THE GLOBAL STANDARD
FOR LIVESTOCK DATA

# Appendix 5 of Section 5 of the ICAR Guidelines - Relationship between conformation and functional traits for dairy and dual purpose cattle

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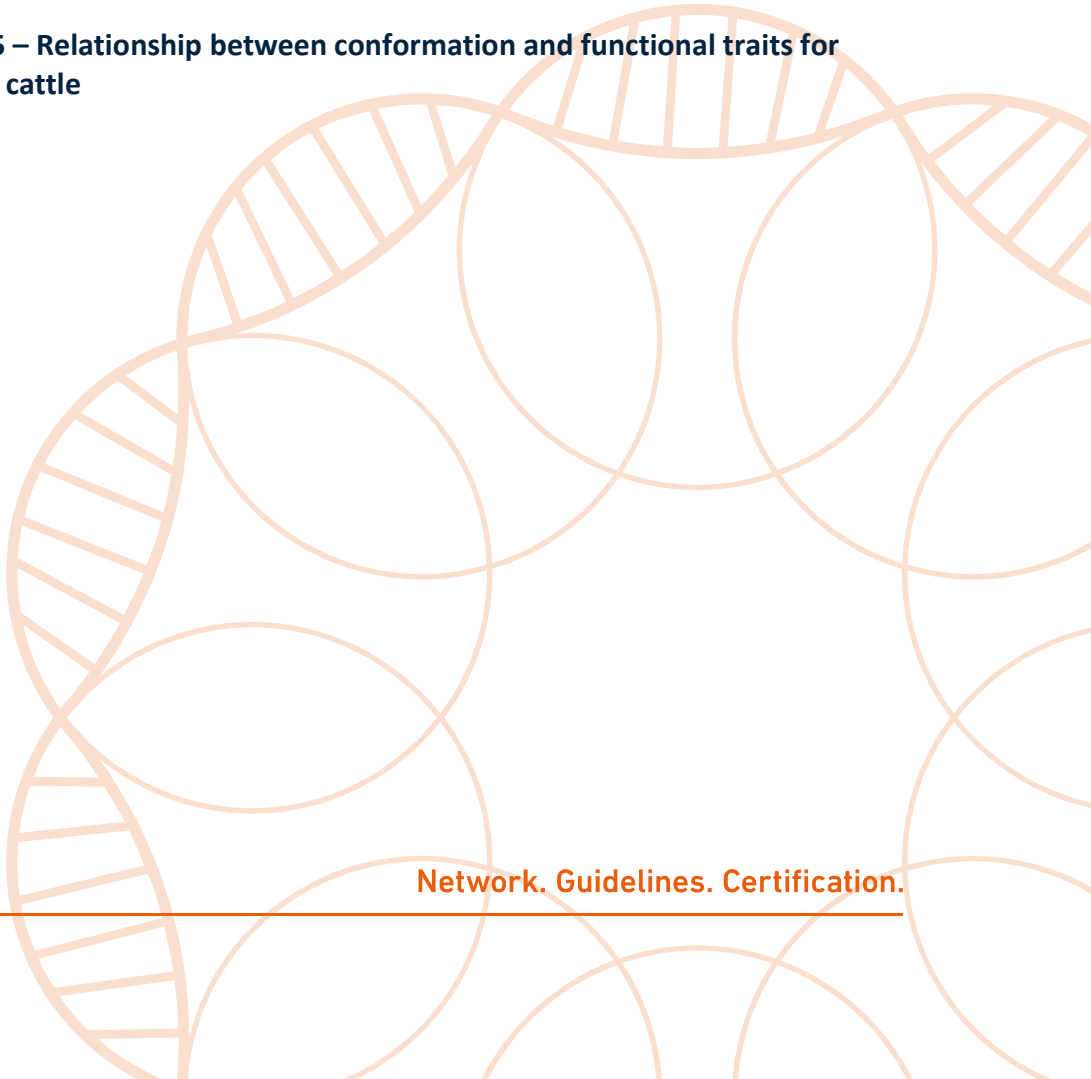
Version March, 2022



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# Change Summary

| **Date of Change** | **Nature of Change** |
|---|---|
| March 2022 | Creation of document. Guidelines rewritten in a more concise way. Relationship between conformation and functional traits added. Standard trait definitions and relationship between conformation and functional traits moved to separate appendices.<br><br>Table added with information about period and number of scores used for estimating the relationships between conformation and functional traits for cattle. |

# 1 Introduction

In this appendix, the relationship between some of the ICAR standard conformation linear traits for dairy and dual-purpose cattle and health and longevity is described in detail. This information can be used to show farmers how the conformation scores can help him to breed a kind of cow which is able to perform the best in the herd.

Results are presented as a deviation in percentage of the phenotypic standard deviation of 6 functional traits:

- Lifetime production: milk production during the whole productive life
- Survival: binary trait for reaching the 4th calving
- Somatic cell count: geometric mean of 1st lactation SCC
- Claw disorders: any disorder observed on the hoof for the disorders sole haemorrhage, digital dermatitis, interdigital dermatitis, sole ulcer, interdigital hyperplasia, and white line disease
- Interval from 1st to last insemination: interval in days between 1st to last insemination resulting in a gestation.
- Calving ease: calving score on a scale of 1 to 4 (easy to caesarean section) at the 1st calving. All animals in the analysis had the opportunity to have a productive life of at least 36 months.

Results are based on analyses conducted in 4 populations, three Holstein populations from Hungary, Netherlands and Switzerland, and the Fleckvieh population from Germany. Only 1st lactation classifications were used for the analysis. A more detailed description of the data can be found in *Table 1*.

The relationships found were very similar for the different populations. Therefore, for each conformation trait the relationship shown in this document is based on data of one population, which is indicated per trait in *Table 1*. Further, *Table 1* shows the number of records used for every conformation trait – functional trait combination, as also the period of the scores.

*Table 1. Period and number of scores used for estimating the relationships between conformation and functional traits for cattle.*

| Trait | Country[1] | Traits[2] | | | | | |
|---|---|---|---|---|---|---|---|
| | | SURV | LP | INT | CE | CLAW | SCC |
| | | Period of scores[3] | | | | | |
| | NLD | 2010-2013 | | 2014-2017 | | | 2015-2016 |
| | CHE | 9/2011 - 12/2016 | | X | | | 9/2011-12/2016 cows born |
| | DEU | 10/2013 - 9/2014 | | X | | | 2014-2016 |
| | | Number of records | | | | | |
| Stature | NLD | 110922 | 117080 | 322532 | | | |
| Chest width | NLD | 110923 | 117120 | 322621 | | | |
| Body depth | NLD | 110923 | 117120 | 322621 | | | |
| Angularity | NLD | 110923 | 117120 | 322621 | | | |
| Rump angle | NLD | 110923 | 117120 | 322621 | 138638 | | |
| Rump width | NLD | 110923 | 117120 | 322621 | 138639 | | |
| Body condition score | NLD | 110923 | 117120 | 322621 | 138639 | | |
| Rear legs rear view | NLD | 110923 | 117120 | | | 44617 | |
| Rear legs set | NLD | 110923 | 117120 | | | 44617 | |
| Foot angle | NLD | 110923 | 117120 | | | 44617 | |
| Locomotion | NLD | 109946 | 115816 | | | 44517 | |
| Fore udder attachment | NLD | 110923 | 117120 | | | | 230127 |
| Front teat placement | NLD | 110923 | 117120 | | | | 230127 |
| Teat length | NLD | 110923 | 117120 | | | | 230127 |
| Udder depth | NLD | 110923 | 117120 | | | | 230127 |
| Rear udder height | NLD | 110923 | 117120 | | | | 230127 |
| Central ligament | NLD | 110923 | 117120 | | | | 230127 |
| Rear teat placement | NLD | 110923 | 117120 | | | | 230127 |
| Bone structure | CHE | 36979 | 36978 | | | | |
| Rear udder width | CHE | 36979 | 36978 | | | | 35318 |
| Muscularity | DEU | 16572 | 39722 | | | | |
| Fore udder length | DEU | 16572 | 39722 | | | | 97232 |

