Updating Swedish emission factors for cattle to be used for calculations of greenhouse gases

On commission of the Swedish Environmental Protection Agency 2016

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Rapport 292
Report

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Swedish University of Agricultural Sciences

Uppsala 2016

ISSN 0347-9838
ISRN SLU-HUV-R-292-SE

Summary and recommendations

It is recommended that the NorFor feed evaluation system is used to calculate enteric methane production from cattle in Sweden.

For ***dairy and suckler cows*** the equation

CH4 (MJ/cow/day) = 1.39*DMI -0.091*FA

should be used, where MJ is methane expressed in energy units, mega joule, DMI is the total dry matter intake (kg/cow/day) and FA is feed content (total feed) of fatty acids (g/kg DM).

For ***growing cattle*** the equation

CH4 (% of GE, MJ) = (-0.046*ConcP +7.1379)/100)

where GE is total gross energy intake and ConcP = concentrate proportion, % of DM.

The following emissions (kg methane per head and year) are valid for year 2015	
Dairy cows	141
Suckler cows	92
Heifers, <1 year	26
Heifers, 1-2 years	58
Heifers, >2 years	77
Bulls/steers, <1 year	27
Bulls/steers, 1-2 years	53
Bulls/steers, >2 years	85

Background

Ruminants are special in their ability to utilize fibre-rich feedstuffs, e.g. grass, into nutritious foods like meat and milk. To enable this, they are equipped with a special digestion with three fore-stomachs, where the rumen is most important. In an adult cow these compartment that often are called the reticulo-rumen, can withhold more than 100 kg and with a water content of up to 90%. In the rumen different microorganisms such as bacteria, archea, fungi and protozoa, degrade the feed. The end products in this process are monomers as sugars and carbon skeletons. These are then fermented to form products such as volatile fatty acids (VFA) which are the main energy source for the host animal (the cow). The main VFAs are propionic, acetic and butyric acid. The environment in the rumen is low in oxygen. To withhold the fermentation it is needed to get rid of the surplus of hydrogen. Formation of methane is a solution to this and is referred to as enteric methane production. Creating of methane means a loss of energy for the host animal in the order of 2-12% of the gross energy (GE) and this is the reason why animal scientists have interested themselves for methane since more than 100 years, e.g. Kellner (1900). During the last few decades it has been found that methane is a powerful greenhouse gas and the research concerning monitoring and mitigating of methane from animal production has increased tremendously worldwide. A large number of prediction equations for enteric methane production have been developed, but most of them demand detailed information of the feeds (e.g. Liljeholm et al., 2009; Ramin et al, 2013).

Energy in animal nutrition

Methane production in animals it is often expressed as a part of the energy in the feeds. Earlier we used digestible energy (DE) as the basis when we calculated enteric methane production. Today energy of enteric methane is often calculated using a conversion factor (Y_{m}) from total gross energy (GE) to methane energy. Energy is expressed in mega joule (MJ). The energy system used in Sweden as a basis for feed evaluation and formulation of diets for cattle has been metabolisable energy (ME) for the last 50 years. In the new feed evaluation system, NorFor, the basis is net energy (NE), (Volden, 2011). All these ways to express energy in animal feeds might cause confusion and therefore it could be of value to present a concise description of different ways of expressing energy. Table 1 gives an over-view.

Lindgren (1980) reviewed literature in order to estimate energy losses in form of methane for ruminants. He concluded that the best prediction came for cattle from the equation:

CH4 (% of DE) = 15.7 – 0.03DCE – 1.44L

Where DCE is the digestibility coefficient of energy and L is the feeding level expressed as multiple of maintenance feeding.

In order to use the equation above it is also needed to go from ME to DE. To achieve this we have to calculate ‘backwards’ using assumptions on energy in urine and in methane (‘metabolisability’) to get ME as % of DE. Lindgren (1980) recommended the equation below to achieve this.

ME (% of DE) =83.2 + 2.53L – 0.045G – 0.184 CP

Where L is the feeding level expressed as multiple of maintenance feeding, G is roughage proportion (%DM) and CP is crude protein (%DM).

The equations referred above have been used for calculations used in national inventories of methane production from dairy cows in Sweden since the early 1990’s (Murphy, 1992; Bertilsson, 2001). The equations have been used in combination with data available from the feed advisory services on typical diets and feed analyses. Standard values have been used for growing animals.

