

Karoline - The Nordic Dairy Cow Model

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What is Karoline?

Karoline is a dynamic and mechanistic whole animal model of a lactating cow

Karoline is part of a new feed evaluation system, NorFor-cattle, which is to be implemented in Sweden, Norway, Iceland and Denmark during 2005-2006

Leading questions:

How can a dynamic simulation model be used in feed evaluation?

Why is such a model useful in feed evaluation?

What can Karoline do?

Model description (1)

Digestion sub-model Metabolism sub-model

- **Forestomachs**
 - **Small intestine**
 - **Hindgut**
- **Portal drained viscera**
 - **Liver**
 - **Extracellular fluid**
 - **Mammary gland**
 - **Muscle and connective tissues**
 - **Adipose tissue**

Model description (2)

Model input: *Feed composition*

- Crude protein (CP)
- Crude fat (CF)
- Potentially digestible NDF (fDNDF, cDNDF)
- Totally indigestible NDF (fINDF, cINDF)
- Starch (ST)
- Lactate (LA)
- Acetate (AC)
- Propionate (PR)
- Butyrate (BU)
- Rest fraction (RF)

Model description (3)

Model input:

Feed N fractions

- Ammonium (NH₃)
- Amino acids (AA)
- Peptides (PEP)
- Soluble protein (SP)
- Insoluble, degradable protein (fISP, cISP)
- Totally indigestible protein (fIDP, cIDP)

Degradation rate constants

- Digestible NDF (K_{DNDF})
- Degradable protein (K_{ISP})
- Starch (K_{ST})

Model description (4)

Model input: *Cow*

- Feed intake (kg DM/d)
- Live weight (kg)
- Week of lactation (1-44)

Model output: *Parameters of animal performance*

- Nutrient digestibilities
- Nutrient absorption rates
- Waste excretions
- Milk yield and composition
- Live weight gain and composition
- Production efficiencies

Back to the leading questions:

How can a dynamic simulation model be used and why is it useful in feed evaluation?

A whole animal model like Karoline can predict animal performance from given feed inputs ~

and thereby predict the *real* value of the feed

Feed evaluation: standard vs real value

- Traditional feed evaluation systems are based only on chemical composition and digestibility of chemical fractions
- Traditional feed evaluation systems assume additivity
- With traditional feed evaluation systems, a given feedstuff and a given feed ration has just one feed value ~ a *standard* value
- *Real* feed value is an expression of obtained animal performance

Feed evaluation: standard vs real value

- The *real* value of a given feed ration depends on feeding level, animal physiological state etc.
- A given feed ration can have (infinitely?) many *real* feed values depending on above factors
- *Real* feed value cannot be determined until animal performance is recorded
- Need for a tool to predict animal performance: a whole animal model

Test of Karoline (1)

	<u>Regression</u>	<u>R²</u>	<u>n</u>
<i>Flow at duodenum, g/d</i>			
OM	$Y = 1,07+223$	0,93	60
Total CP	$Y = 0,96+80$	0,89	61
Microbial CP	$Y = 1,04-98$	0,87	61
NDF	$Y = 1,07-243$	0,95	61
<i>Excretion in faeces, g/d</i>			
OM	$Y = 1,04-11$	0,98	61
CP	$Y = 1,11+3,6$	0,95	61
NDF	$Y = 1,08-136$	0,97	61

Test of Karoline (2)

