

BIRGIT FUERST-WALTL and ROSWITHA BAUMUNG

## **Economic weights for conformation traits in Mountain sheep**

### **Abstract**

Between October 2004 and April 2005, data of 304 and 504 Mountain sheep rams and ewes, respectively, were collected at seven auction sales for sheep breeding stock. Conformation scores of all animals were assessed before the auction started. In Mountain sheep, the scores 1 (worst) to 9 (best) are assigned for the conformation traits type, frame, form, feet and legs and wool. For the analysis of auction price, effects accounted for were the fixed effects of conformation traits, auction and lamb(s) sold with ewe (ewes only) as well as the covariate success at exhibitions. Auction had a significant effect on price in rams ( $P < 0.05$ ) and ewes ( $P < 0.001$ ), while for exhibition success only a trend ( $P < 0.10$ ) could be observed in ewes. Ewes sold with lambs did not achieve significantly higher prices. Within conformation traits, only type was found to have a significant effect in both sexes ( $P < 0.01$  in rams and  $P < 0.001$  in ewes). In rams, frame had a significant effect on auction price ( $P < 0.001$ ) while only a trend could be observed for form and feet and legs ( $P < 0.10$ ). Contrary to these results, in ewes higher scores for form and wool led to significantly higher prices ( $P < 0.05$  and  $< 0.001$ , respectively). By means of the obtained Least Squares Means for score classes, economic weights for conformation traits were derived. The economic weights per genetic standard deviation, ewe place and year range from approximately €0.9 to €4.9 in ewes and €1.3 to €4.8 in rams.

Key Words: Mountain Sheep, Conformation, Economic Weight, Auction

### **Zusammenfassung**

Titel der Arbeit: **Wirtschaftliche Gewichte für Exterieurmerkmale beim Bergschaf**

Daten von 304 weiblichen und 504 männlichen Bergschafen wurden auf insgesamt 7 Schafversteigerungen zwischen Oktober 2004 und April 2005 erhoben. Das Exterieur aller Tiere wurde kurz vor Versteigerungsbeginn bewertet. Beim Bergschaf werden die Merkmale Typ, Rahmen, Form, Fundament und Wolle mit Noten von 1 (am schlechtesten) bis 9 (am besten) bewertet. Für die Analyse des Zuschlagpreises wurden die fixen Effekte der Exterieurmerkmale, die Versteigerung und Lamm bei Fuß (ja/nein bei Schafen) sowie die Kovariable Ausstellungserfolg berücksichtigt. Die Versteigerung hatte sowohl bei Böcken als auch bei Schafen einen signifikanten Einfluss ( $P < 0,05$  und  $P < 0,001$ ) auf den Zuschlagpreis. Für den Ausstellungserfolg konnte nur ein Trend ( $P < 0,10$ ) für Schafe beobachtet werden, während gemeinsam mit den Schafen verkaufte Lämmer zu keinem signifikant höheren Preis führten. Innerhalb der Exterieurmerkmale ergab sich nur für Typ ein signifikantes Ergebnis bei Böcken ( $P < 0,01$ ) und Schafen ( $P < 0,001$ ). Auf den Versteigerungspreis von Böcken hatte außerdem der Rahmen einen signifikanten Einfluss ( $P < 0,001$ ) während für Form und Fundament nur ein Trend beobachtet werden konnte. Im Gegensatz dazu führten bei Schafen höhere Form- und Wollnoten zu signifikant höheren Zuschlagpreisen ( $P < 0,05$  und  $P < 0,001$ ). Mit Hilfe der Least Squares Mittel für die einzelnen Bewertungsklassen wurden wirtschaftliche Gewichte für Exterieurmerkmale abgeleitet. Diese liegen bezogen auf genetische Standardabweichung, Herdendurchschnittsschaf und Jahr zwischen 0,9 € und 4,9 € bei Schafen sowie 1,3 € und 4,8 € bei Böcken.

