European Nitrogen Assessment

Chapter 3: Benefits of nitrogen for food, fibre and industrial production

Supplementary Material*:* Feed N recovery efficiency in the edible weight fraction of animal production

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The main purpose of animal husbandry in Europe is the production of food, i.e., milk, meat and eggs. In addition, animals are kept for hobby and labour (e.g., horses, pats) and for landscape maintenance. In other countries, domestic animals can have various additional functions, such as capital saving, waste converters, etc. (e.g., FAO, 2009; Steinfeld et al., 2010).

For maintenance, growth, reproduction, production and labour, animals require energy, proteins, minerals and vitamins (Suttle, 2010). Depending on the offered feed and the animal species, only a fraction of the energy, proteins, minerals and vitamins in the feed can be retained by the animal; the remainder is excreted via urine and feces. This holds also for nitrogen (N). Excretion rates can be calculated as part of an input-output balance approach on animal level, using the simple equation

Excretion = feed intake – animal products

Note that urine and feces are not considered 'animal products' in this equation; they are considered side-products, which components (energy, nutrients, etc.) can be recycled e.g. to produce fertilizer or energy. In general, between 5 and 45 per cent of the N in the animal feed is retained in animal products (milk, meat, egg), and the remainder (55-95%) is excreted via urine and feces, depending on animal species and productive stage of the animal.

Feed N recovery efficiency in the edible weight fraction is defined as the percentage of the N in the animal feed that ultimately ends up in the edible portion of the animal production. Commonly, a distinction is made between (i) live-weight gain, (ii) carcass weight, and (iii) edible weight. For milk, the differences between these three are negligible; basically all milk produced ends up in edible food. For egg, the differences are also small, but for beef, pork and poultry meat, differences are significant (Table 3.S1). Evidently, expressing feed N recovery efficiency in terms of feed N recovered in live-weight gain yields a (much) higher efficiency than expressed in terms of feed N recovered in the edible weight fraction. Further, the edible fraction is larger than the fraction actually consumed. Here, we use feed N recovery efficiency in the edible weight fraction, assuming that the edible weight is ~90% of the carcass weight. We note that the fraction consumed is 10-20% lower than the edible fraction.

The feed N recovery efficiency in meat depends on animal species, productive stage, housing and management of the animal, and off course the quality of the animal feed. Fish production potentially has the highest feed N recovery, mainly because of the low maintenance costs (not shown). The younger the animal, the higher the potential feed N recovery efficiency. Hence, veal production has a much higher efficiency than beef production. Housed animals have higher efficiencies than grazing animals, in part because of lower maintenance costs, but also because of the possibilities for adjusted feed management.

Table 3.S1. Total animal production in the EU-27 in 2005, assigned mean properties of the animal products and feed N recovery efficiencies in edible weight in the EU-27 (after Lesschen et al., in press). Note, data for Malta and Cyprus were excluded (too low number of animals for proper statistics). The range shown refers to values for different EU Member States.

Product	Production[1]	Carcass fraction	Edible weight	N content	P content	Feed N recovery	
	Gg	kg kg^{-1}	kg kg^{-1}	g kg^{-1}	g kg^{-1}	mean, %	range (%)
Beef	8186	0.58	0.52	33	5.5	8	5 - 13
Cow milk	149310	1.00	0.99	5.5	1	20	12 - 27
Eggs	6665	1.00	0.95	19	1.8	28	19 - 39
Pork	21914	0.75	0.68	25	5.5	25	15 - 30
Poultry	10780	0.71	0.64	33	5.5	35	25 - 49

[1] For meat products expressed in carcass weight.

3.S1 presents the mean feed N recovery efficiency in the edible weight fraction of milk, meat and egg in the EU-27. These mean estimates are based on statistics about animal production and feed use in EU-27 for the whole animal production chain. These estimates are integral estimates, as the feed use by all animals in a production chain are incorporated in the estimations, including the feed use during the non-productive part of the life of the animals, and including the feed that is wasted.

The mean feed N recovery efficiency ranges from 8% for beef to 35% for poultry. There is a wide variation in the means of individual Member States of the EU-27 (last column). This variation is related to various factors, including type of animal breed, production level, and feed management. For example, the category 'poultry' (broilers) include chicken, ducks, geese and turkey; the category 'beef' includes veal calves, beef cattle and slaughtered dairy cows. Note that Member States may have different ratio's between these categories. However, the variation may be related also to errors/uncertainties in the statistics used. For example, there may be inaccuracies in the protein level of animal feed and in animal production due to, for example, the consumption of animal products at home or due to the marketing of animal products locally. Further, there may be inaccuracies in the allocation of feed to animal categories. Further, there are uncertainties in the weight fractions of carcass and edible product.

