# QUANTIFICATION OF NUTRIENT CONTENT IN LIVESTOCK MANURE – THE DANISH NORMATIVE SYSTEM

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# STANDARD VALUES FOR FARM MANURE

- Denmark has a long tradition for calculating standards for manure composition and content of nitrogen (N), phosphorus (P) and potassium (K).

- The first standards were very rough estimates, as the basis for the calculations was mainly theoretical.

- The complexity and dynamics of the system have increased over the years and are now based on input of data from Danish farmers, dairies and slaughter houses on e.g. feeding level, milk production and slaughter weight.
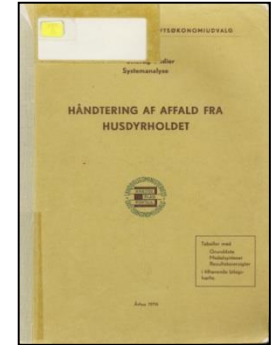
# THE DANISH NORMATIVE SYSTEM

The *ex storage* values on N, P, K, dry matter, volume are used for many purposes:

- Yearly fertilizer planning on every farm with livestock and control of N utilization in manure (Danish Plant Directorate)
- Definitions of livestock unit (1 LU corresponds to 100 kg N *ex storage*)
- Nitrate directive and further environmental issues (regulations)
- Calculation of N, P, K and volume in manure (annually on a total basis for Denmark)
- Calculation of ammonia emission in Denmark
- Calculation of methane emission in Denmark

# FLOW CHART
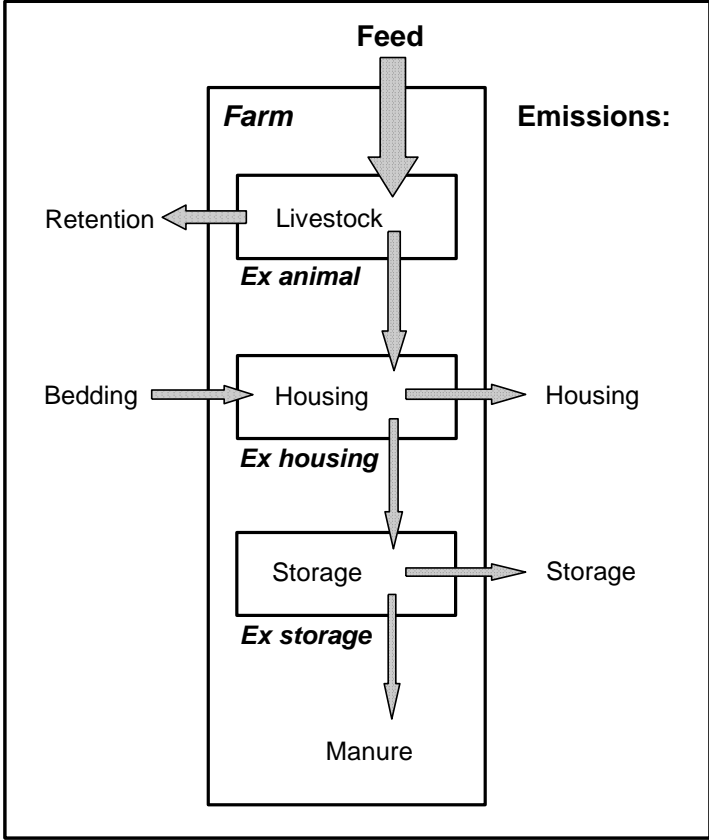
# LIVESTOCK GROUPS

- Cattle (13 categories)
- Pigs (3 categories)
- Poultry (17 categories)
- Goats and sheep (4 categories)
- Fur animals (3 categories)
- Horses (4 categories)

# CATTLE & PIGS

Dairy cow, heavy breed, per year

Dairy cow, Jersey, per year

Heifer calf, heavy breed, 0-6 months

Heifer calf, Jersey, 0-6 months

Heifer, heavy breed, 6-27 months

Heifer, Jersey, 6-25 months

Bull calf, heavy breed, 0-6 months

Bull calf, Jersey, 0-6 months

Bull, heavy breed, 6 months to 440 kg

Bull, Jersey, 6 months to 328 kg

Piglet (7.1 – 31 kg)

