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# AUTOMATIC TECHNOLOGY & BCS RECORDING: POSSIBILITIES, RELIABILITY AND REQUIREMENTS

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The use of images or company names does not imply endorsement or validation of respective system by ICAR or the authors, and is used for illustration of possibilities of inclusion of BCS data from automatic systems in herd recording programs



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# BCS – Multiple Scales

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Traditional manual scoring uses three common scales

- 1-5 (Dairy Cattle)
- 1-9 (Beef Cattle)
- 1-10 (Dairy NZ)

Categorical data with subjective scoring (inherit bias is possible)

Frequency may be limited during lactation or specific life-stage of the animal

	BCS	Description
Thin	1 Emaciated	No palpable fat over spinous processes, transverse processes, hip bones, or ribs. Tail head and ribs project quite prominently.
	2 Poor	Tail head and ribs are less prominent. Individual spinous processes are still sharp to the touch, but some tissue cover on dorsal portion of ribs.
	3 Thin	Ribs are individually identifiable but not as sharp to the touch. Obvious palpable fat along spine and over tail head with some tissue cover on dorsal portion of the ribs.
Optimum/moderate	4 Borderline	Individual ribs are no longer visually obvious. The spinous processes can be identified individually on palpation but feel rounded rather than sharp. Some fat cover over ribs, transverse processes, and hip bones.
	5 Moderate	Cow has generally good overall appearance. On palpation, fat cover over ribs feels spongy and areas on either side of tail head have palpable fat cover.
	6 High Moderate	Firm pressure required to feel spinous processes. A high degree of fat is palpable over ribs and around tail head.
Fat	7 Good	Very spongy fat cover over ribs and around tail head. "Pones" beginning to be obvious. Some fat around the vulva and in crotch.
	8 Fat	Cow very fleshy and over-conditioned. Spinous processes almost impossible to palpate. Cow has large fat deposits over ribs and around tail head, and below vulva. "Pones" are obvious.
	9 Extremely Fat	Cow looks patchy and blocky. Tail head and hips buried in fatty tissue and "ponies" of fat are protruding. Bone structure no longer visible and barely palpable. Animal's mobility might even be impaired by large fatty deposits.

In the dairy cow, body condition is an indicator of the amount of stored energy reserves and changes with different stages of lactation. Fresh cows in peak lactation tend to be in a negative energy balance and therefore lose body condition. Late lactation cows, dry cows and low producers are in a positive energy balance and gain condition. There is no one ideal body condition score. There is a range of desirable scores which change for individual cows over the different stages of each lactation.

Dairy farmers should regularly evaluate the body condition of their cows and heifers so they can fine-tune feeding and management practices. Adequate body reserves are necessary to maintain health, production and reproductive efficiency. Underconditioned cows are prone to reduced milk production and poor persistency of lactation. Overly conditioned cows are predisposed to calving difficulties, fatty liver syndrome, impaired reproduction and metabolic disorders.

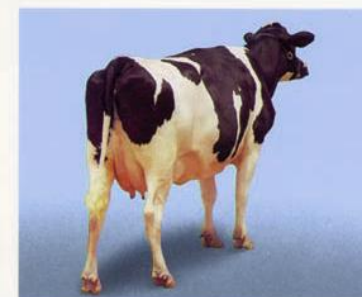
Body condition scoring of cattle is an essential management tool for the progressive dairy farmer. It can be mastered with a little training and good observation skills, using both sight and touch to evaluate each cow.



BCS=3



BCS=1



BCS=4



BCS=2



BCS=5

Photos by Craig Johnson

## Assessing BCS using the DairyNZ method

### Key points

- Body condition score (BCS) is a subjective assessment of a cow's energy reserves, rating the "fatness" of a cow on a scale of 1 to 10, where 1 is emaciated and 10 is obese.



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# Challenges with the 'Golden Standard'

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## A quick look at performance in manual scoring

- It is accepted that human variation is 0.25 BCS score when using 1-5 BCS scale
- Reluctancy by some human scorers to use the full range of BCS
- Some scorers use 0.50 incremental scores, others use 0.25 incremental scores
- Suggested that BCS <2.5 or BCS >4.0 that human scorers should use only 0.50 increments
- Multiple human scorers agreed with absolute BCS 58% of the time
- Deviation by human scorers from absolute BCS 33% of the time

In the dairy cow, body condition is an indicator of the amount of stored energy reserves and changes with different stages of lactation. Fresh cows in peak lactation tend to be in a negative energy balance and therefore lose body condition. Late lactation cows, dry cows and low producers are in a positive energy balance and gain condition. There is no one ideal body condition score. There is a range of desirable scores which change for individual cows over the different stages of each lactation.

