Statistical Indicators

E-22

Beef merit index

▪ Introduction

Since January 1995 slaughter data are collected in Dutch slaughterhouses. The slaughter data are sent to the PVE in Rijswijk by the slaughterhouses. In 1997 and 1998, in co-operation with the ID-DLO and the Animal Breeding and Genetics Group of the LUW (Agricultural University, Wageningen) these data have been used to estimate genetic parameters and determine weighting factors for a beef merit index.
From the Flemish slaughterhouses slaughter data are available for animals slaughtered since January 2006.
The slaughter data are sent to the Animal Evaluation Unit. By adding to them the pedigree and herd information, these data can be used for a breeding value estimation for meat traits. Slaughter data that are recorded are: degree of fleshiness, degree of fat covering and carcass weight. For the veal calves an additional trait is scored: colour of the meat.
From 2014 no slaughter data from Dutch slaughter houses are available any more. There are AI bulls that have no slaughter data of relatives, but that have lactating daughters scored for conformation traits. Therefore, four conformation traits that have a moderate to strong correlation with slaughter traits will be used in the breeding value estimation for the beef merit index. Conformation traits like muscularity, chest width, rump width and body condition score are good predictors for carcass weight, degree of fleshiness and degree of fat covering, traits that determine the beef merit index. The conformation traits will also be used as indicator traits for the beef merit index of living animals.
These slaughter and conformation data lead to a breeding value for meat production: the beef merit index. The beef merit index answers the following questions:

- The beef merit index makes it possible to breed more specifically with a view to meat production suitability within the MRIJ breed.
- The beef merit index provides compact information about the carcass quality and carcass weight of a bull’s offspring. The beef merit index is a good aid to become acquainted with something extra about the transmission pattern of a bull.
- The beef merit index is an instrument to control what happens in the cow and bull population.
- The beef merit index is a tool to handle commercial crossbreeding in a more goal-oriented manner. The differences between bulls and breeds become apparent.

▪ Beef Merit Index and Breeding Goal

Data of Three Animal Categories
In collecting data in the slaughterhouse, slaughter data of three animal groups are recorded, namely dairy cattle, veal calves and fattening bulls. The data that are measured upon slaughtering are: carcass weight, degree of fleshiness, degree of fat covering and meat colour. This last trait is only scored for veal calves.
In addition to slaughter traits heifer conformation traits are included as indicator traits. Traits with a moderate to strong relationship with slaughter traits are added to the breeding value estimation. The following traits are selected: chest width, body condition score, rump width and muscularity.
This means that in the breeding value estimation, breeding values for three animal categories are estimated: for the dairy cows and fattening bulls breeding values are estimated for degree of

fleshiness, degree of fat covering and carcass weight and for the veal calves breeding values are estimated for degree of fleshiness, degree of fat covering, meat colour and carcass weight. This may result in a total of 14 breeding values for 10 meat traits and 4 conformation traits for a bull (as a sire of dairy cows, veal calves and fattening bulls).
Breeding values for the 14 traits are estimated with a multiple trait model accounting for underlying correlations. All data will contribute to the breeding value estimation of each separate trait.
The objective of a beef merit index is to contain these 14 breeding values in 1 figure, so that selection of bulls with respect to carcass quality and carcass weight is simplified.

Breeding Goal for Two Animal Categories

In the beef merit index the slaughter traits of two animal categories, namely veal calves and fattening bulls, are improved with the use of the data of all three animal categories. In order to predict the slaughter traits for veal calves and fattening bulls as well as possible, not only the breeding values of the slaughter traits for these veal calves and fattening bulls are used, but also the breeding values of slaughter traits of the dairy cows. In this way all the available information is used to calculate the beef merit index for the improvement of the slaughter traits for the veal calves and fattening bulls.
The difference between breeding value and breeding goal is therefore as follows:
- in the breeding goal, the traits of degree of fleshiness, degree of fat covering, meat colour and carcass weight for veal calves and the traits of degree of fleshiness, degree of fat covering and carcass weight for fattening bulls are included (in total 7 traits).
- the underlying breeding values are calculated for the following traits: degree of fleshiness, degree of fat covering, meat colour and carcass weight for veal calves; degree of fleshiness, degree of fat covering and carcass weight for fattening bulls; degree of fleshiness, degree of fat covering and carcass weight for cows and the conformation traits chest width, body condition score, rump width and muscularity for heifers (in total 14 traits).