Slaughter pig (31-110 kg)

Sow (including 30 piglets to weaning)

Suckler cows, < 400 kg

Suckler cows, 400-600 kg

Suckler cows, > 600 kg

# HOUSING SYSTEMS

| Dairy cows | Growing-finishing pigs |
|---|---|
| Tie-up housing system with dung channel | Totally slatted floor |
| Tie-up housing system with floor grating | Partially slatted floor |
| Cubicles with solid floor | Solid floor |
| Cubicles with slatted floor | Sub-divided lying area |
| Deep litter (throughout area) | Deep litter |
| Deep litter, feeding area with slatted floor | |
| Straw-bedded sloped floor | |

# MANURE TYPES

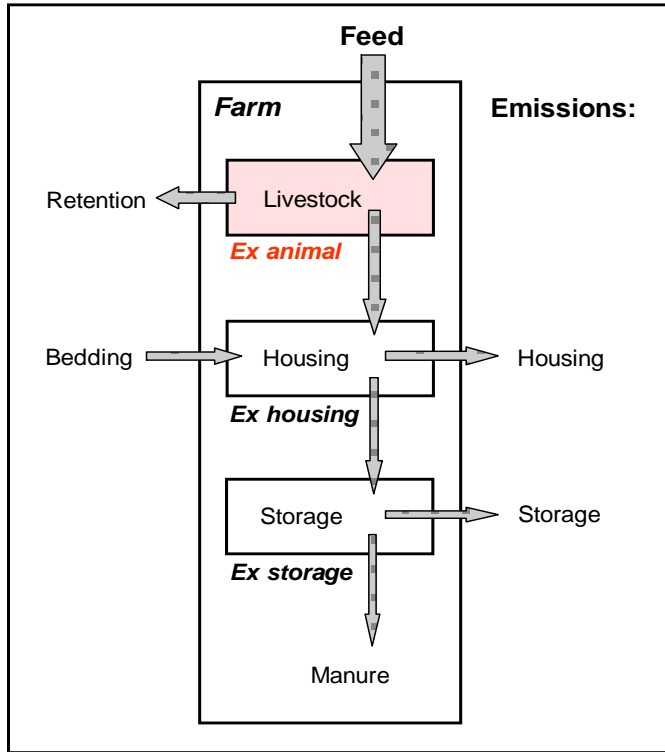| Dairy cows | Growing-finishing pigs |
|---|---|
| Slurry | Slurry |
| Deep litter | Deep litter |
| Separate manure + liquid manure | Separate manure + liquid manure |
| Deep litter + slurry | Deep litter + slurry |

# EX ANIMAL



- Recordings and calculations of feed intake (**farm data**)

- Statistics on nutrient content (**farm data**)

- Nutrient retention in the animal and 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.

