

# NRC energy evaluation system

Eastridge, M.L. 2002. Energy in the New Dairy NRC. Department of Animal Sciences, The Ohio State University, pp. 7.  
 NRC. 2001. Nutrient requirements of dairy cattle. Seventh revised edition. National Academy Press, Washington DC, USA, pp. 13-27.

# Dairy cattle – NRC 2001 net energy evaluation system

*Feedstuff NE<sub>i</sub> content calculation – 5 steps : STEP 1*

- **Estimating total digestible nutrients at maintenance (TDN 1X, %)**
  - \* truly digestible crude protein
  - \* truly digestible fatty acids
  - \* truly digestible neutral detergent fibre
  - \* truly digestible nonfiber carbohydrates (NFC)

# Dairy cattle – NRC 2001 net energy evaluation system

- **Estimating total digestible nutrients at maintenance (TDN 1X, %)**
  - \* truly digestible crude protein (tdCP)
  - \* truly digestible fatty acids (tdFA)
  - \* truly digestible neutral detergent fibre (tdNDF)
  - \* truly digestible nonfiber carbohydrates (NFC)

# Dairy cattle – NRC 2001 net energy evaluation system

- **Estimating total digestible nutrients at maintenance (TDN 1X, %)**
    - \* truly digestible crude protein (tdCP)
- |                              |  |                          |
|------------------------------|--|--------------------------|
| Forages                      |  | Concentrates             |
| $CP * e^{(-1.2 * ADICP/CP)}$ |  | $[1 - (0.4 * ADICP/CP)]$ |

**ADICP = acid detergent insoluble CP**

## Dairy cattle – NRC 2001 net energy evaluation system

- Estimating total digestible nutrients at maintenance (TDN 1X, %)

\* truly digestible crude protein (tdCP)

Forages

$$CP * e^{(-1.2 * ADICP/CP)}$$

Concentrates

$$[1 - (0.4 * ADICP/CP)]$$

\* truly digestible fatty acids (tdFA)

- FA = EE – 1 & 100 % digestibility

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Forages

$$CP * e^{(-1.2 * ADICP/CP)}$$

Concentrates

$$[1 - (0.4 * ADICP/CP)]$$

\* truly digestible fatty acids (tdFA)

- FA = EE – 1 & 100 % digestibility

\* truly digestible neutral detergent fibre (tdNDF)

$$= 0.75 * (NDFn - ADL) * [1 - (ADL/NDFn)^{0.667}]$$

NDFn = NDF – NDICP (neutral detergent insoluble CP)

## Dairy cattle – NRC 2001 net energy evaluation system

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\* truly digestible crude protein (tdCP)

Forages

$$CP * e^{(-1.2 * ADICP/CP)}$$

Concentrates

$$[1 - (0.4 * ADICP/CP)]$$

\* truly digestible fatty acids (tdFA)

- FA = EE – 1 & 100 % digestibility

\* truly digestible neutral detergent fibre (tdNDF)

$$= 0.75 * (NDFn - ADL) * [1 - (ADL/NDFn)^{0.667}]$$

NDFn = NDF - NDICP

\* truly digestible nonfiber carbohydrates (NFC)

$$= 0.98 [100 - [(NDF-NDICP)+CP+EE+CA]] * PAF$$

## Dairy cattle – NRC 2001 net energy evaluation system

- Estimating total digestible nutrients at maintenance (TDN 1X, %)

\* truly digestible nonfiber carbohydrates (NFC)

$$= 0.98 [100 - [(NDF-NDICP)+CP+EE+CA]] * PAF$$

TABLE 2-1 Processing Adjustment Factors (PAF) for NFC<sup>a</sup>

Feedstuff	PAF
Bakery waste	1.04
Barley grain, rolled	1.04
Bread	1.04
Cereal meal	1.04
Chocolate meal	1.04
Coolie meal	1.04
Corn grain, cracked dry <sup>b</sup>	0.95
Corn grain, ground <sup>b</sup>	1.00
Corn grain, ground high moisture <sup>b</sup>	1.04
Corn meal with molasses ground high moisture <sup>b</sup>	1.04
Corn grain, steam flaked <sup>c</sup>	1.04
Corn silage, normal	0.94
Corn silage, mature	0.87
Molasses (beet and cane)	1.04
Oats grain	1.04
Sorghum grain, dry rolled	0.92
Sorghum grain, steam-baked <sup>c</sup>	1.04
Wheat grain, rolled	1.04
All other feeds	1.00

Effect of processing on NFC digestibility – processing adjustment factor

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff NE<sub>1</sub> content calculation – 5 steps : STEP 1

- Estimating total digestible nutrients at maintenance (TDN 1X, %)

- Summative approach

$$\text{TDN}_{1X} (\%) = \text{tdNFC} + \text{tdCP} + (\text{tdFA} \times 2.25) + \text{tdNDF}$$

