

Livestock 3D: A New Dimension in Cow Monitoring

Part 1: Body Condition and Weight

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A dairy cow is constantly changing, but most of the ways we assess her provide only snapshots in time. Body condition may be scored periodically and weight recorded when animals pass through a scale. These observations are valuable, but they depend on when the cow is examined, who evaluates her, and whether a meaningful change happens to be visible at that moment. By the time a problem becomes obvious, however, the cow may have been changing for days or even weeks.

Three-dimensional camera technology approaches the cow differently. Rather than waiting for someone to evaluate her, the system observes her repeatedly as she moves through her normal routine. From above, a 3D camera captures not simply an image, but the depth and contours of the animal. Specialized algorithms can then translate those measurements into information about body condition, body dimensions, and estimated weight.

The distinction from conventional 2D imaging is important. A two-dimensional image records the visible outline of the cow but provides limited information about depth and body geometry. A 3D system measures the surface contours of the animal. Areas such as the hooks, pins, loin, back, and overall body shape can therefore be quantified rather than simply observed.

But perhaps the greatest advantage is not the precision of a single measurement. It is the frequency and continuity of measurement. When the camera is positioned along the cow's path to or from milking, she can be assessed every time she is milked, typically two or three times per day in conventional systems and potentially more often in robotic milking systems. A body condition score of 2.8 describes where a cow is today. Knowing that she moved from 3.3 to 2.8, how rapidly that change occurred, when it happened relative to calving, and whether she has begun recovering tells us considerably more. The same principle applies to body weight. With multiple observations each day accumulated over weeks and months, the cow becomes her own reference. This changes monitoring from identifying a condition to recognizing a trajectory.

From monitoring cows to protecting longevity

That distinction has important implications for cow well-being. Well-being is more than the absence of diagnosed disease. It also reflects how successfully a cow is coping with her environment, nutrition, production demands, and physical condition.

Many of the problems that ultimately compromise well-being and shorten productive life develop gradually. Excessive body condition loss, failure to regain condition, and unexpected weight changes develop over time. Continuous monitoring creates an opportunity to recognize those changes earlier. It does not diagnose the cause, nor does it replace the producer, veterinarian, or nutritionist. Instead, it tells them where to look.

That distinction is particularly important when considering longevity. Longevity is sometimes discussed as though it becomes relevant when deciding whether a cow should remain in the herd.

In reality, productive life is being influenced long before that decision. A cow that repeatedly experiences excessive condition loss and metabolic stress may be moving toward premature removal months or even lactations before the final culling decision. The potential value of 3D monitoring is therefore the opportunity to recognize unfavorable trajectories early enough to intervene.

From the camera to the dashboard

Collecting measurements is only the beginning. Thousands of observations have little practical value if the producer must interpret them one cow at a time. The information must be transformed into something that can guide management. This is where the Livestock 3D dashboard becomes the heart of the system. The dashboard shown in Figure 1 comes from an actual commercial dairy, although the identity of the farm has been withheld for confidentiality. At first glance, it provides a remarkably simple overview of a very large and complex herd.

There are 7,839 active animals in a total herd of 10,708. Of those, 5,111 are currently milking, averaging 186 days in milk. Average body condition score is 3.28, average locomotion score is 1.31 on a 1-to-5 scale, and estimated average body weight is 1,389 pounds.

A herd can have an acceptable average BCS while some cows are losing condition too rapidly and others are becoming overconditioned. Average weight tells us little about whether a particular fresh cow is losing weight faster than expected. The strength of the system is therefore the ability to move from herd to group to individual cow, while retaining the history of how each cow arrived at her current measurement.

Across the dashboard are different layers of information, including body condition, locomotion, weight, milk production, events, anomalies, health scores, and forecasting. Together they provide a broader picture of the animal, but we will begin with two measurements that demonstrate what 3D monitoring adds to conventional cow assessment: body condition and body weight. Both measurements share an important characteristic: neither should be interpreted simply as a number. Their greatest value comes from understanding how they change over time, where the cow is in her lactation, and whether that change is expected.

The objective is not to generate more data. It is to answer a much more practical question: Which cows need our attention, and can we identify them before the problem becomes obvious?