Schlüsselwörter: Bergschafe, Exterieurmerkmale, Wirtschaftliches Gewicht, Versteigerung

### **1. Introduction**

With 'development of vital animals ensuring the highest possible profit under future commercial conditions of production' FEWSON (1993) provided a general definition of a breeding objective. In Austrian sheep breeds, the breeding objectives are currently being revised. Special emphasis is placed on jointly including several performance and

functional traits based on index selection. However, for establishing a total merit index relative economic weights of the traits considered must be known (HAZEL, 1943). For most traits, economic weights may be derived by means of a herd model using a computer program originally designed for the optimization of management decisions (AMER et al., 1994). This program was adapted for the calculation of economic weights in cattle (SÖLKNER et al., 2000; BAUMUNG et al., 2001) and subsequently in sheep (FUERST-WALTL and BAUMUNG, 2006). For conformation traits the same program can not be applied. Anyway, in accordance to cattle (EGGER-DANNER et al., 2000), conformation is an important trait in the individual breeding goal of many sheep breeders. With respect to traits like form and feet and legs, favourable conformation positively affects the length of productive life in livestock (e.g. PASMANN and REINHARDT, 1999; FÜRST and FÜRST-WALTL, 2006). Besides, exhibitions are very popular, especially in Mountain sheep in Austria's western federal countries. Outstanding conformation may therefore result in awards and thus in a higher market value of the animal and its offspring.

As conformation may play a major role in selling breeding stock, the aim of this study was to analyse the effect of different type traits but also other traits on auction price in Mountain sheep. As it is planned to develop a total merit index, the second objective was to derive the necessary economic weights for conformation traits by means of the obtained results.

## 2. Material and Methods

### 2.1 Animals

In total, data of 304 Mountain sheep rams and 504 Mountain sheep ewes were collected at seven Austrian auction sales for sheep breeding stock between October 2004 and April 2005 (Table 1). Places of auction were in the federal countries Tyrol (Imst, Rotholz), Salzburg (Maishofen, Kuchl) and Styria (Leoben).

Table 1

Number of analysed female and male animals at different auctions (Anzahl der untersuchten weiblichen und männlichen Tiere auf der jeweiligen Versteigerung)

Place of auction	Date	No. of animals	
		Ewes	Rams
Imst	October 2 <sup>nd</sup> , 2004	79	86
Leoben	October 9 <sup>th</sup> , 2004	30	10
Rotholz	October 9 <sup>th</sup> , 2004	12	18
Maishofen	October 16 <sup>th</sup> , 2004	184	43
Imst	November 13 <sup>th</sup> , 2004	76	61
Imst	March 12 <sup>th</sup> , 2005	68	69
Kuchl	April 2 <sup>nd</sup> , 2005	55	17

Conformation scores of all animals analysed were recorded by representatives of the breeding organisations just before the auction started. In Mountain sheep, five overall scores (1 = worst to 9 = best) for the conformation traits type, frame, form, feet and legs and wool are assessed. Type mainly reflects the expression, head and ears of the animal. Frame includes the traits length, depth, height, chest width and muscling while shoulder, top line, pelvic angle, udder or testes and overall impression are incorporated in the form score. For feet and legs mainly locomotion, foot angle and rear leg set are taken into account, additionally joints, bow-legs and knock-knees as well as claws are

considered. Finally mainly fineness but also outer coat and length of wool determine the wool score. All conformation scores as well as all other relevant auction data were provided by the respective breeding or umbrella organisation. In Table 2 means and standard deviations for conformation scores and auction price are shown. In Maishofen, wool score could not be assessed as the animals were shorn.

Table 2

Means and standard deviations for conformation scores and auction prices of ewes and rams (Mittelwerte und Standardabweichungen für Exterieurmerkmale und Versteigerungspreise von Schafen und Böcken)

Trait	Ewes			Rams		
	N	Mean	SD	N	Mean	SD
Type	449	5.50	0.96	290	5.68	0.69
Frame	449	5.88	0.87	290	6.20	0.82
Form	449	5.67	0.82	290	5.82	0.79
Feet and Legs	449	5.55	0.75	290	5.60	0.70
Wool	313	6.04	0.65	258	6.10	0.68
Auction price in €	447	246	315	290	943	967

## 2.2 Price Determinants

Apart from conformation traits, which were not printed in the sales catalogue, the following traits (information available for the bidders) were considered as possible auction price determinants:

*Auction:* The effect of auction also includes the effect of judges as different judges did not work at different auction places and the seasonal effect.

*Lambs sold with ewe:* One or more lambs were merged to one class resulting in the effect lamb(s) – yes or no.

*Birth type of the animal and the animal's dam:* Single, twin or multiple.

*Sire dam:* yes or no.