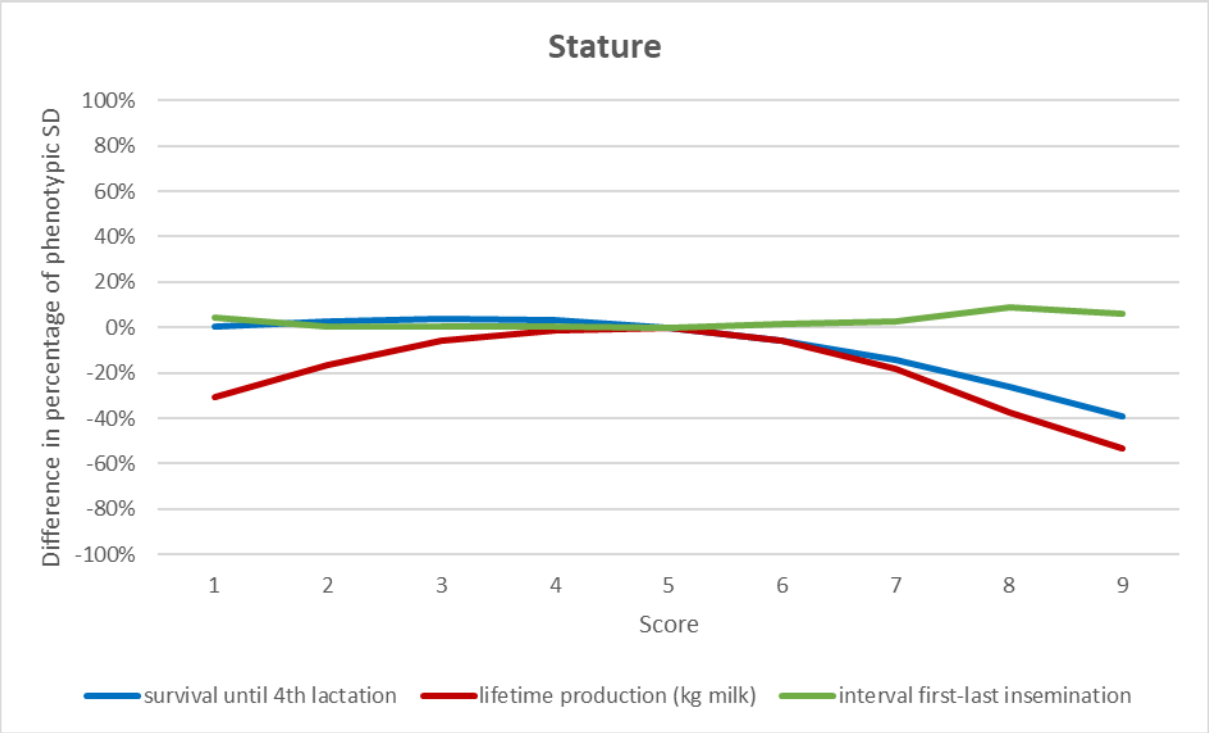
[1] *NLD = the Netherlands, CHE = Switzerland, DEU = Germany.*

[2] *Traits in analysis: SURV = survival until 4th lactation, LP = lifetime production, INT = interval first-last insemination, CE = calving ease, CLAW = claw disorders, SCC = somatic cell count.*

[3] *Date format either YYYY or MM/YYYY.*

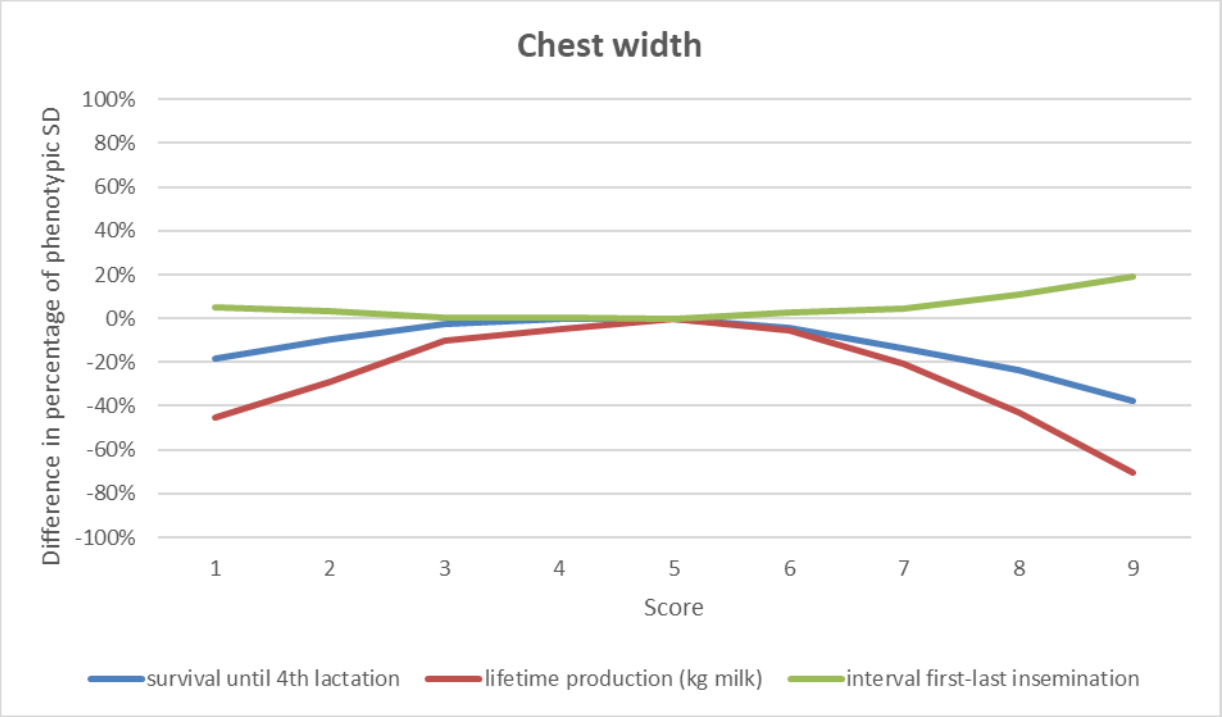
## 2 Stature

Stature is clearly a trait with an intermediate optimum. Very small cows have a lower lifetime production. Their smaller size has no effect on the level of culling rate, so the lower lifetime production is more likely due to lower production per lactation. On the other side of the scale tall cows have a much lower survivability - possibly because of health issues related to their size - which in turn impacts their lifetime production.



## 3 Chest width

The graph shows, that both survival and lifetime production are decreasing when the linear score of the cows move down or up from the middle of the scale. When the chest is narrow the cow has not enough strength to ensure a good lifetime production and survival. When the chest is wider, the cows become “too wide”, they do not represent their age, they look like a mature cow in their young age. This influences the efficiency of the survival and through this, the lifetime production in a negative way.

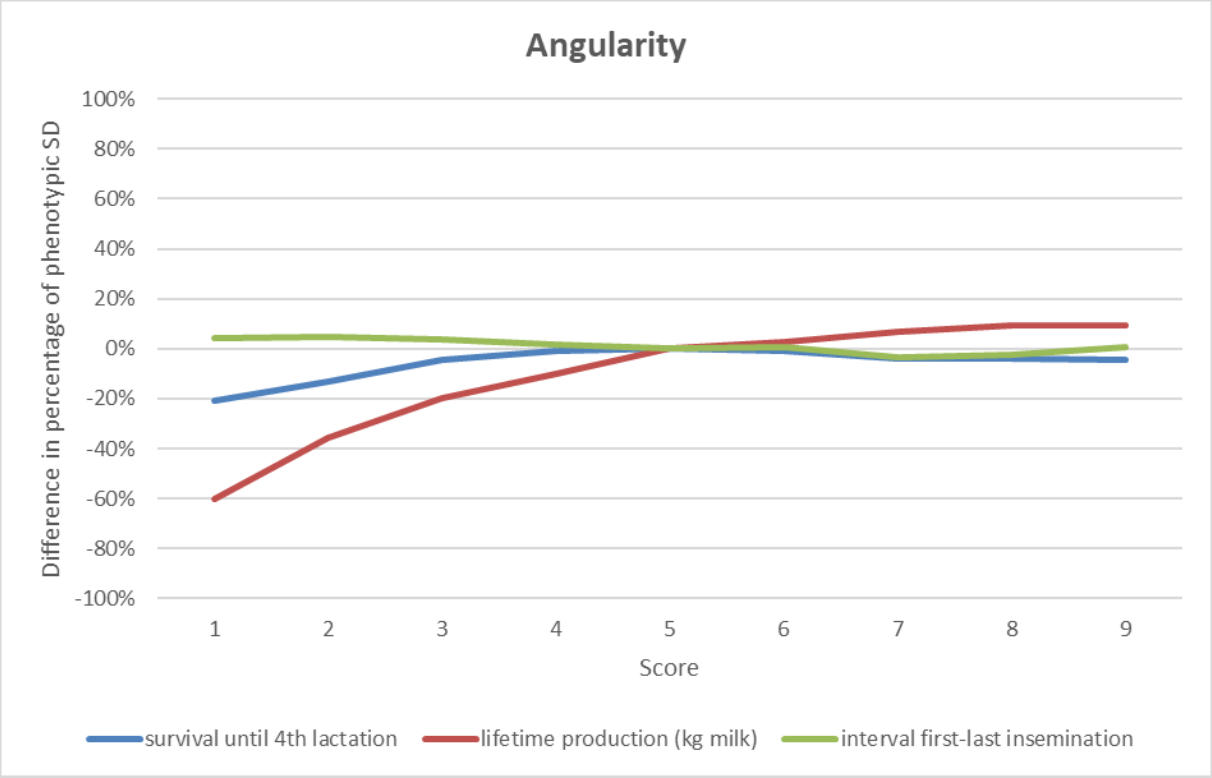


## 4 Body Depth

Body depth has an intermediate optimum in relation to survival and fertility. Deeper cows in 1st lactation, tend to have a reduced fertility (longer interval 1st to last insemination) and a shorter productive life, which results in a lower lifetime production. The effect of shallow cows is only a reduced lifetime production. Fertility does not seem to be hindered in those cows.

