

## EXPERIENCES IN SELECTING ON A TOTAL MERIT INDEX IN THE AUSTRIAN FLECKVIEH BREED<sup>1</sup>

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*Abstract:* Spotted cattle breed is the most common breed in Austria. Austrian Spotted cattle breed is bred as a dual purpose breed for more than 100 years. The breeding objective has changed over the time according to the different economic importance of the traits and according to the different possibilities in using estimated breeding values (EBVs) for selection.

Since 1998 the breeding objective is defined as the aggregate genotype of production traits and functional traits. All economically important traits are combined according to their economic weights in the total merit index (TMI). The TMI is calculated by combining the EBVs of all traits using a selection index procedure. The index weights (b-values) are estimated depending on the reliabilities of the EBVs and are therefore different from animal to animal.

Considering the intensive international exchange of semen from the best bulls, the cooperation in the breeding programs and the similar economic situation in agriculture the breeding organisations of Germany and Austria decided to make a joint across-country evaluation for all traits. Since November 2002 breeding values for all traits and as a logical conclusion the TMI are evaluated jointly.

The result is a high acceptance of the EBVs and the TMI by the farmers because of smaller changes of the breeding values for national and foreign bulls between consecutive evaluations.

The realized economic gain in the different traits is very close to the expected economic gain. In the last 10 years on average 88.2 % of the economic gain were realized in the milk traits, 4.2 % in the beef traits and 7.6 % were realized in the fitness traits.

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<sup>1</sup> Review paper – Revijalni rad

Presented as invited paper the 8th International Symposium «Modern Trends in Livestock Production», Belgrade, October 5th to 8th, 2005 – Uvodno predavanje na 8. međunarodnom simpozijumu «Savremeni trendovi u stočarstvu», Beograd, 5.-8. oktobar, 2005.

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### *Introduction*

Almost 80 % of the cattle in Austria belong to the Spotted cattle breed with a total number of 1.6 million heads. 17,700 farmers keep 250,000 herdbook cows. There are large differences in the size of the farms and in the natural conditions. The farmers are member in local breeding organisations. These breeding organisations work together in an umbrella organisation called “AGÖF – Arbeitsgemeinschaft österreichischer Fleckviehzüchter” (Pichler, 2005). The Federation of Austrian Cattle Breeders (ZAR) is responsible for data recording in Austria according to the guidelines of ICAR. The estimation of the breeding values is done four times a year by the company called ZuchtData EDV-Dienstleistungen GmbH in Vienna in cooperation with the computing centres in Bavaria (LfL Grub) and Baden-Württemberg (Stuttgart).

Many decisions in the breeding program, for example selection of the bull dams, are made by the local organisations together with the farmers. The most important decisions are made within the AGÖF. A milestone was the decision to define the breeding objective in an aggregate genotype including all economically important traits and to combine the EBVs according to their economic weights in the TMI in 1998. Another milestone decision was to take part in the across country evaluation of Germany and Austria. It took two years to change from the national breeding value estimation to the across country evaluation for all traits. The inclusion of the traits was completed in November 2002, so that a joint genetic evaluation is now performed for all traits and the TMI for all breeds.

One of the obvious questions in current dairy cattle breeding is how to combine results from evaluations on production- and functional traits. Different countries and organisations went different ways and some claim that their ways are more “balanced” than those of others. In this paper we would like to present the TMI used for Spotted cattle breed in Germany and Austria. In addition we would like to show the genetic gain absolute and relative in all the traits included in the aggregate genotype realized in the last 10 years.

### *Complex Breeding Objectives In Dual Purpose Breeds*

The optimal way of dealing with complex breeding objectives including several traits is index selection (*Hazel, 1943*). The derivation of a selection index involves decision of which traits are economically important, calculation of marginal gains for those traits, decision about traits to be

recorded, calculation of phenotypic and genetic parameters related to the complete set of traits, and derivation of index weights based on this information. Although the method was developed more than 60 years ago, it is still considered superior to all other approaches of multiple trait selection.

The breeding objective (total merit index, aggregate genotype) is defined by a linear function of economically important traits. In theory, the decision about traits included in the aggregate genotype should only be driven by their economic importance under future conditions of production (Fewson, 1993).