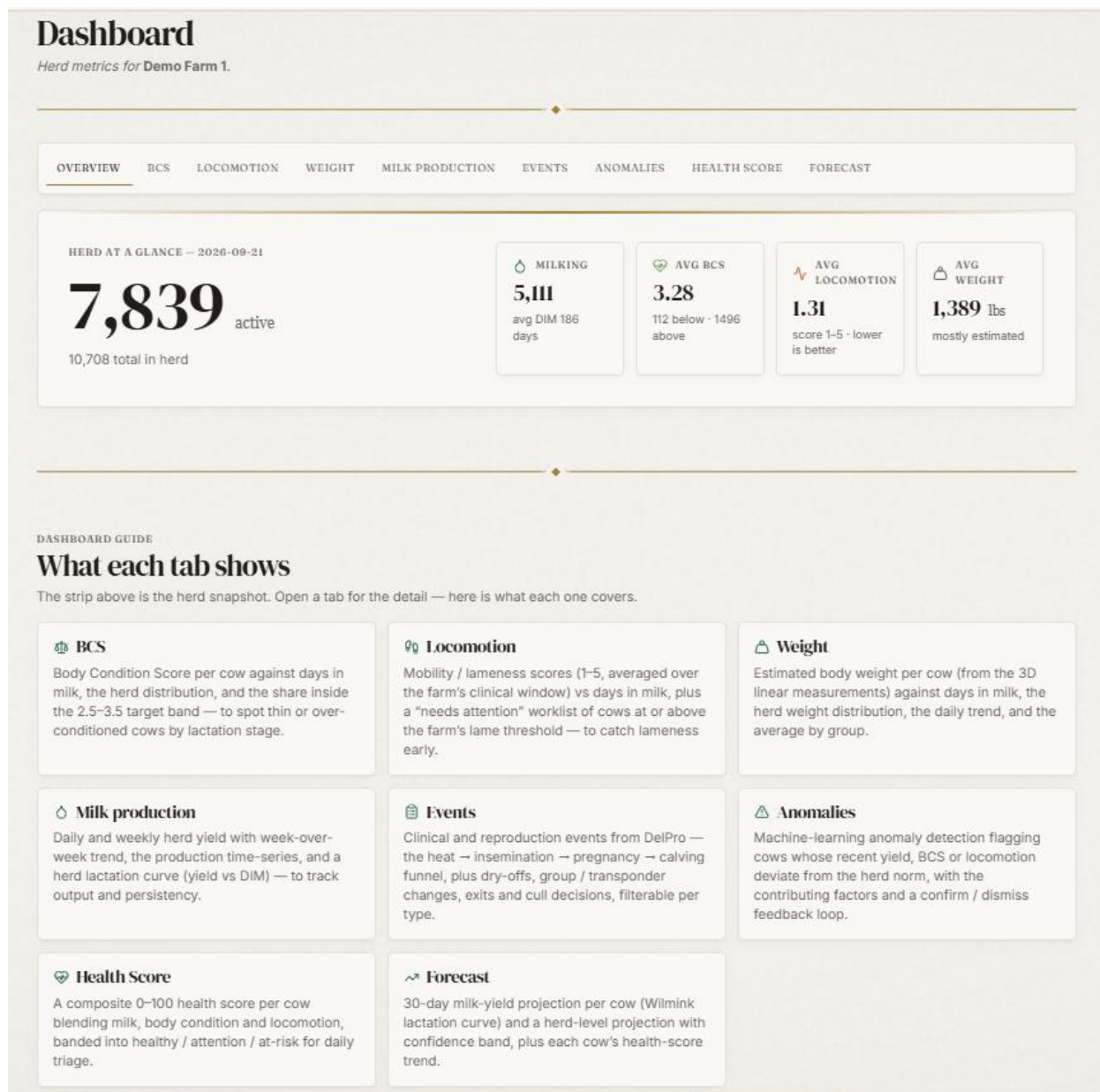


Figure 1. The Livestock 3D dashboard provides an immediate view of the herd while allowing the user to move from herd-level indicators to groups and individual cows. The example shown is from a commercial dairy whose identity has been withheld for confidentiality.

Body condition: the trajectory matters

Clicking on BCS takes the user from the herd average to the distribution and history behind that number. This is where continuous 3D monitoring becomes more useful than an occasional body condition score. The objective is not simply to identify cows that are too thin or too fat, but to determine which cows are changing, how rapidly, and at what stage of lactation.