Table 1. Energy expressed in different ways in the context of animal feeding

Energy unit	Comment
Gross energy (GE)	Energy released in total combustion in access to oxygen. IPCC recommends 18.45 MJ/kg DM feed if own value is not available
- Faecal energy **= *Digestible energy (DE)***	The losses vary from ca 55% of GE in poor feeds as straw and 15% in high quality feeds as grain. Variation 45-85% of GE
- Urinary energy - Methane energy - **= *Metbolisable energy (ME)***	 2-16% of GE A rough figure for ME is 82% of DE
- Heat loss **= *Net energy (NE)***	 Represents the energy in the products, i.e. milk and meat.Net energy is used in the new feed evaluation system “NorFor” Often expressed as net energy for lactation (NE_L) and net energy for growth (NE_G)

Present situation of cattle farming in Sweden

The cattle industry in Sweden has, as in other developed countries, undergone large changes during the latest decades regarding structure and intensity. Numbers of dairy farms and animals have decreased, but the total production of milk, has remained rather stable due to an increase in milk production per cow. The number of farms specialized in beef production has increased, but the demand for beef has increased more. This has been met by an increasing import of meat. From the domestic beef production about two thirds have its' origin from dairy breeds and one third from special beef breeds. Most international beef breeds occur in Sweden and crosses between breeds are also common.

Today most farmers produce the forage for cattle feeding themselves but concentrates are often bought from feed companies. Changes have also occurred in feed evaluation and diet formulation. Most feed farmers and advisers nowadays use the PC based package NorFor™ (http://www.norfor.info/; Volden, 2011). NorFor is used in Sweden, Denmark, Norway and Iceland. A major change with this system is that NorFor is based on net NE instead of the old system that used ME. Values of feeds depend on the complete diet where they occur and might vary. This means that calculations must be carried out with the aid of computers. NorFor is a 'living' system, meaning that a lot of effort is put into developing all the time and information on this is found on norFors' homepage. A working group is developing refining and developing the system all the time on commission of the associations involved in advisory service in all participating countries.

Data about how animals actually are fed on farms are not available to the same extent as 10 years ago. To get figures regarding this, I have used standard diets as available in the web-based advisory package AgriWise (http://www.agriwise.org/) and also published surveys and others concerning feeding of cattle. (Gustafson et al., 2014, Bertilsson et al., 2014; Hessle et al, 2014)

Methane calculations in NorFor

When feed advisors and farmers are formulating diets in NorFor, the enteric methane production from the animal will also be calculated automatically. The values are based on all data on feeds that are put into the system, but as the equations are quite simple they are also possible to calculate by hand. The developed equations are based on Nordic feed trials carried out during the last few years on research stations in all countries involved. Prediction equations for ***dairy cows*** were published by Nielsen et al. (2015). The best equation and the one proposed for use in NorFor was:

(1) CH4 (MJ/cow/day) = 1.39*DMI -0.091*FA

Where

DMI = Dry Matter Intake, per cow and day

FA = Fatty Acids (g/kg DM in total feeds)

For this equation RMSE (root mean square error) was 3.31, CV (coefficient of variance) was 15.3 and R^2 (coefficient of variation) was 0.70. When considering the uncertainty in the calculations on feed intake a total uncertainty of methane calculations of ±20% seems reasonable.

An even simpler equation that was only based on DMI also showed good values with RMSE 3.50, CV 16.1 and R^2 =0.66. This Equation was:

CH4 (MJ/cow/day) = 1.26*DMI

This equation has been used for comparisons in my calculations.

NorFor uses another equation based on data from Danish trials developed by Nielsen (2012) for calculations of methane from growing cattle

This equation is as follows:

(2) CH4 MJ (% of GE) = ((-0.046*ConcP +7.1379)/100)

where

GE is gross energy and

ConcP is concentrate, % of total dry matter (DM)

No calculations on statistical errors have been carried out for these equations, but they should be of the same magnitude as for dairy cows and as feeding of growing cattle varies more than for dairy cows the variation in assumed to be ±25% (authors conclusion).