When making a selection with the beef merit index, the slaughter traits for the veal calves and fattening bulls may be improved, while it has been taken into account which percentage of the calves goes to the beef calf sector (50% of the calves born) and which percentage goes in the direction of the beef bull sector (5% of the calves born) and what is the financial value of the improvement of each slaughter trait.

The reason to include only the veal calves and fattening bulls in the breeding goal is:

The beef merit index is meant for the dairy cattle farmer who, in his choice of active bulls, wants to take into account the expected surplus value of the (bull)calf for the veal calf and beef bull sector. In other words, the beef merit index makes a distinction between active bulls with respect to their genetic value for meat production suitability within the beef calf and beef bull sector.
With the Inet, for example, a distinction is made between active bulls with respect to their genetic value for milk production. In doing so, no attention is paid to what the surplus value of bull calves is when they descend from a sire with a high Inet. For the dairy farmer this means that heifers are there for the milk and for this a selection is made on the Inet, the bull calves are there for the meat and for this group a selection is made on the beef merit index. At the same time the dairy farmer may decide: of this cow I wish to keep the calf, so now I have to consider the Inet, and of this cow I want to sell the calf, so now I must examine the beef merit index.

It has been decided to leave the meat production value for the dairy cow out of consideration with respect to the breeding goal. The main reason is the very difficult interpretation of the economic values of the slaughter traits for the dairy cow. The matter of fact is that the economic value of the weight of the animals is negative – the additional slaughter profits do not compensate for the additional maintenance costs during the entire productive life of the cow (Koenen et al., 2000).
This reflects generally, that, in view of the present economic conditions, meat production directly from the dairy cattle stock is a residual product, and targeted production of this residual product is not profitable from an economic point of view. A second reason for omitting the dairy cow in the

breeding goal is the parallel with the Inet. The beef merit index provides the meat production value of the calf when utilised in the beef cattle sector; the Inet provides the milk production value of the calf when utilised in the dairy cattle sector.

▪ Data

Slaughter data

Classifiers of the PVE (the Netherlands) en IVB (Flanders) score the carcasses of the slaughtered animals in the slaughterhouses. Through the linking of the identification number, the pedigree and herd data associated with the slaughter data may be looked for.
In the slaughterhouses, fleshiness, degree of fat covering and carcass weight of all the animals are recorded. In addition, veal calves receive a score for meat colour.
Fleshiness is scored in accordance with the SEUROP system. This gives a valuation 'S' to a carcass with a large degree of fleshiness and a valuation 'P' to a so-called "culled" dairycow. The official description of the categories is: S = superior degree of fleshiness, E = excellent, U = very good, R = good, O = moderate and P = low. Per main category three subcategories are indicated by -, 0 and +. In this way, there are finally 18 codes for the degree of fleshiness, such as E-, E0, E+, U-, etc. For the breeding value estimation, the 18 codes for the degree of fleshiness are recoded for a scale of 1 to 18 incl., in which S+=18, ..., and P-=1.

The degree of fat covering is scored with figures 1 to 5 incl., in which the value 1 belongs to carcass with an extremely low degree of fat covering and a score 5 is given to a carcass with a very high degree of fat covering. The official description of the categories is: 1 = low degree of fat covering, 2 = light, 3 = average, 4 = high degree of fat covering and 5 = very high degree of fat covering. Per main category, another three subcategories are indicated by -, 0 and +. This leads to 15 final codes for the degree of fat covering, such as 1-, 10, 1+, 2-, etc. For the breeding value estimation, the 15 codes for degree of fat covering are recoded into 1 to 5 incl., in which 1- = 1 and 5+ = 15.
Meat colour is scored in 15 categories, score 1 to 15 incl., in which a higher value corresponds with a darker colour. The first 10 categories are meant for the white veal calves, the last 5 categories are for the so-called pink veal calves. Fattening bulls and cows are not judged for their meat colour..
The carcass weight is measured in kilograms with an accuracy of up to 0.1 kg. Besides the weighed carcass weight, a tare weight is given (for the meat hook, for example) and a correction weight (for late weighing, if any, of the carcass). After correction of the carcass weight for the tare weight and correction weight, the carcass weight remains, which is the determined warm slaughtered weight.