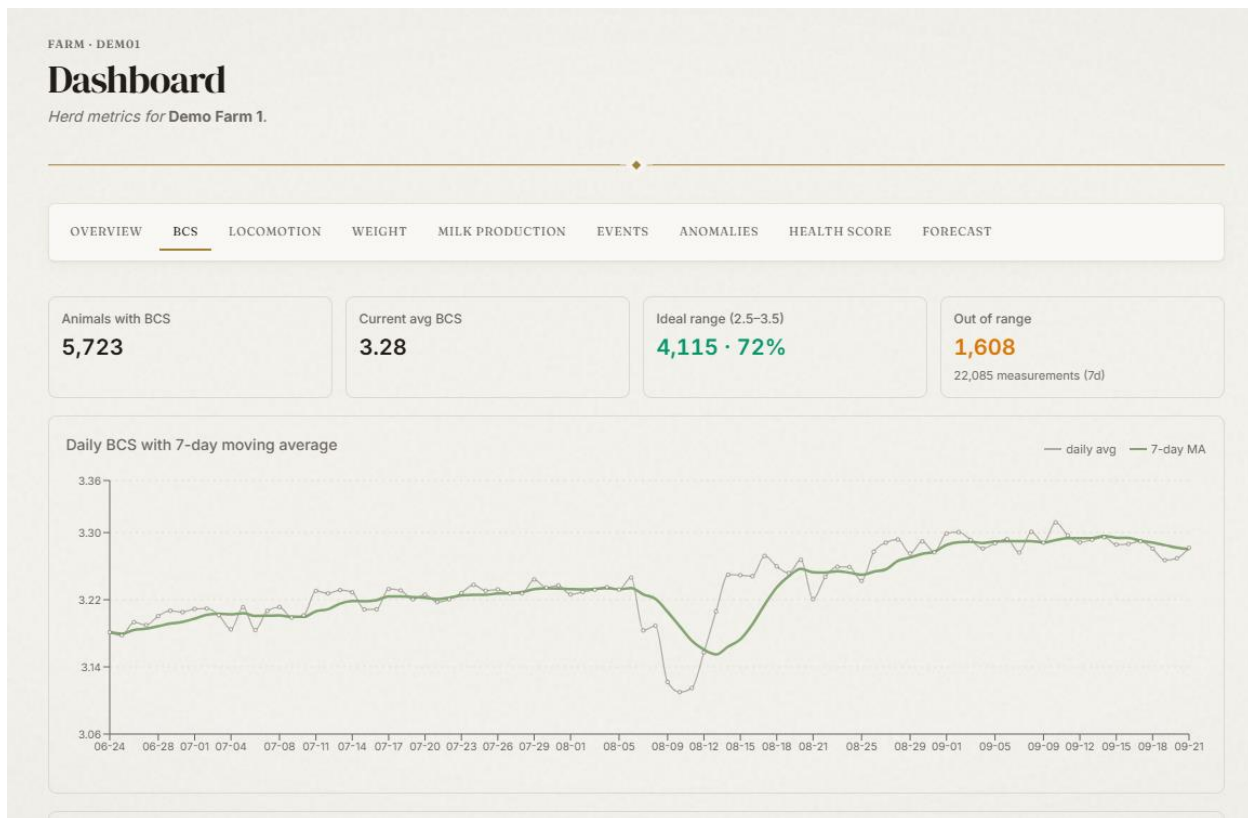


Figure 2. Body condition at a glance. *The BCS dashboard shows the current herd average, the proportion of cows within the target range, cows outside that range, and the daily trend with a 7-day moving average. The value of continuous monitoring is not simply the current BCS but identifying changes and trends over time.*

Body condition normally declines after calving as cows mobilize reserves to support milk production, then should stabilize and recover. The concern is therefore not simply a low BCS, but how much condition is being lost, how rapidly, and when during lactation. Conversely, excessive condition gain later in lactation can identify cows at risk of approaching the dry period overconditioned.

Figure 2 illustrates the advantage of continuous monitoring. In this herd, 5,723 animals have BCS data, and more than 22,000 measurements were collected in just seven days. Rather than relying solely on a numerical output, the user can examine the three-dimensional representation of the cow and the body contours from which these measurements are derived. The measurement therefore remains connected to the animal it is intended to describe. The herd average, however, can conceal important differences among cows. Figure 3 takes the analysis further by showing the distribution of BCS and its relationship with days in milk. In this example, 76.6% of cows are within the 2.5–3.5 range, while 0.7% are below and 22.7% above it. Each point represents an individual cow's 7-day average BCS plotted against DIM, while filters allow the user to examine specific groups and lactations. Together, these views turn BCS from a descriptive score into a management tool. Unexpected trajectories can prompt a closer look at feed intake, ration formulation, grouping, health, or milk production. For well-being and longevity, the objective is not simply to find cows

that are thin or overconditioned, but to identify cows moving in the wrong direction early enough to determine why.

