Feeds and feed energy content, feed energy metabolism

Energy saving farm
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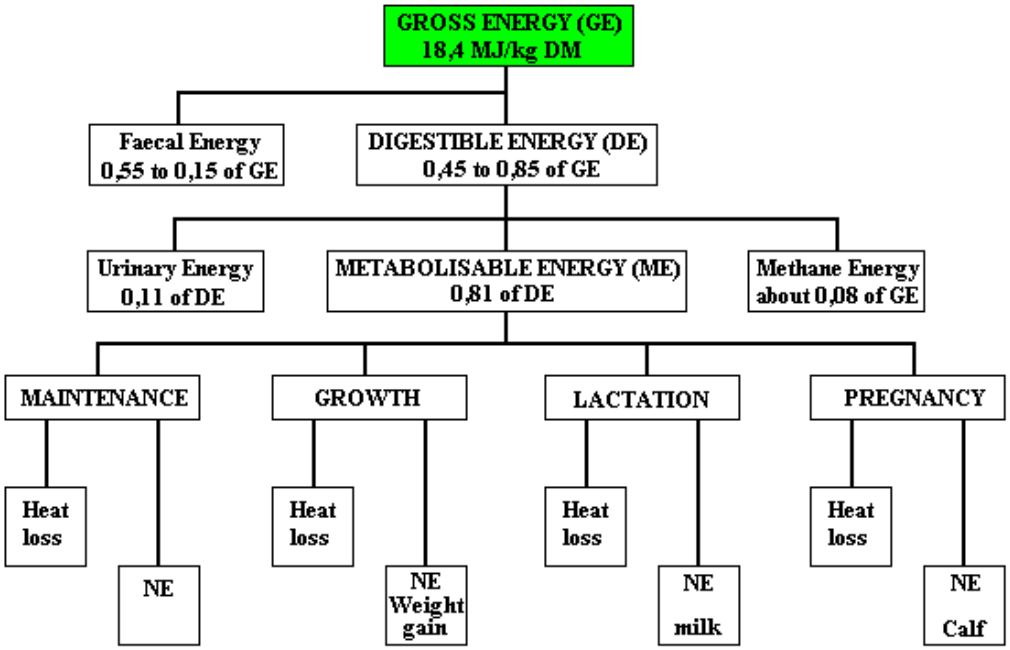
Units of measurement of energy in the livestock feeds and ration formulation

1. The currently accepted unit for measuring energy is the joule (J). More commonly used unit is kilojoule (KJ = 1000 joules) or megajoule (MJ = 1000 kilojules).

Joule - the amount of heat required to raise one cm^2 of water by one degree

2. Previously it was the calorie (cal, Kcal, Mcal) which is equivalent to 4,2 J. Calorie still used in America.

Gross energy (1)



* The gross energy (GE) of a feed is the total amount of energy the feed contains.

* Gross energy is usually measured by burning a sample of the feed in oxygen and measuring the heat produced.

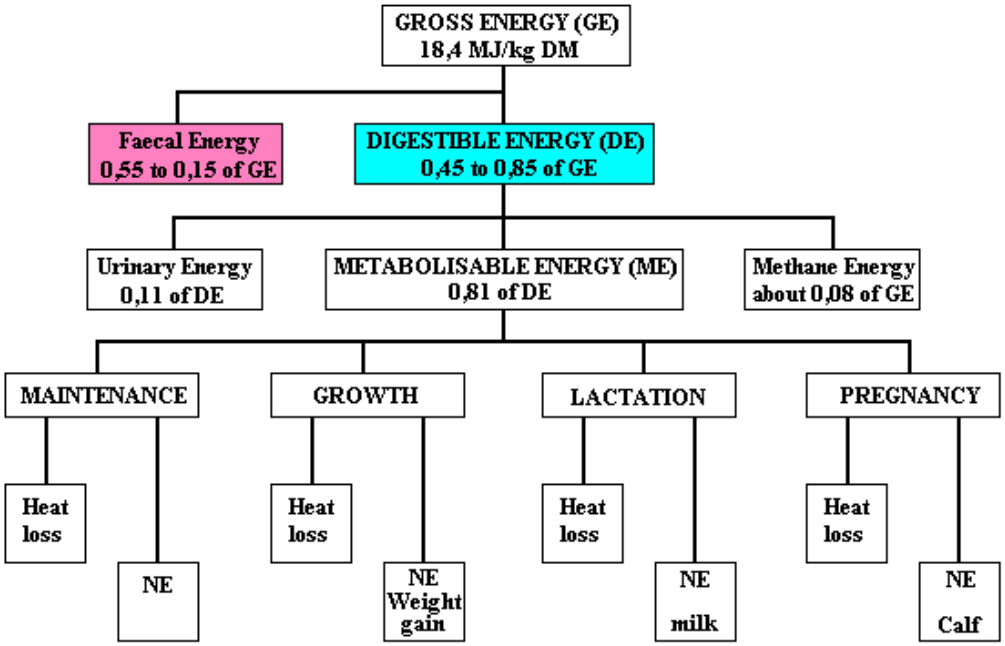
- Carbohydrates (the major component of most feeds) contain about 17,5 MJ GE/ kg DM;
- protein about 26 MJ;
- fat about 44 MJ