*Fertility index of the animal's dam:* the fertility index includes age at first lambing, number of lambs born, stillborn lambs and lambing interval with respect to the age of the ewe as well as the population average. Values are standardized (Mean = 100, SD = 12).

*Exhibition score:* From the exhibition awards of the animal, its dam and its sire a new variable 'exhibition score' was created by summarizing all awards. Different scores were assigned per award depending on rank (1<sup>st</sup> or 2<sup>nd</sup>), on group or overall winner and on level of exhibition (local, district and federal level). Thus scores ranged from 1 point (group, 2<sup>nd</sup> place) to 6 points (overall winner on federal level). A higher total score reflected a higher number of awards and/or a higher level. The average exhibition score was  $7.8 \pm 5.9$  with a range from 0 to 28 and  $9.3 \pm 5.7$  with a range from 0 to 30 in ewes and rams, respectively.

## 2.3 Statistical Analysis

All statistical analyses were performed using SAS Version 8.0 (SAS, 1999). Live weight, birth type of the animal and sales class were not included in the analysis as these effects were not generally available and are correlated with conformation traits, especially with frame. Animals with incomplete data sets and females classified as young sheep were excluded from analysis. Animals which did not fulfil the herd book standards (e.g. unacceptable jaw structure, pigment coating or fertility index of the dam) were excluded from the auction and thus from the analysis. Animals with no bid

were included in the analysis with a price of 90% of the minimum bid. To achieve sufficient class occupancy rams from Leoben had to be discarded and conformation scores  $\leq 4$  were set to 5 and  $\geq 8$  were set to 7.

The following statistical models were applied:

Model (1), ewes:

$$Y_{ijklmnop} = \mu + A_i + T_j + Fr_k + Fo_l + FL_m + W_n + L_o + b_1 * e + \varepsilon_{ijklmnop}$$

Model (2), rams:

$$Y_{ijklmno} = \mu + A_i + T_j + Fr_k + Fo_l + FL_m + W_n + b_1 * e + \varepsilon_{ijklmno}$$

with  $Y_{ijklmno(p)}$  is the individual observation,  $\mu$  is the overall mean,  $A_i$  is the fixed effect of the respective auction  $i$ ,  $T_j$  is the fixed effect of type score  $j$ ,  $Fr_k$  is the fixed effect of frame score  $k$ ,  $Fo_l$  is the fixed effect of the form score  $l$ ,  $FL_m$  is the fixed effect of the feet and legs score  $m$ ,  $W_n$  is the fixed effect of the wool score  $n$ ,  $L_o$  is the fixed effect of lamb  $o$  (ewes only),  $b_1$  is the regression coefficient,  $e$  is the continuous effect of exhibition score and  $\varepsilon_{ijklmno(p)}$  is the random residual.

The effects sire dam, birth type and fertility index were alternatively included in both models but discarded as they were not significant. Interaction effects between all but conformation traits were also tested but were also not found to be significant.

## 2.4 Calculation of Economic Weights

Economic weights for conformation scores are derived according to the economic weights for EUROP grading score in cattle described by MIESENBERGER (1997). Analogue to EUROP grading scores conformation scores are categorical traits. The economic weights may be calculated by utilizing the estimated Least Squares means as well as the number of observations for each score class. Weighted means for scores and auction prices may therefore be calculated. Assuming a standard normal distribution, class limits (u-values) are assigned in the following. Subsequently, shifting by approximately one genetic standard deviation towards the desired score (9) results in new u-values and thus new class ratios. Both, u-values and class ratios may be found in the u-table for standard normal distribution (e.g. ESSL, 1987). From these ratios new weighted means for conformation score and auction price are calculated. The differences between original and new mean prices and scores enable the calculation of approximated economic weights. As costs are not considered, these values are no marginal utilities in the narrow sense. However, with regard to conformation, costs for breeding, keeping and marketing may be assumed to be rather similar.