Conformation traits

The requirements for a classification to be included in the animal model are also written in Chapter E08 of CRV (Conformation traits):

1. the cow must be herd book registered.
2. the cow was a heifer at the time of the classification.
   Only heifer classifications are selected for breeding value estimation none or little selection has taken place. Only one classification will be used. If there are several classifications, the first classification of the animal is chosen.
3. the cow must have calved before 3 years of age.
4. the cow must have a known herd at the time of classification
5. the cow must be classified according to the Z, R, Y or F standard
6. the cow must be in the herd classification system or in an additional classification system (see Chapter E08).
7. Linear traits like chest width, body condition score and rump width are scored from 1 to 9
8. General characteristics like muscularity with a lower value than 71 are set to 71 points and with a higher value than 89 are set to 89 points. Heifers can have maximum 89 points for Overall conformation.

For the breeding value estimation, three groups of animals are distinguished: white veal calves, cows and fattening bulls. For each group, different demands are made upon the data:

for *veal calves*: the sex of the animal is male or female, the slaughtered weight is at least 90 kg and 250 kg at the most, the slaughter age is at least 100 days and 250 days at the most and the meat colour has a score of 1 to 10 incl.;

for *cows*:
slaughter traits: the sex is female, the slaughtered weight is at least 200 kg and 800 kg at the most, the lactation stage is at least 550 days and the slaughter age is at least 600 days, the cows belong to the dairy breed;
conformation traits: only heifer data from 1-1-1995 are included and only data of heifers that have at least a score for body condition.

for *fattening bulls*: the sex is male and the slaughter age is at least 350 days and 850 days at the most.

Furthermore, the sire of the animal must always be known and the animal is at least 87.5% from a known breed.

▪ Statistical Model

The calculation of breeding values is done with a multiple trait animal model, in accordance with the BLUP technique (Best Linear Unbiased Prediction). Using this method, breeding values for all animals, males and females, are estimated, making use of all slaughter data and conformation data of animals and their ancestors and relatives, and making use of the relationship between traits.

➢ Veal calves

The model for the analysis of the data of the white veal calves is as follows:

$$\mathbf{Y_{ijklmno} \quad BS_i + SEX_j + b_k*AGE_k + b_l*HET_l + b_m*REC_m + ANIMAL_n + Residual_{ijklmno}}$$

In which:

$Y_{ijklmnopq}$	= observation of the animal for degree of fleshiness, degree of fat covering, meat colour and carcass weight;
BS_i	= herd*slaughter date i of the animal n;
SEX_j	= sex j of the animal q;
b_k	= regression factor b_k at age of the animal at slaughter, with the linear, quadratic and cubic term;
AGE_k	= slaughter age of animal n (in days);
b_l	= regression factor b_l to the heterosis effect, with linear term;
HET_l	= heterosis effect l of animal n, where 6 effects are distinguished: heterosis between two dairy breeds, heterosis between a dairy and dual-purpose breed, heterosis between a dairy and beef breed, heterosis between a dual-purpose and a beef breed, heterosis between two beef or dual-purpose breeds;
b_m	= regression factor b_m to the recombination effect, with linear term;
REC_m	= recombination effect m of animal n, where 6 effects are distinguished: recombination between two dairy breeds, recombination between a dairy and dual-purpose breed, recombination between a dairy and beef breed, recombination between a dual-purpose and a beef breed, recombination between two beef or dual-purpose breeds;

$ANIMAL_n$	= animal n;
$Residual_{ijklmno}$	= residual of $Y_{ijklmno}$, which is not explained by the model.

- **Cows**

The model for the analysis of the data of the cows is as follows:

$$\mathbf{Y_{ijklmnop} = BS_i + AGE_j + M_k + b_l*LACT_l + b_m*HET_m + b_n*REC_n + ANIMAL_o + Residual_{ijklmnop}}$$

In which:

$Y_{ijklmnopqr}$	= observation of the animal for degree of fleshiness, degree of fat covering, meat colour and carcass weight;
BS_i	= herd*season i of the animal o, in which season is determined by the year of slaughter and in which 2 years form one season;
AGE_j	= age j of the animal r (12 year categories);
M_k	=month k of slaughter of the animal o, in which month is defined as year*month;
b_l	= regression factor b_l on lactation stage of the animal o at slaughter, with both the linear and the quadratic term;
$LACT_l$	= lactation stage at slaughter of animal o (in days);
b_m	= regression factor b_m on the heterosis effect, with linear term;
HET_m	= heterosis effect m of animal o, where 6 effects are distinguished: heterosis between two dairy breeds, heterosis between a dairy and dual-purpose breed, heterosis between a dairy and beef breed, heterosis between a dual-purpose and a beef breed, heterosis between two beef or dual-purpose breeds;
b_n	= regression factor b_n on the recombination effect, with linear term;
REC_n	= recombination effect n of animal o, where 6 effects are distinguished: recombination between two dairy breeds, recombination between a dairy and dual-purpose breed, recombination between a dairy and beef breed, recombination between a dual-purpose and a beef breed, recombination between two beef or dual-purpose breeds;
$ANIMAL_q$	= animal o;
$Residual_{ijklmnop}$	= residual of $Y_{ijklmnop}$, which is not explained by the model.