Gross energy (2)

The gross energy content of some common feeds (MAFF, 1990)

Feed	Gross energy (MJ/kg DM)
Straw	18,3
Fresh grass	18,7
Wheat grain	18,4
Grass silage	19,0
Soya bean meal	19,7
Rapeseed meal	19,7
Fishmeal	19,9
Fat	35,0

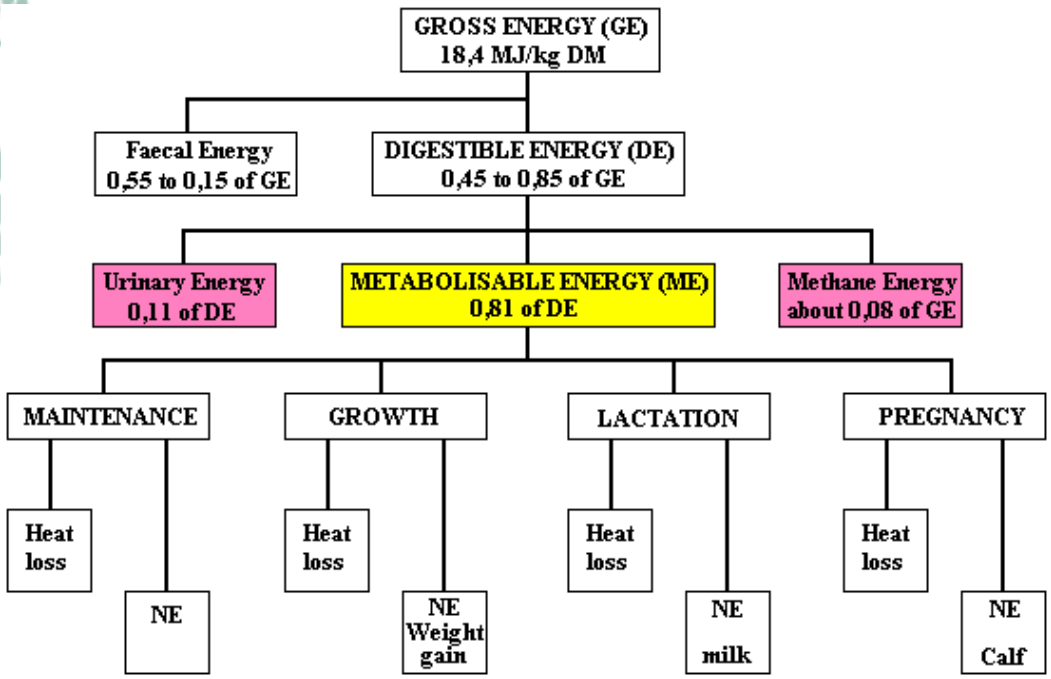
Digestible energy



* Not all the gross energy in a feed is digestible and a varying amount passes out in the faeces.

* The fraction which is digested (digestible energy DE) varies from about 45 % of the GE for poor feeds such as straw to about 85 % for good quality feeds such as barley

