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Feed efficiency and its development in animal production

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Abstract. Feed conversion rates and their development are needed for the determination of the total animal production after the total feed production is known or forecast.

The feed conversion rates for the period 1971—75 were estimated from the feed balance sheets which show the feed use for different animal production lines. They form the basis for the forescasts of the coefficients for 1975—85.

Feed efficiency in milk production is expected to improve by 3 per cent from 0.837 to 0.811 feed units per litre of milk in ten years by 1985. This is a result of the increase of the average yields and average weight of cows: the proportion of the feed needed for the maintenance of the cow decreases. In beef production the feed efficiency is expected to worsen, from 12.0 to 13.8 feed units per kg due to the increase of average slaughter weights. If the slaughter weights do not rise as much as predicted (from 160 to 190 kg in ten years), the feed conversion rate will not increase as predicted. In pork production the feed efficiency is expected to improve from 5.28 to 4.77 feed units per kg and in broiler production from 4.00 to 3.60 feed units per kg.

All values presented above are gross estimates, i.e. they include the waste in handling and feeding. The error of the coefficients may be several per cents but it cannot be specified. The possible error has to be kept in mind when the conversion rate estimates are applied.

1. Introduction

The total production forecasts can be made by predicting a) the average yields in crop production, b) the arable land and its distribution to different crops, c) the development of the feed conversion rates, and d) the net import of feed. If total crop production, and especially the feed production (supply), is known, it is possible to estimate the total animal production when the feed conversion rates are given. Feed conversion rates are here defined as the ratio of feed input expressed in feed units to the unit of output of animal production.

Finnish animal husbandry is based almost entirely on domestic feed, only a small percentage of the feed input is imported. These imports consist of protein feed owing to the lack of high value protein feed. Animal feed yield regulates, therefore, to a large extent the animal production. Since agricultural policy will no doubt also in the future be based on self-sufficiency, the production forecasts depend on the crop yield.

Even though the statistics on the crop and animal productions are reliable and well established, it was found that the ratio of the feed input to the animal production is not clear. There is a lot of information as to feed conversion rates. They are however, mainly results of experiments and often refer only to marginal effects of feed inputs. They do not include the whole rearing period but only a part of it.

It seems to be rather difficult to give reliable estimates of feed conversion rates. When the total annual requirement of the animal production is calculated by using the theoretical feed conversion rates, the balance sheet for some years shows a use of feed greater than the supply, while sometimes the use of feed is smaller than the theoretical requirement.

There are, of course, several explanations for this. The production effect of a feed input depends on several factors, such as the energy and protein contents of the feed. These factors are not in a fixed ratio in the feed from year to year. While the total feed output is usually expressed in feed units, the protein content is ignored. The feed units of the yield are usually based on average conversion rates and no attention is paid to the quality of the crop yield. In addition, the estimate of the total yield may prove to be erroneous. It is thus not realistic to expect to have fixed coefficients between the animal production and the feed input from one year to another.

Feed use efficiency improves as a result of the breeding of animals. Some studies show that the results are quite remarkable. For example, it has been estimated that the milk output per unit of feed has improved by nearly 60 per cent in 30 years in the USA (ANON. 1976). Feed conversion seems to improve also in Finland. Yields per cow, for example, are rising, and the feed input to produce a kilogram of pork is declining, etc.

The improvement in feed use efficiency has to be taken into account in the forecasts for the total agricultural production. A change of 5—10 per cent in 10 years is quite probable. It has naturally a corresponding effect on the self-sufficiency of agriculture, or it may mean, as in the case of Finland, a corresponding cut in the arable land in order to keep the supply-demand situation regulated.

This article is a summary of the studies by HAGGREN (1977) and HAAPA and MAIJALA (1977) which are a part of a comprehensive research project on forecasts of agricultural production.

2. Feed balance sheet

The feed use in different production lines during the years 1970—75 was the basis for estimating the actual feed conversion coefficients.

Theoretical feed conversion coefficients, feed use obtained from farm surveys, commercial production of concentrated feed and the total feed yield formed the basic statistics on which the feed balance sheet was built.

The exact total feed input is not known. Especially the feed from pastures is difficult to estimate, since there are no official statistics. For our purpose it had to be estimated according to the milk production during the grazing

period. This is contrary to the principles of the feed balance sheet but it should not effect the analysis.

