# Genetic Evaluation for Feed Intake in the Netherlands and Flanders, Impact on Efficiency and Responses

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## Abstract

Improving feed efficiency in dairy cows gets worldwide more and more interest. Feed is the main part in the cost of producing milk. At the same time reduction of feed usage 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 using observations on 3200 cows. Using also information of indicator traits, reliability of breeding value for dry matter intake for bulls is on average 59 percent. Adding dry matter intake to the breeding goal, results in a more efficient cow, without negative effects on health and fertility.

**Key words:** dry matter intake, dairy cows, indicator traits, genetic response, the Netherlands

## Introduction

Dairy cows use feed to produce milk, for maintenance and to grow. 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. Breeding values for milk production traits have been used for years in the selection of animals. Breeding values for body weight are also available, using a number of conformation traits.

Milk production and body weight can be used to calculate how much feed a cow needs by using the genetic correlations. But it is also possible to measure the amount of feed taken in. From this dry matter intake, a breeding value can be calculated. The breeding value based on these two sources may then serve to determine to what extent an animal uses the taken feed efficiently, i.e. how much milk will the animal produce from this.

In the Netherlands and Flanders a genetic evaluation has been developed to analyze data collected on feed intake. Breeding values are published and are used in the breeding goal to be able to select for more efficient cows.

## Materials and Methods

### *Data*

For the breeding value estimation, dry matter intake data of Holstein-Friesian cows calved since 1990 is used. These are data of dairy cows were part of research and were collected on a number of dairy farms in the Netherlands. The analysis was performed on about 3200 cows with weekly measurements for dry matter intake, between 2 and 50 weeks per lactation. The dry matter intake trait is measured in kilograms of dry matter per day. Genotypes are available for 1300 cows and for the sires of cows.

In addition, for the parameter estimation, data of a number of predictors is used, like daily milk, fat and protein yield as well as body weight.

A cow is included in the breeding value estimation when she is herdbook registered, meaning that her pedigree is recognized.

### *Method*

Calculation of breeding values for dry matter intake is done using an animal model, according to the BLUP technique (Best Linear Unbiased Prediction). For the breeding value estimation, the genotypes of the animals are used as well, allowing a better determination of the relationships between the animals. The breeding values from the estimation are the result of own observations, 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 with own dry matter intake information. The data have also been used to estimate the genetic correlations between the dry matter intake traits, milk production traits and weight. This means the breeding values for milk production traits and weight are also included in the breeding value for dry matter intake.

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

y = EXP + YM + YSC + AGE + LS + B + PERM +A + Res

where:

y : Observation of animal;
EXP : Experiment, a combination of farm and management/experiment effect;
YM : Year*month of the measurement;
YSC : Year*season of calving;
AGE : Age at calving;
LS : Lactation stage (Days in milk);
B : Breed % of the most important 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.

### *Parameters*

The heritability for dry matter intake varies from 0.28 for lactation 1 to 0.20 for lactation 3 (see 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 dry matter intake 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 directly 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 a breeding value for dry matter intake across all lactations and is similar to, for example, the breeding value for milk production, where the breeding values for milk for the first three lactations have been combined into one breeding value as well. 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 lact 1 | Dmi lact 2 | Dmi lact 3 | Kg milk | Kg fat | Kg prot | Body weigh t |
|---|---|---|---|---|---|---|---|
| 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 weigh t | 0.67 | 0.45 | 0.41 | 0.10 | 0.10 | 0.10 | |

## Results

### *Genetic trends*

In Table 3 the average breeding values for dry matter intake are shown for Holstein AI bulls per year of birth. The average breeding value has increased with 1.5 kg per day from birth year 2006 to 2013. This was combined with an increase of 650 kg milk, 35 kg fat and 24 kg protein. Also the body weight increased genetically with 15.4 kg.

The average reliability for bulls with daughter information in their proof is 59 percent. Bulls with breeding values solely based on genomics, like birth years 2011 to 2013, have on average a reliability of 54 percent.

The information for the breeding value for dry matter is based on direct information and on indicator traits. Direct information for dry matter is based on daughter information and/or genomic information. Compared with usage of solely information from indicator traits the direct dry matter information increases on average the reliability with 5 percent points, resulting in 0.17 extra spread in de dry matter breeding values. This 0.17 is equal to about 12 percent of the genetic standard deviation for dry matter intake.

**Table 3.** Average breeding values for black and white Holstein AI bulls per year of birth for dry matter intake, milk yield, fat yield, protein yield, lactose yield and body weight (kg). For dry matter intake also the average reliability is shown (rel dmi).

| year of birth | Nr bulls | Rel dmi | dmi | milk | fat | prot | lactose | body weight |
|---|---|---|---|---|---|---|---|---|
| 2006 | 444 | 60 | 0.11 | 239 | -1 | 2 | 13 | 0.4 |
| 2007 | 324 | 58 | 0.22 | 294 | 1 | 4 | 15 | 0.2 |
| 2008 | 340 | 59 | 0.55 | 409 | 10 | 9 | 19 | 6.6 |
| 2009 | 345 | 56 | 0.60 | 448 | 12 | 9 | 21 | 6.3 |
| 2010 | 343 | 56 | 0.94 | 478 | 17 | 13 | 23 | 14.2 |
| 2011 | 264 | 54 | 1.12 | 674 | 22 | 18 | 33 | 11.7 |
| 2012 | 233 | 54 | 1.34 | 628 | 29 | 20 | 31 | 14.8 |
| 2013 | 171 | 54 | 1.59 | 887 | 34 | 26 | 42 | 15.8 |

### *Impact breeding goal*

The breeding value for dry matter will be added to the Dutch Flemish production index Inet. The Inet is combining fat, protein and lactose yield with dry matter intake using the economic values for these four traits. For production traits the weights are based on farm gate prices and the weight for dry matter intake is based on feed costs.

The new Inet ($Inet_{dmi}$) is as follows:

$Inet_{dmi}$ = 0.5 lactose + 2.7 fat + 5.4 protein - 60.2 dmi

where the production traits are 305 day yield in kg and dry matter intake (dmi) in kg per day.

The main difference with current Inet and $Inet_{dmi}$ is that $Inet_{dmi}$ takes into account not only the cost for production but also for maintenance. The correlation between current Inet en the new Inet is 0.95.

When adding the $Inet_{dmi}$ to the total merit index NVI it results in a response with less feed intake, and less gain in production. Combining both in Inet the response in euro is 2 percent points higher (table 4).

Extending the breeding goal with feed intake also results in lower response in body weight and stature, while it has no effect on genetic responses for health and fertility traits.

**Table 4**. Difference in response between top 100 bulls using current NVI and NVI including dry matter intake (via Inet including dry matter intake). Response = (new NVI – current NVI)/genet. st.dev.

| trait | response (% gen. st.dev) |
|---|---|
| dry matter intake | -14% |
| Protein yield | -4% |
| Fat yield | -6% |
| Lactose yield | -5% |
| body weight | -21% |
| stature | -17% |
| longevity | 5% |
| udder health | -1% |

## Conclusions

Breeding values for dry matter intake are estimated using observations on 3200 cows of which 1300 are genotyped. Further the majority of the sires have been genotyped.

Usage of dry matter intake breeding values in total merit index results in 2 percent more efficiency for production and feed usage and had no effect on health and fertility traits.

Coming years more data will be added to the genetic evaluation resulting in higher reliability for the dry matter intake breeding values and at the end resulting in a more efficient dairy cow.

## References

Veerkamp, R.F., Calus, M.P.L., de Jong, G., van der Linde, R. & De Haas, Y. 2014. 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.