- **Fattening bulls**

The model for the analysis of the data of the fattening bulls is as follows:

$$\mathbf{Y_{ijkmn} = BS_i + b_j*AGE_j + b_k*HET_k + b_l*REC_l + ANIMAL_m + Residual_{ijkmn}}$$

In which:

Y_{ijlmn}	= observation of the animal for degree of fleshiness, degree of fat covering, and carcass weight;
BS_i	= herd*slaughter date i of the animal m;
b_j	= regression factor b_j at age at slaughter of the animal m, with both the linear and the quadratic term;
AGE_j	= age at slaughter of animal m (in days);
b_k	= regression factor b_k on the heterosis effect, with linear term;
HET_k	= heterosis effect k of animal m, where 6 effects are distinguished: heterosis between two dairy breeds, heterosis between a dairy and dual-purpose breed, heterosis between a dairy and beef breed, heterosis between a dual-purpose and a beef breed, heterosis between two beef or dual-purpose breeds;
b_l	= regression factor b_l on the recombination effect, with linear term;

REC_l	= recombination effect l of animal m, where 6 effects are distinguished: recombination between two dairy breeds, recombination between a dairy and dual-purpose breed, recombination between a dairy and beef breed, recombination between a dual-purpose and a beef breed, recombination between two beef or dual-purpose breeds;
$ANIMAL_m$	= animal m;
$Residual_{ijkmn}$	= residual of Y_{ijkmn}, which is not explained by the model.

➢ **Heifer conformation traits**

The model for the analysis of conformation traits is as follows:

$$\mathbf{Y_{ijklmno} = HD_i + AGEj + LACT_k + b_l{*}HET_l + b_m{*}REC_m + ANIMAL_n + Residual_{ijklmno}}$$

where:

Y_{ijklmn}	= observation of the animal for muscularity, rump width, body condition score or chest width;
HD_i	= herd x date of classification x classification standard i of animal n;
AGE_j	= age at classification of animal n (in months) (varying from 24 to 41 months);
$LACT_k$	= lstage of lactation at classification of animal n (in months) (varying from 1 to 18 months);
b_l	= regression factor b_l for the heterosis effect, with linear term;
HET_l	= heterosis effect l of animal n, where 6 effects are distinguished: heterosis between two dairy breeds, heterosis between a dairy and dual-purpose breed, heterosis between a dairy and beef breed, heterosis between a dual-purpose and a beef breed, heterosis between two beef or dual-purpose breeds;
b_m	= regression factor b_m for the recombination effect, with linear term;
REC_m	= recombination effect m of animal n, where 6 effects are distinguished: recombination between two dairy breeds, recombination between a dairy and dual-purpose breed, recombination between a dairy and beef breed, recombination between a dual-purpose and a beef breed, recombination between two beef or dual-purpose breeds;
$ANIMAL_n$	= animal n;
$Residual_{jklmno}$	= residual of $Y_{ijklmno}$, which is not explained by the model.

The heritabilities used are stated in table 2. For the calculation of the animal effect, the sire and the dam of the animal are also taken into account.
Animal and residual are random effects, effects with regression coefficients like heterosis and recombination are covariables and the remaining effects are fixed effects.

▪ Composition of the Beef Merit Index

In the calculation of the beef merit index, the breeding values of the bulls are weighted in accordance with the reliabilities belonging to these breeding values. Furthermore, the correlations between traits are used as stated in table 1.

The economic values used in the beef merit index have been deduced in a research of Van der Werf (1996 and 1998) and are mentioned in table 3. The economic value of a trait is defined as the increase in profit per genetic progress unit of that trait, when the other traits in the breeding goal remain constant. The selection index is a linear optimisation problem, due to which one must assume that the economic values within the expected range of genetic change are constant.