The estimates of feed use for different animals as obtained from farm surveys seem to overestimate or underestimate the total feed use. Therefore, some modifications had to be made to make the total feed balance sheet consistent with the actual feed supply. The adjustments may not be entirely, but we hope that they are not too far wrong. At least they can serve as first estimates of feed use coefficients which have been adapted to a real and average situation in contrast to the many experiments which tend to give too favourable an idea of feed use efficiency in animal production.

The feed conversion coefficients were calculated on the basis of the feed use balance sheet (Table 1). As indicated, they differ from the theoretical values because they are average estimates and include also the waste in feeding.

Table 1. The development of gross feed conversion rates in economic years 1971/72—1975/76.

	1971/72	1972/73	1973/74	1974/75	1975/76
Cattle					
milk, total f.u./l	0.889	0.920	0.839	0.851	0.837
— production feed, f.u./l ..	0.486	0.502	0.463	0.464	0.472
— maintenance feed, f.u./l	0.403	0.418	0.376	0.387	0.365
meat, total, f.u./kg	11.90	12.87	11.49	11.51	11.86
— young cattle, f.u./kg ...	9.90	10.23	9.51	9.38	10.08
— milk cows, f.u./kg	16.9	18.0	16.0	17.0	16.5
Pork					
production, f.u./kg	5.40	5.42	5.33	5.31	5.28
Poultry					
eggs, f.u./kg	3.84	3.77	3.72	3.64	3.56
poultry meat, f.u./kg	5.52	5.62	5.46	5.37	5.35
— hen's meat, f.u./kg	7.90	7.90	7.90	7.90	7.90
— broiler, f.u./kg	4.16	4.12	4.08	4.04	4.00

The coefficients for milk show a larger variation than do other coefficients. This is due to the compiling of a balance sheet in which the inconsistencis between the supply and the estimated use of feed are included in the milk coefficients.

The development of feed use efficiency was the basis for the forecasts presented in the next chapter.

3. The development of the feed conversion coefficients

3. 1. *Milk*

Feed use of dairy cows can be divided into two components:

a) the feed for the production of milk, and
b) the feed needed for the maintenance of the cow.

The share of the production feed is estimated to be 0.39 feed units per litre of milk (4 per cent fat content) irrespective of the production level. This is a net requirement. For practical purposes about 20 % has to be added for the waste in the handling and feeding.

Another component of the feed use, the feed needed for the maintenance of the cow, covers about 40 per cent of the feed input. It is positively related to the weight of the animal. When e.g. the living weight of a cow is 420 kg, the maintenance feed is 1210 feed units per year. When the weight is 500 kg, 1400 feed units are needed for the maintenance of the animal.

The higher weight is related to a higher yield per cow. In fact, the higher yields have been achieved by raising cattle whose weights have increased. At the same time, the feed use efficiency has improved since the proportion of the maintenance feed has decreased.

There are no exact estimates as to the average weight of dairy cows. The figure used here, 460 kg, is largely based on the population of cow testing herds. The average weight is expected to be 480 kg in 1980 and 490 kg in 1985. This increase is partly a result of the change in the distribution of breeds: the proportion of the original Finnish breed is all the time decreasing and is being replaced by the heavier Ayrshire and Friesian breeds.

The average yield of milk per cow is expected to increase linearly up to 4850 litres in 1985. As stated earlier, the feed use for milk production is kept independent of the yield.

It is calculated that the feed use per litre of milk would be 0.827 feed units in 1980 and 0.811 feed units in 1985. These are gross estimates which include a 20 per cent waste of feed for handling and feeding. The forecasts are given with three decimals, but this is only to indicate the decline of the coefficient. Judging by Table 2, the error may be quite large owing to different factors.

Table 2. Feed conversion rates for milk production in 1975/76 and a forecast for 1980 and 1985.

	1975/76	1980	1985
Maintenance feed, f.u.	1272	1325	1375
Average live weight, kg	449	470	490
Production feed, f.u.	1633	1753	1902
Average yield, l	4165	4470	4850
Net feed requirement, f.u./cow	2905	3078	3277
Net feed requirement, f.u./litre	0.697	0.689	0.676
Gross feed requirement, f.u./litre	0.836	0.827	0.811

The decline of the coefficient is rather small, only 3 per cent, which is a result of the increasing weight of the animal. In this light, the rising milk yields do not seem greatly to improve the economic efficiency of milk production and only the capital costs may go down. Instead, the declining number of dairy cows means, in Finnish conditions, a diminishing number of calves for beef production, which is a disadvantage because the beef supply is already beginning

to be too low. The increase of average slaughter weights is not rapid enough to compensate the decline of the number of slaughtered animals in order to keep the beef production constant.

