Introduction of a genetic evaluation for longevity in Tyrol Mountain sheep

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Abstract

With 15,166 registered ewes (> 0.5 years) on 1,047 farms in 2022, Tyrol Mountain has the largest number of animals among the registered sheep breeds in Austria. Tyrol Mountain is a non-seasonal breed; in 2022, 10,351 lambings from 8,147 ewes were recorded (ÖBSZ, 2023). Official breeding values for Tyrol Mountain sheep in Austria were published for the first time in 2017. At the same time, genetic evaluations have been introduced for other sheep and goat breeds. For the mountain sheep breeds, genetic evaluation currently includes the traits age at first lambing, lambing interval, lambs born and lambs born alive (both maternal and paternal) and the fitness index based on these traits. However, longevity, one of the most important functional traits, is missing from the current breeding objectives. While survival analysis has long been the "state of the art", especially in dairy breeding, many newly established routine genetic evaluations are based on linear models. Therefore, a genetic evaluation for a longevity related trait was developed for Tyrol Mountain, which can be implemented in routine breeding value estimation based on linear models. For this purpose, 5 cumulative periods from first lambing onwards were defined. The traits are the number of lambings in the periods 1, 2, 3, 5 and 8 years after the first lambing. The average number of lambings is 1.8 in the first year and 4.5 within 8 years, the maximum number of lambings after 8 years is 15. Apart from the random animal genetic effect, the evaluation model includes the fixed effects of age at first lambing, year-month, herd, and the random effect of herd-year. The last uncompleted period of living animals is considered by extrapolating their expected performance. All following periods are then set to missing for these animals. Estimated heritabilities for the 5 periods range from 0.03 (period 1) to 0.14 (period 8). Genetic correlations between traits are consistently high, ranging from 0.81 to 0.99. Period 3, i.e. the number of lambings within 3 years after the first lambing, is considered the target trait. The first official breeding values for longevity will be published in June 2024, along with new breeding values for conformation and a total merit index.

Keywords: sheep, longevity, genetic parameters, breeding values.
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Introduction

A considerable variety of sheep breeds exists, which are adapted to different climatic conditions and/or are particularly suitable for different purposes. Accordingly, the Austrian Sheep and Goat Association (ÖBSZ, Österreichischer Bundesverband für Schafe und Ziegen) categorises the different sheep breeds into four groups, namely mountain sheep, land sheep, dairy sheep and meat sheep (ÖBSZ, 2013). Mountain sheep breeds account for the highest proportion of animals (>50% of herd book

ewes). These breeds are mainly kept in alpine regions, are non-seasonal, and are used mostly for lamb production, landscape management, and conservation grazing. Within this group, the Tyrol Mountain breed has the highest proportion of animals among the registered sheep breeds in Austria, with 15,166 registered ewes (> 0.5 years) on 1,047 farms in 2022. In the same year, 10,351 lambs were recorded from 8,147 ewes (ÖBSZ, 2023).

In 2017, official breeding values for Tyrol Mountain sheep in Austria were published for the first time. In parallel, genetic evaluations have been introduced for other sheep and goat breeds (Fuerst-Waltl and Fuerst, 2021; 2022). For the mountain sheep breeds, genetic evaluation currently includes the traits age at first lambing, lambing interval, lambs born and lambs born alive (both maternal and paternal) and the fitness index based on these traits. Breeding values are calculated on two main dates, the beginning of January and the end of June. In addition, breeding values and reliabilities are calculated on a weekly basis, but are only uploaded if the change in reliability exceeds 5% points or if a new result is available from individual performance recording (e.g. lambing). All estimated breeding values (EBV) are standardised to relative breeding values with a mean of 100 (rolling base, rams aged 5-15 years) and a genetic standard deviation of 12 points, with higher values being desirable. Longevity, one of the most important functional traits, is however missing from the current breeding objective. While survival analysis has long been the "state of the art", especially in dairy breeding, for several reasons many newly established routine genetic evaluations are based on linear models and survival yes/no in certain periods (e.g. van Pelt *et al*., 2017; Heise and Simianer, 2019, Zuchtwert AUSTRIA, 2023). In livestock without dairy focus, such as beef or sheep with focus on lamb production, the number of births in a certain period may be of higher interest. Venot *et al*. (2013) proposed the number of calvings at a target age, called "productive efficiency", as a suitable trait for beef cattle. Following the latter concept, a genetic evaluation based on linear models was developed for Tyrol Mountain.