Because genetic progress only finds expression several years after selection, the economic values should be based on expected prices and circumstances.
The economic values for traits in the breeding goal have been deduced with profit functions at herd level. Dairy cattle farming and meat production farming, however, are integrated from an economic point of view, in other words, in the determination of profit it does not matter which type of herd profits from this. For category variables the value is calculated from the marginal shift of frequencies over categories if the average in the underlying scale shifts. The economic value of growth for veal calves and fattening bulls is mainly determined by shortening the period of the rearing period (so a constant final weight).
The various traits in the various animal categories do not find expression to the same degree and at the same point of time. In order to calculate the value of genetic improvement for the various traits back to a common basis, they may be multiplied by a so-called cumulative discounted expression (cde). In the cde of a trait, the time and frequency are allowed for of a superior genotype, resulting from the selection of an individual in a breeding program.

Mortality is also taken into account here. As allowance factor an interest percentage of 3% per year has been assumed.

In the calculation of the cde´s, expression of slaughter trait for veal calves and fattening bulls has been assumed at the slaughter age of 200 and 600 days, respectively.
Calves that are born have some three destinations that affect the cumulative expressions of the slaughter traits: calves serve as replacement of dairy cattle, enter the beef calf sector or go to the beef bull sector. Of all the calves born, 30% finally becomes a dairy cow. To this end, 45% of the calves born are required in the dairy cattle sector so that, having taken into account drop-out around birth and death during the rearing, 30% realise complete heifer lactations. The bull calf sector takes 50% of the calves for its account, while 5% of the calves from dairy cattle are kept and slaughtered as fattening bulls.
The expression of meat production traits is taken relatively to the expression of milk production traits, so that the beef merit index may be compared with the Inet. Of all the calves born, 30% give 1/0.3 times expression to milk production. The expression of milk production is relative 1 at heifer level, in which the Inet is expressed, and as second and higher parity cows produce more, the relative expression of milk has been determined at 1.179. This has resulted in cumulative allowed economic values as stated in table 3 and as they are also used in the beef merit index. The standard deviation of the beef merit index at breeding value level is € 5,57 expressed in the lactation production of a heifer. When the breeding value of the TDM are taken into account, where the breeding value is expressed in an average lactation (over three lactations), the standard deviation is € 8,18.

The euros that result from the beef merit index are directly comparable with the euros of Inet. The economic values used in the beef merit index have, just as for the Inet, the principle of net profits: what are the profits of the improvement of a trait, taking into account the expected costs, such as nutrition costs, fixed costs, death of animals during the fattening period, transport costs etc. Furthermore, one should consider that the differences in euros between the beef merit index of breeds do not equal the differences in prices of new-born calves of these breeds. In order to receive a basic price for price differences between new-born calves of various breeds, table 5 shows the prices for as well calves of pure-bred as for crossbred calves (beef breed with dairy breed).

Table 1. Overview of correlations between traits and animal groups. Genetic correlations (bottom diagonally) and phenotypical correlations (top diagonally) between traits for the animal groups veal calves, fattening bulls and dairy cows, as used in the beef merit index. Also genetic correlations between slaughter ad conformation traits are presented. The traits are carcass weight (kg), degree of fleshiness (subcategories), degree of fat covering (subcategories) and meat colour. The conformation traits are muscularity, rump width, body condition score and chest width.

	veal calves				beef bulls			dairy cows			heifers			
	carcass w	fleshiness	fat cov	colour	carcass w	fleshiness	fat cov	carcass w	fleshiness	fat cov	musc	rump w	condition	chest w
carcass w	**1.00**	0.60	0.57	0.05										
fleshiness	0.62	**1.00**	0.50	-0.03										
fat cov	0.57	0.55	**1.00**	-0.03										
colour	0.03	0.04	0.08	**1.00**										
carcass w	0.49	0.34	0.06	-0.06	**1.00**	0.47	0.24							
fleshiness	0.16	0.72	0.15	-0.01	0.48	**1.00**	0.21							
fat cov	0.09	0.22	0.62	0.08	0.33	0.31	**1.00**							
carcass w	0.31	0.09	-0.05	-0.06	0.58	0.25	0.04	**1.00**	0.55	0.40				
fleshiness	0.10	0.49	0.08	0.05	0.40	0.76	0.21	0.64	**1.00**	0.66				
fat cov	0.05	0.11	0.38	0.14	0.23	0.27	0.58	0.61	0.60	**1.00**				
musc	0.10	0.30	0.05	0.00	0.32	0.38	0.00	0.37	0.64	0.15	**1.00**			
rump w	0.20	-0.10	0.09	0.08	0.38	-0.17	0.19	0.29	-0.07	0.07	0.23	**1.00**		
condition	0.30	0.38	-0.22	-0.06	0.65	0.60	-0.29	0.67	0.78	-0.66	0.81	0.00	**1.00**	
chest w	0.37	0.09	0.01	0.06	0.73	0.14	0.09	0.78	0.43	-0.36	0.67	0.34	0.71	**1.00**