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BCS = 3



BCS = 1



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# Automated BCS Systems

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Simultaneous ID recording with BCS measurement in automatic systems

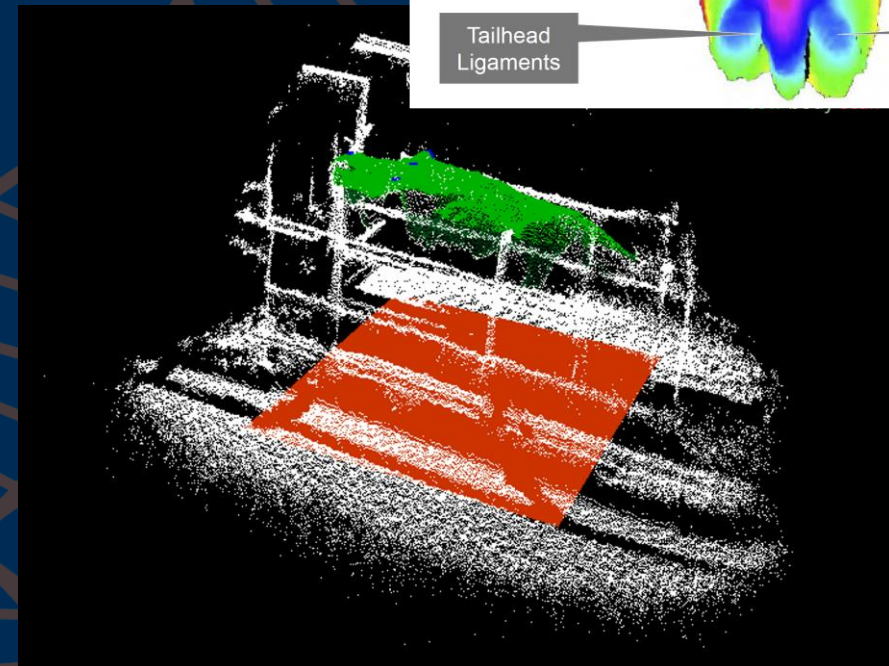
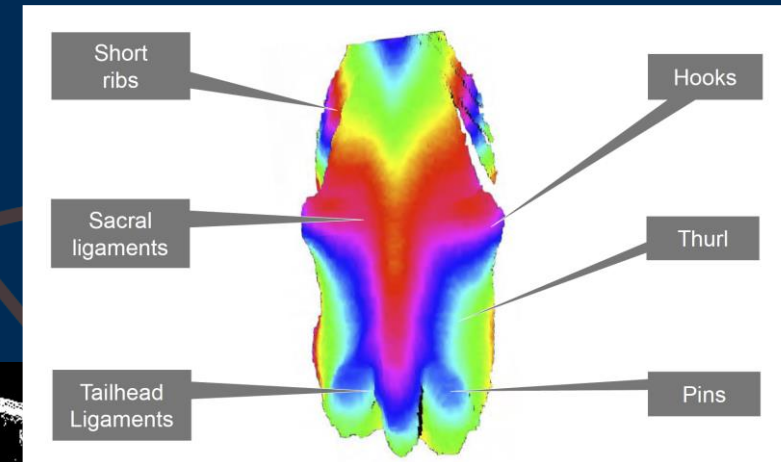
Frequent low-cost measurements (daily)

Use of Thermal or 3D images to estimate BCS from specific body points (proprietary IP)

Two approaches – cows are stationary or cows are moving single file under camera

Automated systems may also provide additional useful data

- Whole body imaging in stationary systems
- Conformation estimates
- Lameness/motility estimates through 'in-motion' systems