3. 2. *Beef production*

Beef production consists of the slaughterings of young cattle and dairy cows. The latter form about one third of the beef supply. The feed requirement has to be estimated separately for young cattle and for dairy cows.

The efficiency of the feed use for young cattle depends on the slaughter weight. On the basis of the studies by Sirén (HAGGREN 1977) it is estimated that the feed use would be 10.4 feed units in 1980 and 12.4 feed units in 1985 per kilogram of beef. This is a gross estimate which includes the waste. The average slaughter weight is put at 160 kg in 1980 and 190 kg in 1985. It is not, however, certain that the average slaughter weight will be as high as predicted since the economy of beef production grows worse when heavier animals are being raised. If there is going to be a sufficient price differentiation according to the weight, the predicted development is possible. At present there is an increase of 1.30 Fmk per kg on the producer price of young beef if the slaughter weight is more than 160 kg.

There are some factors which are going to have a positive effect on feed use efficiency. For example:

a) specialisation and improvement of professional skill in beef production
b) increase in the use of concentrated feed
c) breeding, and
d) an expansion of the milk-beef programme, i.e. cross-breeding of milk and beef cattle.

A negative effect on the average feed use efficiency lies in the increase of heifers for slaughtering. This is necessary in order to increase the beef supply; so far quite a lot of the female calves have been slaughtered as young calves. For the same weight, the male calves need considerably less feed than the female calves.

Table 3. Feed conversion rates for beef production in 1975/76 and a forecast for 1980 and 1985.

	1975/76	1980	1985
Young beef cattle, mill.kg	81.5	80	76
— 1000 pieces	595.6	500	400
— average slaughter weight, kg	135.8	160	190
— gross feed requirement, f.u./kg	9.44	10.4	12.4
Milk cows, mill.kg	31.0	33.5	32
— 1000 pieces	174.2	163	150
— average slaughter weight, kg	193.0	205	213
— feed requirement, f.u./kg	17.0	17.0	17.0
Beef production, mill.kg	112.5	113.5	108
— Gross feed requirement, f.u./kg	11.47	12.3	13.8

As such, the feed use efficiency in beef production is estimated by the Animal Husbandry Department to improve by 0.5 per cent per year (HAAPA & MAIJALA 1977). But as the average slaughter weight is expected to increase, the feed input per unit of output will increase. The average slaughter weight should increase as has been predicted, otherwise the shortage of beef will be inevitable quite soon, which does not fit in with the Finnish self-sufficiency policy.

In the feed balance sheet the feed requirement for rearing a dairy cow is kept constant, 17 feed units per kg. This figure is much higher than that in beef production since the rearing period of a heifer is 22 months. After that period the feed use of a dairy cow is included in the feed balance sheet of milk production.

By combining the feed use for young beef cattle and dairy cows we should achieve an average feed use efficiency for the total beef production. It is calculated to be 11.5 feed units in 1975, 12.3 feed units in 1980 and 13.8 feed units in 1985 (Table 3). These are again gross figures which also include waste. The error — due to various factors — is several per cents but cannot be specified.

3. 3. Pork production

Feed use in pork production is easier to estimate than that of milk production in the sense that there is only one final product. However, there are two production phases, quite distinct from each other, namely piglet production and pork production.

Feed use for piglets rearing up to 20 kg had to be estimated on the basis of research results from experiments. It was 100 feed units in 1975/76 and is estimated to decrease by 5 per cent by 1985 to 95 feed units.

In the fattening period from 20 kg to 97 kg (live weight) the feed use is estimated to fall from 3.50 to 3.10 feed units per kg. The main part, or 3/4, of this is due to the breeding and 1/4 to more efficient production on the farms. Again, the waste is taken into account in the estimates.

The total account (Table 4) shows that feed efficiency in pork production will fall from 5.28 to 4.77 feed units per kg in ten years or nearly ten per cent. This may seem too large a figure, and it may even be too optimistic, but it should be noted that much better results have already been achieved in the experiments.

Table 4. Feed conversion rates for pork production in 1975/76 and a forecast for 1980 and 1985.

	1975/76	1980	1985
— feed requirement, f.u./kg	3.50	3.30	3.10
— feed requirement in the fattening period, 20—97 kg	270	254	239
— piglet production, f.u.	100	97.5	95
— total, f.u./pig	370	351.5	334
— f.u./slaughter weight, kg (average weight 70 kg)	5.28	5.02	4.77

The slaughter weight is today about 70 kg. It should be possible to raise it a little, which would mean better total feed efficiency, since the share of piglet production, which is considerably less efficient than pork production, would decrease.