Table 2. Genetic variances and heritabilities for the traits that are used in the breeding value estimation for the beef merit index.

		genetic variance	h^2
calf	carcass w	50.06	0.19
	fleshiness	0.29	0.24
	fat cov	0.61	0.17
	colour	0.26	0.18
bull	carcass w	159.1	0.20
	fleshiness	0.26	0.32
	fat cov	0.4	0.30
cow	carcass w	313.6	0.23
	fleshiness	0.28	0.17
	fat cov	1.21	0.17
heifer	musc	0.72	0.35
	rump w	0.83	0.40
	condition	0.60	0.30
	chest w	0.49	0.24

Table 3. Economic values and the cumulative allowed economic value (= value used in the beef merit index) of slaughter traits, used for the breeding goal traits of the beef merit index

Trait	unit	economic value	1) cumulative discounted economic value	2) cumulative discounted economic value
white veal calv.				
fleshiness	€/subcategory	5.03	2.74	4.03
fat covering	€/subcategory	-0.21	-0.116	-0.171
growth	€/subcategory	0.227	0.124	0.182
meat colour	€/subcategory	-8.29	-4.52	-6.64
fattening bulls				
fleshiness	€/subcategory	17.82	1.27	1.87
fat covering	€/subcategory	-3.49	-0.185	-0.272
growth	€/subcategory	0.452	0.024	0.035

1) expressed in € comparable to lactation production of a heifer
2) expressed in € comparable to lactation production rated via the TDM

▪ Presentation

Breeding values for the beef merit index are published based on the 2015-base. Cows born in 2010 determine the base of 2015. There are four different bases: Milk goal Black, Milk goal Red, Dual purpose and Belgian Blue. The definitions of these bases are as follows:

Milk goal Black (Z)
Herdbook-registered cows born in 2010 with at least 87.5% HF-blood and up to 12.5% FH-blood and hair colour black pied, with at least one observation in the genetic evaluation. *Milk goal Red (R)*
Herdbook-registered cows born in 2010 with at least 87.5% HF-blood and up to 12.5% MRY-blood and hair colour red pied, with at least one observation in the genetic evaluation.

Dual purpose (D)
Herdbook-registered cows born in 2010 with at least 75% MRIJ-blood and 25% or less HF blood, with at least one observation in the genetic evaluation.

Belgian Blue (B)
Herdbook-registered cows born in 2010 with at least 87.5% Belgian Blue-blood, with at least one observation in the genetic evaluation.

The cows of the Milk goal Black base are used to determine the standard deviation for all bases. Using one standard deviation for the 4 bases has as advantage that only the level differs between the bases and no difference exists between the standard deviations.

Every 5 years, in a year dividable by 5, the reference year for the base is moved 5 years. The base differences are shown in Table 4.

Table 4. Base differences for Beef merit index traits

Trait	Kind of base[1]	Base differences[2]					
		Z=>R	Z=>D	Z=>B	R=>D	R=>B	D=>B
Beef Merit index	C	0	-7	-37	-7	-37	-30
Fleshiness calves	C	-1	-17	-70	-16	-69	-53
Fat covering calves	C	1	3	-12	2	-13	-15
Carcass weight calves	C	0	-4	-15	-4	-15	-11
Meat colour calves	C	0	1	-4	1	-4	-5
Fleshiness fattening bulls	C	-1	-14	-70	-13	-69	-56
Fat covering fattening bulls	C	1	1	-13	0	-14	-14
Carcass weight fattening bulls	C	0	-6	-31	-6	-31	-25
Fleshiness dairy cows	C	-3	-21	-117	-18	-114	-96
Fat covering dairy cows	C	3	7	0	4	-3	-7
Carcass weight dairy cows	C	-1	-5	-54	-4	-53	-49
Muscularity heifers	C	-1	-7	-10	-6	-9	-3
Rump width heifers	C	1	1	3	0	2	3
Body condition score heifers	C	-3	-12	-16	-9	-13	-4
Chest width heifers	C	0	-7	-6	-6	-5	1

(1) C=cow base, S=sire base
(2) Z= Milk goal Black, R= Milk goal Red, D= Dual purpose, B= Belgian Blue

The reason to present the beef merit index at a relative scale is that no discussion will arise about the exact beef prices that have been used in the index, whether it should be a half euro more or less. The beef merit index is meant to rank animals for meat production suitability, and whether the best bull yields 10 euros or 20 euros more, is not relevant.

