock Production Science*. 83: 53-62
- Knook, R. 2011. Rantsoenefficiëntie melkveestapel direct in beeld. De Heus.
- Lely 2017. Lely Juno. Pushing feed automatically, day and night. <https://www.lely.com/the-barn/feeding/juno/>
- Talsma, L. 2014. pH in pens op peil houden. Agrifirm Feed
- DeVries, T.J., M.A.G. von Keyserlingk, and K.A. Beauchemin. 2003. Diurnal feeding pattern of lactating dairy cows. *J. Dairy Sci.* 86:4079-4082