3. 4. Eggs and poultry

It is predicted that feed efficiency in egg production will improve by 10 per cent in 10 years (Table 5). The coefficient, which includes also estimated waste, will drop from 3.56 to 3.08 feed units per kg. The feed needed to raise a chicken to a hen is included in the poultry meat production.

Table 5. Feed conversion rates for poultry in 1975/76 and a forecast for 1980 and 1985.

	1975/76	1980	1985
Egg production			
— production feed, f.u./kg of eggs	3.40	3.20	3.00
— unfit for slaughter	0.16	0.12	0.08
— total f.u./kg of eggs	3.56	3.32	3.08
— chickens	0.36	0.40	0.44
— total f.u./kg (including reproduction)	3.92	3.72	3.52
Poultry meat production			
— broiler, f.u./kg	4.00	3.80	3.60
— hen, f.u./kg	7.90	7.90	7.90
— broiler, mill. kg	7.3	14.0	22.0
— hen, mill. kg	3.9	3.5	3.0
— total, f.u./kg	5.35	4.62	4.12

The reasons for the improvement of feed efficiency are due to breeding and to better feeding technology. The waste in the feeding can be cut down by proper feeding methods.

Poultry meat in Finland consists of the meat of hens and broilers in about an equal proportion. It is, however, predicted that the broiler consumption will increase quite rapidly so that in 1985 about 85—90 % of the poultry meat would be broiler (KETTUNEN 1976). This has a significant impact on the feed requirement. It is estimated that a hen's meat requires 7.90 feed units per kg whereas the figure for a broiler which is 4.00 feed units is expected drop to 3.60 feed units per kg by 1985.

Due to the increased proportion of broilers the feed use for all poultry meat will decline from 5.35 to 4.12 feed units per kg in 10 years. The error in the estimate is several per cents but cannot be properly specified.

4. Discussion

Feed efficiency per unit of output seems to improve 3 per cent for milk, 10 per cent for pork and broiler, 9 per cent for eggs, and to deteriorate 20 per cent for beef by 1985. On an average, the feed efficiency remains more or less constant in animal production, if the forecast for beef production turns out to be correct. Beef production is, therefore, quite crucial for the use of crop production. It is possible that the development of the feed conversion rate for beef will not be so rapid since it assumes that also the average slaughter weight for beef will increase up to 190 kg, which may not prove optimal from an economic point of view.

Some reservations have also to be made for the feed efficiency rates of pork and eggs. The improvement in the feed efficiency has been rather rapid in recent years, but it is not certain that this pacecan be sustained. Theoretically the development is possible; it is now up to the farmers to avail themselves of the new information, technology and systems of feeding.

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SELOSTUS

Kotieläintuotannon rehuhyötysuhde

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Artikkelissa esitellään lyhyesti kotieläintuotannon rehuhyötysuhteen kehitystä 1970-luvulla ja vastaavia ennusteita vuosiksi 1980 ja 1985. Artikkeli perustuu pääosiltaan Erik Haggrénin julkaisuun Kotieläintuotannon rehuhyötysuhde ja sen tuleva kehitys. Se on julkaistu Maatalouden taloudellisen tutkimuslaitoksen tiedonantoja-sarjassa, no 49.

Rehuhyötysuhde-estimaatit on johdettu rehutaselaskelmasta, josta käy ilmi rehujen käyttö eri kotieläimille. Tilastoista saatavia arvioita on jouduttu hieman muuttamaan, jotta rehun kulutus ja tarjonta on saatu täsmäämään. Vuosille 1980 ja 1985 tehdyt ennusteet on laadittu pääasiassa Maatalouden tutkimuskeskuksen Kotieläinjalostuslaitoksen selvitysten perusteella.

Maidontuotannon rehuhyötysuhde alenee 0.828:sta 0.811:een ry:öön/l aikavälillä 1975–1985. Se on seurausta ennen muuta keskituotosten ja lehmien keskipainon kehityksestä. Naudanlihan osalta rehun tarve lihakiloa kohti näyttää nousevan 11.5 ry:stä 13.8 ry:öön, mikäli ennustettu teuraspainon nousu 190 kg:aan toteutuu.

Sianlihantuotannossa rehuntarpeen ennustetaan alenevan 5.28:sta 4.77:ään ry/kg ja kananmunientuotannossa 3.92:sta 3.52:een ry/kg. Broilerintuotannossa oletetaan myös rehunkäytön hyötysuhteen paranevan noin 10 % eli 4.0:sta 3.6:een ry/kg.