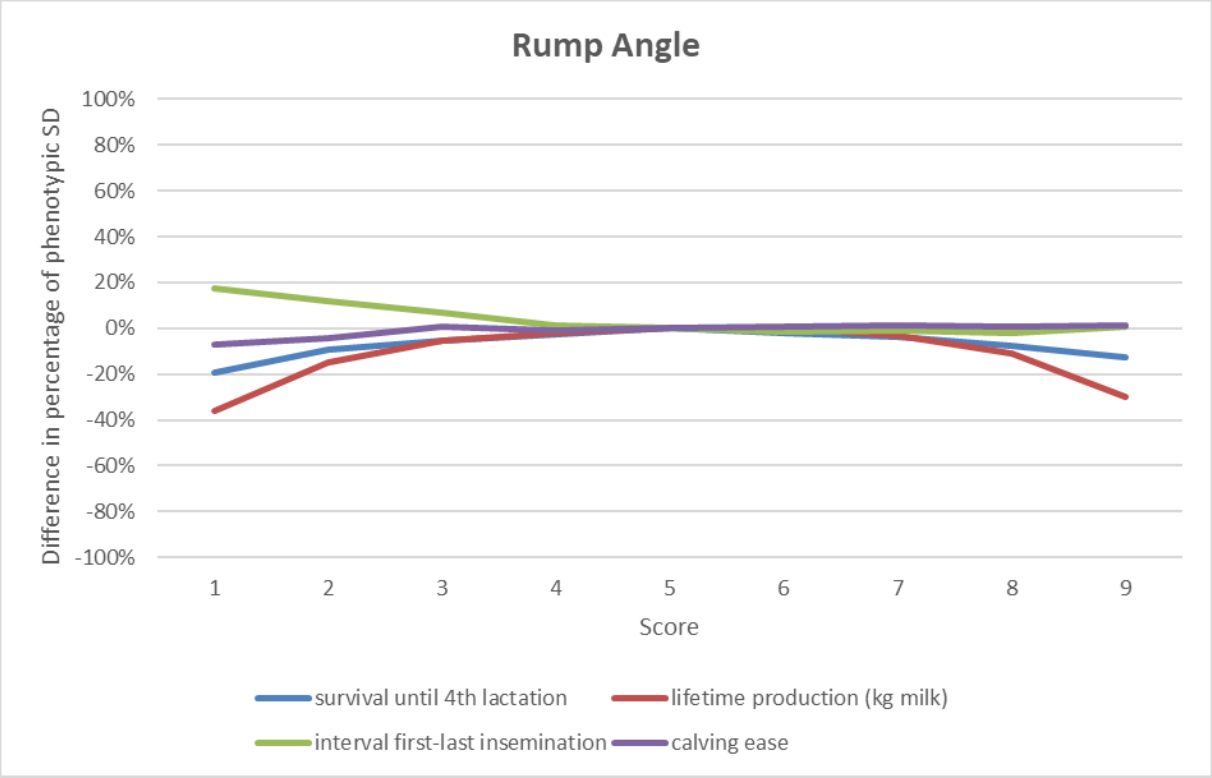
## 5 Angularity

Angularity does not show any relationship with fertility. However, cows with a higher score for angularity have, on average, a higher lifetime production. This relationship is much stronger for Angularity scores below average than above average and is based on the highly positive relationship between production and angularity.



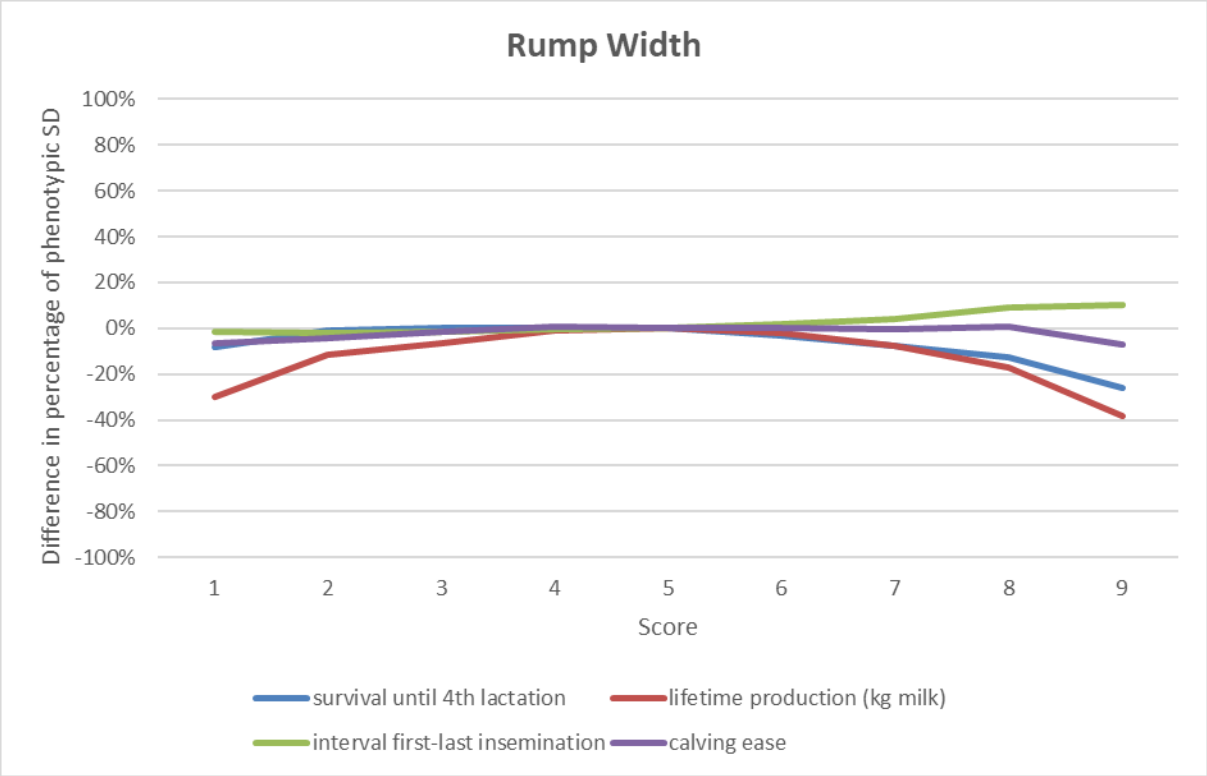
## 6 Rump Angle

For most of the scale, Rump Angle does not have any strong relationship with the traits we analyzed. There is no relationship to calving ease. The relationship with survival is only present for extreme scores. This outcome shows that Rump Angle in relation to survival could be considered more as a defect, than a true linear trait.



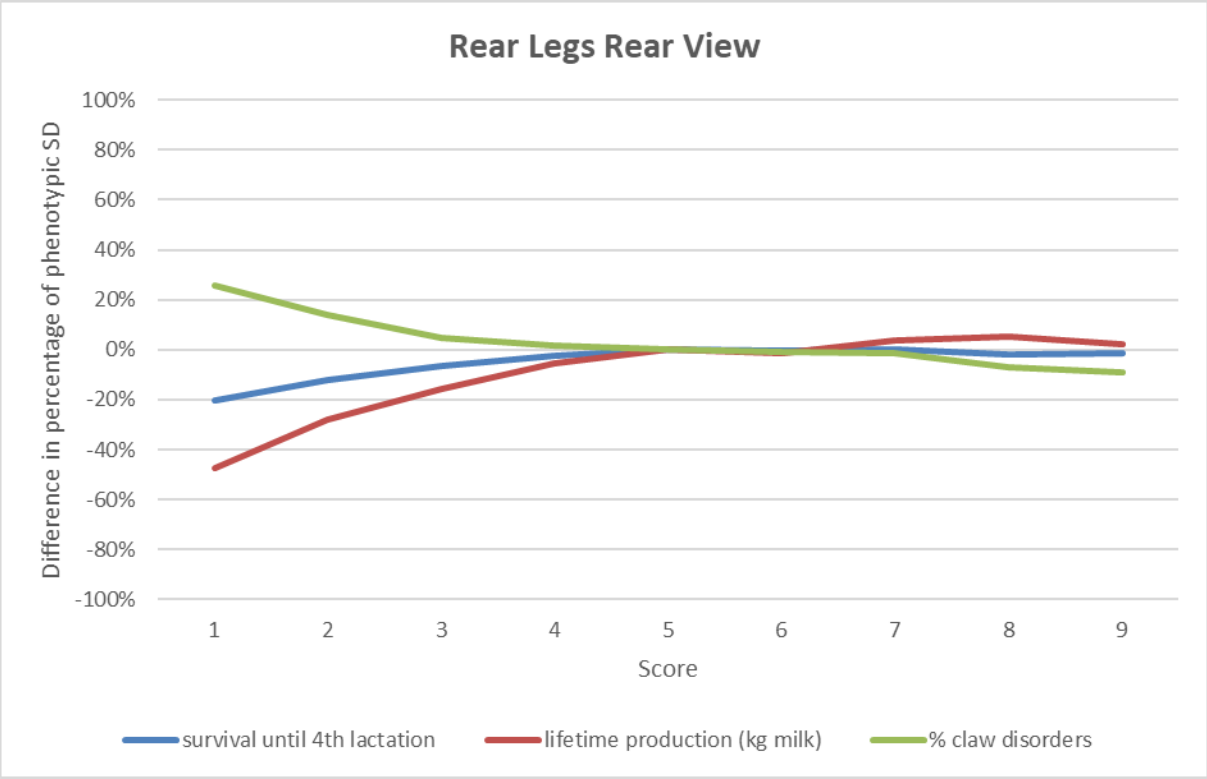
## 7 Rump Width

As shown in the graph, the analyses did not detect any serious effect of Rump Width on calving ease. Beside this finding, extreme narrow rumps have a negative effect on lifetime production. The effect is larger for lifetime production than for survival. The reason might be that narrower rumps lead to narrower udders and lower milk production. On the other side wide-rumped cows are usually large cows. It has been shown that big cows have a reduced lifetime production and survival.



