Feed intake genetic evaluation: progress and an index for saved feed cost

G. de Jong[1], J.J. Bouwmeester-Vosman[1],C. van der Linde[1], Y. de Haas[2], G.C.B. Schopen[2], R.F. Veerkamp[2]

[1]CRV, P.O. Box 454, 6800 AL Arnhem, The Netherlands
[2]Animal Breeding and Genomics Centre, Wageningen UR Livestock Research, PO Box 338, 6700 AH Wageningen, the Netherlands.
E-mail: Gerben.de.Jong@crv4all.com

Abstract

Improving feed efficiency in dairy cows gets worldwide more and more interest. Feed is the main part in the variable cost of producing milk. At the same time reduction of feed intake results in a reduction of the production of greenhouse gases and therefore has a positive effect on the environment. In the Netherlands and Flanders, a genetic evaluation for dry matter intake was developed and currently includes observations on 5600 cows. To facilitate the selection for efficient cows, the Saved Feed Cost for Maintenance index (FSCM) was developed, which is also part of the total merit index NVI. The genetic trend of dry matter intake shows an increase of dry matter intake per day. FSCM has a negative trend, related to an increase of body size over the years. Measuring dry matter intake and adding FSCM to the breeding goal, results in a more efficient cow.

Key words: dry matter intake, dairy cows, saved feed cost, the Netherlands

Introduction

Dairy cows use feed to produce milk, for maintenance and for growth. The amount of feed taken in by a cow depends on the amount of milk produced, composition of the milk, as well as the body weight and growth. Feed cost is a very important variable cost when producing milk. At the same time, it is important to produce milk while emitting as less as possible greenhouse gases. Actually the goal is to get as much milk as possible with less feed.

Since 2014, in the Netherlands, a genetic evaluation was available for feed intake, based on dry matter intake data of about 2500 cows. Since then more data has become available and interest in the trait increased. Based on feed intake breeding value a saved feed cost for maintenance index (FSCM) was developed which indicates the feed cost that can be saved during the lactation. The FSCM is now part of the Dutch Flemish NVI to facilitate breeding for a more efficient dairy cow population.

Materials and Methods

Data

For the breeding value estimation, dry matter intake data of Holstein-Friesian cows calved since 1990 is used. Data providers for the genetic evaluation are research institutes Wageningen Livestock Research, Schothorst Feed Research and ILVO, and feed companies Trouw Nutrition, and AVEVE. Furthermore, CRV started to collect data in a commercial dairy herd with 240 cows and the number of herds will be extended in 2019 with 4 more herds. The genetic evaluation currently uses data on 5649 cows with weekly feed intake measurements, between 2 and 50 weeks per lactation. 2380 Cows were genotyped. The cows originate from 1085 sires, of which 555 sires were genotyped. The dry matter intake trait (DMI) is measured in kilograms dry matter per day.

Method

Calculation of breeding values for dry matter intake is done using an animal model, according to the BLUP technique (Best Linear Unbiased Prediction). The genotypes of the animals allow a better determination of the relationships between the animals. The reliability of the breeding values come from own dry matter intake observations (or from related animals), pedigree information and genotype information from the cow or, if the cow does not have a genotype, the genotype of the cow's sire combined.

In the calculation of breeding values for dry matter intake the following statistical model is used, based on research by Veerkamp (2014):

y = EXP + HM + HY + AGE + LS + B + PERM + A + Res

where:
y : Observation of animal;
EXP : Experiment, a combination of farm and management/experiment effect;
HM : Herd*month of calving;
HY : Herd*year of calving;
AGE : Age at calving per parity, covariable, 3 levels;
LS : Lactation stage (Days in milk) fitted a polynomial with 5 levels;
B : Breed % of the second breed;
PERM : Permanent environment of animal;
A : Breeding value of animal;
Res : Residual

For the animal effect an H-matrix is used containing genomic information for those animals which are genotyped.

Results

Parameters

The heritability for dry matter intake varies from 0.28 for lactation 1 to 0.20 for lactation 3 (Table 1). The genetic standard deviation is 1.24 kg per day in the first lactation and 1.51 kg per day in the third lactation.

Table 1. Heritability (h^2) and genetic standard deviation (kg/day) for dry matter intake.

Trait	h^2	genetic stdev.
Lactation 1	0.28	1.24
Lactation 2	0.25	1.39
Lactation 3+	0.20	1.51

Dry matter intake index

Indices for DMI in lactations 1, 2 and 3 are calculated based on the breeding value for dry matter intake directly from the breeding value estimation for dry matter intake and breeding values for indicator traits from the breeding value estimation of the whole population using the parameters of Table 2. The indicator traits for dry matter are milk, fat and protein yield and body weight.

If an animal has no breeding value for dry matter intake from the breeding value estimation for dry matter intake, the breeding value for dry matter intake is determined completely by the four indicator traits. The breeding values for dry matter intake for lactations 1, 2 and 3 are combined in the dry matter intake index.

