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

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STANDARD VALUES FOR FARM MANURE

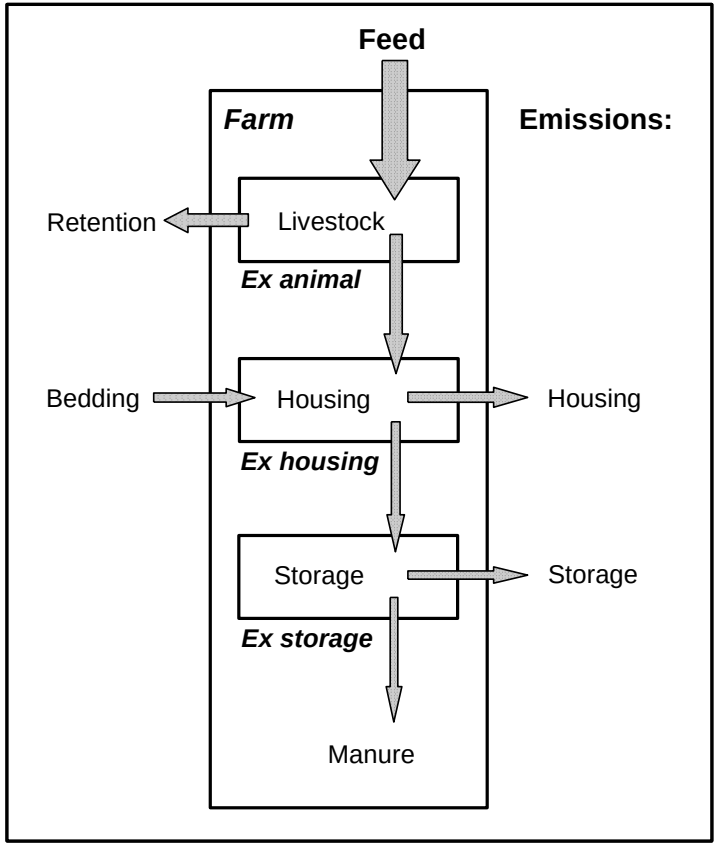
- Denmark has a long tradition for calculating standards for manure composition and content of nitrogen (N), phosphorus (P) and potassium (K).
- The first standards were very rough estimates, as the basis for the calculations was mainly theoretical.
- The complexity and dynamics of the system have increased 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


Feed
Farm
Emissions:
Retention
Livestock
Ex animal
Bedding
Housing
Housing
Ex housing
Storage
Storage
Ex storage
Manure

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	Piglet (7.1 – 31 kg)
Dairy cow, Jersey, per year	Slaughter pig (31-110 kg)
Heifer calf, heavy breed, 0-6 months	Sow (including 30 piglets to weaning)
Heifer calf, Jersey, 0-6 months	
Heifer, heavy breed, 6-27 months	Suckler cows, < 400 kg
Heifer, Jersey, 6-25 months	Suckler cows, 400-600 kg
Bull calf, heavy breed, 0-6 months	Suckler cows, > 600 kg
Bull calf, Jersey, 0-6 months	
Bull, heavy breed, 6 months to 440 kg	
Bull, Jersey, 6 months to 328 kg	