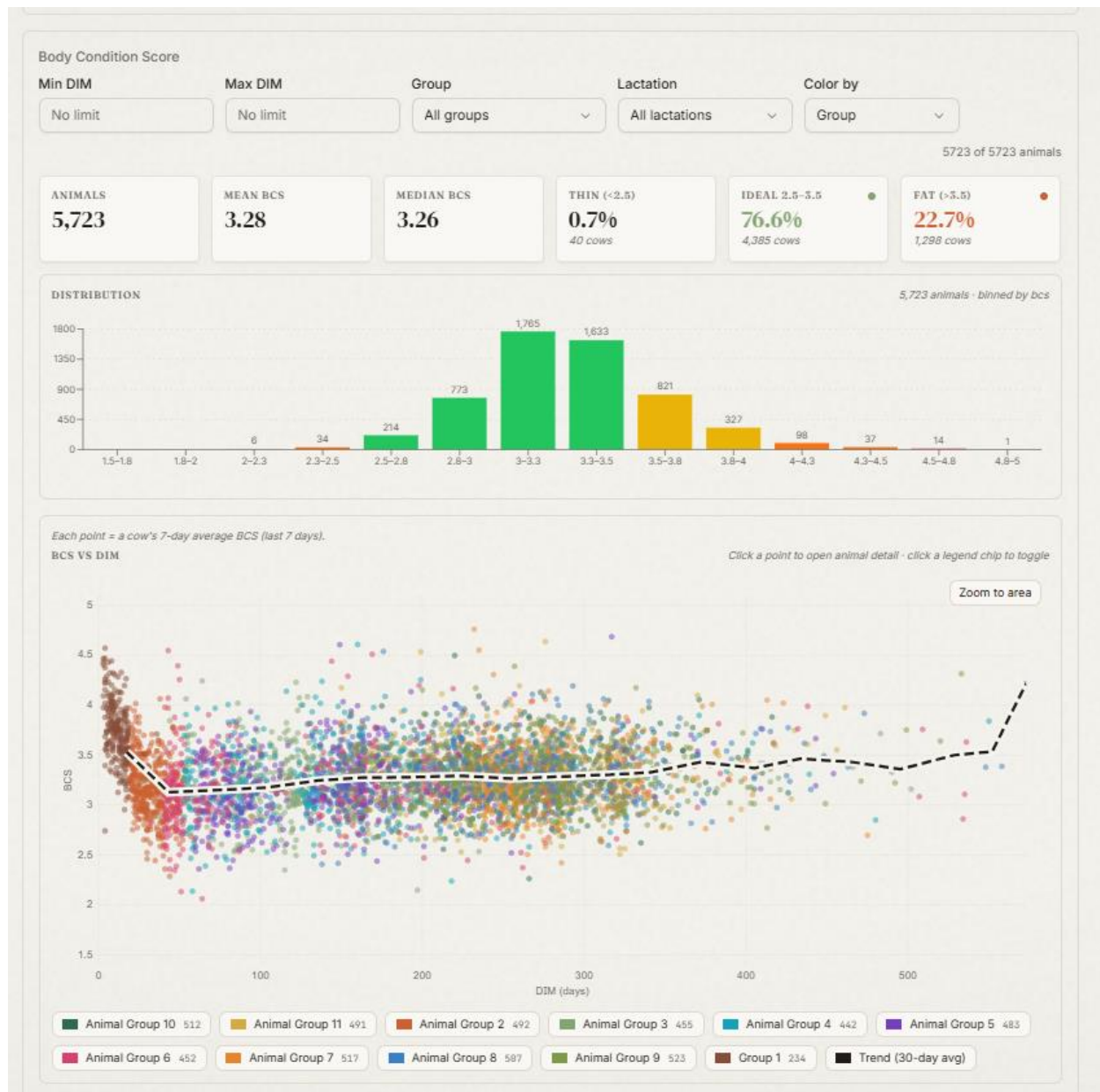


Figure 3. From herd BCS to the individual cow. The dashboard shows the distribution of body condition across the herd and plots each cow's 7-day average BCS against days in milk. Filters for DIM, group, and lactation allow managers to identify where cows outside the desired range are occurring and whether the pattern involves individual animals or particular groups.

