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Breeding programmes for local sheep breeds in Austria

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ABSTRACT

A great variety of different, more or less related, autochthonous sheep breeds exists in the Eastern part of the Alps. The main breed in Austria is called Tiroler Bergschaf (Tyrol Mountain). It is an a-seasonal extensive breed, which is kept for meat production but also for landscape management in alpine regions. Mountain sheep are adapted to the harsh alpine conditions. The actual population size (herd book ewes) is 12,300. The current breeding goal focuses on conformation and type traits. To ensure competitiveness in the future a new breeding programme based on an economic breeding goal must be established. A total merit index with relative economic values of approximately 85% for functional and 15 % for fattening traits is recommended. However, an analysis of auction prices showed that conformation traits, especially type score representing the breed characteristics in Mountain sheep, influence the price at auction in ewes and rams. Therefore it seems justified to discuss the breeders' desire to include the conformation complex in a future total merit index according to the derived economic weights. However, for most other autochthonous local breeds in Austria breeding goals do not focus on classical economic aspects but rather on maintenance of genetic variability, where matings between related animals are avoided and a balanced contribution of breeding rams is aimed for. These breeds are: Alpines Steinschaf, Montafoner Steinschaf, Tiroler Steinschaf, Krainer Steinschaf, Waldschaf, Kärntner Brillenschaf, Zackelschaf and Braunes Bergschaf. All of them are considered being endangered due to their small actual population size; the largest breeding populations consists of about 3000 individuals, the smallest of less than 100. The long-term survival of those breeds will depend on the effectiveness of the actual breeding programmes to preserve genetic variability allowing adaptation to environmental changes and the willingness of farmers to keep those animals even with lower or no federal subsidies.

Key words: Local breeds, Sheep, Conservation breeding, Model calculations, Functional traits.

1. Introduction

As pointed out by Lloyed-Jones already in 1915, the definition of the term "breed" is quite tricky due to its common use. Since this time several authors have emphasized the cultural background to breeds, others their biological attributes. Hall (2004) stated that under the current Convention on Biological Diversity where genetic resources are seen as the property of individual countries, the definition to be used to discuss livestock biodiversity for the future farming will probably be "a breed is whatever a government says it is". However, thanks to FAO (2007) at least a quite reasonable classification system for breed populations exists, distinguishing between local breeds and regional or international transboundary breeds.

Currently, approximately 36,000 purebred herd book ewes (older than one year) of about 30 different breeds are kept in nearly 4000 farms in Austria (Table 1; ÖBSZ, 2007). The main breed is Tiroler Bergschaf (approx. 13,600 herd book ewes) followed by Merinoland (approx. 6250 herd book ewes). About $^2/_3$ of all herdbook sheep clearly belong to multi-purpose local or regional transboundary breeds, the latter mainly found in Austria. Only about 5.5% and 4.4% of the herd book ewes are dairy and meat sheep.

A clear breed definition, i.e. definition of the group of individuals to which the programme should be applied, is essential to carry out breeding programmes. In Austrian sheep breeding it is distinguished between classical breeding programmes aiming to improve performance and functional traits and conservation breeding programmes with a main focus on the maintenance of phenotypic characteristics and the genetic variation within the breed. In the following examples for such breeding programmes and their development are given.

Table 1 Number of herd book ewes (older than 1 year), herd book rams (older than 1 year) and farms , origin (A = autochthonous, F = foreign) and degree of endangerment (DE) according to ÖNGENE (NE = not endangered, E = endangered and HE = highly endangered) for different breeds in Austria

Breed	Farms	Herd book rams	Herd book ewes	Origin	DE
Alpines Steinschaf	29	30	265	A	HE
Braunes Bergschaf	141	154	1934	A	HE
Juraschaf	82	120	1238	F	NE
Kärtner Brillenschaf	193	181	3233	A	HE
Krainer Steinschaf	40	82	718	A	HE
Merinoland	139	353	6267	F	NE
Montafoner Steinschaf	18	21	144	A	HE
Tiroler Steinschaf	347	198	2442	A	E
Tiroler Bergschaf	2473	1619	13609	A	NE
Waldschaf	76	96	941	A	HE
Walliser Schwarznasen	77	73	328	F	NE
Weißes Alpenschaf	11	12	89	F	NE
Zackelschaf	33	46	254	A	HE
Schwarzköpfiges Fleischschaf	50	54	328	F	NE
Suffolk	91	168	805	F	NE
Texel	43	106	441	F	NE
East Friesian	37	231	1514	F	NE
Lacaune	6	135	455	F	NE
Others	94	124	893	-	-
TOTAL	**3980**	**3803**	**35898**		