Material and methods

Five cumulative periods were defined from the first lambing onwards, i.e. 1, 2, 3, 5 and 8 years. The longevity related trait was defined as the number of lambings within each period. Following the concept of Brotherstone *et al*. (1997), the last uncompleted period of animals that are alive is considered by extrapolating their expected performance. All other periods are subsequently set to missing for these animals. Genetic parameters were calculated using the VCE6 software package (Groeneveld *et al*., 2008) and bivariate linear animal models. In addition to the random animal genetic effect, the model included the fixed effects of age at first lambing, year-month and herd, and the random effect of herd-year. Depending on the period, between 12,935 and 22,383 ewes were considered (Table 1); the pedigree data set comprised 41,135 animals. Following intensive discussion with the breeding associations and contrary to dairy breeds, no correction for voluntary culling was made.

Results and discussion

Table 1 shows the number of animals, as well as the mean, standard deviation, minimum and maximum of the defined trait in each period. For period 1, the mean number of lambings is 1.75 ± 0.46, for period 8 it is 4.48 ± 2.90. In the higher periods, the number of lambings is somewhat lower than in other non-seasonal sheep breeds (data not shown). However, this may also be due to conscious management decisions by farmers, as seasonal lambing is potentially advantageous in the case of alpine grazing, which is particularly common in the federal province of Tyrol.

Table 1. Number of animals and mean, standard deviation, minimum and maximum for the number of lambings in the defined periods (1, 2, 3, 5 and 8 years).

Period (yrs)	N	Average number of lambings	Standard deviation	Minimum	Maximum
1	22,383	1.75	0.46	1	3
2	21,332	2.67	1.01	1	5
3	19,890	3.36	1.53	1	7
5	17,454	4.20	2.38	1	10
8	12,935	4.48	2.90	1	15

Table 2. Heritabilities (on diagonal) and genetic correlations (above diagonal) and their standard errors in parenthesis for the number of lambings in the defined periods (1, 2, 3, 5 and 8 years).

Period	1	2	3	5	8
1	0.034 (0.01)	0.97 (0.04)	0.92 (0.06)	0.86 (0.06)	0.81 (0.02)
2		0.063 (0.01)	0.99 (0.01)	0.97 (0.02)	0.96 (0.03)
3			0.089 (0.01)	0.99 (0.01)	0.99 (0.01)
5				0.128 (0.01)	0.99 (0.01)
8					0.140 (0.01)

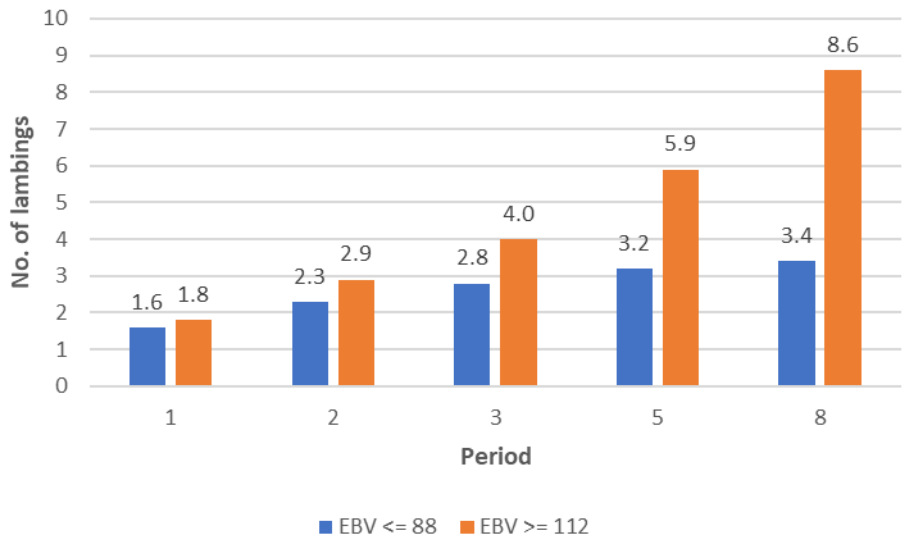

Figure 1. Mean number of lambings of daughters of rams with period 3 breeding values (EBV) of <= 88 and >=112.

