Conformation recording as auxiliary trait for functionality and fitness in dairy goats

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Abstract

In 2016, the International Committee for Animal Recording (ICAR) published the first international guidelines for the linear scoring of dairy goats. A working group with the goal to review and revise these guidelines was established in 2022. First, a literature and internet search were carried out on conformation recording systems for dairy goats that existed worldwide. Ten organizations were identified that carried out a linear scoring of dairy goats (Austria, Canada, France, Germany, Mexico, Norway, Slovenia, Spain, United Kingdom and USA). All organizations were contacted and asked whether they would like to participate in a working group to revise the ICAR guidelines. Eight of them take part in the working group. The working group's proposed changes are to be implemented in 2024.

The ICAR guidelines include 21 traits in three categories as follows: udder (9), legs (5) and body frame (7). The focus of all eight participating organizations was on udder traits. Leg traits are recorded in four countries according to the ICAR guidelines. The

ICAR body frame traits are recorded by four countries; they are often measured and not described linearly.

A breeding value estimation for conformation traits was developed in five of the eight participating countries. In addition, relationships with other traits, in particular *length of productive life* (LPL), were examined. The traits recommended by ICAR will therefore provide even better information in the future as auxiliary traits for breeding healthy and long-living dairy goats.

Keywords: dairy goats; conformation; linear type traits
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Introduction

One goal in dairy goat breeding is to breed healthy and long-living animals to achieve the desired performance. Conformation traits play a major role for production, longevity and profitability (Massender *et al*., 2022; Castañeda-Bustos *et al*., 2017; McLaren *et al*., 2016). While much farm animal's performance can be measured objectively, such as milk production and daily gain, conducting an objective conformation assessment is more complex. ICAR published international guidelines for conformation recording in dairy goats in 2016 to help to ensure the equivalence of conformation recording collected worldwide and to provide practitioners with description procedures that are backed up by scientific knowledge. At that time, four countries were involved in developing the guidelines. Since then, conformation recording has been introduced in several other countries. Practical experience in carrying out the performance test according to the published guidelines as well as scientific studies on the genetic basis of the traits made it necessary to revise the guidelines. Therefore, a working group of experts to review and revise the ICAR guidelines was established in 2022. The working group's proposed changes are to be implemented in 2024. The following describes the distribution of the conformation recording in dairy goats worldwide as well as experience with using the traits from the ICAR guidelines from 2016.

Material and methods

A literature and internet search were carried out in 2022 on conformation recording systems for dairy goats that existed worldwide. All identified organizations were contacted and asked whether they would like to participate in a working group to revise the ICAR guidelines. In a series of online meetings, participants presented and discussed the conformation recording system in their countries. All the information collected was supplemented with references from the literature and shared among the participants. The results of the working group were agreed with the ICAR conformation working group at the ICAR meeting in Bled in May 2024 and are to be incorporated into the guidelines.

Results

Ten organizations were identified that carried out a linear description of dairy goats (Austria, Canada, France, Germany, Mexico, Norway, Slovenia, Spain, United Kingdom and USA). All organizations were contacted and asked whether they would like to participate in a working group to revise the ICAR guidelines. Eight of them responded positively. The stakeholders are representatives of state institutions, universities and breeding organizations. In two countries, only male animals are reported, in two countries both males and females are included and in all other countries female animals

only are reported, providing the information relevant to the sires of those female progeny. Describing the goats includes the responsibility of goat breeders, employees of the breeding associations and state employees.

The ICAR guidelines currently include 21 traits in three categories of udder (9), legs (5) and body frame (7). The focus of the majority of participating organizations is on udder traits. Eight of the ICAR traits are recorded in four countries, seven in two countries and two countries record only two of the ICAR udder traits. Some countries record additional traits such as *udder profile/form*, *rear udder side view* or deficiencies like *teat thickness* or *supernumerary teats*. Leg traits are recorded in four countries according to the ICAR guidelines. Further traits are *front legs set front view*, *front legs set side view* and *feet angle opening*. *Splayed toes* are recorded as a deficiency in one country. The ICAR body frame traits are recorded by four countries; they are often measured and not described linearly. Additionally, *body length* and *chest circumference* are measured in two countries, other traits are *chest depth*, *width of pelvis*, *withers height* and *sacrum height* (all measured). Two countries describe *dairyness*, which considers assessments of for example length, cleanness and flatness of bone, length and leanness of neck, definition and sharpness of withers, ribs angularity, degree of fleshing, femininity and

Table 1. Heritabilities (± SE, if available) of exemplary ICAR goat conformation traits.

Trait	Heritability	Study
Stature	0.20 ± 0.02	Castañeda-Bustos et al., 2017
	0.76 ± 0.18	Lange et al., 2018
	0.52	Luo et al., 1997
	0.18	Muñoz-Mejías et al., 2023
	0.72 ± 0.07	Valencia-Posadas et al., 2022
	0.52	Wiggans and Hubbard, 2001
Loin strength	0.09-0.12	Fuerst-Waltl and Fuerst, 2022
	0.0 ± 0.02	Lange et al., 2018
Rear legs set side view	0.20 ± 0.02	Castañeda-Bustos et al., 2017
	0.04-0.09	Fuerst-Waltl and Fuerst, 2022
	0.15 ± 0.10	Lange et al., 2018
	0.21	Luo et al., 1997
	0.03	Muñoz-Mejías et al., 2023
	0.19 ± 0.09	Valencia-Posadas et al., 2022
	0.21	Wiggans and Hubbard, 2001
Rear legs set rear view	0.0-0.08	Fuerst-Waltl and Fuerst, 2022
	0.0 ± 0.10	Lange et al., 2018
	0.25 ± 0.05	McLaren et al., 2016
	0.23	Muñoz-Mejías et al., 2023
Fore udder attachment	0.13-0.29	Biffani et al., 2020
	0.25 ± 0.02	Castañeda-Bustos et al., 2017
	0.30	Clément et al., 2002
	0.09-0.26	Fuerst-Waltl and Fuerst, 2022
	0.11 ± 0.10	Lange et al., 2018
	0.25	Luo et al., 1997
	0.26-0.33	Manfredi et al., 2001
	0.26 ± 0.02	Massender et al., 2022
	0.15 ± 0.04	McLaren et al., 2016
	0.23	Muñoz-Mejías et al., 2023
	0.30 ± 0.01	Rupp et al., 2011 (Alpine)
	0.25 ± 0.02	Rupp et al., 2011 (Saanen)
	0.13 ± 0.08	Valencia-Posadas et al., 2022
	0.25	Wiggans and Hubbard, 2001

