Optimization of a meat index for Austrian land sheep

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ABSTRACT: A complex deterministic approach was used to evaluate the annual genetic gain for Austrian land sheep. A total population size of 24,600 ewes, including 7,000 herd book ewes was assumed. Model calculations focused on different weights of traits in the meat index and improvement of the performance testing regime. Traits considered were daily gain, EUROP carcass classification score (EUR), muscle depth and fat depth (FAT). A positive genetic gain (=reduction) for FAT may only be achieved when it is given a weight higher than € 0.5 per additive genetic standard deviation. As no direct information on EUR is available, the inclusion of EUR in the breeding goal results in markedly decreased reliabilities of the meat index and is thus questionable. An improvement of performance testing by increasing the test capacity is suggested because of the possible higher selection intensity.
Keywords: Land sheep; Breeding program; Meat performance ; Deterministic calculations

Introduction

In Austria, performance testing for growth and carcass traits has been obligatory for herd book sheep of meat-focused breeds since 2003 (ÖBSZ, 2008). Among those breeds are aseasonal land sheep (Merinoland and Jura) and specialized meat breeds (e.g. Texel, Suffolk). In total, about 8,000 land sheep and 2,000 meat sheep herd book ewes are kept in Austria, respectively (ÖBSZ, 2013). In the breeding goal of Merinoland and Jura sheep, the main focus is on meat and fertility traits, while wool only plays a minor role. In the meat performance test, lambs of both sexes with a live weight of around 40 kg are weighed and scanned with an ultrasound device. Both, fat depth (FAT) and eye muscle depth (MU) are measured twice on the same picture, 2 cm apart laterally, and the average of the two measures is used. More details on data recording can be found in Junkuszew and Ringdorfer (2005) and Maximini et al. (2012). However, small ruminants are currently still lacking a routine genetic evaluation. As a first steps towards an implementation of routine genetic evaluation, variance components needed to be estimated (Maximini et al., 2012). Secondly, sub-indices for trait groups and a total merit index have to be defined. Hence, traits being included and their respective weights in the index have to be determined. The weight of traits in indices may be based on derived economic weights or be chosen in order to achieve desired gains in selected traits. The aim of this study was the evaluation of the annual genetic gain in different scenarios for Austrian land sheep by means of model calculations. The focus was on both different weights of traits in the meat sub-index and the improvement of the current performance testing regime.

Materials and Methods

Model. To model the breeding programs, the computer program ZPLAN version z10.for (Willam et al., 2008) was used. ZPLAN is designed to optimize selection strategies in livestock breeding by deterministic calculations. It is based on a comprehensive methodology of evaluating both the genetic and economic efficiency of breeding strategies, considering one cycle of selection. The gene flow method (Hill, 1974; McClintock and Cunningham, 1974) and selection index procedures constitute the core of the program. Breeding programs and their parameters are defined by the user, and the program calculates a number of criteria such as aggregate genotype, annual genetic gain (AGG) for single traits, discounted returns and discounted profit for a given investment period. The criteria for evaluating alternative scenarios were annual monetary genetic gain (AMGG; monetary superiority per year of the progeny of the selected animals after one selection round in the breeding unit), and AGG. Input parameters were based on information by breeding organizations, as well as preceding analyses of the breeding program and genetic parameters (Fürst-Waltl et al., 2006, Grill et al., 2013), respectively.