Table 2 shows the heritabilities and genetic correlations as well as their standard errors for the five traits, number of lambings in a defined period. All bivariate runs finished with optimal status. Both the heritabilities (h^2 = 0.034 to 0.14) and the genetic correlations (r_a = 0.81 to 0.99) lie within a reasonable range and are consistent. Heritabilities increase markedly with increasing period. Results for other mountain sheep breeds such as Jura or Brown Mountain are however very similar (h^2 = 0.10 and 0.13 in period 8, respectively; data not shown). For the land sheep breed Merinoland, also being non-seasonal, but bred with a focus on meat production (Fuerst-Waltl and Fuerst, 2021)

lower heritabilities were observed in all periods (e.g. h^2 = 0.06 in period 8), though. The genetic correlations range from 0.81 between period 1 and 5 and 0.99 between e.g. period 4 and 5. The periods at younger ages will thus provide suitable predictors for the number of lambings later in life.

Based on the genetic parameters, genetic evaluation test runs were performed by MiX99 (MiX99 Development Team, 2022), which is also used in the routine. In accordance to other traits, natural EBV were standardised to a mean of 100 and 12 points per genetic standard deviation. Figure 1 illustrates the mean number of lambings for daughters of rams with EBV for period 3 <=88 and >=112. The difference between these two ewe groups is 0.2 lambings in period 1, in period 8 it is as high as 5.2 lambings.

The first official EBV will be published in June 2024. Breeding values for all periods are estimated multivariately, but only those for period 3 are published for animals with a minimum reliability of r^2 = 0.20.

The introduction of the new EBV for longevity will be accompanied by the introduction of a genetic evaluation for conformation traits based on linear scoring and a total merit index (TMI). Within the TMI, longevity will have a relative weight of 30%, which is half the weight of all functional traits. The inclusion of conformation traits as auxiliary traits for longevity is not yet feasible as the estimated genetic correlations still have too high standard errors and are therefore unreliable. Linear scoring has only recently been introduced, so ewes with phenotypes for conformation have not had the chance to survive higher periods. Therefore, genetic correlations between conformation and longevity will be re-estimated over the next few years and appropriate traits will be selected based on the results.

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List of references

Brotherstone, S., R.F. Veerkamp, and W.G. Hill, 1997. Genetic parameters for a simple predictor of the lifespan Holstein-Friesian dairy cattle and its relationship to production. Animal Science 65, 31-37. doi:https://doi.org/10.1017/S135772980001626X.

Fuerst-Waltl, B. and C. Fuerst, 2021. Development of a routine genetic evaluation and a total merit index for sheep breeds with focus on meat production. Small Ruminant Research 202, 106467. doi:https://doi.org/10.1016/j.smallrumres.2021.

Fuerst-Waltl, B. and C. Fuerst, 2022. A longevity related trait suitable for the genetic evaluation of Merinoland sheep. Animal. Science proceedings.13:95-96.

Groeneveld E., M. Kovač and N. Mielenz, 2008. VCE Users's Guide and Reference Manual. Version 6.0. Institute of Farm Animal Genetics, Neustadt, Germany.

Heise, J. and H. Simianer. 2019. Zuchtwertschätzung für Nutzungsdauer bei Milchkühen. Ein neues Modell für ein altes Merkmal. Züchtungskunde 91, 45-53.

MiX99 Development Team (2022). MiX99: A software package for solving large mixed model equations. Release I/2022. Natural Resources Institute Finland (Luke). Jokioinen, Finland. http://www.luke.fi/mix99 (10.05.2024)

ÖBSZ, 2023. Jahresbericht 2022. https://www.oebsz.at/fachinformationen/jahresberichte (10.05.2024)

Van Pelt, M.L., G. de Jong and R.F. Veerkamp. 2017. Improving the Genetic Evaluation for Longevity in the Netherlands. Interbull Bulletin No. 51. https://journal.interbull.org/index.php/ib/article/view/1654/1656 (10.05.2024)

Venot, E., P. Schneider, S. Miller, M. Aignet, M. Barbat, V. Ducrocq and F. Phocas, 2013. New French Genetic Evaluations of Fertility and Productive Life of Beef Cows. Interbull Bulletin 47; https://journal.interbull.org/index.php/ib/article/view/1791/1794 (10.05.2024).

Zuchtwert AUSTRIA (2023). Genetic evaluation longevity. https://zuchtwert.at/content/pdf/en/Longevity.pdf (10.05.2024).