In the NorFor package GE is calculated according to Volden (2011). In my calculations GE contents in total feeds were either calculated using the standard value of IPCC (2006) which is 18.45 MJ. The recommendation is to use more diversified values. I have chosen to use values from the textbook by McDonald et al., (2011) which for for grain-based concentrate is 18.4

MJ/kg DM and for grass silage of good quality 20.0 MJ/ kg DM. The values were weighted according to proportions of concentrate and silage in the diet.

Dairy cows

To start with we need to calculate the cows feed consumption. As this is seldom known in commercial farms the best prediction is to use their feed requirements and assume that over longer periods (years) they will consume according to this. To facilitate these calculations and not be depending on access to the NorFor package they are based on the recommendations in metabolisable energy as given in the SLU feed tables (Spörndly, 2003). Recommendations for dairy cows are presented in the appendix. The nutritional values of forages are according to average from analyses performed in Sweden lately (NorFor). Values for the most used commercial compound feeds are used for concentrates.The live weight of cows is assumed to be 650 kg. This is based on experiences from SLU's research herds as well as for research herds where both Holstein and red cows have this weight. The average milk production is calculated from milk delivered to the dairies and on-farm consumption. The later include all milk that does not meet the dairies quality demands.

Table 1. Calculations on milk production in Sweden 2014-15

	2014	**2015**	**References**
No. of dairy cows	344,339	338,379	Holmström, 2015
Milk delivered to Swedish dairies	2,931,252 ,000 kg	2,933,161,000	The Swedish Board of Agriculture
On farm consumption (5.6%)	164,214,150 kg	164,257,0002	Holmström, 2015
Total milk production including home consumption	3,095,402,000 kg	3,097,418,000	Calculated[1]
Milk, kg/cow/year	8,989	9,154	Calculated[1]
Fat,%	4.25	4.25	Holmström, 2015
Protein,%	3.42	3.42	Holmström, 2015
ECM, kg/cow/year	9,272	9,441	Calculated[2]
ECM, kg/cow/day	25.4	25.9	Calculated[2]

[1]Calculated from figures above, [2]ECM, energy corrected milk was calculated as ECM= milk, kg* ((383*fat, % + 242*protein, %) + 783.2)/3140 (Sjaunja et al, 1990).

Calculations using equations 1 and 2 for the year 2014 are presented in Table 2 where the years 1993 and 1998 are included for compasons as these were used in the report by Bertilsson (2001).

From these figures the recommendation is to use figures from Equation (1), which is the one that NorFor uses. Equation (2) is simple and might be used if figures on fat content in feeds is not known. For comparison the values for the Lindgren (1980) equations are also included.The conversion factor (Y_M) is very close to the standard value of 6.5% proposed by IPCC (2006). The value that we get here, 141 kg CH4/cow/year is also comparable to those used in Norway and Denmark which are 139 and 136 respectively (Storlien & Harstad, 2015; Mikkelsen et al., 2014).

Table 2. Calculations of methane production by dairy cows using eqation from NorFor and compared to old calculations by the method of Lindgren (1980)

Parameter	**1993**	**1998**	**2014**	**2015**	**References**
ECM/cow/year	6542	7415	9,272	9,441	Table 1
ECM/cow/day	17.9	20.3	25.4	25.9	
Total energy requirements, MJ ME for maintenance, milk production and pregnancy, Per cow and day	163	176			Spörndly, 2003
Silage, MJ ME/kg DM	9.5	9.9	10.1	10.1	Spörndly, 2003
Concentrate, MJ ME/kg DM	13.4	13.4	13.4	13.4	Author's judgement
Silage fatty acids (FA), g/kg DM	12	12	12	12	NorFor
Concentrate FA, g/kg DM	43	43	43	43	NorFor
Forage proportion, %DM	50	50	45	45	Author's judgement
MJ ME/kg total feeds in diet	11.5	11.6	11.9	11.9	Calculated[1]
FA, g/kg DM total feeds	27.5	27.5	29.1	29.1	Calculated[1]
Dry Matter Intake (total), kg DM/cow/day	14.2	15.2	17.2	17.4	Calculated[1]
MJ GE/cow/day	273	292	328	332	Calculated[1]
CH4, MJ/day	17.3	18.6	21.2	21.5	Equation1[1]
CH4, g/day	310	334	381	386	Calculated[1]
Y_M, %GE	6.3	6.4	6.5	6.5	Calculated[1]
CH4, kg/cow/year	***113***	***122***	***139***	***141***	***Calculated[1]***
CH4, kg/cow/day	118	126	142	144	Calculated[1]
CH4/cow/year	126	132	140	140	Lindgren, 1980

[1]Calculated from figures in the table and from equations mentionned in the text.