Scenarios. Table 1 presents selected input parameters for the reference scenario, describing the current land sheep population. In Table 2, heritabilities, phenotypic and genetic correlations are shown for the traits of interest. For daily gain (DG), MU and FAT, genetic parameters based on land sheep data analyses were used, while for the EUROP carcass classification score (EUR), values were assumed based on literature and phenotypic relationships (Maximini et al. 2012; Grill et al., 2013). Genetic and phenotypic standard deviations as well as economic weights per additive genetic standard deviation (w/s_a) for the reference scenario (1) and two alternative scenarios (2, 3) are given in Table 3. Traits with w/s_a represent traits in the breeding goal. For all scenarios, performance testing information (own performance, performance of sire, dam, paternal and maternal half sibs) was available for all traits but EUR. In the reference scenario, economic weights as derived by Fürst-Waltl et al. (2006) were used for DG and EUR, while the ultrasound measurements fat and muscle depth were considered as auxiliary traits. In scenario (2), ultrasound measurements were additionally given an economic weight. As no direct information is available for EUR, we decided to reduce w/s_a to zero in scenario (3) in order to strengthen MU and FAT. Currently, only approximately 20% and 6% of potential female and male replacement animals are performance tested. As basically all tested animals are needed for replacement, selection intensity and thus annual genetic gain are negatively affected. Hence, proportions of performance tested herd book animals' offspring were increased to 30 and 40% (females) and 15 and 25% (males) within scenarios (1) and (3).

Table 1. Selected input parameters for modelling the breeding program of Austrian land sheep (reference situation)

Total population	24,600
No. of herd book ewes	7,000
No. of herd book rams	400
Ø no. ewes/ram	15
Ø productive life rams	2.5 years
Ø productive life ewes	4.5 years
Ø age ewes at first lambing	1.5 years
Ø age rams at birth of first offspring	1.2 years
Ø lambing interval	0.75 years
Ø no of offspring/lambing	2
Ø generation interval	2.95 years
Ø rearing losses	15 %
No. of performance tests/year (females/males)	2,000 (1500/500)

Table 2. Heritabilities (on diagonal), phenotypic correlations (below diagonal) and genetic correlations (above diagonal) for traits considered in the meat index

	DG	**EUR**	**MU**	**FAT**
DG	**0.16**	0.05	0.11	-0.28
EUR	0.25	**0.25**	0.40	-0.30
MU	0.31	0.30	**0.20**	-0.25
FAT*	-0.43	-0.20	-0.23	**0.25**

DG = daily gain, EUR = Europ carcass classification score, MU = muscle depth, FAT = fat depth
*higher values favourable

Results and Discussion

Effects of weights in the total merit index. In Figure 1, AGG per trait expressed in additive genetic standard deviations is shown. In the reference scenario, the highest AGG is achieved for DG. For EUR and MU, only a slightly positive AGG may be achieved. Due to the undesired genetic relationship between FAT and all other traits, FAT and thus fat coverage increases. Both MU and FAT are by definition auxiliary traits, as currently payment is not based on either trait. However, breeding organizations aim at improving both traits, increasing MU and slightly decreasing FAT. The first is likely to result in higher yielding carcasses, while reducing fat cover up to a certain point meets customer demands. Thus, in scenario (2) both MU and FAT were given an economic weight of € 0.5 per s_a each (Table 3). The rather small weight markedly improved the genetic gain of MU and reduced the negative gain of FAT, without considerably affecting DG and EUR (Figure 1). AMGG was also hardly altered (-3%, data not shown). In scenario (3), the relative weights of the traits in the subindex were DG : EUR : MU : FAT = 48 : 0 : 31 : 21 (Table 3). When including EUR in the index without any economic weight, the AGG were positive for all single traits (Figure 1). In comparison to the reference scenario (1), AGG for DG decreased by about 20%, but was still on a rather high level. At the same time, AGG for EUR was still close to zero and thus hardly affected. Further, AMGG was also improved by about 9%. As mentioned earlier, no direct information on EUR is available and genetic improvement can only be achieved by correlated selection response. The inclusion of EUR as a breeding goal trait (scenarios 1 and 2) resulted in a markedly decreased reliability of the meat index (data not shown) and is thus questionable.