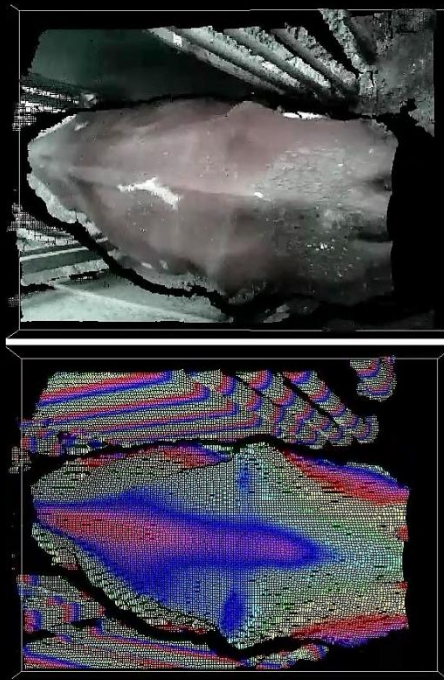




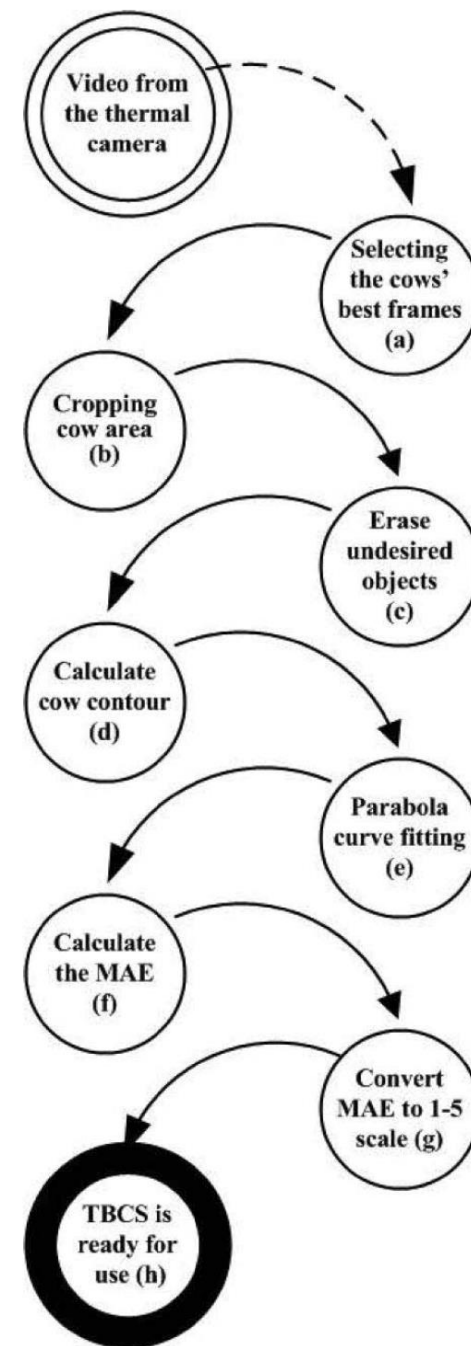
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## From a Thermal or 3D image to BCS Score

Actual view



3D view used for  
calculating score





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# Comparison of Manual BCS with TBCS