Within the last 20 years breeding objectives in cattle breeding have become more complex because of economic reasons on the one hand, functional traits became more favourable especially in high yielding dairy cows, and because of more possibilities in including new traits in the routine breeding value estimation on the other hand. Especially in dual purpose breeds like Spotted cattle breed we have to deal with a situation where we have many different traits to combine in one breeding objective.

An overview of the actual status of the genetic evaluation in Austria is shown in table 1. For a detailed description of each genetic evaluation, please refer to *Emmerling et al., (2002)* (milk, persistency), *Schild et al., (2003)* (beef), *Fuerst and Egger-Danner, (2002a)* (longevity), *Fuerst and Egger-Danner, (2002b)* (fertility), *Fuerst and Egger-Danner, (2003)* (calving ease and stillbirth) and *Sprengel et al., (2001)* (somatic cell count and milkability).

#### *Total Merit Index*

The TMI is calculated using the EBVs of the single traits (except type), by taking the respective economic values, the reliabilities and the genetic relationships among the traits into account. This computation method (index method) represents the best method currently available. The economic values of the single traits are derived with the so-called “herd model” by applying proper business criteria according to the price situation in Austria (*Miesenberger, 1997*). Economists from both countries have observed that the economic situation in Germany and Austria is very similar. In addition to the TMI and the EBVs of the single traits a milk value, beef value and fitness value for each animal are also calculated. For these indices the same procedure and economic weights are used.

Simulation studies (*Gierzinger, 2002*) have shown that breeding for the described total merit index in the Austrian Spotted cattle breed results in an 11 % higher monetary gain compared to breeding for a milk value (Figure 1). Including the beef traits and especially the fitness traits in the

aggregate genotype is necessary. Otherwise we would get a negative genetic trend in most of the fitness traits. We would end up in very high yielding Spotted breed cows with for example worse longevity and much higher somatic cell score than now. Increasing the weight of milk production, however, would considerably worsen most beef traits and functional traits.

In the TMI of the Spotted cattle breed in Austria and Germany, the traits specified in table 2 are included with the same weighting for sires and cows. Within a global comparison, the fitness traits have a very high economic value, whereas the type traits are not directly included in the total merit index. At present, investigations are made on the economic weights for future conditions of farming and on including health traits in the breeding program.

*Table 1. Actual status of routine breeding value estimation in Austria*

*Tabela 1. Trenutno stanje u rutinskoj oceni priplodne vrednosti u Austriji*

Trait/Index Osobina/Indeks	Method/Metoda	Since year/od godine	
		First/ prva <sup>1</sup>	Latest/ poslednja <sup>2</sup>
Production traits/ Proizvodne osobine			
Milk, Fat, Protein/ Mleko, mast, protein	Random-regression-test-day, AM	1963	2002
Beef/meso	Multi trait AM	1995	2002
Functional traits/ Funkcionalne osobine			
Longevity/dugovečnost	Survival analysis, sire-mgs model	1995	2001
Persistency/istrajnost	Random-regression-test-day, AM	1992	2002
Fertility/plodnost	AM (male, female)	1995	1995
Calving ease/lakoća telenja	Multi trait AM (direct, maternal)	1995	2003
Stillbirth/br. mrtvorodenih	Multi trait AM (direct, maternal)	1998	2003
Somatic cell score/ broj somatskih ćelija	Fixed-regression-test-day, AM	1998	2002
Milkability/muznost	Fixed-regression-test-day, AM	2000	2002
Type traits/osobine tipa	Single trait AM	1998	2000
Milk value/vrednost osobina mlečnosti	Index method	1985	2002
Beef value/vrednost tovnih osobina	Index method	1995	2002
Fitness value/kondicija	Index method	1998	2002
Total merit index/indeks ukupne vrednosti	Index method	1998	2002

<sup>1</sup> first year of breeding value estimation of this trait in Austria independent of the procedure

<sup>2</sup> year of implementing the actual used method

AM = BLUP animal model,

Figure 1. Breeding progress depending on selection criteria in the breeding program of Spotted cattle in Austria

Slika 1. Odgajivački progres zaviso od kriterijuma u selekciji u okviru odgajivačkog programa šarene rase goveda u Austriji