## 8 Rear Legs Rear View

There is a strong relation between hocked-in rear legs and claw disorders. Leg position with extreme toe-out implies a bad foot position. This can influence the susceptibility to claw diseases. It is probably this relationship that explains the reduced survival and lifetime production of cows with low score for Rear Legs Rear View. For above average score for Rear Legs Rear View there is no relation anymore with the three analyzed traits.



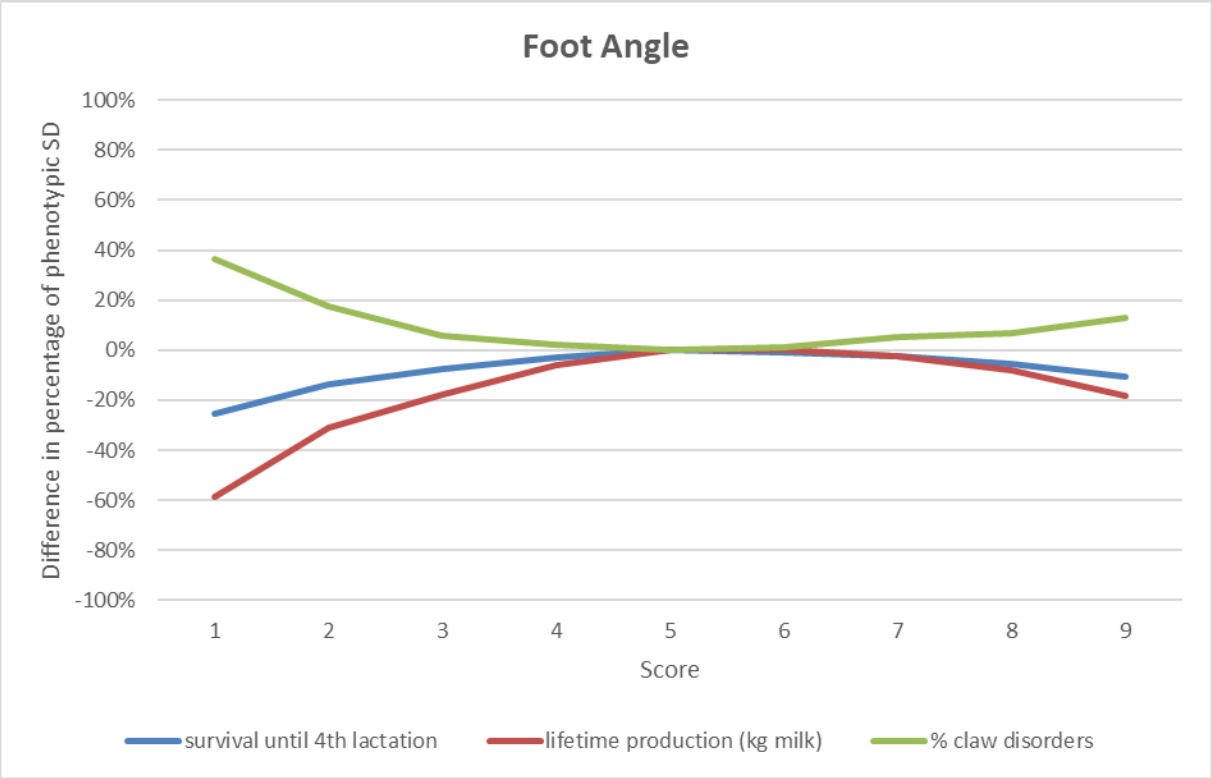
## 9 Rear Legs Set

Rear Legs Set is a trait with an intermediate optimum. Based on the data, both extremes, straight or sickled, show a tendency to reduced performance for functional traits. However, cows with sickled legs are more susceptible to claw problems and reduced lifetime production than those with straight legs.

## 10 Foot Angle

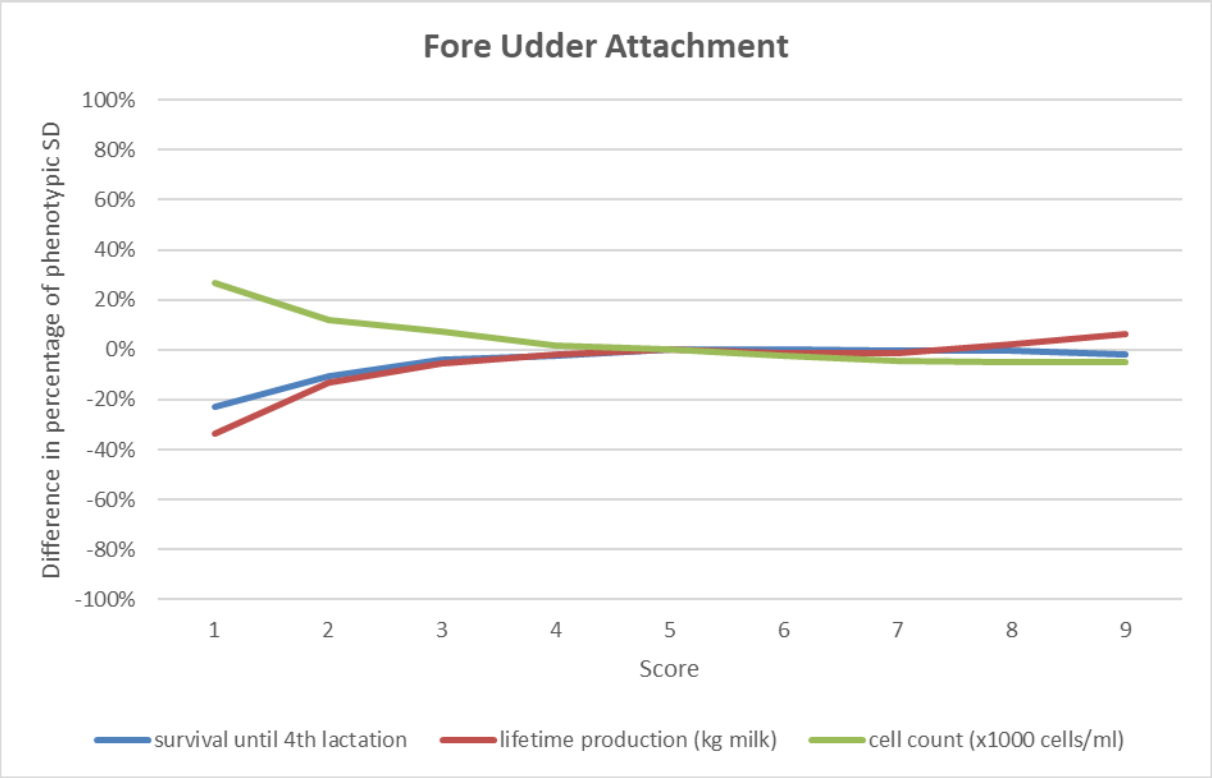
Cows with very low Foot Angle are much more susceptible to claw disorders than those with steeper Foot Angle. Steep Foot Angle is only a problem when it is extreme, especially a score for less than average angle. Survival and lifetime production are lower as well for cows with low Foot Angle.

Foot Angle is highly correlated with hoof height. Above average hoof height (more angle) will allow the weight of the cow to be more evenly distributed on the hoof and can lead to less claw disorders. Cows with higher hoofs are more stable in different conditions (slatted floor, pasture). The thickness of the heel prevents some injuries.



