Sensor validation from a manufacturer point of view

C. Bagenvik

DeLaval International AB, P.O. Box 39, 147 21 Tumba, Sweden

Abstract

The general trend over the world is that dairy farms are getting larger and that it is difficult to find skilled labour. Farmers are more and more starting to utilize automation and technology to increase their efficiency. Effective milk production, doing more with less, with healthier animals that live longer also reduces the environmental footprint on farm and increases the profitability for the farmer.

One section of the automation process that is taking place is the development of sensors to monitor different conditions in the animals or at the farm. There are many different sensors available in the market, some used for farm management and some more for genetic evaluation and research. At DeLaval, we see a strong need in standardizing the validation of sensors to make it easier for our customers to compare and select the sensors best suited for their needs and operations.

Keywords: Cecilia Bagenvik, DeLaval, Sensors, Validation.

Introduction

At DeLaval we have the vision to make sustainable food production possible; helping our customers to do more with less. Sustainability for us is represented by four areas:

- Environment
- Social responsibility
- Animal welfare
- Farm profitability

Sensors in milk production can help in all four of these areas if they are used correctly. If we, as technology providers, can help in keeping the animals comfortable, stress free, and healthy we can help our farmers in becoming more efficient and extending the life time of their animals.

Sensor validation

Sensors and data in dairy production

There are many different parameters a sensor can measure on a dairy cow. For some of these areas there are commercial sensors available, but not for all.

The question is what is worth the most to measure. Which areas contributes the most to the environment, social responsibility, animal welfare and farm profitability. When working with innovation and product development at DeLaval, those are the four questions that we ask ourselves.

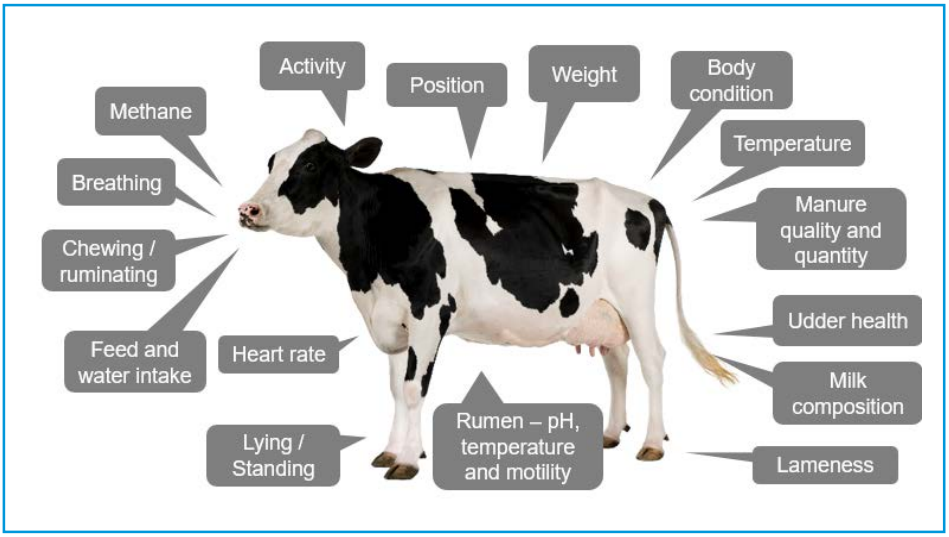

Figure 1. Parameters that potentially can be measured on a dairy cow.

There are many contributors to data on a dairy farm. Not only the sensor data but the animals themselves and other equipment used on the farm contributes tremendously with data, for example sort gates, milking systems or feed stations. All this data can then be further processed in traditional models or machine learning algorithms to tell us a lot of different things about the individual cow or a group of cows.

For the farmer, all that data in itself doesn't provide much value. It is what we can tell or predict from the data that results in an action that is valuable. The farmer needs to be alerted on the animals in the herd that need attention, animals that need a specific treatment or action. Then less attention can be given to the group of cows that are productive and healthy.

Sensor validation – to be able to compare

One area that is quite mature in the sensor segment is heat detection. Many different technologies are available. For the farmer, there are many aspects to consider when selecting sensor technology. For example the method. Heat detection can be provided in many different ways, for example by measuring activity and other behaviors with a tag in the ear, on the neck or attached to the leg. It could also be to measure hormone level in milk, or animals standing to be mounted.

In the search for the right technology, there are many definitions and difficult words used, and it cannot be easy as a farmer to understand what to select. Some manufacturer statements are based on serious research, some are based on more limited tests and sometimes the marketing statement more describes a vision in the future, not what the sensor can do here and now. To standardize the sensor validation would make the different heat detection sensor options more comparable to each other. Then the customers can make conscious decisions about which sensor that is best suited for them. A sensor that has proven quality and is based on evidence.

Sensor data – for different purposes

When working with sensor development in DeLaval our main focus is to help our farmers in achieving their specific goals at the farm, for example to improve reproduction, health or productivity. This means that our focus is on farm management. In the ICAR Sensor Device Task Force, we are also working with the areas of sensor data for genetic evaluation and research. If we take the BCS camera as an example, a 3D camera that automatically measure the body condition score of an animal, it has been developed as a farm management tool, but of course the data can be used also for other purposes.