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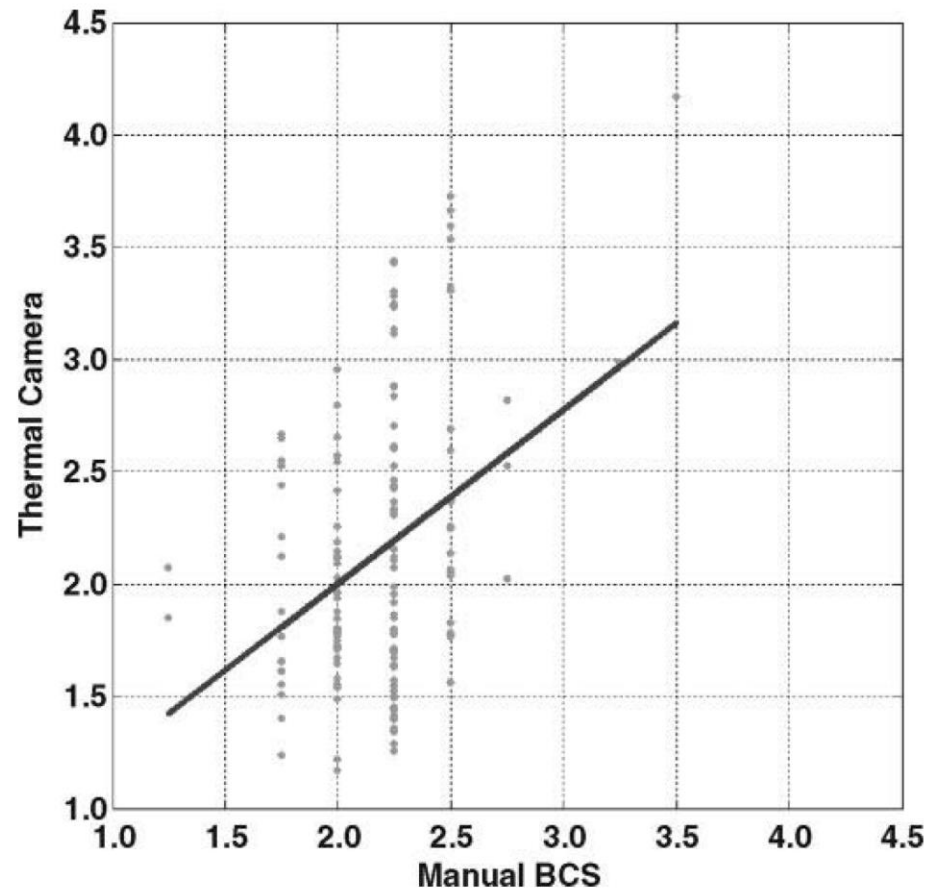
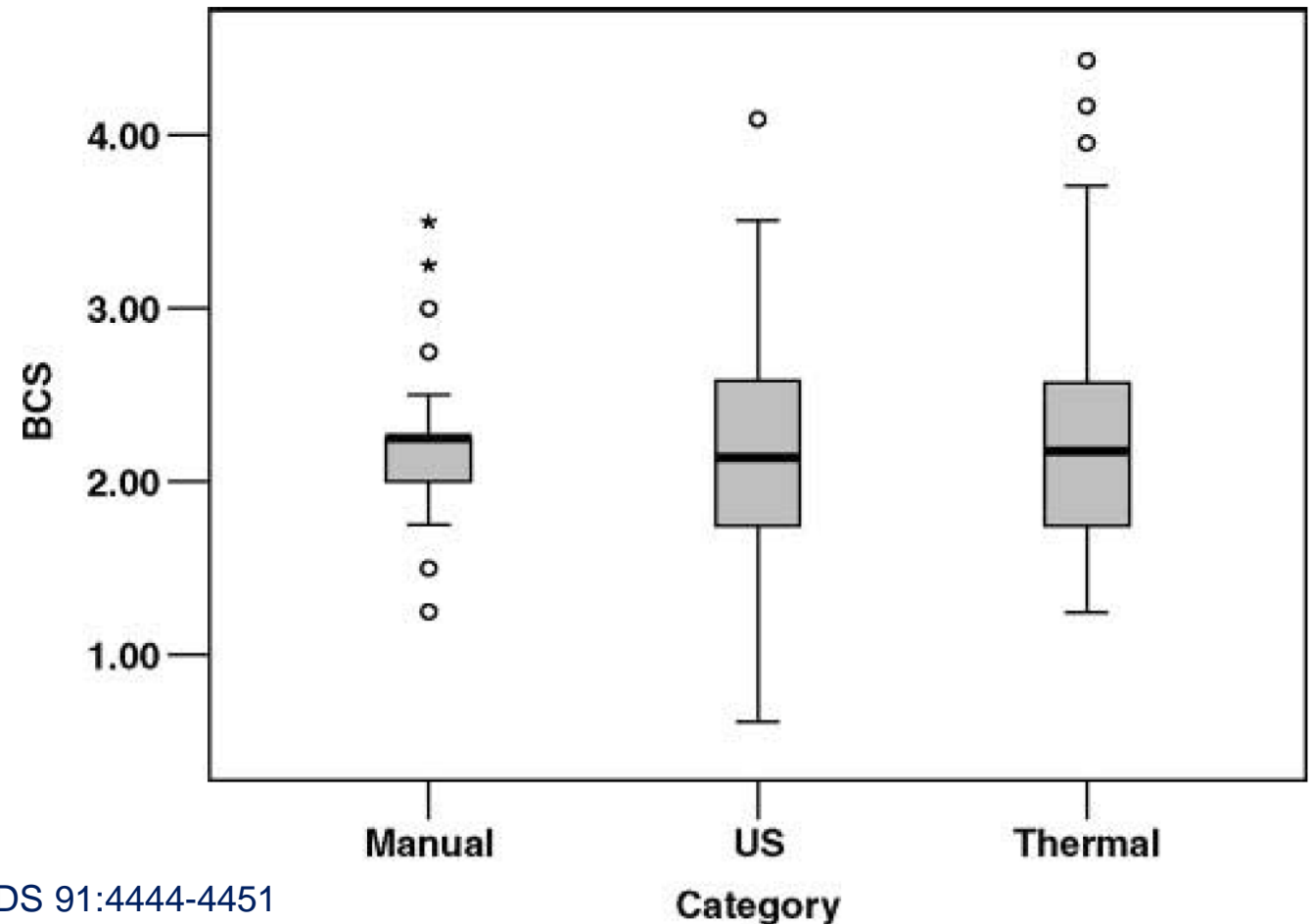


Figure 4. The link between the thermal camera scoring and the manual BCS.



JDS 91:4444-4451



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# Comparison of Manual and Automatic BCS