## 3. Results and Discussion

Overall Least Squares Means were €281 for ewes and €1027 for rams. In Table 3 levels of significance for fixed and continuous effects are shown. The auction significantly affected the price in ewes ( $P < 0.001$ ) and rams ( $P < 0.05$ ). In ewes lowest prices were found in Leoben, highest prices in Imst (Table 4). The same was observed in rams, however, data from Leoben could not be taken into account due to insufficient number of observations. In cattle, FÜRST-WALTL et al. (2004) observed differences between auction places of €261 (Fleckvieh heifers) and €103 (Braunvieh heifers). The high differences between auction places illustrate the distinction between eastern and western federal countries with regard to prices of breeding stock. Breeders in western countries are generally willing to pay higher prices for breeding stock. It

should be noted that the auction in Maishofen could not be considered in this analysis, as animals were shorn and therefore wool score was not assessed.

Table 3

P-values for fixed and continuous effects (P-Werte für fixe und zufällige Effekte)

Effects	P	
	Ewes	Rams
Auction	<0.001	<0.022
Lamb	0.335	-
Exhibition score	0.081	0.635
Type	<0.001	0.004
Frame	0.301	<0.001
Form	0.045	0.084
Feet and Legs	0.542	0.081
Wool	<0.001	0.116

Ewes sold with lambs achieved higher prices (€419 with lambs, €358 without lambs, Table 4). However, this difference was not significant ( $P>0.05$ , Table 3). The exhibition score had no significant effect on auction prices of both sexes ( $P>0.05$ , Table 3). A trend ( $P<0.10$ ) for an increase of €6.73 per point of exhibition score could be observed in ewes.

Table 4

Least Squares Means in € for Auction and Lamb sold with ewe,  $R^2$  and residual standard deviation (RSD) (Least Squares Mittel in € für Versteigerung und Lamm,  $R^2$  und Residualstandardabweichung (RSD))

	Least Squares Means	
	Ewes	Rams
Auction		
Imst, October 2004	438	1381
Imst, November 2004	523	1174
Imst, March 2005	553	1288
Kuchl, April 2005	466	580
Leoben, October 2004	154	-
Rotholz, October 2004	196	1248
Lamb sold with ewe		
Yes	419	-
No	358	-
$R^2$	0.39	0.35
RSD	313	794

Among effects which were not considered, sales class would have certainly explained a great proportion of the auction prices' variation. In an earlier work in cattle (FÜRST-WALTL et al., 2004) sales class was included in the model accounting for pedigree and performance information as well as order of auction. Besides being only partly available in this study, conformation traits are integrated in the sales class. Least squares means for conformation traits may therefore be biased if sales class is considered. Fertility index was assumed to have an impact on price, especially in ewes. One reason for having no significant effect may be that offspring of animals with very bad fertility index do not fulfil herd book requirements and are therefore excluded from the auction. Although twin is said to be the desired birth type, prices between birth types did not significantly differ. The same applies to selected sire dams compared to other ewes.

In Table 5 results for conformation scores are shown. In both sexes, type had a significant effect on auction price ( $P<0.001$  in ewes and  $P<0.01$  in rams). Ewes and

rams with a type score of 7 led to price differences of €295 and €653 compared to animals with type scores of 5 or below. Breeders of Mountain sheep are interested in animals representing the breed ideal, especially as these animals are favoured at shows. The same applies to frame in rams which may explain the rather high difference of €611 between frame scores of 7 and higher and those of 5 and below. In ewes, frame did not significantly affect the auction price. Consideration of maintenance requirements, especially under alpine pasturing conditions, may have partly caused this result. In cattle, larger female animals were observed to achieve significantly higher prices at auctions (e.g. FÜRST-WALTL et al., 2004). However, weight, being positively correlated to frame, is probably of higher importance in cattle auctions as not only private but also corporate bidders compete for animals.

Form only significantly affected auction price in ewes ( $P < 0.05$ , Table 3) while in rams only a trend ( $P < 0.10$ ) could be observed. In cattle, the pelvic angle, which is one of the traits incorporated in the form score in sheep, was observed to have a significant effect on auction price in Fleckvieh and Braunvieh heifers while the effect top line was not significant in Braunvieh heifers (FÜRST-WALTL et al., 2004). Differences in auction prices depending on feet and legs score were not significant in both sexes ( $P > 0.10$  in ewes and  $P < 0.10$  in rams, Table 3, Table 5). While PLACKE (1982) reported a significant effect of feet and legs on the auction price in Holstein heifers, the latter result is in accordance with the study in Fleckvieh and Braunvieh mentioned before (FÜRST-WALTL et al., 2004). It may be assumed that the available time in the ring is too short for some bidders to be able to distinguish between different feet and legs score classes. Finally, wool score had a significant effect on auction price in ewes ( $P < 0.001$ ) while in rams no significant effect could be observed ( $P > 0.10$ ).