To still be able to compare the importance of the beef merit index in relation to the Inet, the economic value is determined on the basis of the prices of 1995 (Van der Werf).
In the determination of the standard deviation, the starting point is breeding values with a reliability of 80%. So 4 points in the breeding value correspond with approximately 0.9*genetic standard deviation.
The (genetic) standard deviation of the beef merit index is 8.18 euro. This means that 4 breeding value points correspond to 0.894*8.18 = 7.30 euro. These 7.30 euros are standardised into the euros of Inet. The standard deviation of the Inet in euros is approximately 12 times bigger than the standard deviation of the beef merit index.

For the translation to the offspring, an additional step has to be made. The beef merit index reveals in the profit of the calf. The Inet reveals in several lactations of a cow. A calf that is born is destined for: either the milk production or the beef production. If we consider the calf, the breeding value must not be compared to the lactation production, but to the life milk production of a cow. Calculation shows that 4 breeding value points then correspond with a value of € 20, of which half will be transmitted to the offspring.
In addition to the beef merit index, the underlying breeding values are also calculated, while the presentation is also on a relative scale. For the cattle farmer one figure is presented, the beef merit index. The underlying breeding values are available to the owners of the bulls and those interested. All the breeding values become together with rough averages and number of offspring in 3 animal categories available, so that all the important underlying information of the beef merit index is accessible.

For the presentation at a relative scale of the slaughter traits applies:
>100 : better than average degree of fleshiness
lower degree of fat covering
higher/faster growth
higher carcass weight
lighter meat colour
higher conformation score
In brief, a breeding value of over 100 means that one may make money.

▪ Differences between Breeds

Table 5. Average beef merit index of bulls of various breeds, in which the reliability of the beef merit index is at least 55% and presented on the Milk goal Black base. In column 2 and 3 the surplus value of the calves is shown

Breed	Average beef merit index	Value in euro (100=0) Calves with sire of given breed, and dam is dairy	Value in euro (100=0) Calves with sire and dam of same breed
Jersey	82	-45.00	-90
Holstein Friesian	99	-2.50	-5
Brown Swiss	100	0.00	0
Dutch Friesian	105	12.50	25
Montbéliarde	107	17.50	35
MRIJ	111	27.50	55
Fleckvieh	116	40.00	80
Piemontese	122	55.00	110
Limousin	122	55.00	110
Blonde d’Áquitaine	128	70.00	140
Improved Red&White	135	87.50	175
Belgian Blue	141	102.50	205

Table 6. Average breeding value for the underlying traits used in the beef merit index for the breeds Holstein-Friesian, MRIJ, Dutch-Friesian (FH) and Belgian Blue. Breeding values presented on the Milk goal Black base.

Trait	HF	FH	MRIJ	BBL
cows				
Fleshiness	101	117	123	212
Fat covering	100	91	92	101
Carcass weight	99	99	105	151
veal calves				
Fleshiness	100	118	119	163
Fat covering	100	95	96	110
Growth	100	102	105	114
Meat colour	100	95	99	104
fattening bulls				
Fleshiness	102	117	118	169
Fat covering	100	95	98	115
Growth	100	100	106	129
heifers				
Muscularity	0	0	108	0
Rump width	99	102	99	0
Condition	99	112	113	0
Chest width	99	98	107	0

Table 7. Averages for the traits of degree of fleshiness, degree of fat covering, meat colour, carcass weight, slaughter age, lactation length at slaughter, muscularity, rump width, body condition score and chest width for the data used in the breeding value estimation.

Trait	veal calves	dairy cows	fattening bulls	dairy heifers
fleshiness	O 0	O -	O+	
fat covering	2 0	3 -	3 -	
meat colour	6	---	---	
carcass weight	144 kg	293 kg	362 kg	
age at slaughter	196 days	2011 days 5yr6m	613 days	
lactation length at slaughter		260 days		
muscularity				81.3
rump width				4.9
body condition score				4.9
chest width				4.9

▪ Application of beef merit index

The beef merit index is a good tool to apply for more specific cross breeding. It gives information about carcass quality and carcass weight of the offspring of a bull. It appears there is a lot of variation within a breed. The difference between a low and a high Belgian Blue bull for beef merit index is around the 40 points. As for the value of the calf this differs around € 100.-. At the same time it is possible to compare bulls of different breeds with each other. The variation in beef merit index within a breed gives many overlap with other beef breed (see figure 1). For example a good Belgian Blue bull is always the best that is available, regarding the beef production suitability. But not every Belgian Blue bull is good. It appears that a Belgian Blue bull with a low beef merit index scores lower than a good BA bull with a high beef merit index.