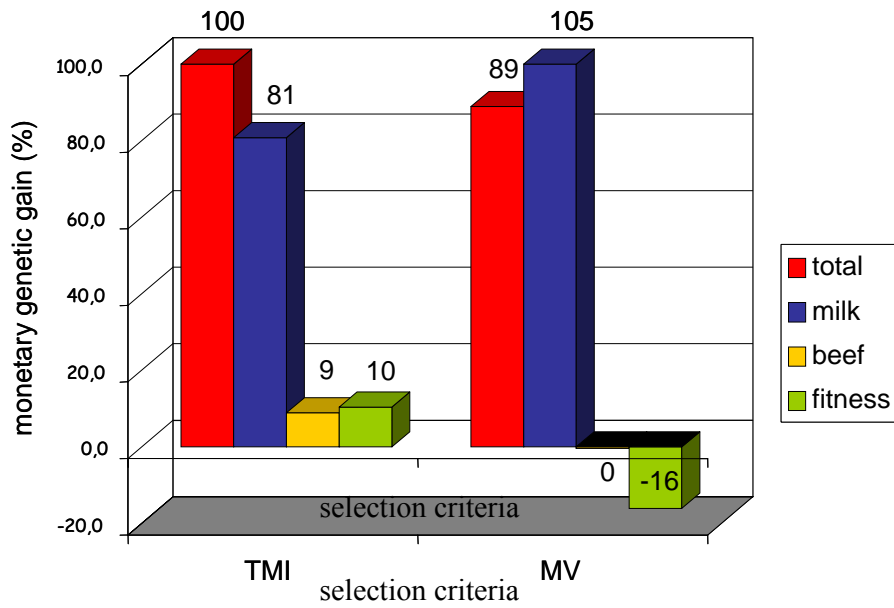


Table 2. Economic weights (absolute and in genetic standard deviations) of the traits in the Austrian total merit index for Spotted cattle breed

Tabela 2. Ekonomske vrednosti (apsolutne i u standardnim genetskim odstupanjima) osobina u okviru indeksa ukupne vrednosti za šarenu rasu goveda u Austriji

Trait/Osobina		Economic value/ ekonomska vrednost €/unit <sup>1</sup>	Relative value per genetic SD (%)/relativna vrednost prema genetskoj SO (%)	
Milk /Mleko	Fat yield/prinos masti	0.73	9.8	39.3
	Protein yield/prinos proteina	2.92	29.4	
Beef/Meso	Net daily gain/neto dn. prirast	1.34	9.9	16.4
	Beef percentage/udeo mesa	0.45	3.3	
	EUROP grade/EUROP kat.	0.45	3.3	
Fitness/Kondicija	Longevity/dugovečnost	1.85	13.6	44.3
	Persistency/istrajnost	0.24	1.8	
	Fertility (male) /plodnost (mužjak)	0.61	4.5	
	Fertility (female)/plodnost (ženka)	0.61	4.5	
	Calving ease (direct)/lakoća telenja (neposredna)	0.15	1.1	
	Calving ease (maternal)/lakoća telenja (majčinska)	0.15	1.1	
	Stillbirth (direct)/ mrtvorodenja (nposedna)	0.33	2.4	
	Stillbirth (maternal)/ mrtvorodenja (majčinska)	0.33	2.4	
	Somatic cell score/br. Somatskih ćelija	1.21	8.9	
	Milkability/muznost	0.52	3.8	

<sup>1</sup> unit = kg for fat and protein yield, EBV points for all other traits / jedinica = kg za prinos masti i proteina, EBV (ocena priplodne vrednosti) za ostale osobine

### Genetic Progress

For the Spotted cattle breed, the theoretical expected relative monetary genetic progress when optimally selecting for the TMI should be as listed in table 3, with an approximate ratio of 82% milk, 8% beef and 10% fitness. Despite the high economic value of the fitness traits, no genetic improvement is expected for most traits, except for longevity. There are several reasons for this big gap between the economic weights for the traits and the expected genetic progress of the several traits or trait groups. The reasons for the relative high genetic gain in the milk production traits compared to the other traits are for example:

- very high genetic correlation between protein yield and fat yield
- low or even negative genetic correlations within the fitness traits and the beef traits and between these traits and the milk production traits
- low heritabilities for the fitness traits
- low reliabilities for the EBVs of the fitness traits
- fitness traits are partly later expressed in life and therefore later available for breeding value information

The realized relative monetary gain was calculated from the observed genetic trends by multiplying the genetic gain per year (birth year of bulls 1990 – 2000) with the according economic values. The ratio of the realized monetary gain in the last 10 years was 88% milk, 4% beef and 8% fitness. The ratio of the expected genetic gain in the different traits was almost the same as expected.