Table 5

Effect of conformation traits on the auction price of mountain sheep ewes and rams (number of animals in brackets) (Einfluss der Exterieurmerkmale auf den Versteigerungpreis von weiblichen und männlichen Bergschafen (Anzahl der Tiere in Klammer))

Effect		Least Squares Means in €(n)		
Score class		<=5	6	>=7
Type	Ewes	290 (60)	291 (186)	585 (35)
	Rams	818 (91)	1114 (140)	1471 (18)
Frame	Ewes	373 (50)	355 (142)	437 (89)
	Rams	895 (28)	1001 (132)	1506 (89)
Form	Ewes	355 (93)	336 (132)	477 (56)
	Rams	931 (74)	1159 (132)	1312 (43)
Feet and Legs	Ewes	348 (83)	364 (176)	452 (22)
	Rams	923 (109)	1007 (127)	1473 (13)
Wool	Ewes	305 (27)	262 (192)	598 (62)
	Rams	956 (42)	1129 (149)	1317 (58)

The obtained Least Squares Means for the conformation score classes were used to derive economic weights as described earlier. The results for both sexes, referring to one genetic standard deviation of the respective trait, are shown in Table 6. As genetic parameters for conformation traits can currently not be estimated due to insufficient data quality, literature values of sheep and cattle had to be used to obtain the given

genetic standard deviation (DE VRIES, 2004; FÜRST et al., 2005). Economic weights were calculated irrespective of level of significance as trends for higher prices with higher scores could generally be observed.

The economic weights for conformation traits are distinctly higher for rams than for ewes (Table 6). This result reflects the generally higher price level in rams and thus differences between conformation score classes. In rams, the highest value was calculated for frame (€176), followed by type (€114), form (€58), wool (€57) and feet and legs (€48). In ewes, economic weights range from €11 (feet and legs) to €60 (type). In Fleckvieh and Braunvieh heifers, economic weights of about €19 and €51 were found per genetic standard deviation of frame score. Further economic weights of €10.44 for feet and legs (Fleckvieh) and €6.48 for form (Braunvieh) were reported (FÜRST-WALTL et al., 2004).

Table 6

Derived economic weights in € per genetic standard deviation ( $s_a$ ) and % realisation for Mountain ewes and rams (Abgeleitete wirtschaftliche Gewichte pro genetischer Standardabweichung ( $s_a$ ) und % Realisation für Schafe und Böcke der Rasse Bergschaf)

	Type	Frame	Form	Feet and Legs	Wool	Realisation (%)
Ewes	60	21	17	11	28	8.19
$s_a$	0.40	0.43	0.30	0.26	0.27	
Rams	114	176	58	48	57	2.71
$s_a$	0.35	0.44	0.30	0.27	0.31	

The derived economic traits are related to an average reference animal, i.e. an average ram or ewe sold by auction. To correctly include the conformation complex in a future total merit index, the economic weights have to be additionally related to an average herd book sheep place and year. It is therefore necessary to calculate realisation factors. The realisation is the proportion of rams or ewes sold by auction per year of the total number of herd book ewes. In Mountain sheep, the realisation is 8.19% in ewes and 2.71% in rams (Table 6). The economic weights per average herd book ewe therefore range from approximately €0.9 to €4.9 in ewes and €1.3 to €4.8 in rams.

The results 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. As a next step, economic weights for performance and fitness related traits will be derived for Mountain sheep.

#### Acknowledgements

The authors wish to thank the Austrian Sheep and Goat Association, ÖBSZ, for funding and their authorized representatives Ing. Hubert Moosbrugger (Landeskontrollverband Vorarlberg), Michael Zeiler (Steirischer Schafzuchtverband), Johann Jaufenthaler (Landes-Ziegenzuchtverband für Tirol), Ing. Johannes Fitsch (Landes-Schafzuchtverband Tirol) and Mag. Lidija Filipčič (Plandata) for collecting and providing the data. Furthermore, we are thankful for the help of our diploma student Doris Schiller. Funding by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (Project 1330) is gratefully acknowledged.

