Statistical Indicators
E-20
NVI

▪ Introduction

Over the years, the breeding goal for dairy cattle has changed from a sole focus on production to attention for production, longevity, health traits and type. The typical cow on which the breeding goal is based, is a healthy cow with an efficient production from a healthy udder and constant fertility, which combines longevity with good feet and legs and functional type. To reach this objective, different breeding values have been developed for a large number of traits.

NVI combines information from breeding values to classify animals based on the breeding goal. The starting point in defining NVI is the breeding goal, and relations between breeding values are also taken into consideration.

NVI has replaced DPS and from February 2007 onwards sires are ranked according to this overall index. Traits in NVI have been given weight in such a way that a desired gain per trait is achieved.

In the development of NVI the economic values for the three production traits have been maintained in the way they are employed in the INET. For the other traits weighing factors generating the desired gain have been calculated. For longevity (LON), fertility (FER), udder health (UDH), udder, feet & legs and calving traits (CAL), target values have been identified to achieve the desired gains. Consolidation of fertility and improvement of the other traits constituted the starting point.

After an update of the NVI in 2012 the NVI was adjusted in April 2018 again. Since April 2018 claw health and saved feed cost (SFC) are included in the NVI. This NVI is used for animals which are published on the dairy goal black and the dairy goal red base. For the dual purpose breeds a separate NVI is available. The NVI for dual purpose is used for animals which breeding values are published on the dual purpose base and on the Belgium bleu base.

The economic weighing of the production traits can be found in the E-chapter on INET (E-9). This figure has been adopted directly into NVI.

▪ Selection Response

NVI is a figure on which sires are ranked and the goal is to rank the sire that produces strong daughters that come as close as possible to the breeding goal first. Besides production traits, there are functional traits in the breeding goal. Functional traits can be subdivided in longevity, health traits and type. Over the past years the importance of health has only increased. The farmer values a healthy cow, because the result is a sustainable cow with the best return and, moreover, a cow that is a pleasure to work with. Besides, consumer organizations also follow the doings of dairy farmers. Especially the health of cows is being followed critically. Type has been introduced in NVI consisting of udder and feet & legs. Most farmers agree that a cow with a functional udder and good feet & legs ensures better udder health and more pleasure in work.

NVI is based on achieving a desired selection response, i.e. which type of cow do you get.To determine this, the correlations among the traits that you want to improve are necessary. Selection on a certain trait will generally also lead to a change in another trait, the so-called correlated response. For example, selection on protein results in a decreased fertility.

Table 1 shows the genetic correlations, the heritabilities and the genetic variances which have been used to calculate the expected response. The selection response depends on the correlations which are used, because the overall index consists of several traits.

Table 1. Genetic correlations between traits and heritabilities (h^2) and genetic variances for the traits in NVI

		Lact	Fat	Prot	LON	UDH	IFL	CI	UDD	F&L	DCE	MCE	DLV	LVA	CLW	SFC	Aant doch	h^2	varianties
Inet	Lactose	-															125	0,55	472106
	Fat	0,38	-														125	0,58	784
	Protein	0,88	0,58	-													125	0,50	361
Longevity	Longevity	0,36	0,35	0,42	-												125	0,12	72900
UDH	UDH	-0,03	-0,02	-0,06	0,36	-											125	0,089	20
FER-index	Interval 1^e-last insem. (IFL)	-0,34	-0,24	-0,29	0,25	0,27	-										125	0,08	20
	Calving Interval(CI	-0,44	-0,33	-0,37	0,11	0,21	0,85	-									100	0,15	20
Udder	Udder	-0,08	-0,04	-0,10	0,11	0,27	-0,05	0,00	-								75	0,34	20
F&L	F&L	0,02	0,04	0,05	0,25	0,21	0,00	0,00	0,35	-							75	0,17	20
CAL-index (CAL)	Direct calving ease (DCE)	0,07	0,15	0,11	0,24	0,15	0,20	0,24	0,00	0,00	-						200	0,068	20
	Maternal calving ease (MCE)	0,00	0,00	0,00	0,16	0,09	0,25	0,24	0,10	0,10	0,19	-					75	0,048	20
	Direct vitality (DLV)	0,05	0,09	0,02	0,14	0,05	0,10	0,14	0,00	0,00	0,60	0,14	-				400	0,038	20
	Maternal vitality (MLV)	-0,04	-0,07	0,03	0,16	0,07	0,32	0,24	0,00	0,00	0,11	0,34	-0,16				140	0,085	20
CLW	Claw health	0,00	0,15	0,07	0,33	0,09	0,10	0,14	0,15	0,65	0,16	0,06	0,03	0,10			15	0,175	20
SFC	Savde feed cost	0,20	0,35	0,30	0,50	-0,03	-0,10	-0,30	-0,09	-0,29	0,41	-0,20	0,17	-0,05	0,11		20	0,25	2015
BI	Beefindex	0,01	--,02	0,03	-0,17	-0,03	0,00	0,05	-0,07	0,06	-0,22	0,04	-0,13	-0,03	-0,05	-0,40	125	0,25	20

Table 2 shows the selection responses for sires which will be achieved after one generation. The highest response is achieved for longevity. Udder health, udder and feet & legs also improve significantly. Fertility and the calving traits improve, but to a lower extent than other trait, which is in accordance with the breeding goal. The relative progress for kg fat and kg protein is very similar to the progress for kg milk and lactose. This means that fat and protein content will stay at the same level. The response for percentage fat with NVI is +0.01% and -0.01% for percentage protein, both on dairy goal Black base.