The beef merit index also shows that a good MRIJ bull scores better for beef merit index than a bad Piemontese.
This immediately shows the value of the beef merit index for a breed as MRIJ. It is now possible to breed selective for beef production suitability on the basis of the beef merit index.
With the more dairy breeds the beef merit index will not directly take an important place in the future. Still the beef merit index shows that MRIJ can give more suitable animals for beef production than Holstein and Dutch Friesian can. However, within the breed is also a lot of variation: with Holstein the highest bulls score over 100 points, the lowest beneath 90 points.
When the cows of the dairy breeds are studied it appears that the Dutch Friesian breed scores a little better for beef merit index than HF. The slaughter weight of dairy cows for Dutch Friesian is 7,5 points lower than for Holstein (average index of 97 vs. 99), while the fleshiness and fat covering scores better (see table 6). But MRIJ is as for fleshiness superior to FH and HF. This shows clearly that MRIJ gives more than only milk.

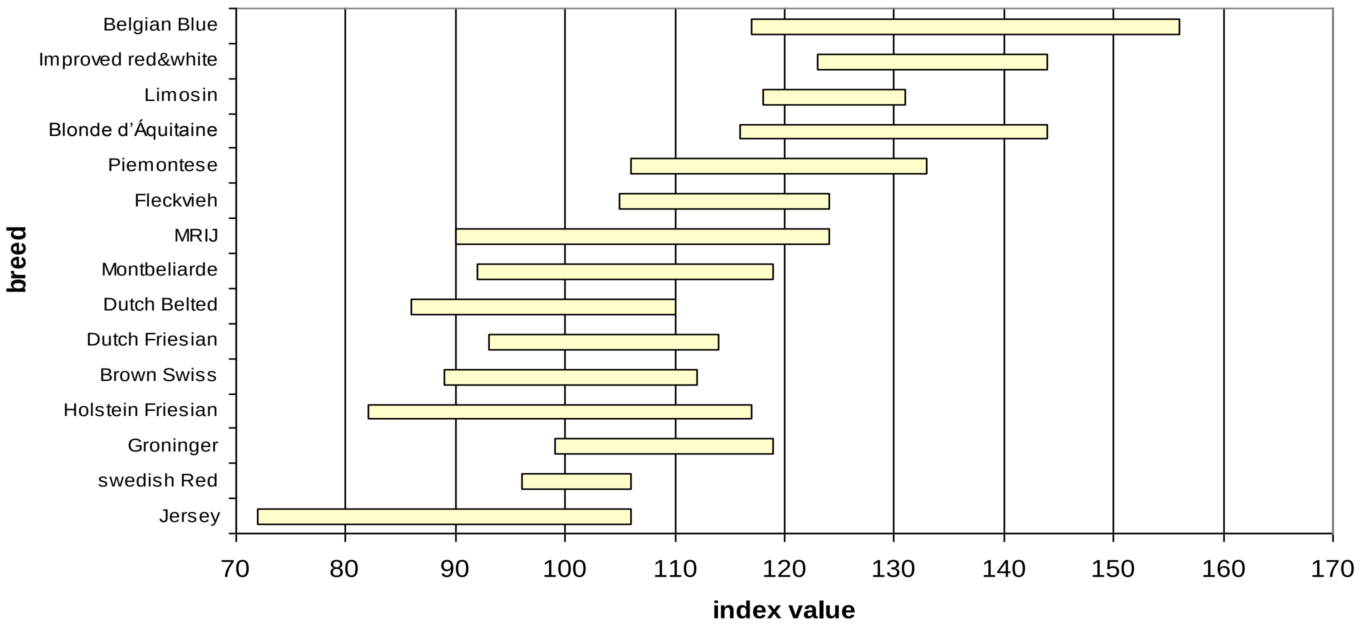

Figure 1: Variation of beef merit index of bulls within a breed and the overlap which exists between breed. Breeding values presented on the Milk goal Black base.

▪ Publication

The beef merit index is published at 30% reliability. Besides the beef merit index, the breeding values Calving Ease and Vitality are shown in the publication. Together these three traits give the dairy farmer the ability to select bulls which have an economically favourable beef production.

▪ Literature

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