Suckler cows

Suckler cows are defined as cows kept to feed calves, own or others, for beef production. The suckler cows in Sweden are kept in vary diverse environments. The herds are small and many breeds and crossed of breeds are used. For these calculations I have assumed an average weight of the cows of 750 kg as most cows are crosses with heavy breeds and weighings on commercial farms show this weight in average (Hessle, 2016). The milk yields (kg ECM/cow/day) assumed are as follows (Hessle, 2016):

Month 1	14
Month 2	12
Month 3	12
Month 4	10
Month 5	10
Month 6	8

The cows are assumed to be spring-calving (April). All feed requirements are calculated according to Spörndly (2003) , requirements for maintenance, milk production and pregnancy included (See Table 3).The energy conversion value (Y_m) value is well within the propes standard range of IPCC of 6.5±1.0%. A comparison with Norway (Storlien & Harstad, 2015; Mikkelsen, 2011) shows that they proposed the values118 and 60 kg methane/cow/year respectively.

Table 3. Calculations on methane production from suckler cows

Parameter	Figure	References
ECM, kg/cow/year	2013	Hessle, 2016
ECM/cow/day	5.5	Calculated[1]
Total energy requirements, MJ ME maintenance, milk production and pregnancy, per cow and day	103.1	Spörndly, 2013
Silage, MJ ME/kg DM	9.5	Author's judgement
Silage FA, g/kg DM	12	NorFor
Forage proportion, %DM	100	Author's judgement
Dry Matter Intake (total), kg DM/cow/day	10.9	Calculated[1]
MJ GE/cow/day	217	Calculated[1]
CH4, MJ/day	14.0	Equation1[1]
CH4, g/day	252	Calculated[1]
YM, %GE	6.4%	Calculated[1]
CH4, kg/cow/year	***92***	***Calculated***[1]

[1]Calculated from figures in the table and equations mentionned in the text.

Growing cattle

Heifers

Heifers are mainly used for replacements in the herds, either dairy or beef type. In these calculations I have assumed that calves weigh 40 kg at birth and their growth is 0.7 kg/day. Live weight at 18 months of age is 450 kg and at 24 months 600 kg. The feed requirements are according to Spörndly (2003) that are shown in the appendix. The Y_m figures for animals older than 1 year are closed to the IPCCs standard values. The lower value for heifers younger than one year is expected as their diet contains a higher percentage of concentrate.The Norwegian figures were 22 kg methane/cow/year for animals < one year and 69 for animals older than one year.

Table 4. Calculations on methane production from heifers

	< 1 year	1-2 years	>2 years	References
Average weight	200	385	580	Authors calculations
Energy requirements, MJ ME/animal/day	46	71	94	Spörndly, 2003
Concentrate, %DM	50	15	15	Authors judgement
MJ ME/kg DM silage	9.5	9.5	9.5	Authors judgement
MJ ME/kg DM concentrate	13.4	13.4	13.4	Authors judgement
MJ ME/kg DM feeds	10.5	10.1	10.1	Calculated[1]
Kg feeds/animal/day	4.3	7.0	9.3	Calculated[1]
MJ GE/animal/day	81	131	174	Calculated[1]
CH4, MJ/animal/day[1]	3.9	8.5	11.2	Equation2[2]
Y_M %GE	4.8	6.4	6.4	Calculated[2]
CH4, kg/animal/year	**26**	**58**	**77**	**calculated[2]**
CH4, kg/animal/year	25	55	72	Calculated[3]

[1]Calculated from figures in the table and in the text, [2] calculated according to equation 2, [3]calculated from dry matter intake and assumption that GE in total feeds is 18.45.

Bulls and steers

Bulls may be of many breeds, both dairy type and beef type, but are mainly kept indoors and reared intensively for slaughter at 14-18 months of age with diets based on concentrate and high-quality forage, 50/50 on DM basis. Older bulls than 2 years include breeding animals.