2. Endangered sheep breeds

2.1 The choice of breeds

Similar to the problems regarding the definition of "breed" it is difficult to asses a risk status. Still no consistent system for the recognition and definition of factors directly measuring the degree of endangerment of breeds of farm livestock exists (Alderson, 2009). Therefore the first step before implementing national conservation breeding programmes must be to derive a clear definition to which populations the planned programmes should be applied. In Austria, this issue was handled by ÖNGENE, the Austrian national association for genetic resources. This organisation was founded in 1982. ÖNGENE had to decide for which of the established breeds Austria has to take over the responsibility for conservation activities. The responsibility was finally defined for local Austrian breeds but also regional transboundary breeds originating either from today's national territory or the K&K Austrian-Hungarian monarchy.

Based on the recommendations of ÖNGENE a definition of the degree of endangerment (DE) was derived. It roughly followed the threshold for eligibility for financial incentives in the EU taking simply the number of breeding females into account (e.g. less than 10,000 breeding ewes in sheep).

From all sheep breeds kept in Austria, nine breeds are considered being autochthonous. Eight of them are officially acknowledged being endangered or even highly endangered (Tab. 1). The official acknowledgement of those 8 breeds was partly based on the use of molecular genetic information. E.g., Montafoner Steinschaf was considered as a variety of Alpines Steinschaf until molecular genetic results supported its acknowledgement as separate breed (see Figure 1., Baumung.et al. 2006).

2.2 The conservation breeding programme

The overall goal in Austrian conservation breeding programmes is to maintain genetic diversity within breeds rather than improving performance traits. The conservation breeding programmes are a combination of in situ conservation measures keeping living animals on private farms and ex situ measures (gene bank, zoo populations).

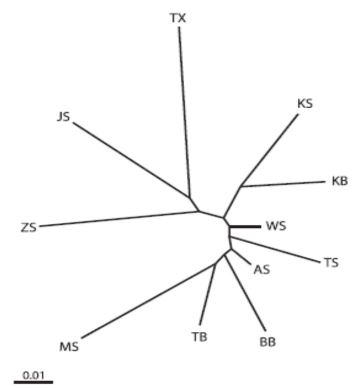

Figure 1 Unweighted pair group method with arithmetic mean-distance tree based on Nei's minimum distance TX, Texel; KS, Krainer Steinschaf; KB, Krainer Steinschaf; TS, Tiroler Steinschaf; AS, Alpines Steinschaf; WS, Waldschaf; TB, Tiroler Bergschaf; BB, Braunes Bergschaf; MS, Montafoner Steinschaf; ZS, Zackelschaf; JS, Juraschaf.

2.2.1. In situ conservation

For each sheep breed one official breeding organisation is responsible for the realization of the breeding programme. Such a responsible organisation (RO) characterises the breed, sets the breed's standard and keeps the herdbook records in a national data base.

Further, the RO has the duty to manage planned matings and to provide a large number of unrelated breeding rams. Parentage verification for all breeding rams is obligatory. Additionally in highly endangered breeds farmers are not allowed to choose breeding rams freely, they have to choose a ram from a list of rams provided by the RO. The RO generates the list by searching available rams with the lowest average genetic relationship to the farmers' ewe flock. To avoid over proportional use of some rams (popular sire effect) the number of offspring already produced by each ram is also considered when ranking the rams on the list. When a certain number of offspring is already recorded, a ram can not be listed anymore. Lambs sired by rams not belonging to such list can not become breeding animals themselves. With this simple but practicable procedure it is aimed to balance the genetic contribution of breeding animals and to keep the rate of inbreeding within the total population low.

Each year ÖNGENE controls the impact of the breeding programme by calculating pedigree based measures for the whole breed like the rate of inbreeding, the effective population size based on the rate of inbreeding, the used number of sires and dams and the effective number of sires and dams. In a yearly meeting of the ROs organized by ÖNGENE feedback is given regarding actual problems, breed development and impact of the conservation breeding programmes.

