French energy and protein feeding standards for growing and fattening cattle

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Introduction

The French population of growing and fattening cattle includes both dairy (60 - 65 per cent) and beef (30 - 35 per cent) animals, which also differed by sex and age at slaughter. For these different types of animals : young fattening bulls, steers and heifers, growing males and females, new energy and protein allowances were proposed in 1978 (GEAY *et al*, 1978) which are related to the weight and daily gain.

A. Energy feeding standards

In the new system proposed in France, the net energy content of a feedstuff for both maintenance and meat production is the product of its ME content multiplied by the efficiency kmf, depending on the animal production level (APL) (VERMOREL, 1978*a*,*b*).

APL varies continuously as a function of weight and body weight gain according to the type of animal. However, a distinction has been made between two groups of cattle only : the fast-growing and fattening, and the slow-growing animals.

1. The fast-growing male and female cattle (APL = 1.5) consist of animals whose daily gain is higher than 0.750 kg/d. The differences between the breeds of young bulls or between the production systems of steers and heifers in feed efficiency and in body composition, were taken into account. Thus, the energy allowances for 3 classes of young bull breeds, 3 classes of slaughter age steers, and 2 classes of slaughter age heifers, were determined. These allowances and the energy value of feedstuffs with which they are fed have been expressed in terms of "meat" feed units (Unités Fourragères Viande : UFV). One UFV represents the NE value for maintenance and meat production of 1 kg standard barley : 1.855 Mcal.

2. With the slow-growing animals (APL : 1.2), whose daily gain is lower than 0.750 kg/d, males and females were considered separately. The net energy system for lactation (UFL) appeared to suit this kind of animal and therefore the allowances and energy value of feedstuffs with which slow-growing animals were fed was expressed in terms of "milk" feed units (Unités Fourragères Lait : UFL). One UFL represents the NE value for lactation of 1 kg standard barley : 1.730 Mcal.

From the results of our feeding trials using different types of animals and a different quantity of supplied energy, a relationship was established, for each category of animal, between energy intake (UFV), liveweight (W) and liveweight gain (ΔW) actually measured throughout the experimental period :

$$\text{Energy intake (UFV or UFL)} = aW^{0.75} + bW^{0.75}.\Delta W^{1.4}$$

This kind of equation was chosen to break down the net energy intake into two parts : the first, proportional to the metabolic weight by analogy with the maintenance requirements ; the second, to express the calorific value of gain, taking into account its relationship to the weight and daily gain, obtained from numerous measurements of body gain composition by the comparative slaughter technique.

The energy allowances of different categories of animals have been given in the feeding tables for different weights and different rates of gain (ex. Table 1 for early maturing bulls).

TABLE 1

DAILY REQUIREMENTS FOR EARLY MATURING BULLS (FRIESIAN)

Liveweight (kg)	Daily gain (g/d)	UFV/d	PDI (g/d)	DCP (g/d)
150	800	2.9	382	393
	1000	3.2	438	454
	1200	3.6	492	513
	1400	4.0	544	570
	1600	4.4	595	626
200	800	3.6	418	427
	1000	4.0	473	487
	1200	4.5	526	545
	1400	4.9	577	601
	1600	5.4	626	654
250	800	4.2	451	458
	1000	4.7	505	517
	1200	5.3	557	573
	1400	5.8	606	627
	1600	6.4	653	678
300	800	4.7	481	486
	1000	5.4	535	544
	1200	6.0	585	599
	1400	6.7	633	651
	1600	7.4	677	699
350	800	5.5	510	512
	1200	6.1	562	569
	1400	6.8	611	623
	1600	7.5	657	672
	1800	8.3	699	719
400	800	6.0	537	537
	1000	6.7	588	593
	1200	7.5	636	645
	1400	8.3	679	692
	1600	9.2	720	736
450	800	6.6	563	561
	1000	7.4	613	616
	1200	8.2	659	666
	1400	9.1	701	711
	1600	10.0	739	753
500	800	7.1	589	584
	1000	8.0	637	637
	1200	8.9	681	686
	1400	9.8	721	729
	1600	10.8	757	768
550	800	7.7	613	649
	1000	8.5	660	698
	1200	9.5	703	741
	1400	10.5	741	778

B. Protein feeding standards

To replace the digestible crude protein system (DCP) a new system has been proposed (JARRIGE *et al*, 1978 ; VERITE *et al.*, 1979) called the PDI system (Protéines Digestibles dans l'Intestin Grêle), which estimates the quantity of α amino nitrogen ($N \times 6.25$), except from endogenous secretions, truly absorbed in the small intestine. This quantity is the sum of two fractions :

1. the *dietary protein* undegraded in the rumen but truly digestible in the small intestine (PDIA),
2. the *microbial true protein* which is truly digestible in the small intestine (PDIM).

From data collected in the literature, the flow of nonammonia nitrogen entering the duodenum (ND) was related to insoluble N intake (INI) representing the *dietary fraction* (1) and to the digestible organic matter intake (DOM) representing the *microbial fraction* (2). The equation obtained was :

$$ND = 0.65\ INI + 0.0215\ DOM.$$

From this equation it appears that 1) 65 per cent of INI had escaped rumen degradation or 35 per cent of INI was degraded in the rumen : $dg = S + 0.35\ (1 - S)$ where S = N solubility; 2) 21.5 g N/kg DOM or 135 g/kg DOM of microbial protein had been produced in the rumen.