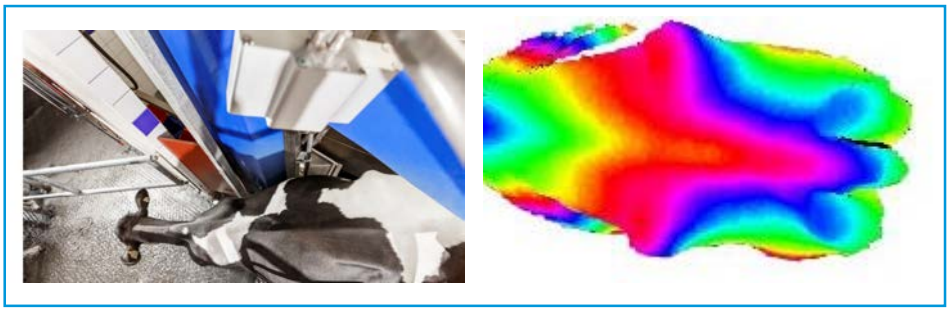

Figure 2. DeLaval Body Condition Scoring BCS

In the farm management application, the camera is replacing the traditional manual body scoring. We are going from a score a few times per lactation or monthly to scoring several times per day. The data is further processed in the biomodels of DeLaval DelPro and consumed by the farmer through reports, graphs or standard operating procedures, SOPs. The farmer is interested in different parameters during different parts of the lactation. Here the relative value and trends in the data is most important. In this application the absolute value of BCS is not as important.

If the BCS data on the other hand should be used for genetic evaluation the absolute value is the important data point. This puts other requirements on the sensor and the algorithms. Many different breeds, ages of animals, stages of lactation etc. must be included. The relative values and the trends are not as important in this application.

Another example of where a discussion and method for sensor validation is really needed is for Somatic Cell Count, SCC. When we want to validate a sensor that measures SCC from the farm management perspective, one value that we can provide is a sensor that detects clinical and subclinical mastitis cases without giving too many false alarms. That can be validated for example in sensitivity and specificity of detecting mastitis. This can be achieved by measuring SCC but also by a combination of other data sources such as cow specific information, electrical conductivity, milk yield and flow, LDH, or activity of the cow. The accuracy of the SCC sensor is only one part of the puzzle, it is the complete system to detect mastitis that is important to validate.

The same SCC sensor can also be used for measuring milk quality and securing that bulk tank SCC is on a good level. For this application, the validation process needs to target the ability of the sensor to measure SCC accurately. When using SCC in genetic evaluation or research it is also the accuracy of the measured SCC that is important, not the mastitis detection in itself.

Sensor validation against golden standard

Another aspect of sensor validation is when the golden standard available is lacking or weak. If we take BCS as example, the golden standard is manual observations. Manual scorers varies between each other but also the same scorer varies. It is difficult to be consistent. Even if scorers are trained in the same method it is quite common that the score varies ± 0.25 score. Looking at the graph in the picture below we can see the green line in the middle is the scoring of 1000 cows by the 3D camera. The blue and red lines represents ± 0.25 score. And the blue small dots in the back represents the manual scoring for the same animals. The sensor that we want validated, the camera, is much more consistent and repeatable than the golden standard, the manual scoring.

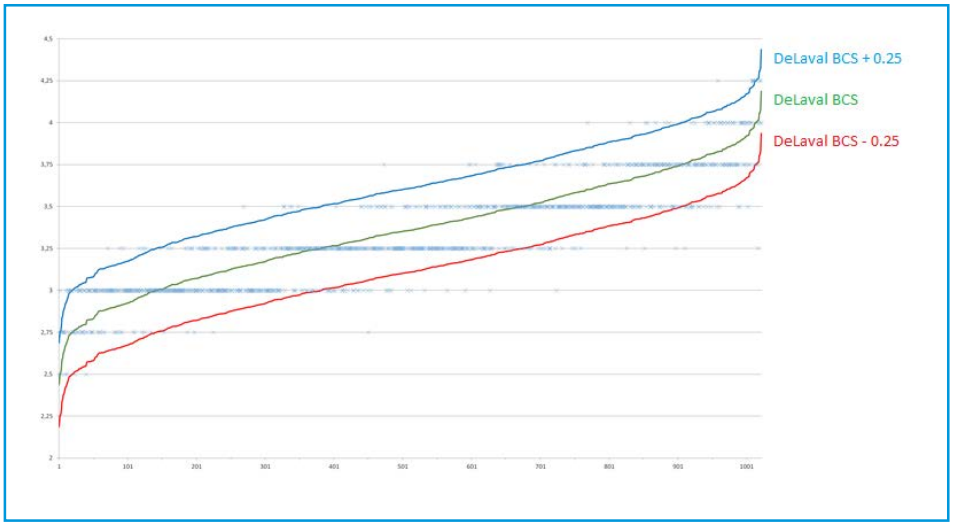

Figure 3. BCS data from individual animals.

The need of sensor validation

We at DeLaval chose to be part of the ICAR Sensor Validation Task Force because we see all these challenges that I have shown a few examples of. Both for us as manufacturers but mostly for the community of farmers. We also think that precision dairy farming is and will be an important area in the near and coming future. Many of our customers are investing and we want them to make decision based on facts and figures.

We see it as a benefit to have the possibility to get a quality stamp from an independent organization such as ICAR and that we can show that we have good accuracy and good quality in our products measured in a comparable way with other manufacturers. We also see it as a good opportunity to get guidance in our work with product development, verification and validation to ensure that we provide our customers with sensors that will help them in the right way. Making sustainable food production possible.