Metabolisable energy

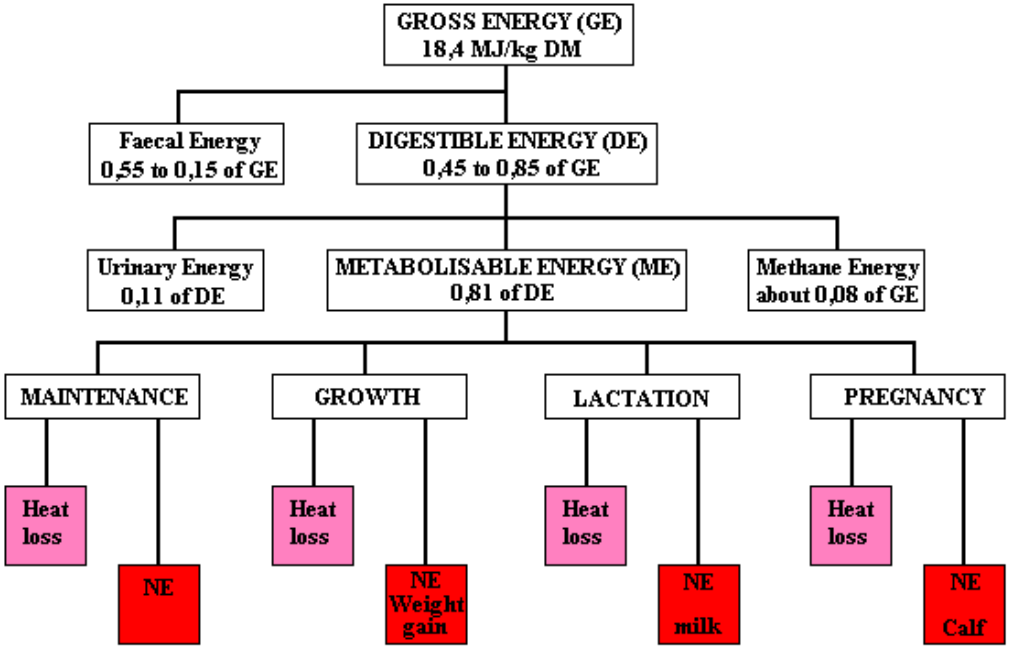


* Further losses of energy occur in the rumen (ruminants) or in the large intestine, colon (monogastric animals) as methane.

* Some of the waste products of metabolism, excreted in urine, also contain energy and for simplicity such energy is regarded as being unavailable to the animal and is considered together with the methane energy.

* The DE of the feed minus the losses in methane and urine is therefore the energy available to the animal – metabolisable energy (ME). It is about 81 % of the DE.

Net energy (1)

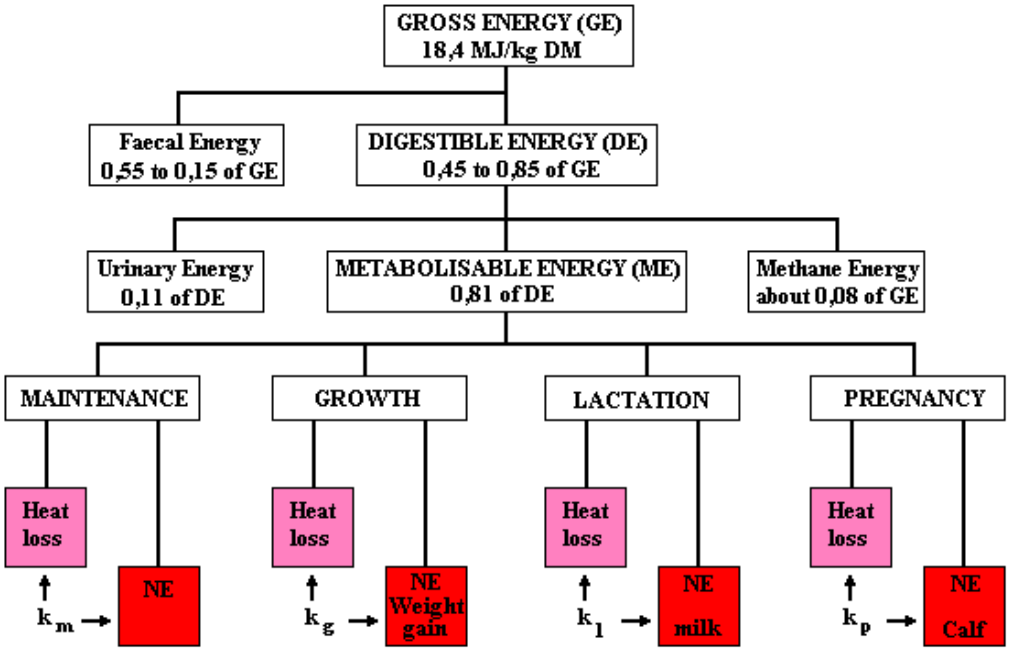


* The ME content of feed represents the amount of energy that can be used to support the various body functions.

* The conversion of the energy sources from the form in which they are absorbed (mainly as VFA) into forms that the body tissues use, such as glucose, lactose and fat, involves several biochemical steps and some of the absorbed energy is lost as heat.

* The heat produced is lost into the environment and the remaining energy which is converted into a useful form is called net energy (NE).

Net energy (2)



* NE can be used for maintenance of body functions, milk production, body tissue growth and foetal tissue growth.