refinement, and fineness and texture of skin (extremes are coarseness and sharpness). A *loose shoulder* is recorded as a defect in two countries, describing the lateral deviation of the shoulder joint due to relaxation of the muscles between the chest and front legs. A breeding value estimation for conformation traits was developed in five of the eight participating countries. Table 1 shows example genetic parameters for a few selected ICAR traits. The genetic and phenotypic relationships amongst conformation traits and milk yield in mixed breed UK dairy goats scored during their first lactation in the UK were reported by McLaren *et al*. (2016). The genetic correlations estimated between the conformation traits and milk yield, across the first lactation, demonstrate the changes that occur during this time period. The majority of the correlations estimated between milk yield and both the udder and teat traits were negative and antagonistic. These results are consistent with those of Clément *et al*. (2002), who found null or negative correlations in French goat breeds.

In addition, relationships with other traits, in particular length of productive life (LPL), were examined. Genetic correlations were estimated between the final score and functional productive life at 72 months of age (FPL72) (0.52 ± 0.11), fore udder attachment and FPL72 (0.37 ± 0.09) and udder depth with FPL72 (0.36 ± 0.10). This suggests that selection for these type traits can improve FPL72 in dairy goats (Castañeda-Bustos *et al*., 2017). Findings from these genetic analyses were incorporated into the revision of the ICAR traits.

Finally, the working group agreed to skip the traits rear udder height, locomotion, chest and rump width. The following traits are to be included: teat orientation rear and side view, feet angle opening and chest circumference. Teat orientation is the direction of the teats in relation to the udder viewed from rear/side. Feet angle opening is the angle between the hind legs, when the goat is walking, and chest circumference is the circumference measured behind the shoulder blades. The angularity trait is renamed rib structure. Chest circumference replaces chest width. At rear udder height and rump width, the general opinion was that these traits are not relevant for the majority of the population. For locomotion, all group members agreed that recording the trait was not

Table 2. Summary of the working group's resolutions.

Trait group	Keep	Skip	New
Udder traits	Fore udder attachment Central ligament Rear udder width Udder depth Teat placement rear view Teat length Teat form	Rear udder height	Teat orientation rear view Teat orientation side view
Leg traits	Rear legs set rear view Rear legs set side view Front pasterns side view Hind pasterns side view	Locomotion	Feet angle opening
Body frame traits	Stature Body depth Rump angle Loin strength Rib structure (before: Angularity)	Chest width Rump width	Chest circumference

Table 3. Examples of defects in dairy goats

Defect	Definition
Loose shoulder	Weakening of the muscles between the chest and the front limbs, which can cause problems when standing up
Jaw: undershot and overshot	Underdevelopment of the lower or upper jaw
Supernumerary teats	More than two teats (which sometimes produce milk)
Double teats	Teat splits in two teats
Unbalanced udder	Udder halves are expressed to varying degrees
Udder warts	Non-milk-producing protrusions on the udder
Weeping teats/udder	Milk can filter through pores in the skin to the udder surface
Splayed claws	Enlarged gap between the claws

practical. Table 2 provides an overview of the existing, new and deleted traits for the guidelines for linear scoring in goats

A list of defects has also been drawn up to supplement the guidelines. Table 3 shows the defects and their definition.

Discussion

Milk produced from dairy goats is an important source of nutrition for many populations worldwide, and is considered to be a niche market for others. As the formalisation of breeding programs to enhance productivity has become more accessible world-wide, it is important to consider functional fitness traits as being integral to these breeding programmes. From four countries in 2016, there are now (in 2024) ten countries, which have introduced linear scoring in dairy goat breeding. The importance of the ICAR guidelines increases with the extension of linear scoring in different countries. It is therefore necessary to regularly adapt the guidelines to new developments, which has now been done by the sub-working group. At the same time, dissemination to all relevant organizations and harmonization among describers within and across populations will be essential to ensure adequate data quality and comparability. Studies of the genetic basis show that all of the traits proposed by ICAR are heritable, mostly in the low to moderate range, depending on the populations studied. Therefore, the traits can be improved by selection. Findings of McLaren *et al*. (2016) and Clément *et al*. (2002) on negative or null correlations between conformation traits and milk yield show the importance of scoring conformation scores in dairy goats as breeding programmes would benefit from including these traits in order to ensure that selection for increased productivity is not accompanied by the deterioration of functional fitness. In addition, morphological traits are genetically favourably correlated with somatic cell count (Rupp *et al*., 2011). Thus, taking morphology into account in the selection objective is also a way of acting on udder health. Through the improvement of conformation traits based on the ICAR guidelines, the productive life of goats can be extended, the economic value of the animals can be improved and the income of breeders can be increased. To ensure this, further efforts should be made to investigate genetic relationships with LPL and other health-related traits in the target populations..

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