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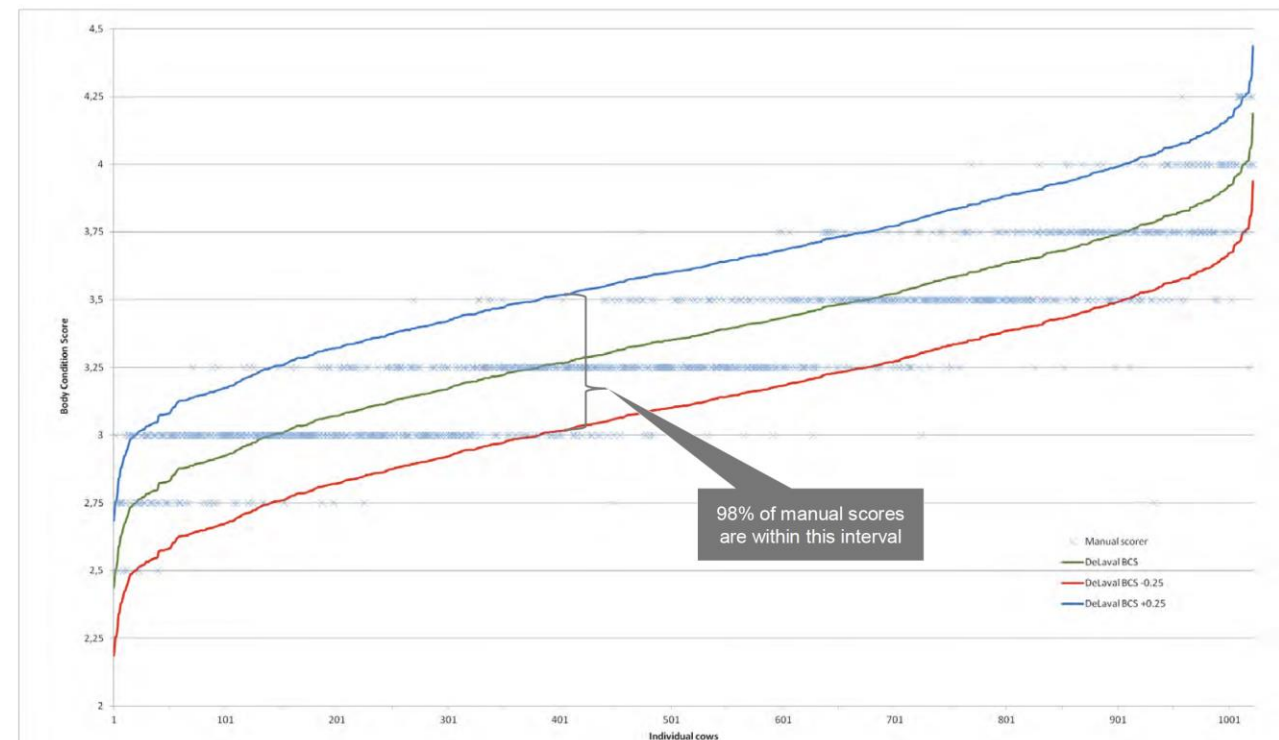
## Multiple Manufacturer Internal Validation Studies

In this example, courtesy of DeLaval:

- 98% of manual BCS was within 0.25 of automatic system scores
- Scoring is on continuous scale but limited observations at extreme low and high BCS

Statistical analysis on variation between categorical scores and continuous scoring on a similar scale is inappropriate but the it appears the repeatability is lower or similar in studies

## Performance testing 1022 cow farm







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# Comparison of Manual and Automatic BCS

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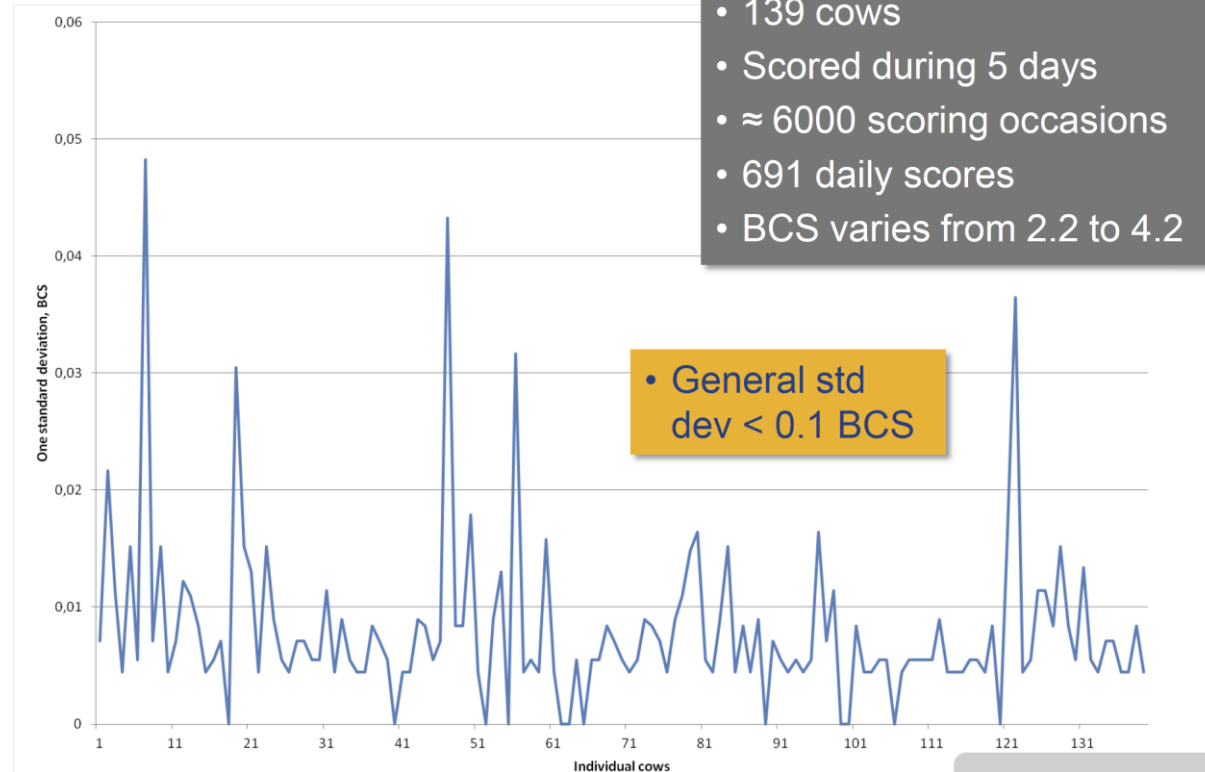
## Multiple Manufacturer Internal Validation Studies