Weight: more than a number on the scale

Body weight is another measurement that becomes more informative when viewed as a trajectory rather than a single value. The 3D system estimates weight from the cow's body dimensions each

time she is measured, providing repeated observations without requiring her to step onto a conventional scale.

In Figure 4, estimated weights are available for 5,108 cows, with nearly 20,000 measurements collected over seven days. The upper graph shows daily herd weight and its 7-day moving average, while the distribution shows how cows are spread across weight ranges. As with BCS, however, the herd average is primarily a starting point.

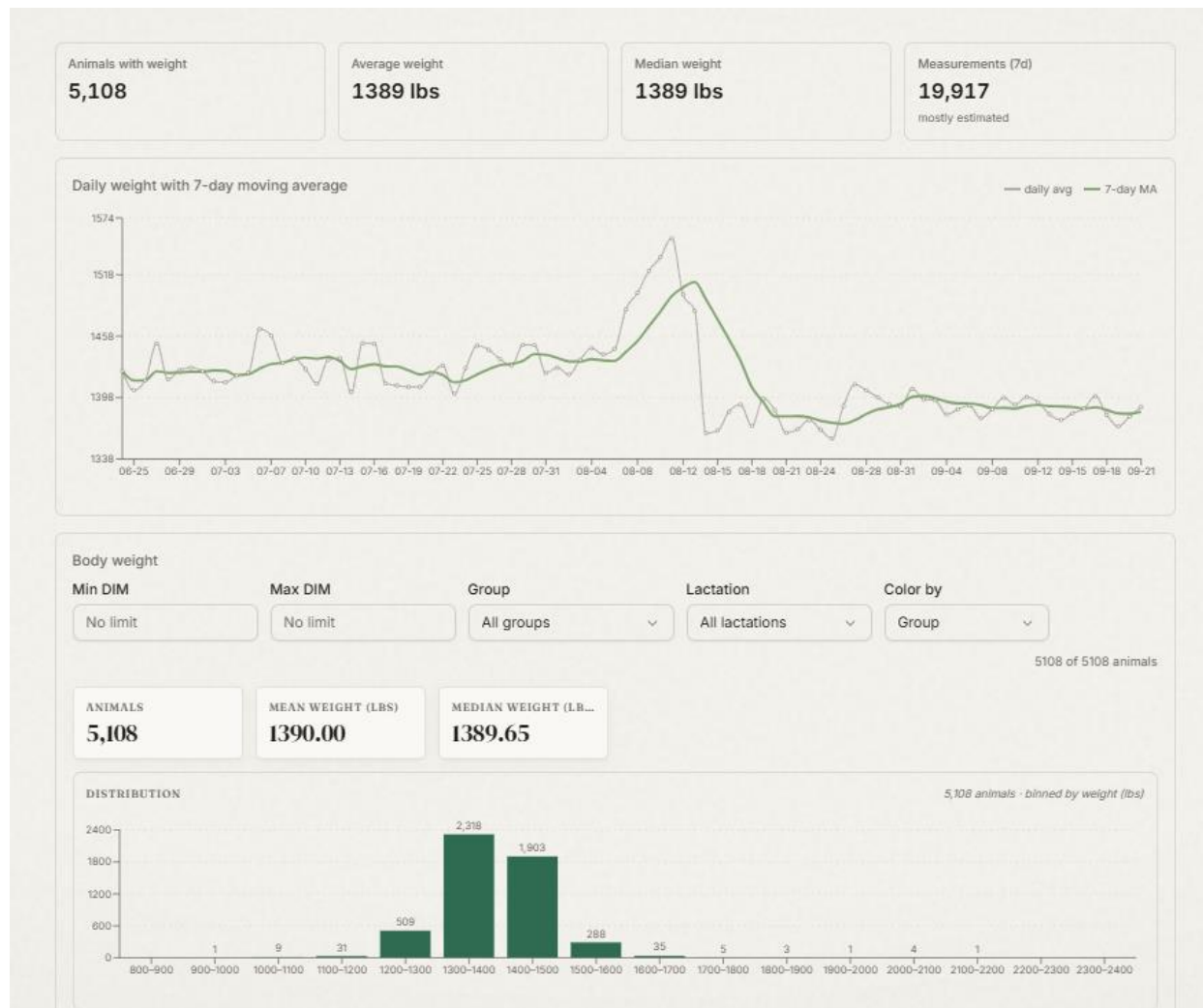


Figure 4. Herd body weight over time. The weight dashboard summarizes estimated body weight, measurement frequency, the daily herd trend with a 7-day moving average, and the distribution of cows across weight ranges.