* The efficiency with which ME is converted to NE is referred to as k which may be suffixed to indicate the fate of the NE

Net energy (3)

Energy digestion by a mature sheep fed on grass hay at maintenance

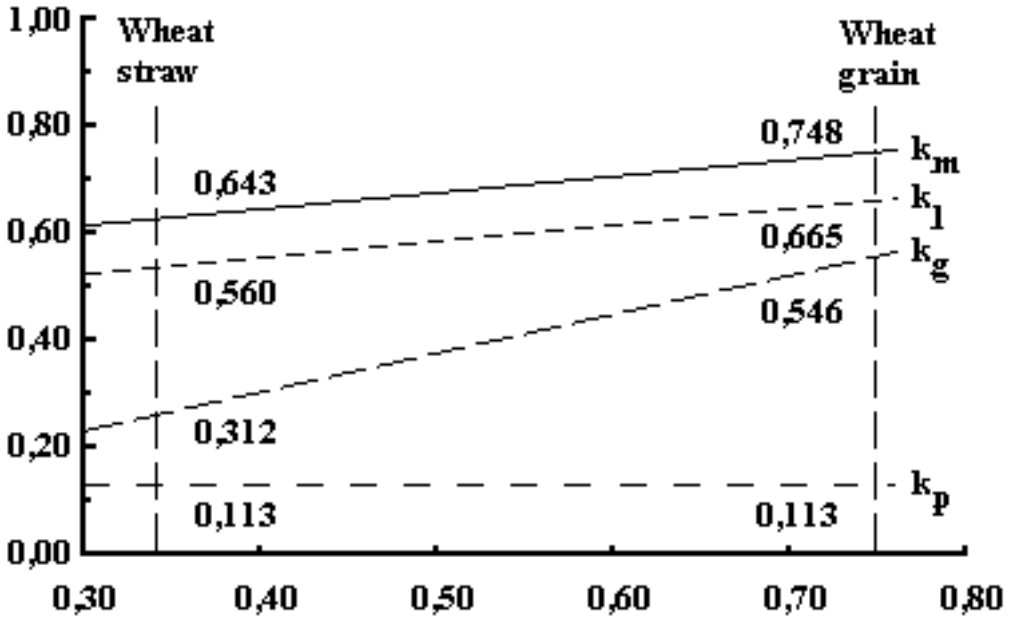
Energy measurements	***MJ***
Energy intake	19,1
Faecal energy	7,4
Urinary energy	0,7
Methane energy	1,3
Heat loss	3,8
Energy calculations	***MJ***
Gross energy	19,1
Digestible energy	19,1 – 7,4 = 11,7
Metabolisable energy	11,7 – 0,7 – 1,3 = 9,7
Net energy	9,7 – 3,8 = 5,9
k_m	5,9 / 9,7 = 0,61

Efficiency of conversion of ME to NE (1)

* For a given animal on a given diet there is considerable variation between the different k values, with the biologically more important functions having higher values for k (i.e. you must stay alive first (maintenance) before you can consider growth, pregnancy or milk production)\

* ME is converted to NE with an efficiency of about:
  - *for maintenance (k_m) 0,72;*
  - *for lactation (k_l) 0,62;*
  - *for growth (k_g) 0,53*
  - *for pregnancy (k_p) 0,133*

Efficiency of conversion of ME to NE (2)



* Method for measuring feed quality: q = ME/GE
- *wheat straw, GE-18,1; ME-6,1; q-0,34*
- *wheat grain, GE-18,1; ME-13,6; q-0,75*

* As the quality of a diet falls the efficiency of conversion of ME to NE falls. *For example if a cow is given poor feeds such as straw her digestive tract has work hard (increased chewing, rumination, faecal excretion) to extract the energy from the feed whereas if she is given the same amount of energy in a high-quality feed such as rolled barley the effort and therefore energy required to extract the nutritive value would be less.*

Efficiency of conversion of ME to NE (3)

* It is generally considered that the efficiency of digestion and metabolism falls as the level of production increases. This is partially due to the fact that all biological processes have a finite capacity (i.e. an udder can only synthesis so much lactose and casein) and partially because high-yielding animals require to eat more feed, digest more, excrete more faeces and urine etc., all of which put an increasing energy demand on the animal

*If the efficiency of the use of ME falls with increasing production, the cow giving 30 liters milk and gaining 500 g/day is working harder than the animal giving the same yield but loosing 500 g/day and therefore will be less efficient. Being less efficient the former cow will require more energy to produce milk.

Conclusions

* Energy calculation levels in animal nutrition are:
- *gross energy*
- *digestible energy*
- ***metabolisable energy***
- ***net energy***

* Efficiency of conversion of energy depends:
- *The fate of energy in the body*
- *The quality of the energy (feed) in the diet*
- *Level of production*

This material has been produced in ENPOS project. ENPOS is acronym for ***Energy Positive Farm***.

The project partners are
• University of Helsinki, department of Agricultural Sciences – Agrotechnology
• MTT Agrifood Research Finland - Agricultural Engineering
• Estonian University of Life Sciences

Project home page is at http://enpos.weebly.com/

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