In this example, courtesy of DeLaval:

- SD was  $<0.1$  BCS
- Scoring is on continuous scale but limited observations at extreme low and high BCS

Statistical analysis on variation between categorical scores and continuous scoring on a similar scale is inappropriate but the it appears the repeatability is lower or similar in studies

## Repeatability Standard deviation Test farm 1

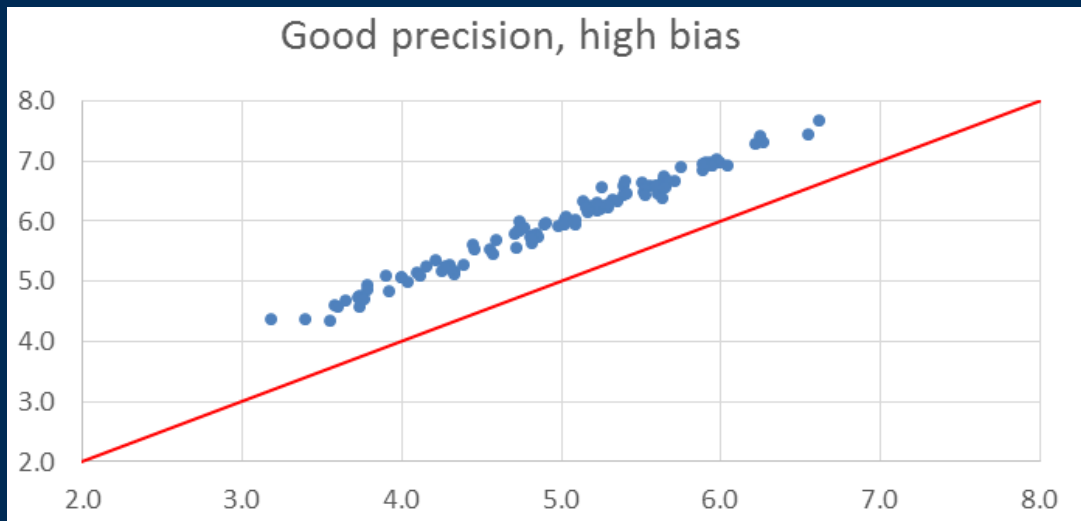
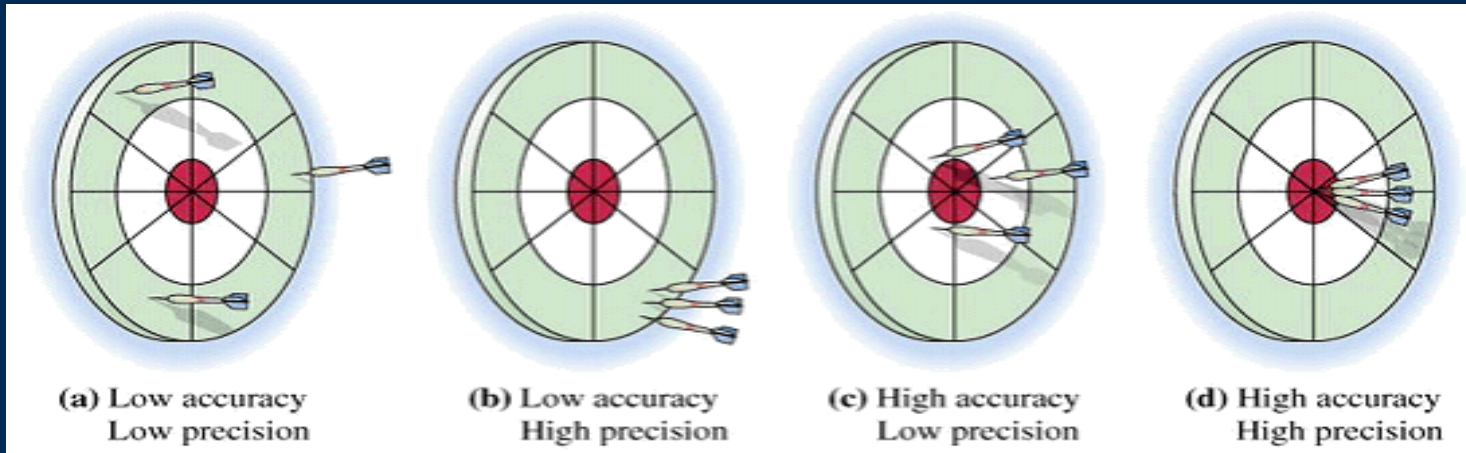




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# Do We Need Accuracy or Precision?