The realized genetic gain in the different trait groups is given in Figure 2.

Table 3. Theoretical and realized monetary gain when optimally selecting for total merit index  
Tabela 3. Teoretska i ostvarena novčana dobit uz optimalnu selekciju na osnovu indeksa ukupne vrednosti

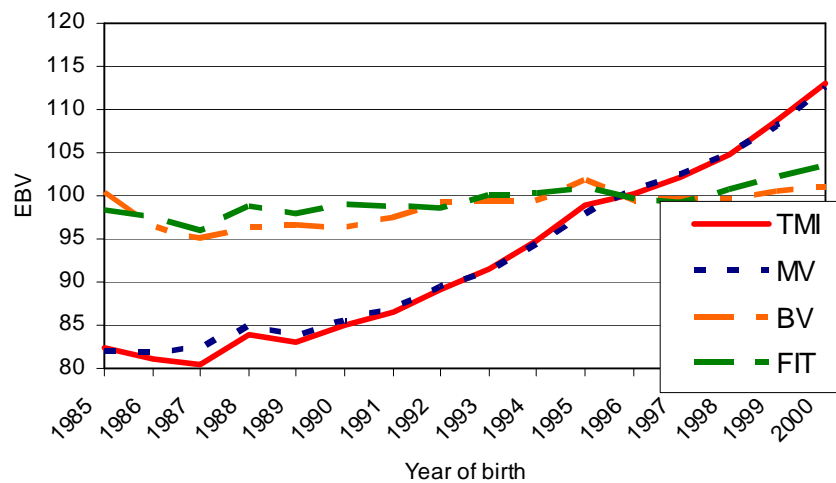
Trait/osobina		Relative monetary gain/ relativna novčana dobit (%) Theoretical/teoretska		Relative monetary gain/ relativna novčana dobit (%) Realized/ostvarena	
Milk / Mleko	Fat yield/prinos masti	19.4	<b>81.5</b>	21.0	<b>88.2</b>
	Protein yield/prinos proteina	62.1		67.3	
Beef/ Meso	Net daily gain/neto dn. prirast	8.8	<b>8.2</b>	5.3	<b>4.2</b>
	Beef percentage/udeo mesa	-1.4		-0.3	
	EUROP grade/EUROP kat.	0.8		-0.9	
Fitness	Longevity/dugovečnost	6.9	<b>10.4</b>	3.7	<b>7.6</b>
	Persistency/istrajnost	0.5		-0.7	
	Fertility (male) /plodnost	-0.1		2.2	
	Fertility (female)/plodnost	-0.8		-0.9	
	Calving ease (direct)/ lakoća telenja	-0.2		-0.2	
	Calving ease (maternal)/lakoća tel.	0.6		0.3	
	Stillbirth (direct)/mrtvorodenja	0.2		0.2	
	Stillbirth (maternal)/mrtvorodenja	0.7		0.4	
	Somatic cell score/br. som. ćelija	-0.2		-0.5	
	Milkability/muznost	2.8		3.1	

<sup>1</sup> unit = kg for fat and protein yield, EBV points for all other traits / jedinica = kg za prinos masti i proteina, EBV (ocena priplodne vrednosti) za ostale osobine

<sup>2</sup> theoretical monetary gain when optimally selecting for total merit index / teoretska novčana dobit uz optimalnu selekciju na bazi indeksa ukupne vrednosti

<sup>3</sup> realized monetary gain calculated from observed genetic trends: genetic gain per year (birth year 1985 – 2000) multiplied by economic value / ostvarena novčana dobit izračunata preko registrovanih genetskih trendova: genetski prirast po godini (godina rođenja 1985-2000) umnožena za ekonomsku vrednost

Figure 2. Genetic trends for the Total merit index (TMI), milk value (MV), beef value (BV) and fitness value (FIT) calculated on the basis of the estimated breeding values (EBV) for bulls  
Slika 2. Genetski trendovi kod indeksa ukupne vrednosti (TMI), vrednost osobina mlečnosti (MV), vrednost tovnih osobina (BV), kondicija (FIT) izračunati na bazi ocene priplodne vrednosti (EBV) za bikove



*TMI is accepted by the farmers*

It is very important that the breeding objective is accepted by the farmers. The AGÖF asked their members for the criteria they look at, when they select a proven bull for insemination. Almost 50 % of the breeders, in total 7559 farmers, answered the questionnaire. The farmers were allowed to mark maximum 4 criteria (Sölkner *et al.*, 2000).