## References

- AMER, P.R.; KAUFMANN, A.; KÜNZI, N.:  
Implications for farmers and political institutions from a Swiss cattle farmmodel. 3<sup>rd</sup> International Livestock Farming System Symposium, September 1-2, Aberdeen, Scotland, UK (1994)
- BAUMUNG, R.; SÖLKNER, J.; GIERZINGER, E.; WILLAM, A.:  
Ecological total merit index for an Austrian dual purpose cattle breed. Arch. Tierz., Dummerstorf **44** (2001), 5-13
- DE VRIES, F.:  
Zucht auf Scrapie Resistenz. Dissertation, Tierärztliche Hochschule Hannover, Deutschland (2004)
- EGGER-DANNER, CH.; GIERZINGER, E.; WILLAM, A.; SÖLKNER, J.:  
Zuchtplanung und Optimierung der Zuchtprogramme für die Rassen Fleckvieh und Braunvieh. Abschlussbericht des Forschungsprojektes L 1087/97 im Auftrag des BM für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, der Arbeitsgemeinschaft österreichischer Fleckviehzüchter und der Arbeitsgemeinschaft österreichischer Braunviehzüchter (2000)
- ESSL, A.:  
Statistische Methoden in der Tierproduktion. Österr. Agrarverlag, Wien (1987)
- FÜRST, C.; FÜRST-WALTL, B.:  
Züchterische Aspekte zu Kalbeverlauf, Totgeburtenrate und Nutzungsdauer in der Milchviehzucht. Züchtungskunde **78** (2006), 365-383
- FÜRST, C.; EMMERLING, R.; DODENHOFF, J.; KROGMEIER, D.; NIEBEL, E.:  
Zuchtwertschätzung beim Rind. <http://www.zar.at/download/ZWS/Exterieur.pdf> (2005)
- FUERST-WALTL, B.; BAUMUNG, R.:  
Economic weights for performance and fitness related traits in East Friesian dairy sheep. Proc. 8<sup>th</sup> World Congr. Genet. Appl. Livest. Prod., Belo Horizonte, Brazil (2006), 34
- FÜRST-WALTL, B.; WIESER, J.; FÜRST, C.; SÖLKNER, J.:  
Einfluss des Exterieurs auf den Versteigerungspreis von Fleckvieh und Braunvieh Kalbinnen. Züchtungskunde **76** (2004), 149-161
- FEWSON, D.:  
Definition of the breeding objective. In: Design of livestock breeding programmes. Animal Genetics and Breeding Unit, University of New England, Armidale, NSW, Australia, pp. 53-58 (1993)
- HAZEL, L.N.:  
The genetic basis for constructing selection indexes. Genetics **28** (1943), 476-490.
- MIESENBERGER, J.:  
Zuchtzieldefinition und Indexselektion für die österreichische Rinderzucht. Dissertation, Universität für Bodenkultur, Wien (1997)
- PASMAN, E.; REINHARDT, F.:  
Genetic relationships between type composites and length of productive life of Black-and-White Holstein cattle in Germany. Interbull Bulletin **21** (1999), 117-121.
- PLACKE, K.H.:  
Untersuchung zur Exterieurbeurteilung in der Schwarzbuntzucht. Dissertation, Christian-Albrechts-Universität, Kiel (1982)
- SAS:  
SAS/STAT Software: User's Guide, Version 8.0, SAS Institute Inc., Cary NC, USA (1999)
- SÖLKNER, J.; MIESENBERGER, J.; WILLAM, A.; FÜRST, C.; BAUMUNG, R.:  
Total merit indices in dual purpose cattle. Arch. Tierz., Dummerstorf **43** (2000), 597-608

Received: 2006-02-28

Accepted: 2006-09-11

Authors' address

Dr. BIRGIT FUERST-WALTL\*, University of Natural Resources and Applied Life Sciences Vienna (BOKU), Department of Sustainable Agricultural Systems, Division Livestock Sciences, Gregor Mendel-Str.33,  
A-1180 VIENNA, AUSTRIA E-Mail: birgit.fuerst-walrtl@boku.ac.at

Dr. ROSWITHA BAUMUNG, University of Natural Resources and Applied Life Sciences Vienna (BOKU), Department of Sustainable Agricultural Systems, Division Livestock Sciences, Gregor Mendel-Str.33,  
A-1180 VIENNA, AUSTRIA E-Mail: roswitha.baumung@boku.ac.at

\*Corresponding author