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Point to Ponder with BCS Scoring on Usability

## ACCURACY vs. PRECISION

With repeated (daily) estimates of BCS, is precision more important than the absolute value?

We are looking for changes (delta) over time/lactation

- Individual cow changes
- Groups of cows (pen/string/life stage)

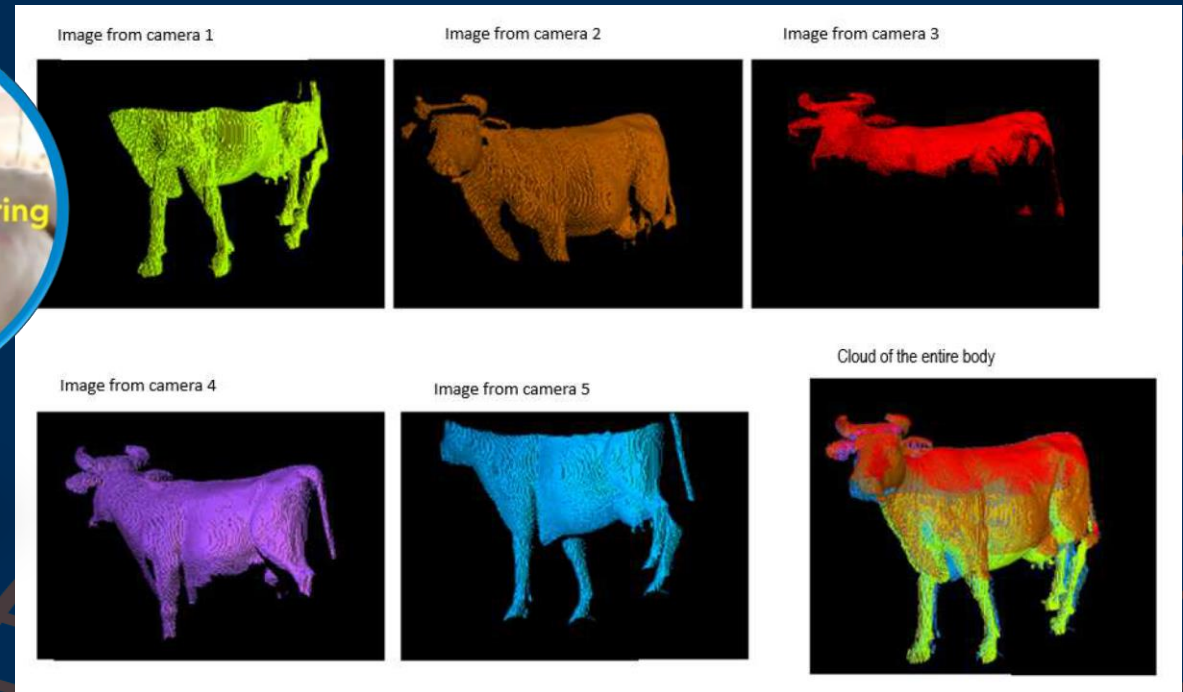
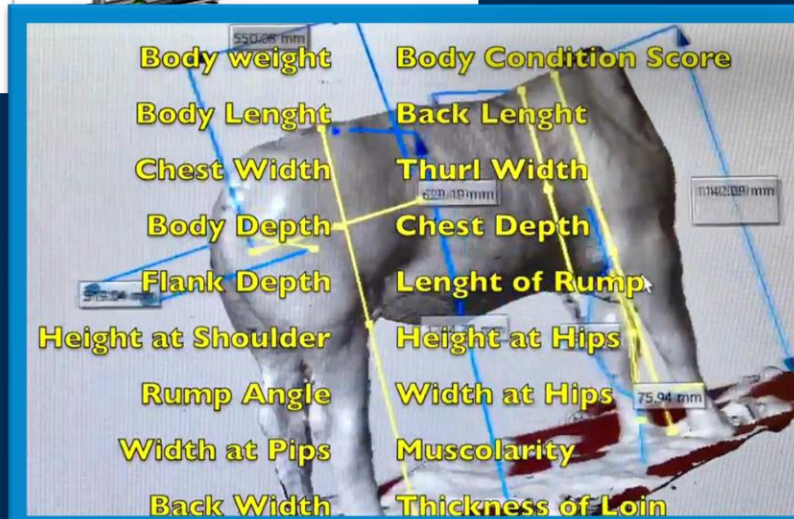
Can we make an adjustment for the 'system effect' if deemed necessary?