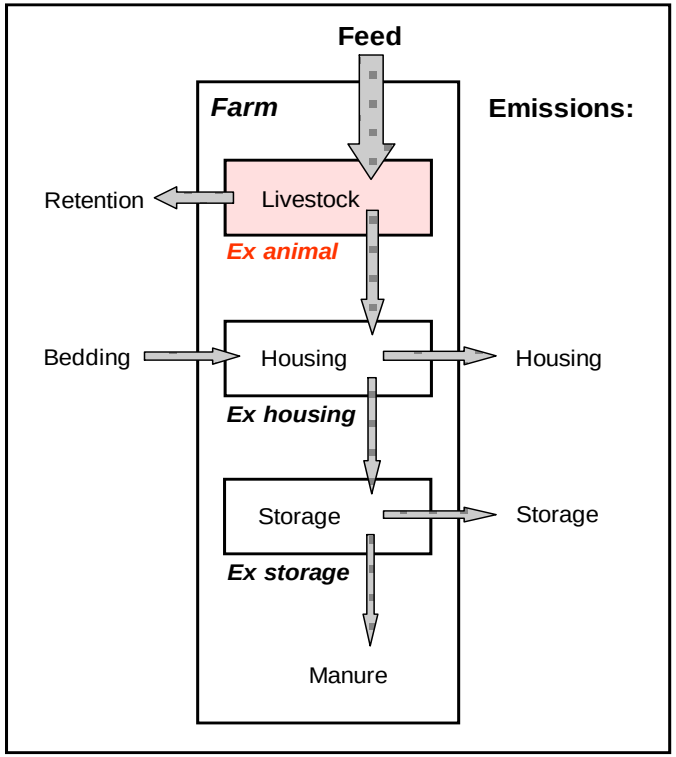
HOUSING SYSTEMS

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

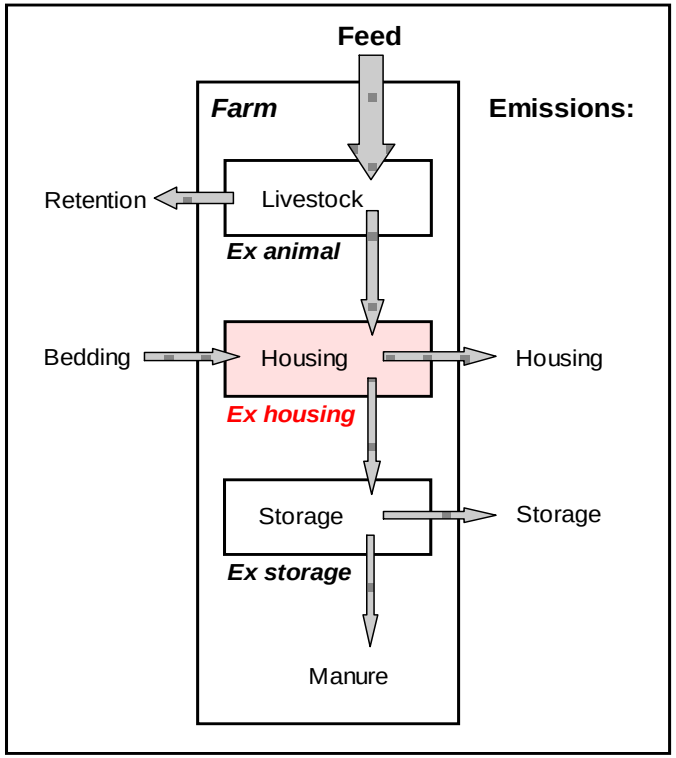
EX ANIMAL



- 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

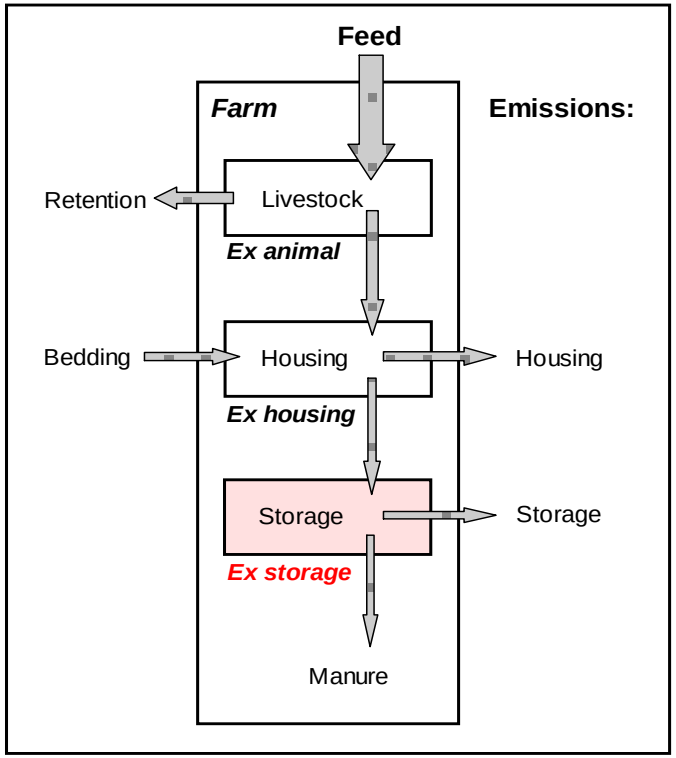
EX HOUSING



- 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 :

Milk yield, kg milk/cow per year:	7450
Milk protein, kg/cow per year:	251
FU per cow per year:	6030
Crude protein per FU:	176
Digestible crude protein, g per FU:	131
Phosphorus, g per FU:	5.1
Feed efficiency, %:	82

Ex animal, total excretion:

Amount:	17.7 tons
N:	128 kg
P:	23.0 kg
K:	100.0 kg

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 10.41	20.0 3.4	54.8 58.5	13.7 53.8	21.3 2.1	33.6 72.6	5.08 5.62	1.27 5.17	1.97 0.20	3.12 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 13.05	31.0 6.6	65.8 59.6	16.4 33.8	13.5 11.5	83.5 50.0	7.96 4.57	1.99 2.59	1.63 0.88	10.10 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