2.2.2 Ex-situ conservation

The Austrian gene bank was established 1997. The basic idea was to back up the in situ conservation programs and to provide material for planned matings in endangered breeds. According to Smith (1984) it was decided to store at least semen from 25 unrelated sires per breed. Actually semen from 160 rams belonging to the 8 endangered breeds is stored, only in case of Waldschaf and Kärntner Brillenschaf semen of more than 25 donors is already available. Ex situ - in vivo conservation activities play just a subsidiary role. However, some zoos (e.g. Tiergarten Schönbrunn) participate in the conservation breeding programmes.

3. Non-endangered sheep breeds

The main breed in Austria is called Tiroler Bergschaf (Tyrol Mountain). It is an a-seasonal extensive breed, which is kept for meat production but also for landscape management in alpine regions. Mountain sheep are adapted to the harsh alpine conditions. The actual population size (herd book ewes) is 12,300. The current breeding goal focuses on conformation and type traits. To ensure competitiveness in the future a new breeding programme based on an economic breeding goal was developed.

Table 2 Number of subsidised animals and farms *(italic)* taking part in the official conservation breeding programme per year for endangered sheep breeds in Austria.

	Birth year							
Breed	2001	2002	2003	2004	2005	2006	2007	2008
Alpines	-	-	-	-	-	-	173	254
Steinschaf							*30*	*42*
Braunes	396	466	652	670	870	808	1241	1572
Bergschaf	*32*	*28*	*45*	*59*	*77*	*71*	*128*	*162*
Kärntner	669	904	1197	1636	1924	2019	2270	2746
Brillenschaf	*77*	*100*	*131*	*159*	*182*	*163*	*225*	*252*
Krainer	130	245	299	308	430	403	598	767
Steinschaf	*16*	*22*	*23*	*24*	*40*	*31*	*48*	*59*
Montafoner	-	62	69	38	69	79	65	93
Steinschaf	-	*9*	*9*	*6*	*10*	*11*	*8*	*11*
Tiroler	1474	1574	1892	1960	2051	1980	1889	1774
Steinschaf	*140*	*154*	*179*	*191*	*187*	*175*	*191*	*187*
Waldschaf	398	492	601	678	719	668	663	712
	64	*75*	*90*	*99*	*107*	*89*	*104*	*110*
Zackelschaf	67	94	115	146	150	142	222	209
	15	*21*	*28*	*27*	*27*	*23*	*35*	*41*

3.1 Estimation of economic values in Tiroler Bergschaf sheep

Due to the federal structure of animal breeding in Austria, performance data were recorded and maintained by several different breeding organisations conducting their own breeding programmes for many years. However, in 2004 a central data base for all Austrian sheep and goats was implemented. At the same time, the respective breeding organizations started to revise breeding objectives aiming at nationwide breeding objectives for the different breed groups of sheep (dairy, meat, mountain and endangered). The definition of breeding objectives is among the first and most important steps when defining a breeding programme (e.g. Ponzoni, 1986). In breeding objectives (of non endangered breeds), relevant traits have to be included according to their economic importance.

Economic values are defined by the value of one unit superiority of a trait keeping all other traits in the aggregate genotype constant (Hazel, 1943). Correct relative levels of economic values of breeding objective traits must be known for establishing a total merit index (Hazel, 1943) and should result in optimum levels of genetic improvement according to future production scenarios (Groen *et al*., 1997). Fewson (1993) suggests the inclusion of 10 to 15 most important traits. Generally, little attention was paid to derivation of economic values in sheep, especially with respect to functional traits becoming increasingly important in animal breeding. In dairy sheep, only some recent studies covered both, production and functional traits (Legarra *et al*., 2007a, 2007b; Fuerst-Waltl and Baumung, 2009; Wolfova *et al*., 2009). Other works included pasture-based sheep in UK (Conington *et al.,* 2004), in the tropics (Kosgey *et al*., 2003) and in Arabic sheep (Haaghdost *et al.,* 2008). However, virtually no information is available on the economic importance of various traits of local sheep kept in the Alpine regions.