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# Stationary BCS & Conformation Systems

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Usable BCS and conformation estimates

Non-automated system but combined with other periodic observations, provides quality data for herd management and genetic evaluations



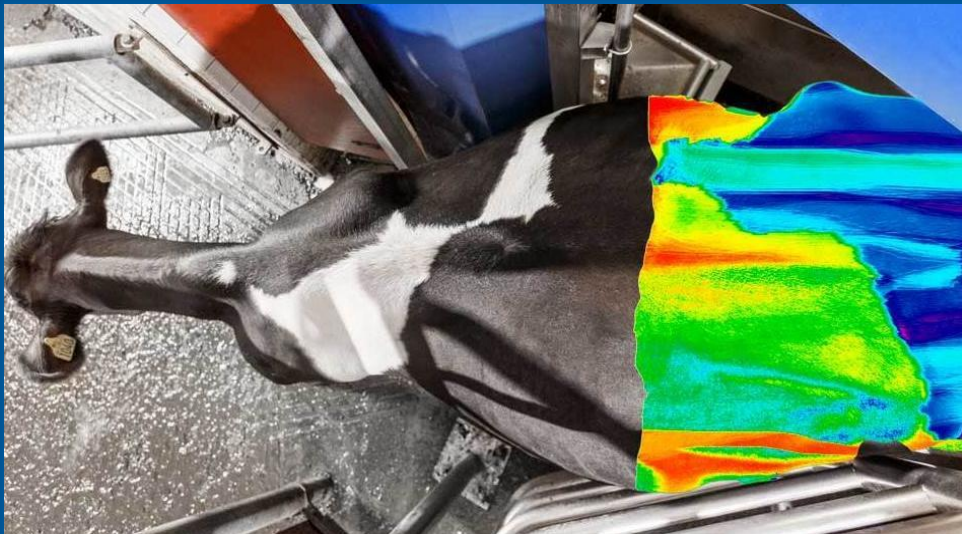


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# Automated BCS System Considerations

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## Turning Data into Useful Information



System validation while protecting manufacturer IP?

Sensitivity to light/darkness?

Sensitivity to hide colour, hair length, cleanliness?

Other physical system requirements?

Accuracy, repeatability and reproducibility of BCS values?

Consistency over time?

Algorithm or software updates?

Does the system require periodic calibration, maintenance and/or adjustment?





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## Animal Data Exchange

Conformation Score Event (59 Includes BCS)

Score (1 to 9)

List of all traits can be found at:

[ICAR/icarConformationTraitType.json at ADE-1 · adewg/ICAR · GitHub](#)

Scoring Methods

Manual

Automated

Device

Name	From	Type	Description
resourceType	<a href="#">icarResource.json</a>	string	Always icarConformationScoreEventResource
meta		icarMetaDataType	Meta data (source creation and update dates etc)
id	<a href="#">icarEventCoreResource.json</a>	string	Unique ID for each event
animal		icarIdentifierType	A scheme+ID combination that identifies the animal.
eventDateTime		icarDateTimeType	Date and time of the observation
location		icarIdentifierType	A scheme+ID combination that identifies the location (herd/farm)
traitLabel		icarIdentifierType	A scheme+ID combination that identifies the national/local recording systems label for that trait
responsible		string	Name or identifier of the person responsible for the action/observation
contemporaryGroup		string	Optional identifier for the contemporary group that influenced the trait observed.
score	<a href="#">icarConformationScoreEventResource.json</a>	number	Numeric 1-9 score (decimals allowed in some countries and some scores)
traitScored		enum	A value from the full list of conformation traits. For BCS use BodyConditionScore
method		enum	Manual or Automated
device		icarDeviceReferenceType	Details of the device (if any) used for automated scoring.



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Angularity  
Back Length  
Back Width  
Body Condition Score  
Body Depth  
Body Length  
Bone Structure  
Central Ligament  
Chest Depth  
Chest Width  
Claw Angle  
Flank Depth  
Foot Angle  
ForePasterns SideView  
Fore Udder Attachment  
Fore Udder Length  
Front Legs FrontView  
Front Teat Placement  
Height At Rump  
Height At Withers  
Hind Pasterns SideView  
Hock Development  
Length Of Rump

Locomotion  
Loin Strength  
Muscularity  
Muscularity Shoulder SideView  
Muscularity Shoulder TopView  
Muzzle Width  
Rear Legs RearView  
Rear Legs Set  
Rear Legs SideView  
Rear Teat Placement  
Rear Udder Height  
Rear Udder Width  
Rounding Of Ribs  
Rump Angle  
Rump Length  
Rump Width  
Skin Thickness  
Stature  
TailSet  
Teat Direction  
Teat Form  
Teat Length  
Teat Placement RearView

Teat Placement SideView  
Teat Thickness  
Thickness Of Bone  
Thickness Of Teat  
Thickness Of Loin  
Thigh Length  
Thigh Rounding SideView  
Thigh Width RearView  
Thurl Width  
TopLine  
Udder Balance  
Udder Depth  
Width At Hips  
Width At Pins



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## Are There Other Considerations?

Additional Conformation Traits?

Other Scoring measurements that should be considered (currently 1-9 score with decimal)

Are there Sensor Data Proxys that fall outside the current ADE definition?