Steers (castrated bulls) are fed on pasture during the growing season and are often kept on semi-natural pastures where nature conservation is major ’product’ from these animals and where society pays the farmers subsidies for having them. The aim is that these animals should be slaughtered before two years of age, but depending on when they are born these category of animals might be older than two years at slaughter.

General assumptions of these calculations are that bulls are slaughtered at a live wight of 600 kg and steers of 625 kg. Growth rates are 1.2 kg/animal/day for bulls and 0.9 kg for steers.

Proposed Norwegian values are 27 kg methane/animal/year for animals younger than one year and 79 kg for animals older than one year.

Table 5. Calculations on methane production from bulls and steers

	< 1 year	1-2 years	>2 years	References
Average weight	250	500	625	Authors calculations
Energy requirements, MJ ME/animal/day	71	107	121	Spörndly, 2003
Concentrate, %DM	70	50	10	Authors judgement
MJ ME/kg DM silage	10.1	10.1	10.1	Authors judgement
MJ ME/kg DM concentrate	13.2	13.2	13.2	Authors judgement
MJ ME/kg DM feeds	12.3	11.7	10.4	Calculated[1]
Kg feeds/animal/day	5.5	8.7	9.8	Calculated[1]
MJ GE/animal/day	102	162	185	Calculated[1]
CH4, MJ/animal/day[1]	4.0	7.8	12.3	Calculated[2]
Y_M %GE	3.9	4.8	6.7	Calculated[2]
CH4, kg/animal/day	0.072	0.141	0.222	Calculated[2]
CH4, kg/animal/year[1]	**27**	**53**	**85**	Equation2[2]
CH4, kg/animal/year[2]	26	51	79	Calculated[3]

[1]Calculated from figures in the table and and in the text, [2]calculated according to equation 2, [3]calculated from dry matter intake and assumption that GE in total feeds is 18.45.

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Appendix (from Spörndly, 2003; AgriWise, 2015)

Rekommenderad giva till mjölkkor av omsättbar energi, AAT, PBV, kalcium och fosfor.

	Omsättbar energi (MJ/dag)	***Smb rp (g/dag)***	***AAT (g/dag)***	***PBV * (g/dag)***	***Ca (g/dag)***	***P (g/dag)***
För underhåll, per dag:						
Generellt	0.507 MJ / kg levande vikt $^{0.75}$			3.25 g/kg levande vikt $^{0.75}$		
Levande vikt i kg:						
400	45		291	0 – +300	25	15
500	54		344	0 – +300	28	17
600	62		394	0 – +300	31	19
700	69		442	0 – +300	34	21
Tillägg för mjölkproduktion, per kg 4 % mjölk (ECM):						
	5,0		40		2,6	1,8
Tillägg för tillväxt (ca 250 g/dag) 1:a kalvare, per dag:						
	8,0		52		5	3
Tillägg/avdrag för ändring av levandevikten, äldre kor:						
Viktökning, per kg	35,8		250	0 – +300	-	-
Viktminskning, per kg	-34,5		-185	0 – +300	-	-

För lakterande kor justeras den summerade energimängden per dag ovan för att beräkna den slutliga rekommendationen som:

Y = 1,11 X – 13,6 där Y = rekommenderad energigiva
X = MJ för underhåll+mjölkproduktion+viktändring

För att beräkna den rekommenderade givan av AAT per dag multipliceras energigivan Y, med 7.6 g AAT/MJ

Därutöver görs ett tillägg för dräktighet, per dag:

Månad	Levande vikt, kg	Omsättbar energi	Smb rp	AAT	PBV	Ca	P
7:e månaden	400	5		41	0 – +300	6	4
	500	7		51	0 – +300	7	5
	600	8		59	0 – +300	8	6
	700	9		66	0 – +300	9	7

8:e månaden	400	8	68	0 – +300	8	6
	500	11	85	0 – +300	10	7
	600	13	98	0 – +300	12	8
	700	15	109	0 – +300	14	9
9:e månaden	400	15	116	0 – +300	12	9
	500	19	146	0 – +300	15	11
	600	23	168	0 – +300	18	13
	700	27	188	0 – +300	21	15

PBV, g per dag i hela foderstaten:

Idealt värde	0
Rekommenderat intervall	0 - +300

* PBV-värdet för foderstaten bör vara inom intervallet 0 till +300 g/dag. Den nedre gränsen ska om möjligt uppnås och den övre gränsen bör inte överskridas, eftersom det innebär dålig proteinhushållning.