3.1.1 Model

For the derivation of economic values, a computer program originally designed to optimize management-related decisions on cattle farms (Amer *et al.,* 1996), first being modified for the estimation of economic values in cattle by Miesenberger (1997) and second for dairy sheep (Fuerst-Waltl and Baumung, 2009) was adapted. The underlying herd model is based on a deterministic approach. A Tiroler Bergschaf sheep herd with lamb fattening and rearing of young sheep for replacement was simulated in a steady state over an infinite planning term according to

Miesenberger (1997) and Reinsch (1993). The economic value of a trait was derived by calculating the difference in herd profit before (reference scenario) and after a genetic change. For these purposes daily results weighted by the proportion of the respective ewe class were summarized over the lambing interval or until culling. The proportion of ewes in different lactations depended on the percentage of culling for infertility, for involuntary or voluntary reasons. Within scenario, the herd distribution stayed constant over time. All relevant revenues and costs were calculated per day. Revenues resulted from selling milk, fattened lambs and animals for replacement. As in the original program (Miesenberger, 1997; Fuerst-Waltl and Baumung, 2009) all costs (including fixed costs) were regarded as variable according to Smith *et al.* (1986). All results were expressed per average ewe place and year as Reinsch (1993) showed that economic values per herd place and year estimated by Markov chains are independent of discount rate and initial state of herd when assuming an infinite planning term. To avoid double counting (Dempfle, 1992) economic values were derived separately for each trait keeping all other traits constant. For each trait, the result was expressed as marginal utility in € referring to an improvement by one unit (e.g. 1 g daily gain, 1% stillbirth) and as economic value in € per genetic standard deviation (sa).

3.1.2 Assumptions

The central data base for all Austrian sheep and goats, data of the Federal Research Institute for Alpine Regions Raumberg-Gumpenstein, results of questionnaires sent out to breed representatives and literature values were used to describe the Tiroler Bergschaf sheep population as accurately as possible. In Table 3 the assumed herd distribution is shown. Voluntary culling was only assumed until 4th lactation. Culling for infertility, for involuntary or voluntary reasons generally occurred at days 120, 245 and 120, respectively.

Table 3 Proportions (in %) of ewe classes by lactation and fate for the reference herd

	Lactation								
	1	2	3	4	5	6	7	8	9+
Involuntary culling	0.70	0.56	0.43	0.93	0.96	1.19	0.92	0.72	3.72
Fertility culling	0.76	1.35	1.03	0.85	0.70	0.58	0.45	0.35	0.00
Voluntary culling	3.52	2.41	1.14	0.23	0.00	0.00	0.00	0.00	0.00
Survivors	18.50	14.19	11.60	9.59	7.93	6.17	4.79	3.72	0.00
Total	23.49	18.50	14.19	11.60	9.59	7.93	6.17	4.79	3,72

Table 4 Assortment of assumptions

Trait (unit)	Value
Lactation length(d)	120
Age at first lambing (d)	450
Min. days open (d)	55
1st lactation yield (kg)	110
Stillbirth rate (%)	6.7
Single/Twin/Multiples (%)	35/56/9
Male lambs for breeding (%)	7.7
Fattening period (kg)	18-40
Gras CP (g)[1]/ MJ ME	169/10.97
Barley CP (g)/MJ ME	120/12.93
Corn silage CP (g)/ME MJ	85/10.80
Gras silage CP (g)/ME MJ	169/10.04
Hay CP (g)/ME MJ	148/9.39

[1]crude protein

Table 5 Assortment of revenues and prices

Trait (unit)	€/unit
Barn costs (ewe/year)	21
Barn costs (fattening lamb/day)	0.03
Barn costs (replacement/year)	12
Lamb carcass weight (kg)	4.81
Ewe carcass weight (kg)	1.5
Repl. fem. carcass weight (kg)	4.35
Labor costs (h)	10
Barley (kg DM)	0.12
Concentrate lamb fattening (kg)	0.25
Gras (kg DM)	0.09
Corn silage (kg DM)	0.11
Gras silage (kg DM)	0.12
Hay (kg DM)	0.13

In Table 4 an assortment of assumptions and in Table 5 a fraction of prices and revenues considered are stated. Further details are described in Fürst-Waltl *et al.* (2006). For the calculation of milk yield in higher lactations, the average milk yield of the first lactation was multiplied by ageing factors. Highest yields were assumed for the 4th lactation with an ageing factor of 1.39. The functions of Wood (1967) and Gompertz (Fitzhugh, 1976) were used to estimate daily milk, fat and protein yield and live weight and daily gain, respectively.
Daily energy and protein requirements were calculated according to AFRC (1993), GfE (1996, 2001) and Kirchgessner (2004). A linear planning algorithm was used to select a least cost ration meeting the protein and energy requirements (Press et al., 1986) for each day. Differences in requirements because of live weight changes (growth and mobilization of body reserves) and gestation were taken into account. Revenues and costs for wool were neglected as they are approximately balanced. Of all lambings, 94% were considered as easy, 4% as difficult while in 2% veterinarian assistance was necessary at € 50/lambing. Lambing occurred aseasonally distributed.