The potential feed N recovery efficiency in animal products is higher than the mean values shown in Table 3.S1. For example, the feed N recovery efficiency can be as high as 50% in veal and poultry (including chicken and ducks), 35% in pork production and 30% in milk production. Such high feed N recovery efficiencies require highly productive animals, low-protein phase feeding and good management.

At whole system level, the feed N recovery efficiency can be higher than at animal level. At system level, the N in animal manure and the N needed for animal feed production are also included in the estimations.

The N recovery efficiencies presented in Table 3.S1 compare well with values from three studies in the Netherlands (Sebek and Temme, 2009; inferred from statistical data by CBS 2010; see also Table 3.4 in Jensen et al. 2011; Chapter 3 this Volume);

and Westhoek personal communication). However, Smil (2002; 2004) published N conversion efficiencies for the US that are quite different from those for the EU27. Smil's values for milk are twice as high as those for the EU27 and do not appear plausible as means for the whole USA. Possibly, the results presented by Smil represent the net efficiency during lactation only. In contrast, the estimated efficiencies for pork and poultry are lower for the US than for EU27. For egg production feed N recovery seems higher in US than in EU-27. Possibly, these differences relate to differences in time. For example, mean feed N recovery efficiencies in the Netherlands have increased by about 5% since 1990 (e.g. pork increased from 20% to 24%).

Summarizing the comparison from Table 3.S2 and Figure 3.S1, the feed N recovery efficiency for beef is lowest, followed by pork and milk, and is highest for poultry and eggs.

Table 3.S2. Comparison of feed N recovery efficiencies (%) estimated for EU27 (see Table 3.S1) with estimated values for the US and the Netherlands.

	Lesschen et al. (2010)	Smil (2002; 2004)	Sebek (2008); CBS (2010)
	EU27	US	Netherlands
Beef	8	7	8
Pork	25	13	21
Poultry	35	25	28
Eggs	28	35	28
Milk	20	38	21

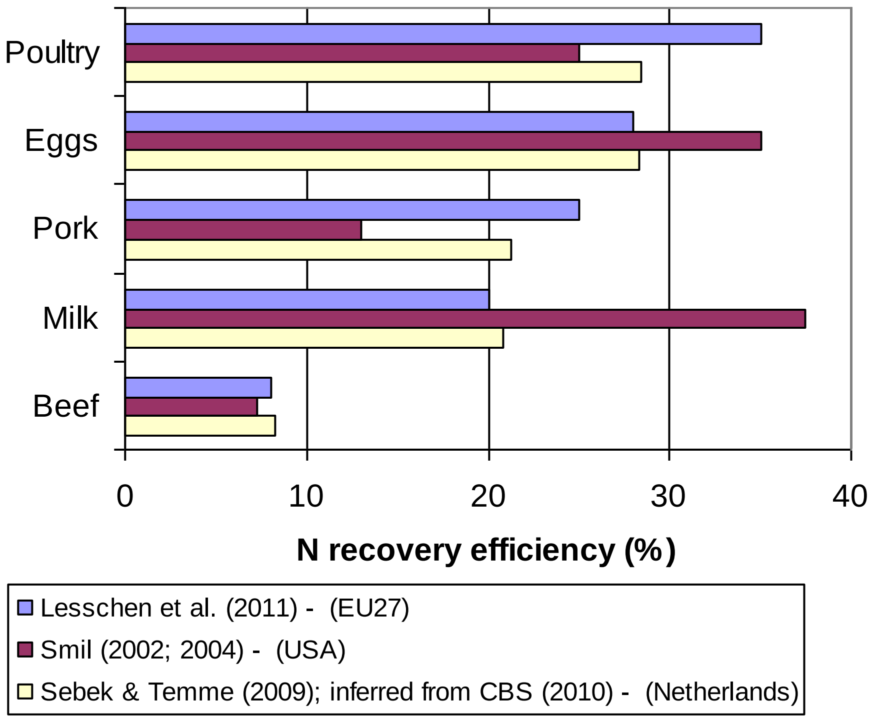

Figure 3.S1. Comparison of feed N recovery efficiencies (%) between EU27 with values for the US and the Netherlands (See Table 3.S2).

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