Average FA content

metabolic faecal TDN

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff NE<sub>1</sub> content calculation – 5 steps :

- Estimating total digestible nutrients at maintenance (TDN 1X, %)

- Corrections – different individual equations

\* Animal protein meals (different equation) (no non-structural carbohydrates, but NDIresidue)

$$\text{TDN}_{1X} (\%) = \text{CP}_{\text{digest}} * \text{CP} + \text{FA} * 2.25 + 0.98 * (100 - \text{CP} - \text{Ash} - \text{EE}) - 7$$

\* Fat supplements (10% glycerol + 90% fatty acids)

$$\text{TDN}_{1X} (\%) = 0.1 * \text{EE} + \text{FA}_{\text{digest}} * \text{EE} * 0.9 * 2.25$$

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff NE<sub>1</sub> content calculation – 5 steps : STEP 2

- Estimating digestible energy at maintenance (DE 1X, Mcal/kg DM)

- multiplying digestible nutrient concentrations by respective heats of combustion

\* carbohydrates: 4.2 Mcal/kg

\* protein: 5.6 Mcal/kg

\* long chain fatty acids: 9.4 Mcal/kg

\* glycerol: 4.3 Mcal/kg

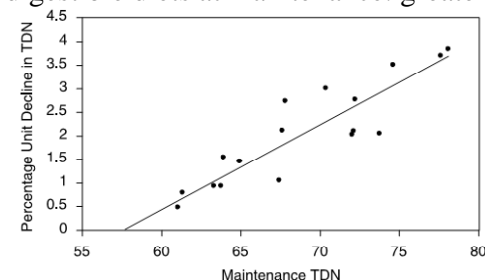
\* correction metabolic faecal energy = 0.07 x 4.4 Mcal/kg

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff NE<sub>1</sub> content calculation – 5 steps : STEP 3

- Estimating digestible energy at actual intake (DE 3 or 4X, Mcal/kg DM)

- highly digestible diets at maintenance: greater depression rate



⇒ TDN <sub>1X</sub> (%)	62	67	72	77
% ↓ digestibility	1.5	1.8	3.8	4.7

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff $NE_i$ content calculation – 5 steps : STEP 4

- Estimating metabolisable energy from digestible energy at actual intake ( $ME_3$  or  $4X$ , Mcal/kg DM)

- Empirical formula
- Correction for higher EE levels ( $DE = ME$ )

$$ME_p \text{ (Mcal/kg)} = [1.01 \times (DE_p) - 0.45] + 0.0046 \times (EE - 3)$$

## Dairy cattle – NRC 2001 net energy evaluation system

### Feedstuff $NE_i$ content calculation – 5 steps : STEP 5

- Estimating  $NE_1$  from  $ME$  at actual intake ( $NE_1$  3 or  $4X$ , Mcal/kg DM)

- Empirical formula
- Correction for higher EE levels ( $NE = 0.8 ME$ )

$$NE_{1p} \text{ (Mcal/kg)} = 0.703 \times ME_p - 0.19 + [(0.097 \times ME_p + 0.19)/97] \times [EE - 3]$$

- Estimating  $NE_M$  from  $ME$  at actual intake ( $NE_M$  3 or  $4X$ , Mcal/kg DM)

- Empirical formula

$$NE_M = 1.37 ME - 0.138 ME^2 + 0.0105 ME^3 - 1.12$$

## Energy supply and requirements

1. Supply – energy content of feed
2. Requirements – energy requirements of animal based on needs for maintenance & production (e.g. meat, milk production, labour,...)
3. Units – same for supply and requirements (MJ)

## Dairy energy requirements

### 1. Maintenance

- $0.080 \text{ Mcal } NE_M / \text{kg } W^{0.75}$   
(+ 10% activity allowance – compared to former edition)
- Adjustment for breed

## Dairy energy requirements

### 2. Lactation

- Energy contained in the milk produced =  $\Sigma$  heats of combustion of individual milk components (fat, protein, lactose)
- Heats of combustion (Mcal/kg): fat (9.29), protein\* (5.47), lactose (3.95)

$$\begin{aligned} \text{NE}_L \text{ (Mcal/kg)} &= 0.0929 \times \text{Fat \%} + 0.0547 \\ &\quad \times \text{Crude Protein \%} \\ &\quad + 0.0395 \times \text{Lactose \%} \end{aligned}$$

## Dairy energy requirements

### 3. Pregnancy

- Importance during dry period
- $k = 0.64$

$$\text{NE}_L \text{ (Mcal/d)} = \frac{[(0.00318 \times D - 0.0352) \times (\text{CBW}/45)]}{0.218}$$

### 4. Activity & environmental effects

### 5. Tissue mobilisation and repletion