

Quantification of nitrogen and phosphorus in manure in the Danish normative system

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Denmark has a long tradition for calculating standards for manure composition and content of nitrogen (N), phosphorus (P) and potassium (K). Twenty years ago, the first standards were very rough estimates, as the basis for the calculations was mainly theoretical. Since then, the standards have been revised several times, and the complexity and dynamics of the system have increased over the years (Poulsen & Kristensen, 1998; Poulsen *et al.*, 2001). The standard values (*ex storage*) are used for fertilizer planning and control by Danish farmers and authorities. In addition, the standards (*ex storage*) have recently been used to define the Danish Livestock Unit (LU) and for other purposes.

The system is based on calculations of input and output, and the procedure is divided into three steps. First, we calculate the standards *ex animal* (excretion), and after that we take into consideration what happens in the stable (e.g. emissions and addition of bedding materials in the different housing systems) and calculate standards *ex housing*. Finally, we incorporate emissions etc. during storage and obtain standards *ex storage*. In principle, the system can be used for all nutrients. Currently the Danish system includes, in addition to N, P and K, manure volumes and dry matter contents. The flow dynamics are shown in Figure 1. The system calculates standards for each relevant species of livestock, and we have included cattle, pigs, poultry, furred animals, horses, sheep and goats. Each species is further subdivided into subcategories and weight classes, age classes etc. relevant for Danish livestock production. Depending on species and category, standard values are calculated per produced animal or per animal per year.

Ex animal. Calculations of standard values are performed as a simple difference between input and output. Input is founded on recordings and calculations of feed intake for the different categories combined with statistics on nutrient concentrations in the diets. Thereafter, the nutrient

Nutrient flow

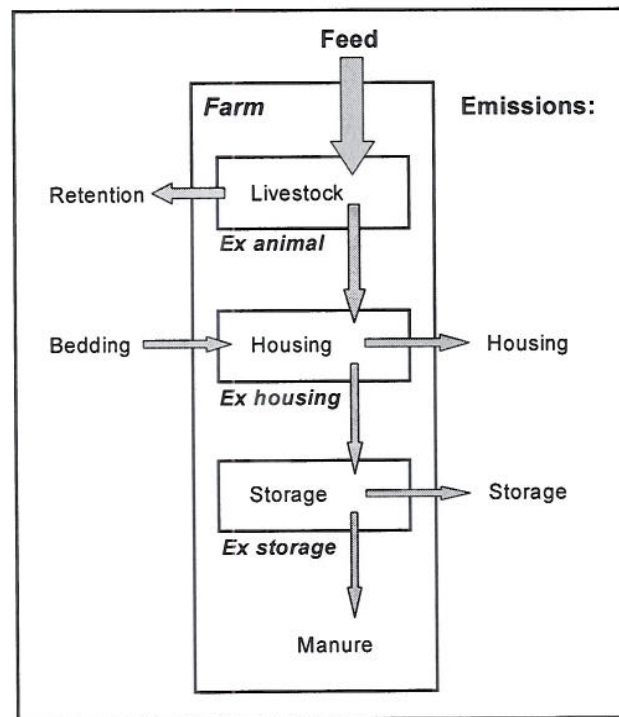


Figure 1. The flow dynamics of the Danish normative system that quantifies nutrient content in livestock manure *ex animal*, *ex housing* and *ex storage*.

retention in the animal products is calculated based on standard values obtained from published literature and then subtracted. The separated excretion of nutrients into faecal and urinary fractions is also calculated using digestibility coefficients of the different nutrients.

Ex housing. Based on *ex animal* standards we then calculate the content of nutrients in manure leaving the stable for storage or to be spread directly on agricultural soil. First, we include for each species (and subclass) the different housing systems relevant for Danish agriculture. Thereafter, default values for N loss due to emissions are included for each housing system mainly based on results from experimental studies. So far, the emissions are calculated based on total N, but the principle will soon be based on TAN (total ammonia nitrogen). Hereafter, the

contributions of nutrients from bedding materials are added, and the soaking of urine into the bedding materials and faeces is calculated in order to establish values for (i) slurry (faeces and urine together) and separately for (ii) faeces (manure or deep litter) and (iii) urine (liquid manure). For each housing system the manure type (the three mentioned types above) is defined and standards *ex housing* are calculated.

Ex storage. Based on the *ex housing* standards, the final step takes into consideration what happens while the different manures (from different livestock species and categories and species specific manure types) are stored. First, the losses of N (due to emissions of ammonia and denitrification) and dry matter are subtracted. Furthermore, redistributed nutrients, dry matter and liquid due to leakage of juice from faeces etc. are included in the model.

The obtained standards are default values that are used by most farmers, but the Danish normative system also includes possibilities for correction of the standards if the farmers can document that their own farms' values on e.g. dietary N or P content deviate from the default values. In such cases the farmer can use defined equations and calculate farm-specific corrected values for nutrient content in the manure on the specific farm. Therefore, the Danish system is very dynamic, detailed and specific and reflects the current Danish livestock production. The standard values are updated annually (www.manure.dk) and are to a large extent based on data from Danish livestock production (official statistics on performance, feed intake, housing of animals etc.).

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References

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- www.manure.dk (annually updated standard values on N, P and K in manure from different livestock species and categories)*