

## DISTRIBUTION OF NITROGEN, PHOSPHORUS, POTASSIUM AND CARBON BETWEEN MANURES IN FUNCTION OF BARN CATEGORIES

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Fate of nitrogen (N), phosphorus (P), potassium (K) and carbon (C) in agriculture is a major concern for fertility or environmental reasons. In Wallonia (Belgium), different types of barns for cattle are recognized (table 1) leading to production of 4 manure types (Pain and Menzi, 2011): slurry (SL), liquid fraction (LF), farm yard manure (FY) and semi-solid manure (SSM). Distributions of nutrients between manure types after their excretion at barn have to be known for example to estimate losses to the environment (ex: IPCC., 2006; Hutchings *et al.*, 2013)).

### Materials and Methods

Distribution between manure types for a given element x barn category was the mean of the distributions for the nine animal categories considered in the Nitrate directive. For a given element x barn system x animal category, the distribution was derived from the amount of the excreted element in the manure divided by the total element excretion. The total element excretion was the sums of the amounts of the element in the different manures. The amounts of the element in the different manures were calculated from the amount of the element remaining after manure storage to which a proportion is added due to losses at barn and storage: [Concentration (kg/t FM) x production (m<sup>3</sup>) x density (t/m<sup>3</sup>)]/[1-proportion of losses (g/g of excreted)] = Excreted.

The N, P, K and DM concentration in manures before application and volume productions (i.e. after storage) were taken from the nitrate directive and Piazzalunga *et al.*, 2012. One concentration of N per manure type was available, all animal categories included. Density of 0.7, 0.9, 1.0 and 1.0 t fresh manure/m<sup>3</sup> were used for respectively FY, SSM, SL and LF. Proportion of losses for N and P, K and C are in table 2. For FY, seeped liquid fraction during storage on field was considered as lost while for, SSM, it was not because of the obligation to keep it on store with seeped fraction collecting system. For C, the distribution was estimated as equal to OM distribution.

### Results and Discussion

The theoretical distributions of excreted elements are presented in table 3. Negative losses of OM and P relatively to their excretion were used for FY because of their lower losses compared to their supply with straw for bedding (table 2). No losses of P and K should normally occur in SSM storage systems with collection of seepage. However, the values used reflect more the reality than the theoretically null losses values used for SL and LF. Furthermore, intermediate results are the estimations of excreted N by the nine animal categories in the different barn systems. They show high variation (mean of the variation coefficient: 14%) probably reflecting the unaccounted variability of elements concentrations in link to the different manure types by using the few recognized generic values.

Table 1: Barn types (Nitrate directive: AGW, 2013; Nitrawal, 2013).

1. Cubicle house with and without bedding supply
2. With slatted floor or without bedding supply
3. Deep litter or fully covered by bedding with partial manure removal by scrapping at low frequency (>5 days)
4. Tied stall with bedding supply
5. Cubicle house with bedding supply
6. Fully covered by bedding with partial manure removal by scrapping at low frequency (< 5 days)
7. Cubicle house with partial bedding supply
8. Partially covered by bedding

Table 2: Coefficients used for the estimation of the excretion (g/kg excreted).

Manure	Proportion of losses				Straw supply			
	N	OM <sup>a</sup>	P	K	DM <sup>b</sup>	N	P	K
FY <sup>c</sup>	312	-191	-215	150	1690	168	215	229
SSM <sup>c</sup>	214	105	21	89	185	21	31	18
SL <sup>d,e,f</sup>	410	100	0	0	0	0	0	0
LF <sup>d,e,f</sup>	410	100	0	0	0	0	0	0

<sup>a</sup>OM: organic matter = DM<sup>b</sup>-ash; <sup>b</sup>DM =Dry matter; Source: <sup>c</sup> Mathot *et al.*, 2011, <sup>d</sup> Lambert *et al.*, 2006; <sup>e</sup>Vredenne *et al.*, 2008; <sup>f</sup>IPCC 2006.

Table 3: Theoretical distribution (g/kg excreted) of the elements (C, N, P, K) in manure type (1 to 8 see table 1) at release by animal (mean (standard deviation) of the nine animal categories).

Element	Manure	Barn category							
		1	2	3	4	5	6	7	8
C	FY			1000 (0)			452 (45)		523 (37)
	SSM	577 (36)			948 (2)	963 (3)	507 (43)	577 (41)	
	SL	423 (36)	1000 (0)					423 (41)	477 (37)
	LF				52 (2)	37 (3)	41 (3)		
N	FY			1000 (0)			412 (45)		413 (39)
	SSM	496 (40)			917 (3)	941 (5)	519 (40)	496 (40)	
	SL	504 (40)	1000 (0)					504 (40)	587 (39)
	LF				83 (3)	59 (5)	69 (5)		
P	FY			1000 (0)			411 (45)		386 (38)
	SSM	500 (40)			1000 (0)	1000 (0)	589 (45)	500 (40)	
	SL	500 (40)	1000 (0)					500 (40)	614 (38)
	LF								
K	FY			1000 (0)			505 (45)		610 (37)
	SSM	573 (39)			846 (6)	887 (9)	390 (36)	573 (39)	
	SL	427 (39)	1000 (0)					427 (39)	390 (37)
	LF				154 (6)	113 (9)	104 (9)		

## Conclusions

Even if aware of the limits of the approach, it is proposed, to use those distributions to help in modelling the fate of element in manure like as recommended by IPCC methodology.

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