3.1.3 Traits

Fattening traits - Daily gain, dressing percentage and EUROP grading score: An improved performance of daily gain (live mass/age at slaughter) resulted in a shortened fattening period to derive economic values. To increase daily gain, the parameters of the Gompertz curve (Fitzhugh, 1976) were altered in lambs without changing adult ewe size. For dressing percentage (slaughter mass/live mass), the performance was increased by one percent. For EUROP grading score the method described by Miesenberger (1997) and Fuerst-Waltl and Baumung (2009) was followed.
Functional traits - Length of productive life, stillbirth rate (including lambs born dead and losses until 48h after birth), losses before 1st mating (of all lambs surviving until 48h a fixed percentage was assumed to die on day 21), lambing interval, and litter size: For length of productive life, economic value was derived by decreasing the probability of involuntary culling by one percent in all lactations. This resulted in a change in herd distribution and thus in a different profit. The derivation of economic values for litter size followed the method described for EUROP grading score, while for stillbirth rate and losses before 1st mating the traits were improved by 1 percent according to dressing percentage. The economic value for lambing interval was derived by reducing days to first service rather than improving the conception rate.
As genetic parameters for these traits were not available for the Tiroler Bergschaf population, literature values from other populations had to be used for meat and functional traits (e.g. Wessels, 2003; De Vries, 2004; ZuchtData, 2007) to calculate s_a. For details see Fürst-Waltl *et al.* (2006).

3.1.4 Results

In the reference situation, a profit of 11.71 € per average ewe place and year was achieved. This profit is distinctly lower as for Austrian dairy sheep (Fuerst-Waltl and Baumung, 2009). However, for the appraisal of results it has to be considered that this result does not really represent the actual profit as some effects being presumably neutral with regard to economic values were not taken into account (e.g. wool production, claw trimming, electricity). In Table 6, means for all traits across lactations in the reference situation as well as their genetic standard deviations and heritabilities are shown. Further, marginal utilities, economic values per genetic standard deviation (s_a) and relative economic weights for traits and trait groups are provided.

Derivation of economic values

All presented marginal utilities refer to an improvement of the trait mean by one unit. They are expressed per average ewe place and year. Economic values are calculated by multiplying the marginal utilities with the genetic standard deviations of the traits.
Fattening traits -Within fattening and slaughter traits, daily gain was found to have the highest economic value with € 4.16 (Table 6). In Austrian dairy sheep, daily gain was also found to have the highest economic value (Fuerst-Waltl and Baumung, 2009). In accordance to dairy sheep

(Fuerst-Waltl and Baumung, 2009) lowest economic value among fattening and slaughter traits was € 1.53 for the EUROP grading score.

Table 6 Means in the reference situation, genetic standard deviation (sa) and heritabilities (h2) as well as marginal utilities (€/unit), economic weights (€/genetic standard deviation s_a) and relative economic weights for all traits considered

Traits (unit)	Mean	h^2	s_a	Marginal utility in €	Economic value in €/ s_a	Relative economic weight (%)
Daily gain (g)	285	0.30	27	0.15	4.16	7.81
Dressing percentage (%)	47.5	0.40	1.50	2.02	3.03	5.69
EUROP grading score (points)	3.20	0.25	0.295	5.20	1.53	2.87
Longevity (d)	1083	0.12	304	0.015	4.63	8.69
Litter size	1.87	0.04	0.12	113.6	13.57	25.47
Stillbirth (%)	6.7	0.02	3.54	2.14	7.58	14.23
Losses before first mating (%)	5	0.05	4.80	2.23	10.70	20.08
Lambing interval (d)	285	0.05	16.5	0.49	8.08	15.17

Functional traits - The functional trait with the highest economic value is litter size (€ 13.57, Table 6). For stillbirth rate and losses before first mating, economic values of € 7.58 and 10.70 were derived. Compared to dairy sheep, these economic values are markedly higher (Fuerst-Waltl and Baumung, 2009). Reasons therefore most likely include higher prices for breeding stock and a slightly lower prolificacy in the reference situation. Due to the high economic value of losses before first mating, breeding organizations should consider recording losses until the animals are registered in herd books. Currently, only stillbirth rate including losses within the first 48h are routinely recorded for replacement animals.