Figure 5 brings the individual cow into the picture. Each point represents a cow's 7-day average estimated weight plotted against days in milk. This makes it possible to determine whether weight changes are consistent with stage of lactation and to identify animals or groups deviating from the expected pattern. Weight and BCS also provide complementary information. Weight can change because of body tissue, gut fill, pregnancy, and other factors, whereas BCS more specifically reflects changes in body reserves. Interpreting the two together therefore provides a more complete

picture than either measurement alone. A cow losing both weight and condition rapidly after calving, for example, presents a different management signal from one whose weight changes while BCS remains relatively stable.

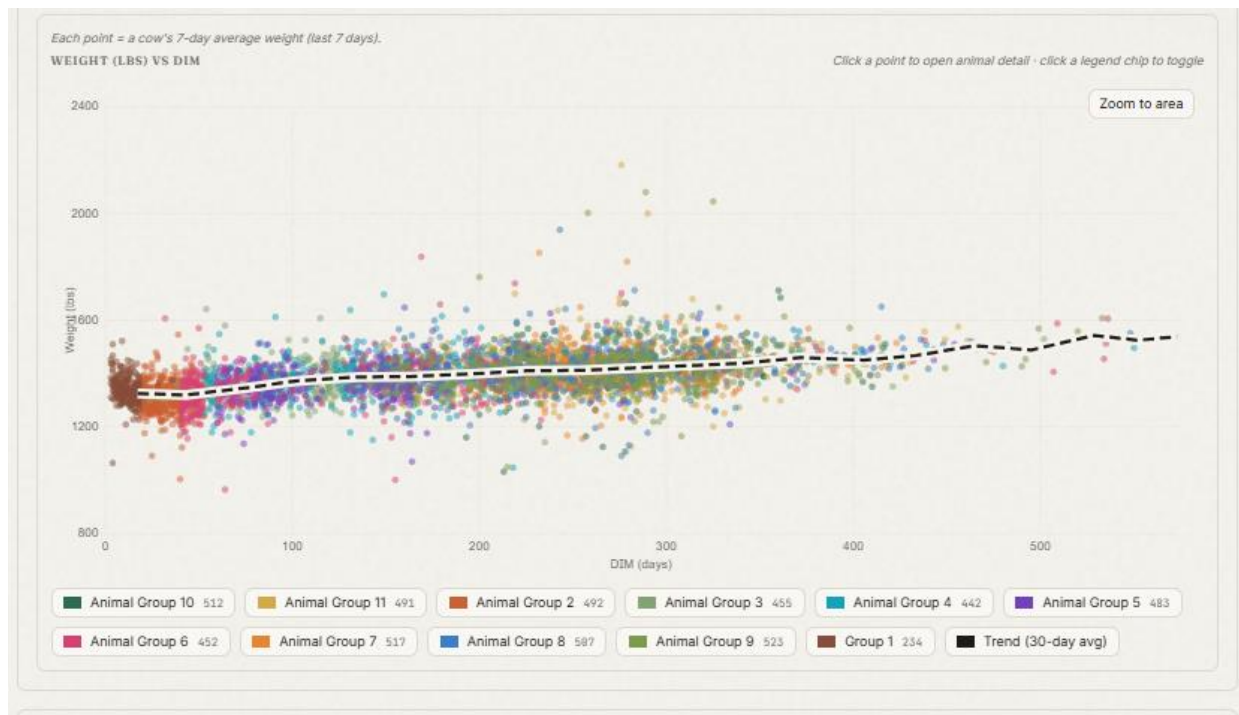


Figure 5. Body weight in relation to stage of lactation. *Each point represents an individual cow's 7-day average estimated weight plotted against days in milk. Group and lactation filters allow managers to distinguish individual deviations from broader patterns within the herd.*

The cow behind the numbers

Weight alone does not describe a cow's body condition. Two cows can have similar body weights while carrying very different amounts of body reserves because of differences in frame size, gut fill, pregnancy, and body composition. This is why body condition score remains essential even when estimated body weight is available.