Nutrient flow = feed intake × dietary nutrient concentrations - nutrient retention in body and products
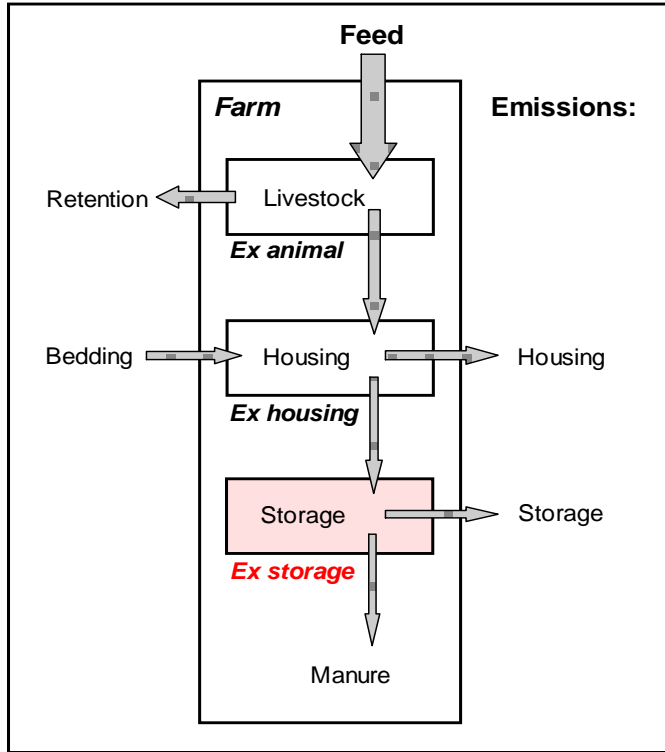
# EX HOUSING
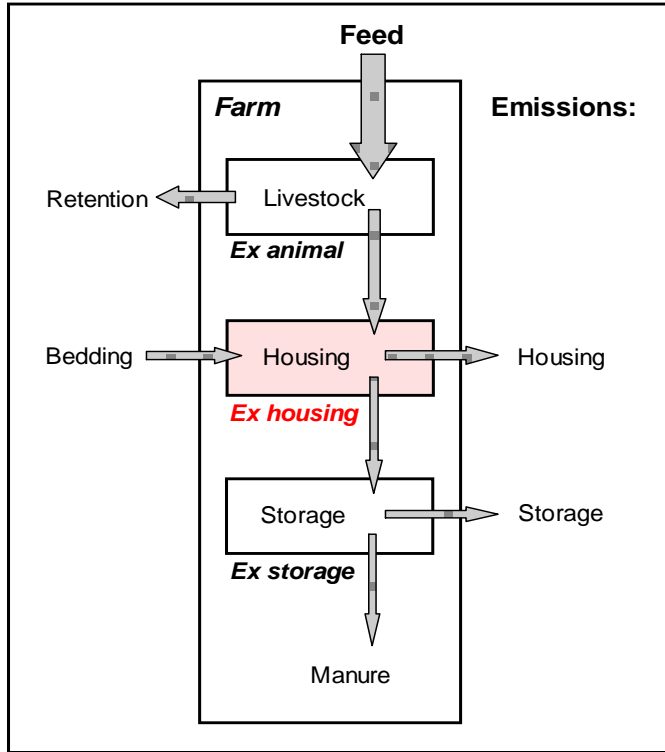


- For each species (and subclass) data for relevant housing systems

- Default values for N loss due to emissions are included based on TAN (total ammonia nitrogen).

- Contributions of nutrients from bedding materials are added.

- For each housing system the manure type is defined.

Nutrient flow = nutrient content (*ex animal*) – emissions + bedding

# EX STORAGE



- Losses of N (due to emissions of ammonia and denitrification) and dry matter are subtracted.

- Formation of ammonia

- Redistribution of nutrients due to leakage of juice from faeces etc.

- Rain

Nutrient flow = nutrient content (*ex housing*) – emissions

# MODEL OUTPUT

- Nitrogen (N, $NH_3$-N)
- Phosphorous (P)
- Potassium (K)
- Dry matter
- Volume

# MODEL OUTPUT

1 cow per year, heavy breed

| Preconditions : | | Ex animal, total excretion: | |
|---|---|---|---|
| Milk yield, kg milk/cow per year: | 7450 | Amount: | 17.7 tons |
| Milk protein, kg/cow per year: | 251 | N: | 128 kg |
| FU per cow per year: | 6030 | P: | 23.0 kg |
| Crude protein per FU: | 176 | K: | 100.0 kg |
| Digestible crude protein, g per FU: | 131 | | |
| Phosphorus, g per FU: | 5.1 | | |
| Feed efficiency, %: | 82 | | |