For lambing interval, the third highest economic value (€ 8.08, Table 6) was derived. In other Austrian sheep breeds (Fürst-Waltl *et al.*, 2006) similar results for lambing interval were found with marginal utilities up to € 0.81 (aseasonal mutton sheep) per day. A short lambing interval is especially important in aseasonal breeds where 3 lambings are expected in two years.

For length of productive life, an economic value of € 4.63 was estimated. Evidence suggests that the decreasing milk yield in higher lactations and the selling of breeding rams play a major role in this context. Legarra *et al.* (2007a) reported positive, albeit very low, marginal utilities for longevity in dairy sheep and consider this trait to be of little importance. Fuerst-Waltl and Baumung (2009) even reported a slightly negative economic value for Austrian dairy sheep. Unlike sheep, functional longevity was found to be the most important functional trait in Austrian dairy cattle (Miesenberger, 1997), a result which is mainly caused by obviously higher replacement costs. In Table 6 not only the absolute economic values but also relative economic values are shown. These were in %: meat : functional traits = 16 : 84, respectively.

3.2 Model calculations for an optimized breeding program in Tiroler Bergschaf sheep

Model calculations may be used to predict the genetic gain and the profit in a given situation and to determine the effect of alternative breeding strategies. Thus, the success of breeding programmes or genetic and economic effects of breeding measures, e.g. new methods of performance testing may be quantified.

One aim of the following part of this study therefore was the evaluation of annual monetary genetic gain, the genetic gains per trait and discounted profit of a scenario reflecting a somewhat optimized present situation in Austrian Tiroler Bergschaf sheep breeding. Willam *et al.* (2002) showed in dual purpose Simmental cattle that the inclusion of functional traits in the total merit index leads to higher genetic gains or at least to reduced negative genetic gains in these traits. Thus, the main issue of the following model calculations was the use of a total merit index including fattening and functional traits based on the economic values estimated in the first step. Another objective was to investigate the effect of alternative breeding strategies with increased economic weights of functional traits.

3.2.1 Methods

For modelling the breeding programs the computer program ZPLAN (Karras *et al.,* 1997) 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. Selection groups have to be defined which are specific for their sources of information and selection intensities. For the following analysis, 7 selection groups were defined. For the selection index part of ZPLAN the information available for the evaluation of an individual has to be defined by type and number of relatives contributing to the index of an animal. For fattening traits performance recording is currently only available for a very limited number of animals. Therefore, in the reference situation the animals were assumed to have no performance testing for these traits. Ewes had one recorded lambing at the time of selection; additionally her dam and sisters of the dam, parental full and half sibs, granddams and own full and half sibs were considered. Generally it was assumed that at time of selection half of the sibs were already born. For female ancestors, three lambings with information on litter size, stillbirth, losses of replacement stock and lambing interval as well as length of productive life were available.
In a first step in the program, a breeding program based on the current situation and on the economic values derived was defined and evaluated. Second, alternative breeding schemes were defined. The selection intensities were adjusted for finite population size using the approximate method of Burrows (1972). However, ZPLAN cannot consider reduced genetic variance due to selection and inbreeding. Details about the methodology used in ZPLAN are described in Nitter *et al.* (1994) and Wünsch *et al.* (1999).
The essential population parameters for the base situation are presented in Table 7. For the total merit index, the appropriate traits and their economic values, heritabilities and genetic standard deviations were adopted from chapter 3.1.