Källa: Fodertabeller för idisslare 2003, SLU, Inst. för husdjurens utfodring och vård, Uppsala, 2003. Senast uppdaterad 2008-12-03. Granskad utan åtgärd 2015-04-15.

Tabell 4a. Rekommenderad daglig energigiva till växande nötkreatur (MJ omsättbar energi per dag och djur) samt lägsta rekommenderade energikoncentration i totalfoderstaten (MJ/kg ts) för att nå angiven tillväxt (efter Norrman, 1977a och Olsson & Lindell, 2002).

Viktintervall, Kg		**Daglig viktökning, kg**						
		0,0	**0,10**	**0,20**	**0,30**	**0,40**	**0,50**	**0,60**
	Lägsta energikonc	7,5	8,0	8,4	8,8	9,2	9,6	10,0
76-125	Kraftfoderstat[1)]	15,0	16,5	18,5	20,0	22,0	24,0	26,5
	Blandfoderstat [2)]	15,0	17,0	19,0	21,0	23,5	26,0	28,5
	Lägsta energikonc	7,5	8,0	8,4	8,8	9,2	9,6	10,0
126-175	Kraftfoderstat	20,5	22,0	24,0	26,0	28,5	30,5	33,0
	Blandfoderstat	20,5	22,5	25,0	27,0	30,0	32,5	35,5
	Lägsta energikonc	7,5	8,0	8,4	8,8	9,2	9,6	10,0
176-225	Kraftfoderstat	25,0	27,0	29,5	31,5	34,0	36,5	39,5
	Blandfoderstat	25,0	27,5	30,0	33,0	35,5	39,0	42,0
	Lägsta energikonc	7,1	7,5	8,0	8,4	8,8	9,2	9,6
226-275	Kraftfoderstat	30,0	32,0	34,5	36,5	39,5	42,0	45,0
	Blandfoderstat	30,0	32,5	35,0	38,0	41,5	44,5	48,5
	Lägsta energikonc	7,1	7,5	8,0	8,4	8,8	8,8	9,2
276-325	Kraftfoderstat	34,0	36,5	39,0	41,5	44,5	47,5	51,0
	Blandfoderstat	34,0	37,0	40,0	43,0	46,5	50,5	54,0
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
326-375	Kraftfoderstat	38,5	41,0	43,5	46,5	49,5	53,0	56,5
	Blandfoderstat	38,5	41,5	44,5	48,0	52,0	56,0	60,0
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
376-425	Kraftfoderstat	42,5	45,0	48,0	51,0	54,5	58,0	61,5
	Blandfoderstat	42,5	45,5	49,0	53,0	57,0	61,0	65,5
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
426-475	Kraftfoderstat	46,5	49,0	52,5	55,5	59,0	63,0	67,0
	Blandfoderstat	46,5	50,0	53,5	57,5	61,5	66,5	71,0
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
476-525	Kraftfoderstat	50,0	53,0	56,5	60,0	64,0	68,0	72,0
	Blandfoderstat	50,0	54,0	58,0	62,0	66,5	71,5	76,5
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
526-575	Kraftfoderstat	54,0	57,0	60,5	64,5	68,5	72,5	77,0
	Blandfoderstat	54,0	58,0	62,0	66,5	71,0	76,5	82,0
	Lägsta energikonc	7,1	7,5	7,5	8,0	8,4	8,4	8,8
576-625	Kraftfoderstat	57,5	61,0	64,5	68,5	73,0	77,5	82,0
	Blandfoderstat	57,5	61,5	66,0	71,0	76,0	81,0	87,0

[1)] Totalfoderstatens energikoncentration antas vara 12,0 MJ/kg ts
[2)] Totalfoderstatens energikoncentration antas vara 10,0 MJ/kg ts

Utöver tabellens gränser kan beräkning enligt formel nedan ske till 825 kg levandevikt och daglig viktökning upp till 2,00 kg.
Tabellen gäller till normal slaktmognad