The true digestibility of dietary protein in the small intestine (ddp) was calculated from the faecal N (NF), the digestible and indigestible organic matter (DOM, IDOM) of each feed :

$$ddp = \frac{0.65\ INI - (NF - 0.0040\ DOM - 0.0091\ IDOM)}{0.65\ INI}$$

and that of microbial true protein (80 per cent of microbial crude protein) was considered equal to 0.70.

However, each contributes to microbial protein synthesis both by the degradable nitrogen and by the available energy that it supplies to the rumen micro-organisms. Thus each feed is further characterised by two PDIM values and one PDIA value :

PDIMN (which results from its degradable nitrogen content) (g/kg DM)

$$= (g)\ CP \times dg \times 0.80 \times 0.70 = (g)\ CP\ (0.65\ S + 0.35) \times 0.56$$
$$= (g)\ CP\ (0.196 + 0.364\ S)$$

PDIME (which results from its available energy content)

$$= \text{microbial N} \times 6.25 \times 0.80 \times 0.70 \times DOM$$
$$= 135 \times 0.80 \times 0.70 \times DOM\ (kg) = 75{,}6\ DOM\ (g/kg\ DM)$$

$$PDIA\ (g/kg\ DM) = CP\ (1 - dg)\ ddp$$

Then, as a whole, two PDI values are ascribed to each feed : one PDIN = PDIA + PDIMN and the other PDIE = PDIA + PDIME.

The lower of these two values is the PDI value of the feed when given alone. The higher of the two values is a potential value reached when the feed is associated with an adequate complementary feed. When calculating the PDI value of a diet, the PDIN and PDIE values of the different ingredients are summed up separately : the PDI value of the diet is the lower of the two values.

The *protein requirements* of the above mentioned types of cattle have been expressed both in PDI and in DCP. The latter has been maintained to make the transition easier. These requirements were obtained analytically by adding together the requirements for maintenance and production.

The requirements for maintenance were estimated from nitrogen balance trials on non-producing animals (JARRIGE *et al.*, 1978). The value retained amounted to 3.25 g of PDI and 3 g of DCP/kg $W^{0.75}$. The requirements for production, corresponding to the needs of the tissues, have been calculated from the quantities of protein retained per day using a calculated efficiency of absorbed protein utilisation of 0.60 for PDI and 0.55 for DCP. The protein retained per day was determined from the gain of the fat-free mass (FFM) using a relationship derived from the equation:

Protein weight : $0.1259\ FFM^{1.096}$ (ROBELIN and GEAY, 1978).

The protein allowances of different categories of animals have been given in the feeding tables for different weights and different rates of gain (ex. Table 1 for early maturing bulls).

References

GEAY Y., ROBELIN J., BERANGER C., MICOL D., GUEGUEN L., MALTERRE C., 1978. Bovins en croissance et à l'engrais. In : "INRA, *Alimentation des Ruminants*". INRA Publications Versailles, 297-344.

JARRIGE R., JOURNET M., VERITE R., 1978. Azote. In : "INRA, *Alimentation des Ruminants*". INRA Publications Versailles, 89-128.

ROBELIN J., GEAY Y., 1978. Estimation de la composition chimique du corps entier des bovins à partir du poids des dépôts adipeux totaux. *Ann. Zootech.* 27, 159-167.

VERITE R., JOURNET M., JARRIGE R., 1979. A new system for the protein feeding of ruminants : the PDI system. *Liv. Prod. Sci.*, 6, 349-367.

VERMOREL M., 1978*a*. Energie. In : "INRA, *Alimentation des Ruminants*". INRA Publications Versailles, 48-88.

VERMOREL M., 1978*b*. Feed evaluation for ruminants. II. The new energy systems proposed in France. *Liv. Prod. Sci.*, 5, 347-366.

Federal Republic of Germany energy and protein feeding standards for growing and fattening cattle

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Beef production in the Federal Republic of Germany is based mainly on fattening of bulls. Steers being negligible, only a small number are fattened on pasture. Heifers and cows are not normally fed special fattening rations. Most of these animals are slaughtered because of low yield, sterility or disease.

Male calves to be fattened are bred almost entirely in dairy herds i.e. they result from dual-purpose breeds. Although experiments have shown remarkable differences between bulls of these breeds with respect to protein and fat deposition, there are no specific recommendations for practical use. In 1973 a working group of the "Deutsche Landwirtschafts-Gesellschaft" calculated protein and energy feeding standards to be used for all fattening bulls in the Federal Republic of Germany (Table 1).

The experimental background of these standards was :

1. Measurements of protein and fat deposition of Friesian bulls by whole body analysis (liveweight range 150 - 600 kg).
2. Feeding experiments with growing bulls.
3. Records of practical farms.

Rations were based on concentrates and maize silage or beet top silage supplemented by some hay. In some cases sheep were used to measure the digestibility of the feedstuffs.

As shown in Table 1 recommendations for net energy are given for different daily gains. The omission of figures for the extreme rates of daily gain in parts of the Table is to indicate that these extremely low or high rates of gain do not have practical relevance at the respective intervals in the fattening period.

Protein feeding standards are about 10 - 20 per cent higher than the real requirements. This is to avoid negative effects on performance if crude protein content in forage is overestimated.