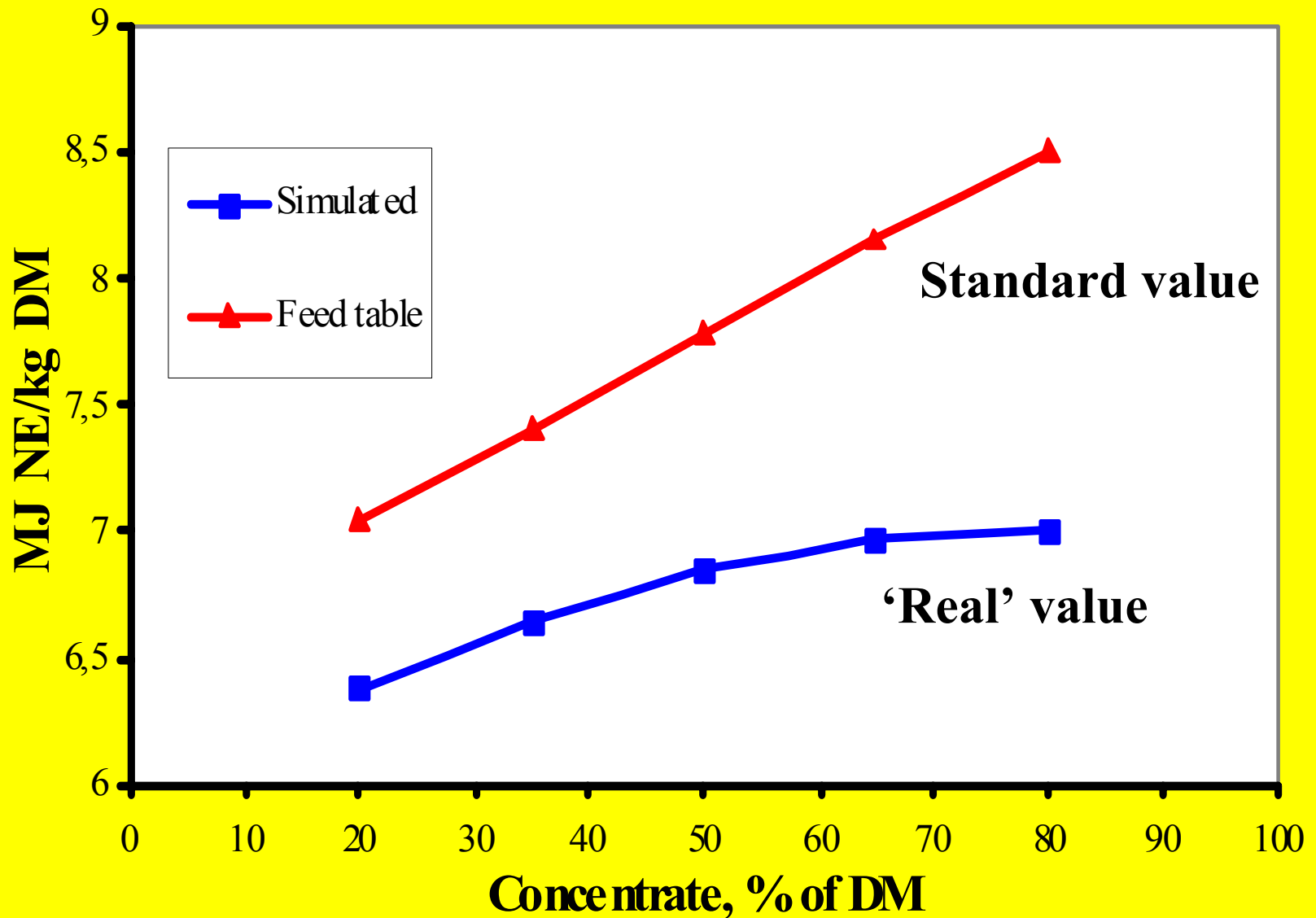
	<u>Regression</u>	<u>R²</u>	<u>n</u>
Milk, kg/d	$Y = 0,90 + 2,1$	0,88	142
ECM, kg/d	$Y = 0,97 + 0,1$	0,85	142
Milk fat, g/d	$Y = 0,93 + 14$	0,62	142
Milk protein, g/d	$Y = 0,80 + 156$	0,80	142

Model behaviour (1)

Simulation of *real* feed value

- Basal diet (kg DM/d): barley (2), SBM (1), RSC (1), clover grass silage (16)
- Gradual replacement of silage with barley
- Increase in concentrate:forage ratio from 20:80 to 80:20
- Cow: 625 kg LW, 16th week of lactation
- Ration feed value (MJ NE/kg DM) based on simulated cow performance

Feed value at increasing concentrate level



Conclusions (1)

- Karoline can simulate the performance of dairy cows during the lactation period in response to different feed rations
- Karoline predicts the *real* value of the input feed on basis of the simulated animal performance
- Karoline is well suited as an evaluation tool in the new NorFor-system for dairy cows

Conclusions (2)

- Karoline can predict nutrient digestion and milk yield quite accurately
- Karoline predicts milk composition less accurately and should be improved in this respect
- Karoline should also be further developed to include:
 - regulation of feed intake (meal feeding)
 - foetus production
 - digestion and metabolism of individual amino acids, fatty acids and macro minerals