Viktintervall, kg	**Daglig viktökning, g** 0,70	0,80	0,90	1,00	1,10	1,20	1,30	1,40	1,50
	10,5	10,9	11,3	11,7	12,1	12,6	12,6		
76-125	29,0	31,5	34,0	37,5	40,5	44,5	48,5		
	31,5	34,5	38,0	42,0	46,0	50,0	55,0		
	10,5	10,9	11,3	11,3	11,7	12,1	12,1	12,6	
126-175	36,0	38,5	42,0	45,0	49,0	53,0	57,5	62,5	
	39,0	42,5	46,0	50,0	54,5	59,5	65,0	71,0	
	10,5	10,9	11,3	11,3	11,7	11,7	12,1	12,1	12,1
176-225	42,5	45,5	49,0	52,5	57,0	61,5	66,0	71,5	77,5
	45,5	49,5	53,5	58,0	63,0	68,5	74,5	81,0	88,0
	9,6	10,0	10,5	10,9	11,3	11,7	11,7	12,1	12,1
226-275	48,5	52,0	55,5	60,0	64,5	69,0	74,5	80,5	87,0
	52,0	56,5	61,0	66,0	71,0	77,0	83,5	90,5	98,5
	9,2	9,6	10,0	10,5	10,9	11,3	11,3	11,7	11,7
276-325	54,5	58,0	64,0	67,0	71,5	76,5	83,0	89,5	96,5
	58,5	63,0	70,0	73,5	79,0	85,5	92,5	100,5	109,0
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
326-375	60,0	64,5	68,5	73,5	79,0	84,5	91,0	98,0	105,5
	64,5	69,5	75,0	80,5	87,0	94,0	101,5	109,5	119,0
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
376-425	66,0	70,0	75,0	80,0	86,0	92,0	98,5	106,0	114,5
	70,5	76,0	81,5	87,5	94,5	102,0	110,0	119,0	129,0
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
426-475	71,5	76,0	81,0	86,5	92,5	99,5	106,5	114,5	123,5
	76,5	82,0	88,0	94,5	102,0	110,0	118,5	128,0	138,5
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
476-525	77,0	82,0	87,0	93,0	99,5	106,5	114,0	122,5	132,0
	82,0	88,0	94,5	101,5	109,5	117,5	127,0	137,0	148,5
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
526-575	82,0	87,5	93,0	99,5	106,0	113,5	121,5	130,5	140,5
	87,5	94,0	101,0	108,5	116,6	125,5	135,5	146,0	158,0
	8,8	9,2	9,6	10,0	10,5	10,9	10,9	11,3	11,3
576-625	87,5	93,0	99,0	105,5	112,5	120,5	129,0	138,5	149,0
	93,5	100,0	107,5	115,0	124,0	133,0	143,5	155,0	167,5

1) Kraftfoderstat: $(0.475*V^{.75})+(T*(6.28+0.0188*V))/((1-0.3*T)*0.522)$
2) Blandfoderstat: $(0.475*V^{.75})+(T*(6.28+0.0188*V))/((1-0.3*T)*0.435)$
V= vikt i kg, T= viktökning i kg/dag. Gäller till V=825 kg och T= 2.0 kg/dag

Tabell 4b. Tillämpning av tabell 4a för olika djurmaterial (efter Norrman, 1977a och Olsson m fl, 1994 och Olsson & Lindell, 2002)

Kön och ras	**Anpassning**
Tjurar	
SRB och SLB	inga
Korsningar med minst 50 % av :	Vid utfodring för en daglig viktökning av 0,8 kg eller mer enligt :
Tung köttras [1]	Minus 15 % eller enligt : 1-0.21*(T-0.8)
Lätt köttras [2]	Minus 5 % eller enligt : 1-0.07*(T-0.8)
	där T = tillväxt i kg per dag
Stutar	
SRB och SLB och lätt köttras	Plus 5 % vid utfodring för en daglig viktökning av 0,7 kg eller mer
Korsningar med minst 50 % tung köttras	inga
Kvigor	
SRB ochSLB och lätt köttras	Plus 5 % vid utfodring för en daglig viktökning av 0,6 kg eller mer
Korsningar med minst 50 % tung köttras	Plus 5 % vid utfodring för en daglig viktökning av 0,7 kg eller mer

1) Tung köttras är Charolais, Simmental, Limosin och Blonde d´Aquitaine

2) Lätt köttras är Hereford och Angus