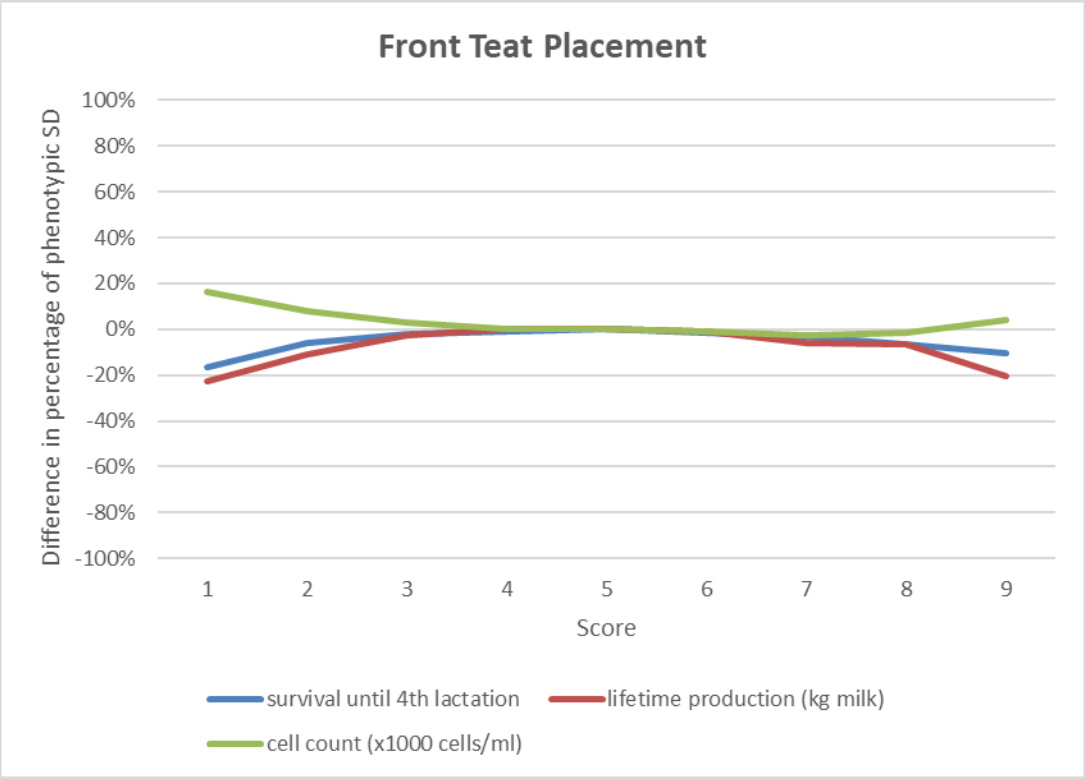
## 11 Fore Udder Attachment

The Fore Udder Attachment does not have a large impact on udder health, survival or lifetime production, unless the attachment is very loose. For extreme loose Fore Udder Attachment an increase in somatic cell count is found.



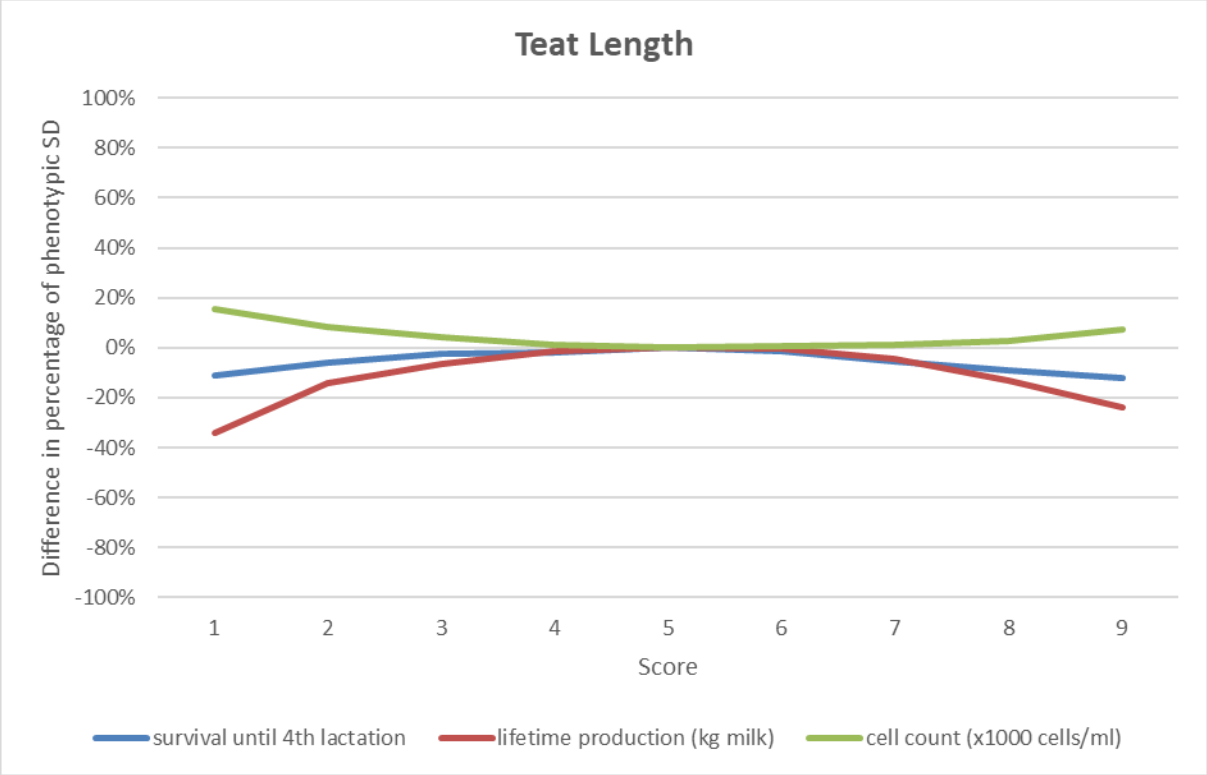
## 12 Front Teat Placement

Front Teat Placement does not have a strong association with any of the analyzed traits, except for extreme scores. Low value, that is teats which are to the outside of the quarters are often seen with cows having higher cell count and lower survival. Milkability with conventional milking systems is hindered when teats are far apart. This aspect might lead to a higher cell count.



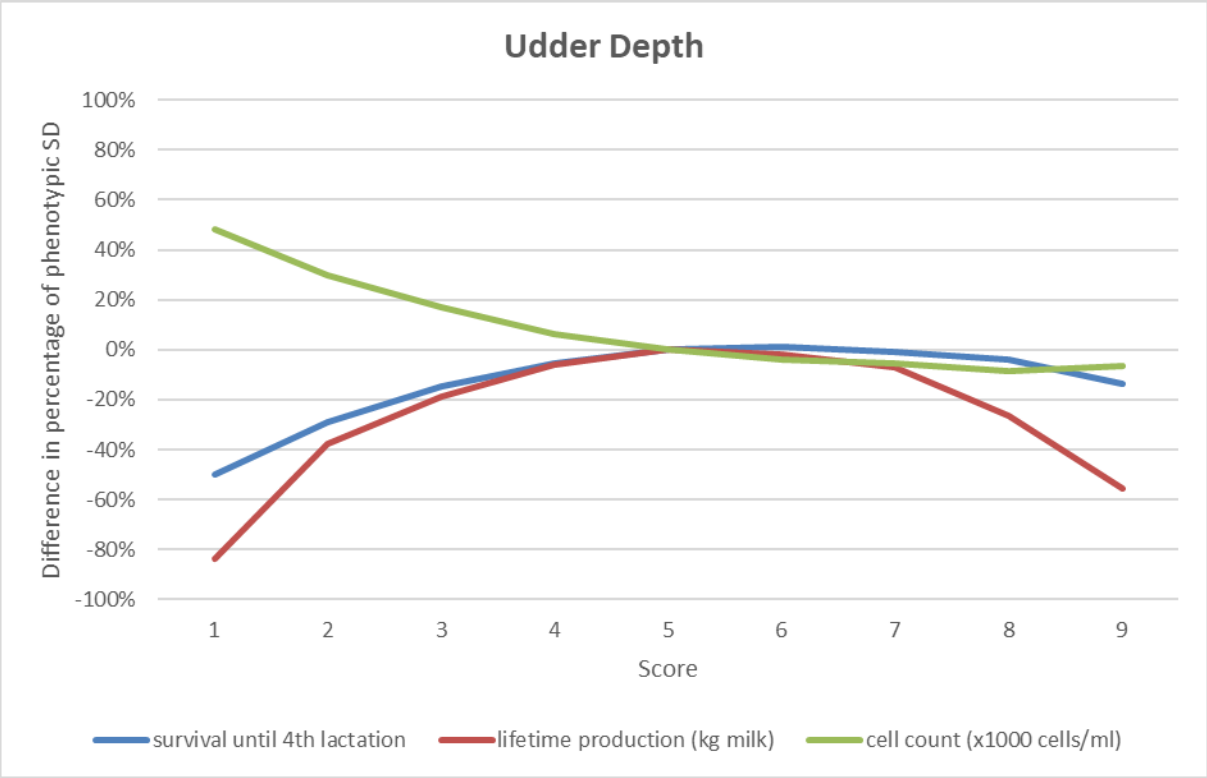
## 13 Teat Length

As for Front Teat Placement, Teat Length is a trait with an intermediate optimum. However, the effect on survival and lifetime production is more important. Short teats are linked to a shorter productive life. On the other end of the scale, long teats are linked as well to shorter productive life. The association might be caused by teats being more prone to injuries or to infections.