The 3D viewer brings these measurements back to the individual animal. Figure 6 shows an actual 3D capture of a cow together with her measurements. In this example, the system reports a BCS of 3.58 while also providing stature, chest girth, and other body measurements. Rather than relying solely on a number, the user can examine the three-dimensional surface of the cow and the body contours from which these measurements are derived.

This ability to move from the herd dashboard to the individual animal is important. Weight tells us how heavy the cow is; BCS helps tell us about the body reserves she is carrying. Used together, and followed over time, they provide a much more meaningful assessment of physical condition than either measurement alone.

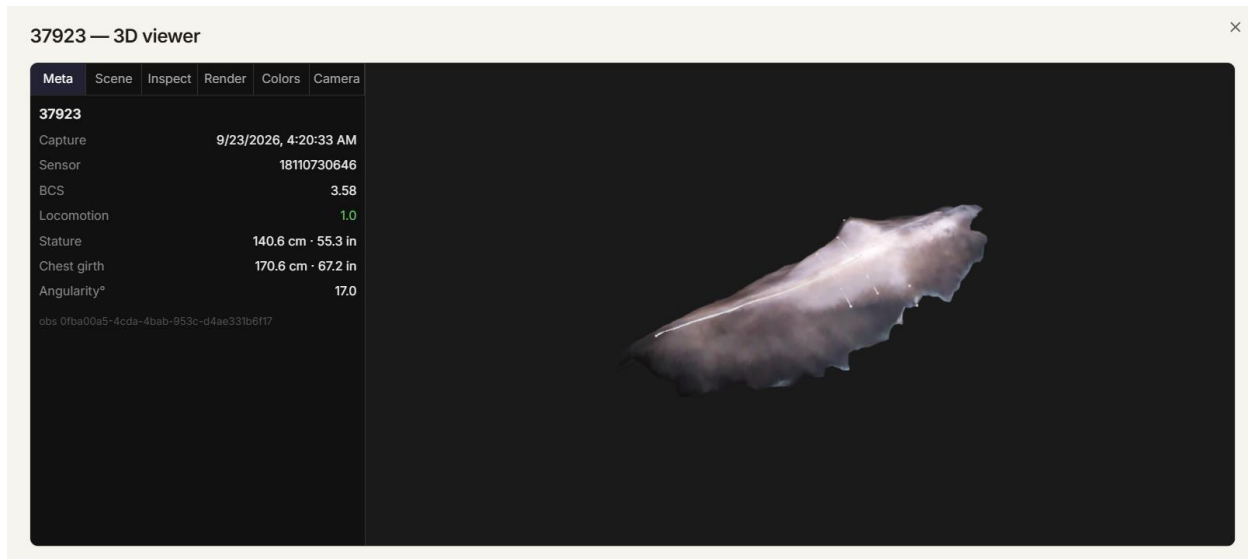


Figure 6. *From the data to the individual cow. The 3D viewer allows the user to examine an individual animal and the measurements derived from her three-dimensional body profile, including BCS, stature, chest girth, and other physical characteristics. This example illustrates why estimated body weight and body condition should be interpreted together rather than as interchangeable measures.*

From measurement to management

BCS and estimated weight demonstrate what continuous 3D monitoring adds to traditional cow assessment. The value is not simply greater measurement frequency, but the ability to recognize direction, rate of change, and deviation from the expected trajectory. The cow becomes her own reference, while herd and group patterns provide the context needed to interpret those changes.

This technology does not replace looking at cows. It changes which cows we look at, when we look at them, and how much we already know when we do. In Part 2, we will turn to locomotion and examine how continuous 3D monitoring can identify changes in mobility before they become obvious, and what that can mean for cow well-being and productive life.

Further reading.

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4. Song, X., E. A. M. Bokkers, S. van Mourik, P. W. G. Groot Koerkamp, and P. P. J. van der Tol. 2019. "Automated Body Condition Scoring of Dairy Cows Using 3-Dimensional Feature Extraction from Multiple Body Regions." *Journal of Dairy Science* 102(5):4294–4308. <https://doi.org/10.3168/jds.2018-15238>