The results are given in table 4.



*Table 4. Results of a questionnaire “ Which criteria are important for the selection of a proven bull for insemination?” (maximum 4 criteria)*

*Tabela 4. Rezultati ankete “ Koji kriterijumi su važni za selekciju odabranih bikova za inseminaciju?” (maksimalno 4 kriterijuma)*

	Spotted cattle breed/šarena rasa
Total merit index/ indeks ukupne vrednosti	68.8
Milk value/ vrednost osobina mlečnosti	49.0
Fitness value/ vrednost osobina kondicije	22.6
Beef value/ vrednost tovnih osobina	13.8
EBVs for milk yield/ PV za prinos mleka	29.2
EBVs for milk components/ PV za komponente mleka	53.1
Performance of dam/ performance majke	15.9
Performance of daughters/ performance kćeri	21.1
Pedigree/ pedigre	26.9
Reliabilities of the EBVs/ pouzdanost PV	29.2
Picture of the bull/ slika bika	10.4
Type of daughters/ tip kćeri	14.4
Price for semen/ cena semena	10.7

### *Conclusions*

The breeding objective in a dual purpose breed like Spotted cattle breed is very complex. The tools for selecting for production and functional traits are available in most countries and of course also in Austria. These tools are recording schemes for traits of economic importance, genetic evaluation procedures based on an animal model and index selection theory.

All economically important traits are included in the aggregate genotype. According to the economic situation in Austria and Germany the economic weights for fitness traits are very high compared to the production traits or compared to other countries. Nevertheless, because of low genetic correlations between the fitness traits, lower heritabilities of the fitness traits compared to the production traits and lower reliabilities of the EBVs the genetic gain in the fitness traits is very low. Increasing the weight for milk production, however, would considerably worsen most beef traits and functional traits.

Model calculations show that breeding for a TMI including fitness traits and beef traits leads to 11 % higher economic gain in the Austrian Spotted cattle breed compared to breeding for a milk value. The genetic trends over the last 10 years show that it is possible to increase the milk production traits without losing fitness or beef in the Spotted cattle population.

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ISKUSTVA U SELEKCIJI BAZIRANOJ NA INDEKSU UKUPNE  
VREDNOSTI AUSTRIJSKE ŠARENE RASE

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*Rezime*

Šarena rasa goveda je najzastupljenija rasa u Austriji. Austrijsko šareno goveče se gaji kao rasa kombinovane/dvostruke upotrebe više od 100 godina. Odgajivački cilj se menjao prema ekonomskom značaju različitih osobina u određenim vremenskim periodima korišćenjem ocene priplodne vrednosti u selekciji.

Od 1998. godine odgajivački cilj je određen kao agregatni genotip proizvodnih i funkcionalnih osobina. Sve osobine značajne sa ekonomskog aspekta su kombinovane u skladu sa svojom ekonomskom vrednošću u indeksu ukupne vrednosti - Total Merit Index (TMI). TMI se izračunava kombinovanjem ocena za priplodnu vrednost svih osobina korišćenjem procedure za indeks selekcije. Indeksne vrednosti (b-vrednosti) se ocenjuju zavisno od pouzdanosti ocen priplodne vrednosti i zbog toga razlikuju od životinje do životinje.

Uzimajući u obzir intenzivnu međunarodnu razmenu semena od najboljih bikova, saradnja u odgajivačkim programima i slična ekonomska situacija u poljoprivredi, odgajivačke organizacije u Austriji i Nemačkoj su odlučile da rade zajedničku međudržavnu ocenu za sve osobine. Od novembra 2002. godine priplodne vrednosti za sve osobine i kao logički zaključak TMI se ocenjuju zajednički.

Rezultat ovakvog rada je visok stepen prihvatljivosti ocen priplodne vrednosti i TMI od strane farmera zbog manjih promena odgajivačkih vrednosti za nacionalne i inostrane bikove između uzastopnih ocena.

Ostvarena ekonomska dobit kod različitih osobina je veoma blizu očekivane ekonomske dobiti. U poslednjih deset godina u proseku 88.2 % ekonomske dobiti je ostvareno na osobinama mlečnosti, 4.2 % na tovnim osobinama i 7.6 % na osobinama kondicije.

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