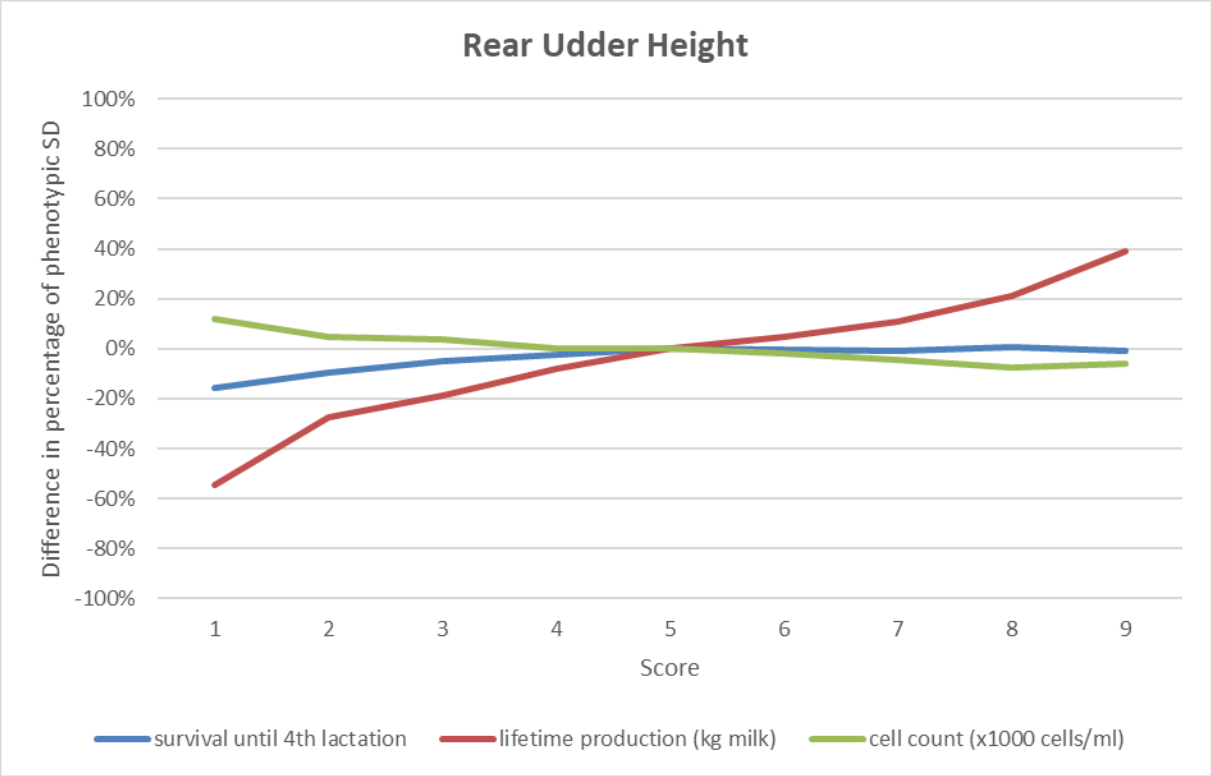
## 14 Udder Depth

Udder depth is a trait with an intermediate optimum. It shows the most striking relation with health and longevity traits. A lower udder floor is related to a poor survival and lifetime production. Cows with this kind of udder are at higher risk of being culled as many difficulties might arise, such as udder health problems (also indicated by the higher somatic cell count), udder injuries, difficulties with the attachment of the milking machine, etc. The relationship at the high end of the scale (shallow udders) shows an interesting effect. Although survival remain high with higher udder floor, lifetime production plumets. Cows with a high score, are usually poor producers. Even though they live a rather long productive life, their lifetime production remains low.



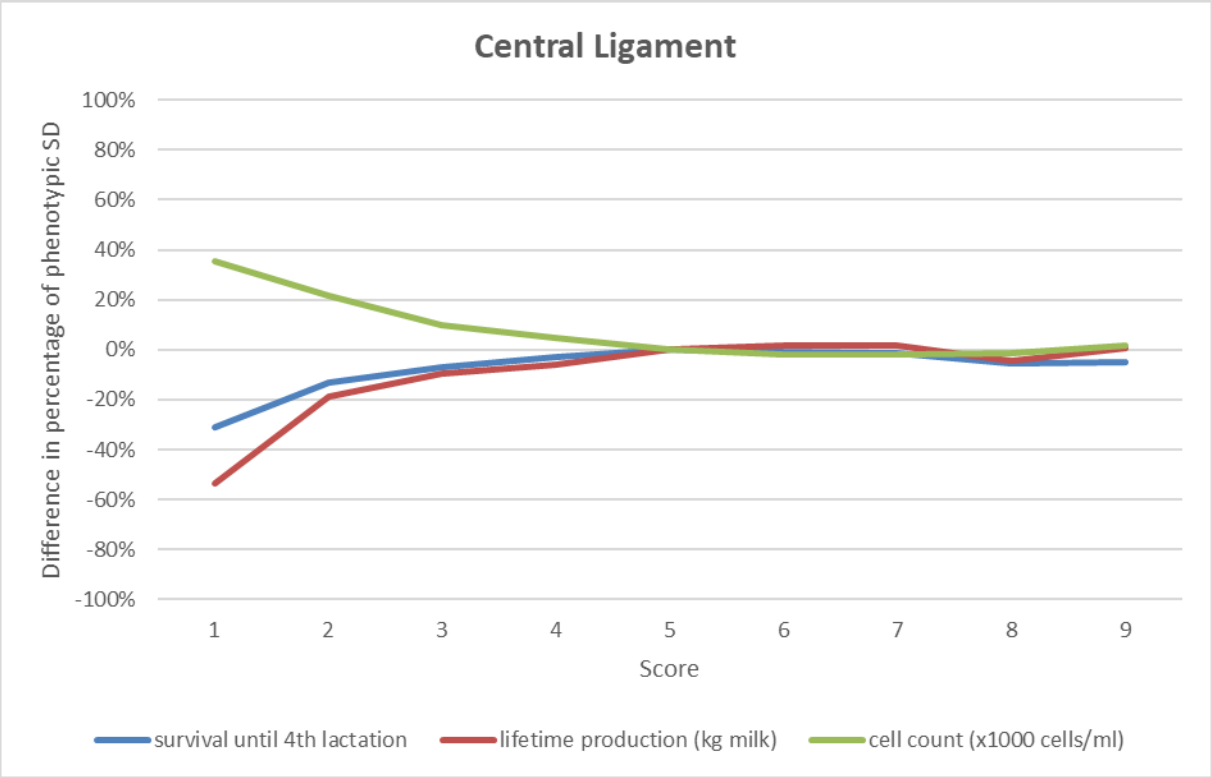
## 15 Rear Udder Height

The association between lifetime production and Rear Udder Height is positive and nearly linear. The reason is to be found in a positive relationship with milk production, as there is more room to produce milk. But at the same time, higher rear udder makes it possible to have larger udders without lowering udder depth. These 2 elements combined result in not only a better lactation production, but rather a larger lifetime production. The association with survival and somatic cell count is minor.



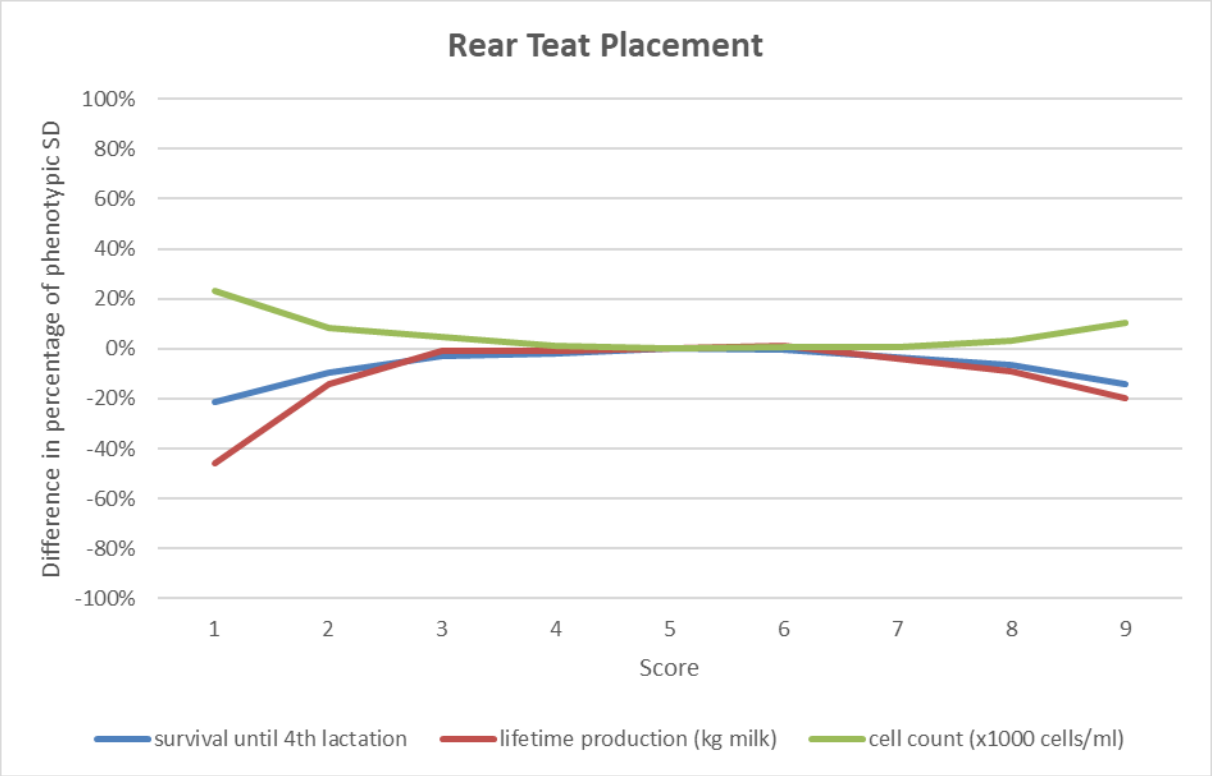
## 16 Central Ligament

A strong Central Ligament is necessary to ensure that the udder is able to produce milk during a long time without becoming too deep after a several lactations. However, extreme depth of the udder cleft does not seem to be needed, as the effect of central ligament is non-existent from the middle of the scale onwards. But low scores for this trait are related to poor udder health and longevity. On the lower side of the scale, the relationship is like the one for Udder Depth and Front Teat Placement, showing that these traits describe in common the inability of the udder to last for multiple lactations.