Table 2. Expected selection response for sires for the traits in NVI after one generation in absolute and relative units (as a percentage of the genetic standard deviation)

Trait	unit	absolute	relative
Fat	Kg	15,9	57%
Protein	Kg	10,5	56%
Lactose	Kg	14,3	51%
% fat	%	0,01	
% protein	%	-0,01	
Longevity	Dgn	214	79%
Udderhealth	Pnt	2,0	44%
Udder	Pnt	1,0	23%
Feet & Legs	Pnt	1,5	33%
FER-calving interval	Pnt	0,8	17%
FER-interval 1^e-last insemination	Pnt	1,2	26%
Direct calving ease	Pnt	1,6	35%
Maternal calving ease	Pnt	0,9	20%
Direct vitality	Pnt	0,8	18%
Maternal vitality	Pnt	1,0	23%
Claw health	Pnt	2,0	45%
Saved feed cost (SFC)	Eur	14,7	33%

Point = point breeding value
Relative selection response = absolute selection response / genetic standard deviation * 100%

All traits together realize a respons of 87 points NVI per generation with a selection-intensity of 1.0. In practice this is equal with about 10 NVI point per year in cows.
The responses from Table 2 are consistent with the breeding goal that was taken as a starting point. Therefore, the weights of the breeding values which lead to the responses in Table 2 are the weights in the NVI.

▪ Weighing Factors in NVI

The NVI formula 2018 for dairy reads as follows:

NVI_d =   0.40 x Inet + 0.08 x LON + 4.7 x (UDH-100) + 6.3 x (FER-100)

+ 1.8 x (UDD-100) + 3.6 x (F&L-100) + 1.8 x (CAL-100)

+ 2.7 x (CLW-100) + 0.23 x SFC

And the NVI for dual purpose is:

NVI_{dp} =   0.35 x Inet + 0.09 x LON + 5.2 x (UDH-100) + 5.2 x (FER-100)

+ 5.2 x (UDD-100) + 6 x (F&L-100) + 2 x (CAL-100)

+ 5.2 x (BI-100)

Inet = 0.3 x kg lactose + 2.1 x kg fat + 4.1 x kg protein

UDH = 0.477 * [SCM-100) + 0.641 * (CM -100) +100

FER = 0.52 x (IFL–100) + 0.52 x (CI–100) + 100

CAL = 0.08 x (DCE-100) + 0.08 x (MCE-100) + 0.55 x (DLV-100) + 0.83 x (MLV-100) +100

BI = beef index, based on slaughter traits

The units of the NVI are points and the genetic standard deviation is 87.
For udder health, fertility, udder, feet & legs, claw health and calving traits breeding values above 100 are desirable, and for inet, longevity and saved feed cost a higher breeding value is desirable. Sires scoring high for longevity and over 100 for udder health, fertility, udder and feet & legs produce daughters that will stay longer on the farm, with less udder infections, better fertility and better udder and feet and legs. Sires with these favourable qualities will have a higher NVI. Sires that score low for these traits will have a lower NVI.

The importance of traits in NVI can be expressed in different ways:

1. Relative importance of traits in NVI based on the sum of the standard deviation of traits in NVI

The relative importance of a trait is calculated by multiplying the weighing factor with the genetic standard deviation of the trait and then divided by the total of all traits, expressed in percentage. For example, the weighing factor of udder health is 4.7 and the genetic standard deviation is 4.5. The total of all weighing factors multiplied by the genetic standard deviations is 189. Therefore udder health has a relative importance in NVI of (21.15/189)*100 = 12%.

2. Relative weights of traits in NVI based on the response

The relative weight of a trait is calculated by multiplying the weighing factor with the response of the trait and then divided by the total of all traits, expressed in percentage. For example, for longevity the weighing factor is 0.08 and the response is 214 days. The total of all weighing factors multiplied by the responses is 87 points. Therefore longevity has a relative weighing in NVI of (17.12/87)*100 = 20%.

3. Relative contribution of traits in NVI

The relative contribution of a trait is expressed as a percentage, and reflects the decrease in response in points NVI with respect to the total response in points NVI, if this trait would be left out of NVI. The total response is 87 points of NVI. Now if for example fertility would be left out of the NVI the response would be 84.0 points of NVI. The relative contribution of fertility to NVI will thus be 100 - (84.0/87)*100 = 3%

The relative importance, weighing and contribution of traits to the NVI are shown in Table 3.

Table 3. Relative importance, weights and contribution of traits in NVI for dairy

	importance	weights	contribution
Inet	29%	39%	21%
Longevity	12%	20%	19%
Udder health	12%	11%	9%
Fertility	16%	8%	3%
Udder	5%	2%	2%
Feet&Legs	9%	7%	6%
Calving traits	5%	3%	3%
Claw health	7%	6%	6%
Saved feed cost	5%	4%	3%

▪ Reliability

The reliability of NVI is calculated from the reliability of the underlying traits (INET, longevity, somatic cell count, fertility index, udder and feet & legs), the variances of these traits and the weighing factors they have in NVI. The reliability of NVI represents the part of the total variance in NVI that is explained by the reliability of the breeding values of a sire for the underlying traits and the variances of these underlying traits.

▪ Base differences

The breeding values for kg milk, kg fat, kg protein, longevity, udder health, fertility, udder and feet & legs and calving traits are published the bases: Milk goal Black, Milk goal Red, Dual purpose and Belgian Blue. NVI can be converted to a different base by first converted the underlying traits and indexes and then compute the NVI.

▪ Publication Requirements

NVI of a sire is published as soon as the sire has a published breeding value for milk production traits. The requirements for publication of milk production traits can be found in chapter E-7.