Table 3. Phenotypic and additive genetic standard deviations (s_p and s_a) and economic weights in € per additive genetic standard deviation (w/s_a) in the meat index for the reference scenario (1) and alternative scenarios (2, 3)

				w/s_a		
	Unit	**s_p**	**s_a**	**(1)**	**(2)**	**(3)**
DG	g	30.05	11.83	3.48	3.48	3.48
EUR	class	0.46	0.23	1.47	1.47	0
MU	cm	0.18	0.09	0	0.5	2.2
FAT	cm	0.13	0.06	0	0.5	1.5

DG = daily gain, EUR = Europ carcass classification score, MU = muscle depth, FAT = fat depth

Improvement of performance testing. By improving the proportion of tested offspring within the reference scenario, AMGG is more than doubled (Table 4). This illustrates the importance of selection intensity but also of higher reliabilities, as more information on relatives is available. Regarding the AGG of single traits, DG is further improved, while for FAT the negative development is more pronounced. Scenario (3) already results in a positive AGG in case of the current testing regime (Table 4, Figure 1). When increasing the proportion of tested offspring to 30% females and 15% males, AGG of DG, MU and FAT but also AMGG are doubled. A further increase of performance testing (40% and 25% females and males, respectively) does not improve AGG and AMGG by the same extent. Compared to all other scenarios, the AMGG and the AGG for MU and FAT are the highest.

Table 4. Average annual genetic gain (expressed in additive genetic standard deviations), AGG, and annual monetary genetic gain, AMGG, for the reference (1) and alternative scenario (3) and selected improvements of performance testing

		AGG				AMGG
Scenario		DG	EUR	MU	FAT	
(1)	**w%**	**70**	**30**	**0**	**0**	
20/6.5*		0.10	0.01	0.01	-0.04	0.35
30/15		0.19	0.02	0.03	-0.08	0.70

40/25		0.24	0.02	0.04	-0.10	0.88
(3)	**w%**	**48**	**0**	**31**	**21**	
20/6.5*		0.08	0.01	0.03	0.02	0.38
30/15		0.16	0.01	0.07	0.04	0.76
40/25		0.20	0.02	0.09	0.05	0.97

DG = daily gain, EUR = Europ carcass classification score, MU = muscle depth, FAT = fat depth, w% = relative weight in the index

*Percentage of tested female and male offspring; 20% females and 6.5% males correspond to the current situation

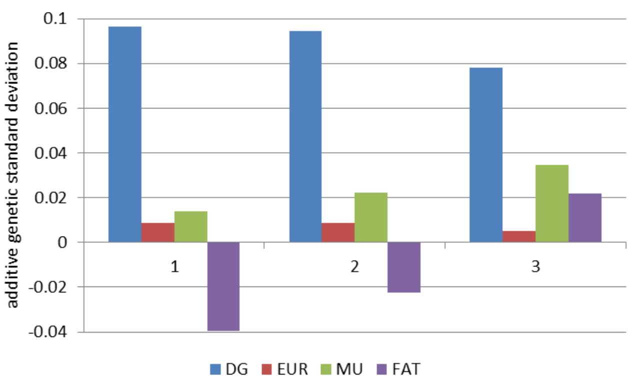

Figure 1. Average annual genetic gain (expressed in additive genetic standard deviations) for the reference (1) and alternative scenarios (2, 3) for the traits DG = daily gain, EUR = Europ carcass classification score, MU = muscle depth, and FAT = fat depth

Conclusions

In the Austrian sheep populations with a focus on meat, currently no routine genetic evaluation is implemented. First test-runs shall however already be carried out in 2014. Breeding organizations aim at published sub-indices for meat, conformation and fitness and finally also a total merit index. Within the meat index, model calculations were needed in order to evaluate possible weights but also an improved situation regarding performance testing. A positive AGG (and thus reduction) for fat cover, which is currently still desired in land sheep breeds, may only be achieved when FAT is given a weight higher than € 0.5 per additive genetic standard deviation. This trait certainly needs to be monitored so that the reduction of fat does not have negative side effects at a later date. An improvement of performance testing is suggested because of the possible higher selection intensity. The introduction of a genetic evaluation of single meat traits and a meat index is only the first step for this population. Further developments towards evaluation of functional and conformation traits and the definition of a total merit index will follow.

Acknowledgements

Funding by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Austrian Federal Association for Sheep and Goats, ÖBSZ, (Projects 100552 and 100884) is gratefully acknowledged.

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