The dry matter intake index is calculated as follows:

Dry matter intake index =
0.41 x index for lactation 1
+ 0.33 x index for lactation 2
+ 0.26 x index for lactation 3+

Table 2. Genetic correlations between dry matter intake (DMI) and indicator traits.

	DMI lact1	DMI lact2	DMI lact3	Kg milk	Kg fat	Kg prot
DMI lact1						
DMI lact2	0.88					
DMI lact3	0.80	0.89				
Kg milk	0.55	0.58	0.56			
Kg fat	0.58	0.60	0.58	0.50		
Kg prot	0.59	0.61	0.59	0.91	0.65	
Body weight	0.67	0.45	0.41	0.10	0.10	0.10

Saved feed cost maintenance

The breeding value dry matter intake indicates how many kg dry matter a cow needs per day. A cow uses feed for production, but also for maintenance and activities.

Feed saved for maintenance (FSM) can be derived from the breeding value dry matter intake.

FSM = (1000/E *(5.9 kg fat + 3.0 kg protein + 2.43 kg lactose)/301) - DMI

where kg fat, kg protein and kg lactose are breeding values for 305-day production for kg fat, kg protein and kg lactose (= production day 5 to day 305). The weight factor is kVEM (feed units milk) needed to produce 1 kg fat, protein or lactose.
E is 940 VEM per kg dry matter.

FSM indicates how much feed for maintenance can be saved by for example lower body weight, less activity or by more efficient digestion or usage of feed. A positive breeding value is preferable as feed is saved.

Saving costs for dry matter intake for maintenance can also be expressed on lactation base: multiply FSM with the standard number of lactation days and the feed cost per kg feed (0.20 euro per kg dry matter). The result is a breeding value for saved feed costs for maintenance (SFCM).

SFCM = 60.20*FSM
(unit is euros per lactation)

Results

Genetic trends

In figure 1 the average breeding value for dry matter intake (DMI) and FMS are shown for Holstein AI bulls per year of birth. The average breeding value for DMI has increased on average 0,17 kg per year form year 1990 to 2013. The increase was 0,28 kg per year for the last 10 birth years. The main reason for this increase is the increase of production. The genetic trend for FSM is slightly negative, which is mainly related to an increase of body size and the extra feed this takes for maintenance.

The average reliability for bulls having direct information on feed intake on daughters or based on genomics is just above 40 percent (figure 2). When adding the indicator information from production traits and body weight the average reliability increases to 56 percent. For the last birth years, representing the genomic bulls, the reliability for DMI is 64 percent, the reliability of FSM, and therefore also for SFCM, is on average 55 percent. For bulls having only genomic information the average reliability is 46 percent.

Figure 1. Average breeding values for black and white Holstein AI bulls per year of birth for dry matter intake without predictors (DMIdir), dry matter intake including predictors (DMI) and FSM (Feed Saved Maintenance).

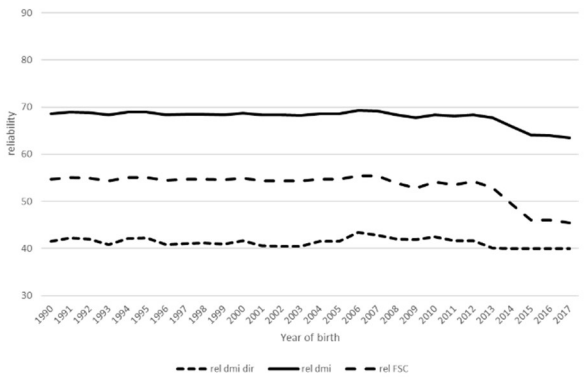

Figure 2. Average reliability for black and white Holstein AI bulls per year of birth for dry matter intake without predictors (DMIdir), dry matter intake including predictors (DMI) and FSM (Feed Saved Maintenance).

FSCM in breeding goal

FSCM was added to the Dutch-Flemish index NVI to facility breeding for a more efficient cow. The weighing factors and the relative weights are in Table 3. FSCM has a relative weight of 5%, which is comparable with udder composite and calving traits index.

Table 3. Weights and relative weight of traits in the Dutch-Flemish NVI.

	NVI 2018	**Rel weight**
Inet	0.40	29%
Longevity	0.08	12%
Udder health	4.7	12%
Fertility	6.3	16%
Udder Composite	1.8	5%
F&L Composite	3.6	9%
Calving traits index	1.8	5%
Claw health	2.7	7%
Saved Feed Cost Maintenance	0.23	5%

Conclusions

Breeding values for dry matter intake are estimated using observations on more than 5600 cows of which 2380 are genotyped. Further the majority of the sires have been genotyped.

DMI breeding values are used to derive FSCM, which is a good indicator which cows need less feed to produce the same amount of milk. FSCM is part of the total merit index NVI which enables to breed for a more efficient cow.

References

R.F. Veerkamp, M.P.L. Calus, G. de Jong, C. van der Linde, Y. De Haas. Breeding Value for Dry Matter Intake for Dutch Bulls based on DGV for DMI and BV for Predictors. Proceedings 10th World Congress of Genetics Applied to Livestock Production, Vancouver, 2014.