Table 7 Population parameters for model calculations in Tiroler Bergschaf sheep

Herd book ewes	10000
Non herd book ewes	90000
Artificial insemination (%)	0
No. of ewes/service ram	25

Table 8 Annual monetary genetic gain, and discounted returns, costs and profit for the reference situation

Evaluation criteria	No. of ewes/ram	
	Reference scenario	Alternative scenario
Ann. monet. genetic gain	2.96	3.02
Discounted returns	8.77	9.93
Discounted costs	1.37	1.37
Discounted profit	7.40	8.56

3.2.2 Evaluation criteria and alternative scenarios

The criteria to evaluate alternative breeding strategies used in this study are defined as follows:
Annual monetary genetic gain (AMGG): Monetary superiority per year of progeny of the selected animals of one selection cycle in the breeding unit.
Discounted profit (P): Discounted returns minus discounted breeding costs, discounted return is the monetary value of genetic superiority expressed by improved animals in the whole population (breeding and commercial unit) over the time of investment (20 years).
Natural genetic gain: Genetic gain in natural units and year.

An alternative scenario was defined as follows:
As male animals have no information on fattening traits in the reference scenario, it was assumed that all male service rams have measures on daily gain and muscling score as auxiliary trait. The genetic correlations to daily gain, dressing percentage and EUROP grading score were set to 0.35, 0.15 and 0.15, respectively. No additional costs are accounted for as this information is routinely recorded but not utilized.

3.2.3 Results

In table 8 the results for the reference situation and for the alternative scenario (information on daily gain and muscling score) are presented. From table 8 follows that a positive annual genetic gain is possible under the current situation of performance testing. However, a breeding value estimation and following selection based on breeding values are preconditions not corresponding to reality. Utilizing the available information on service rams' muscling score and daily gain increases the annual monetary genetic gain by approximately 15%.

Even more important for decisions of breeding organisations are developments of single traits, expressed as natural genetic gains (Table 9). As performance testing is currently missing, all fattening traits show a negative genetic gain in the reference scenario, while positive genetic gains are found for all functional traits.

Table 9 Natural genetic gain for the reference and alternative scenario

Trait	Unit	Natural genetic gain/year	
		Reference scenario	Alternative scenario
Daily gain	g	-0.111	4.193
Dressing percentag	%	-0.020	-0.023
EUROP grading score	Scores	-0.003	0.001
Stillbirth	%	0.143	0.069
Replacement losses	%	0.382	0.318
Litter size	Number	0.011	0.009
Length of productive life	d	19.0	15.8
Lambing interval	d	0.75	0.62

With the alternative scenario the natural genetic gains for the functional traits slightly decrease, but are still positive. On the other hand, natural gains become positive for daily gain and EUROP grading score implying that considering the traits muscling score and daily gain of service rams would be beneficial in Tiroler Bergschaf.

4. What future?

The set up of a modern breeding programme implies the thorough definition of breeding objectives and, for the construction of a total merit index, the knowledge of the economic importance of the traits considered. Thus, economic values were derived for essential traits in the Austrian Tiroler Bergschaf sheep population for the first time. To meet the demands of sustainability, not only production but also functional traits have to be considered, even if their heritabilities are rather low. The breeding organisations now have a tool to select for a total merit index which should result in higher economic efficiency. Model calculations showed that a positive genetic gain may be achieved in case of a breeding value estimation and subsequent selection. While in other species the incorporation of molecular genetics in selection is discussed, in the sheep breeding programme for the main Austrian sheep breed currently no performance testing for fattening traits exists resulting in negative genetic gains for these traits. As no routine performance testing based on computer tomography or ultra sound are currently planned, at least information on service rams, including muscling score and daily gain, should be utilized to prevent from future negative genetic gain. The future of Austria's main sheep breed will largely depend on the ability of the responsible breeding organisations to implement a modern breeding programme and keep this characteristic Alpine breed competitive.

During the last decade a quite positive development of local endangered breeds in Austria was observed. Steadily increasing census sizes with low rate of inbreeding allow hoping this trend continues in the near future. However, it has to be stated that this positive trend can not be disentangled from the rather high subsidies paid to farmers participating in the official conservation programmes. Since 1995, when Austria joined the European Union, the Federal Ministry of Agriculture, Forestry, Environment and Water Management has provided the Austrian Agri-environmental programme (ÖPUL). Currently financial incentives for the maintenance of rare breeds are part of ÖPUL discontinuing in 2013. A drastic reduction or a complete cancellation of such subsidies after 2013 will most probably lead to a reduction in census size of several sheep breeds resulting in loss of genetic diversity. Loss of genetic diversity can further be expected if the planned matings which are only reluctantly accepted by the farmers will not be applied anymore. However, in case of prolonged financial support especially the larger local breeds will start with moderate selection for performance and functional traits probably based on optimal genetic contributions.

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