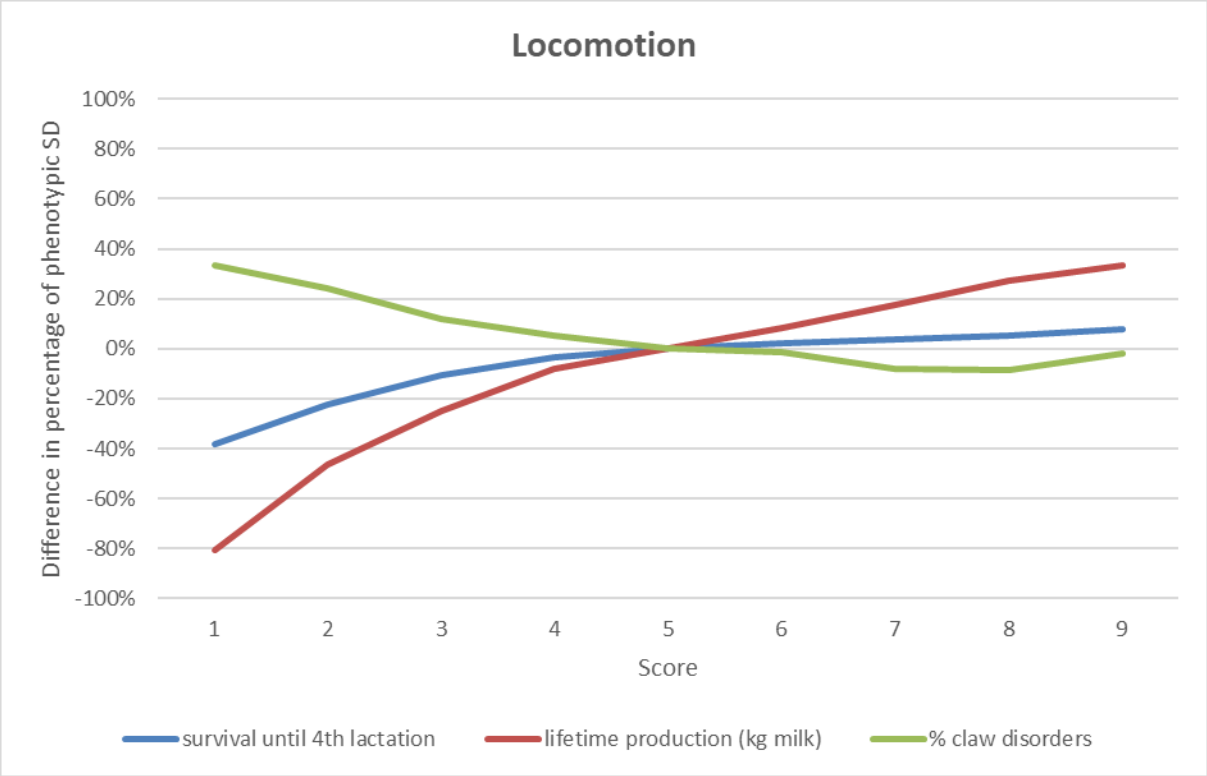
## 17 Rear Teat Placement

The graph shows that Rear Teat Placement is a trait for which extremes should be avoided. Wide Rear Teat Placement (low score) is often related to a weak Central Ligament. This relationship could explain the lower survival and the high cell count associated with low scores for Rear Teat placement. It should be mentioned, regarding this trait, that an important part of the data comes from farms without robotic milking. Even though, rear teats which are placed close together are linked with a slightly lower survival.



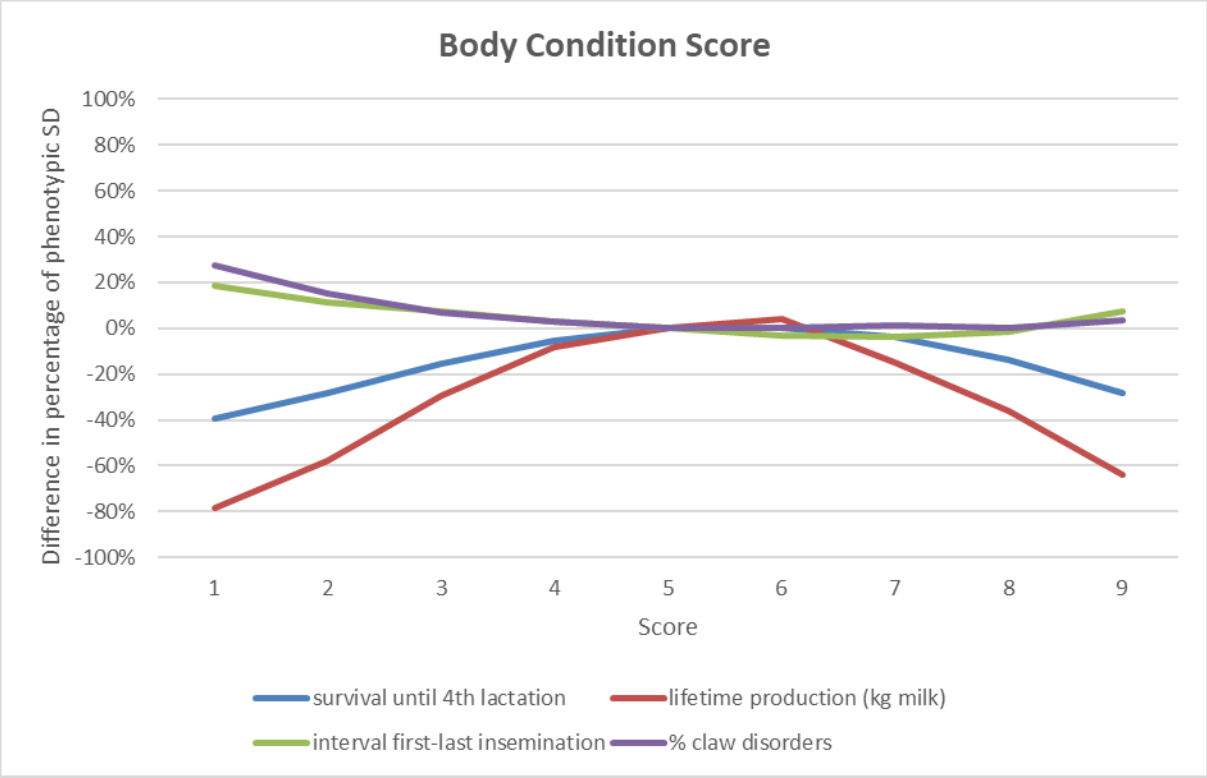
## 18 Locomotion

The relation of locomotion with survival and lifetime production is strong. Lifetime production is much more reduced than survival in cows with a low score for locomotion. The cause of the association with claw disorder might be claw diseases leading to a bad locomotion as well as locomotion leading to claw diseases.