| Amount ex storage: Housing system | Manure type | Manure, t | Dry matter, percentage | Total content: | | | | Content per t manure | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Kg N | Kg NH$_4$-N | Kg P | Kg K | Kg N | Kg NH$_4$-N | Kg P | Kg K |
| Tie-up housing system with dung channel | Manure + liquid manure | 10.80 | 20.0 | 54.8 | 13.7 | 21.3 | 33.6 | 5.08 | 1.27 | 1.97 | 3.12 |
| | | 10.41 | 3.4 | 58.5 | 53.8 | 2.1 | 72.6 | 5.62 | 5.17 | 0.20 | 6.98 |
| Tie-up housing system with floor grating | Manure + liquid manure | 19.84 | 10.6 | 121.7 | 84.5 | 23.4 | 106.3 | 6.14 | 4.26 | 1.18 | 5.36 |
| Cubicles with solid floor | Slurry | 23.17 | 9.1 | 115.3 | 68.0 | 23.4 | 106.3 | 4.98 | 2.93 | 1.01 | 4.59 |
| Cubicles with slatted floor | Slurry | 23.17 | 9.1 | 121.7 | 73.9 | 23.4 | 106.3 | 5.25 | 3.19 | 1.01 | 4.59 |
| Deep litter (throughout area) | Deep litter | 15.62 | 30.0 | 128.5 | 32.1 | 26.5 | 158.6 | 8.23 | 2.06 | 1.69 | 10.15 |
| Deep litter, feeding area with slatted floor | Deep litter + slurry | 8.27 | 31.0 | 65.8 | 16.4 | 13.5 | 83.5 | 7.96 | 1.99 | 1.63 | 10.10 |
| | | 13.05 | 6.6 | 59.6 | 33.8 | 11.5 | 50.0 | 4.57 | 2.59 | 0.88 | 3.83 |
| Straw-bedded sloped floor | Deep litter | 14.71 | 24.0 | 108.4 | 27.1 | 24.2 | 120.9 | 7.37 | 1.84 | 1.65 | 8.22 |

# CORRECTION FOR OWN DATA

- **Corrrection for yield, dairy cow heavy breed, 146.4 kg N ex animal :**

- For each 100 kg ECM deviation from 10.120 kg EKM is 0.54 % of N and P excretion added/subtracted.


- 9.500 kg ECM ( -620 kg): 6.20 × 0.54 % = 3.35 %

- N excretion = 0.9654 × **146.4** = **141.5** kg N ex animal

# CORRECTION FOR OWN DATA

- **Correction for yield, feed intake and feed composition, dairy cow, heavy breed, 146.4 kg N ex animal :**
- Correction-factor for differences in yield, feed intake and feed composition:
- ((kg feed dry matter per cow per year × g crude protein per kg feed dry matter/6250) – (kg milk per cow per year × %protein in milk/638) – 1.73)/**146,41**
- (Standard: 7739 kg feed dry matter per cow per year; 163 g crude protein pr. kg feed dry matter; 10044 kg milk per cow per year; 3.41 % protein in milk

- 8000 kg feed dry matter per cow per year, 165 g crude protein per kg feed dry matter, milk yield 10000 kg mælk per cow per year, milk protein content 3.40 %
- Korrectionfactor = ((8000 × 165/6250) – (10000 × 3.40/638) – 1.73)/146.41 = 1.067
- N excretion = 1.067 × 146.4 = **156.2** kg N ex animal

# INTERNET

Website: http://anis.au.dk/forskning/sektioner/husdyrernaering-og-miljoe/normtal/

# EVALUATION OF THE DANISH SYSTEM

- A dynamic and flexible system based on updated and realistic default values and recent data from farms
- Detailed system with more than 150 categories (animals and housing systems)
- Each farmer should be able to identify his production
- Possibility to use correction factors to be used instead of default values
- Comprises N, P, K, dry matter and volume
- Adapted to Danish livestock production (very detailed)
- Needs to be updated regularly to be "realistic" and useful
- Every step in the calculations needs to be described and documented to keep the system reliable
- Volumes is currently provides as an extra service and needs to be updated in the current form (water addition during housing and storage)

# Thank you