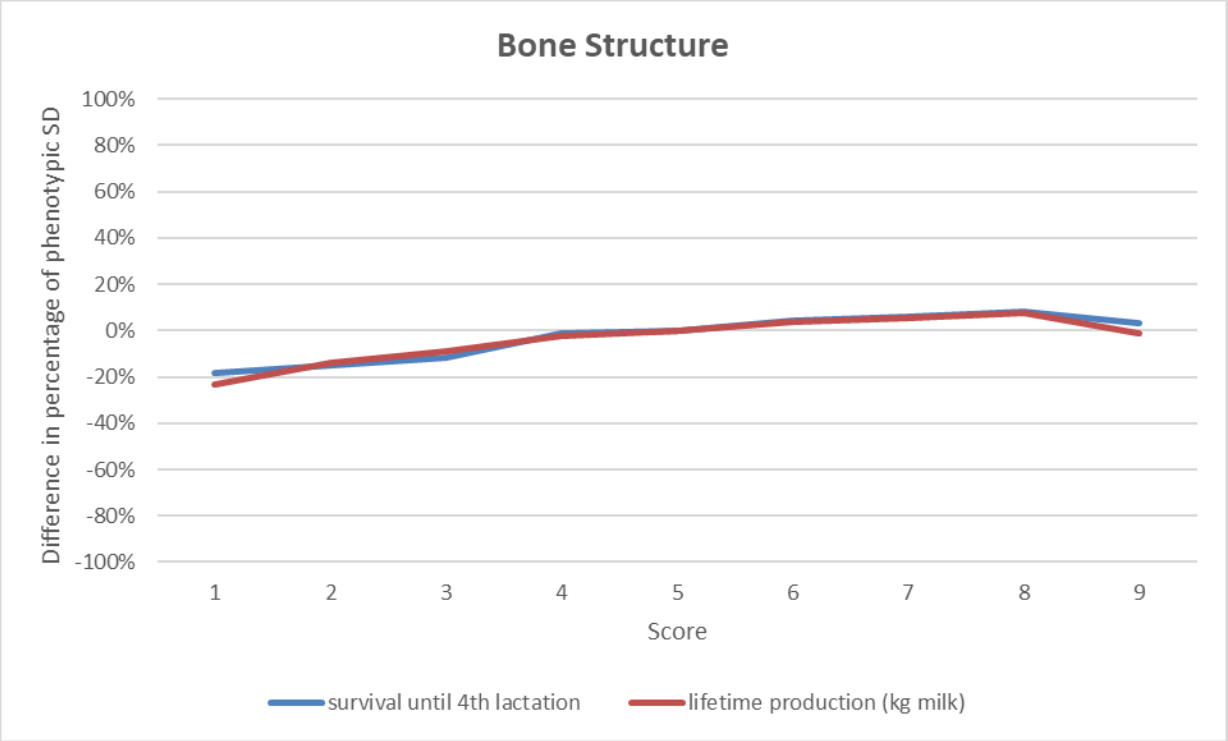
## 19 Body Condition Score (BCS)

For Body Condition Score, the most important association can be found with longevity traits, both survival and lifetime production. For both traits there is an intermediate optimum. Cows with extreme low score for BCS appears to have more claw disorders and higher interval between first and last insemination.



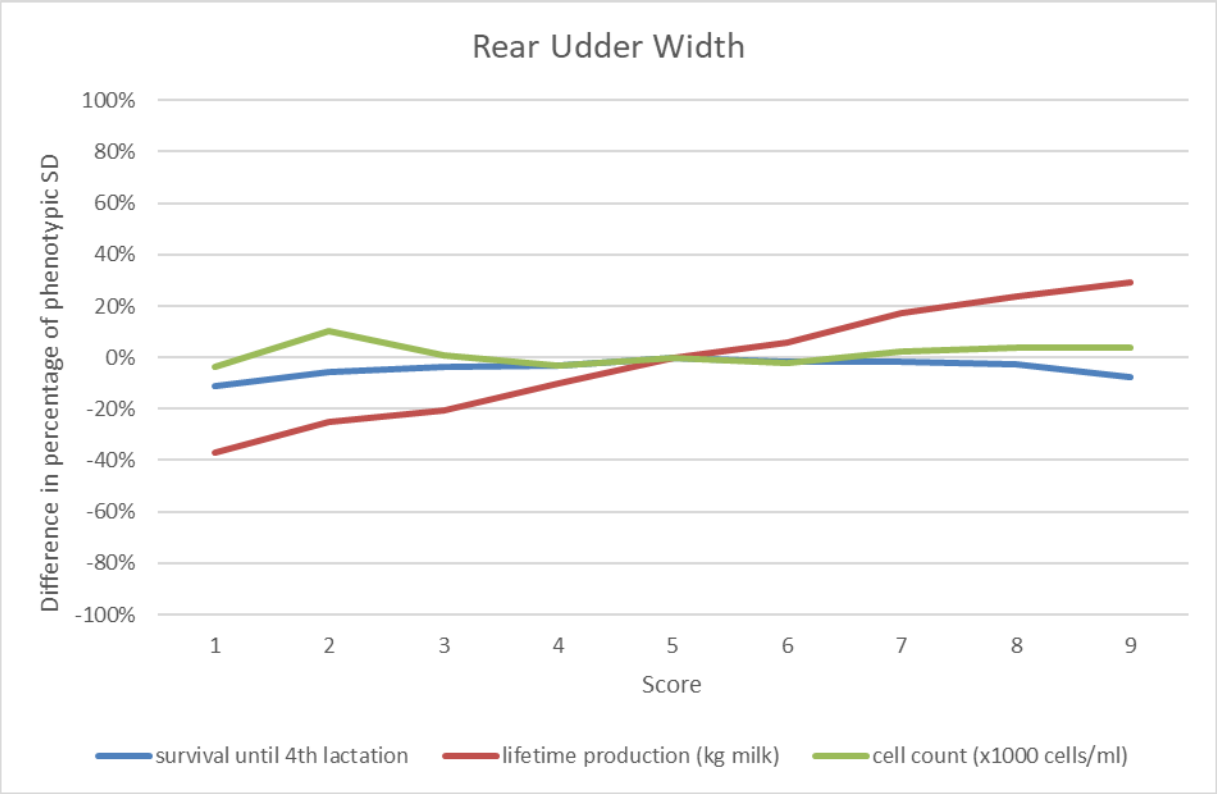
## 20 Bone Structure

The thickness of the bone has a weak relation with survival and lifetime production. Low values - meaning a coarse bone structure - are related to a lower survival.



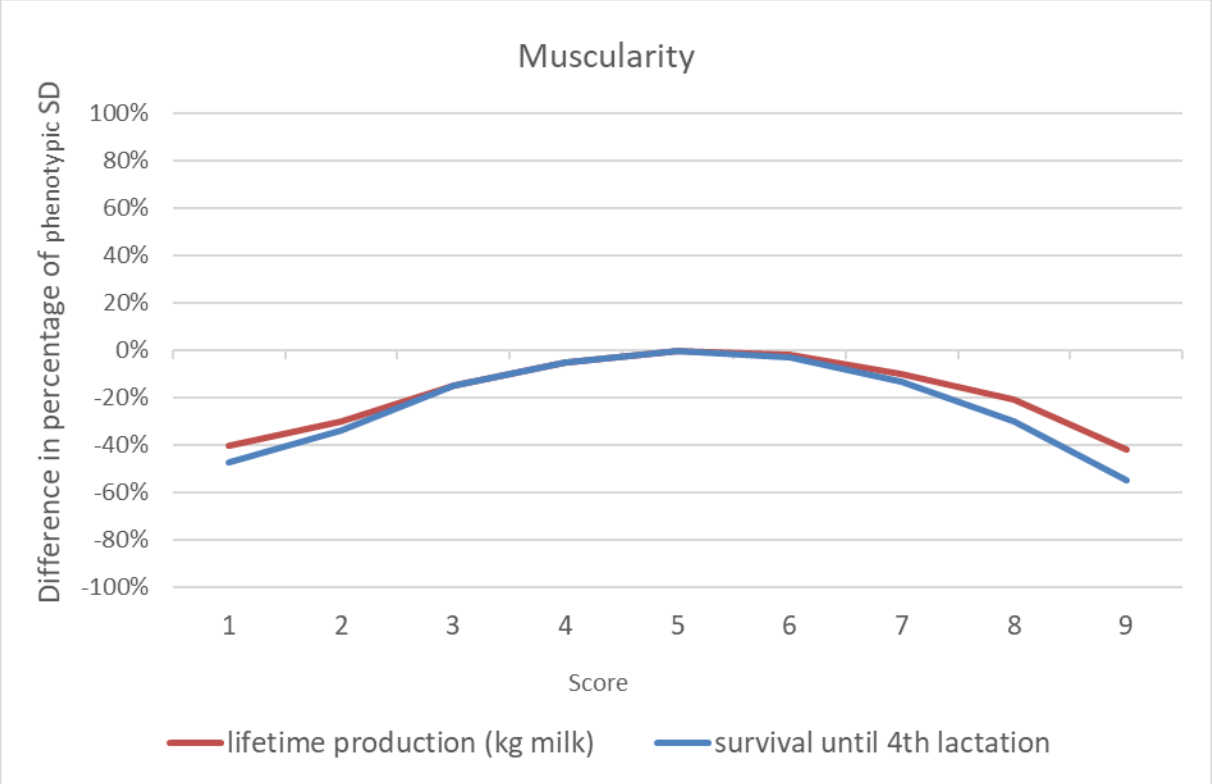
## 21 Rear Udder Width

Rear Udder Width has a positive and nearly linear relationship with lifetime production. This relationship is like the one found with Rear Udder Height. The reason is that more room is available for milk production, without deepening the udder.



## 22 Muscularity

Muscularity, a standard trait for dual purpose cattle, shows an intermediate optimum for survival and lifetime production. The use of Muscularity in linear description is also an indicator of functional traits. As with milk production, its optimum should be defined in relation to the breeding goal for meat production on one hand, and survival on the other hand.



## 23 Fore Udder Length

Fore Udder Length, a second trait that is specific for dual purpose cattle, has an intermediate optimum for survival, and for lifetime production. Shorter fore udders are found in cows with low production. Very long fore udders usually produce more milk, what leads to a higher lifetime production.