FATE OF NUTRIENTS IN EU AGRICULTURE- ENVIRONMENTAL AND ECONOMIC IMPACTS

by

Winfried E.H. Blum

Institute of Soil Research, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

E-mail: winfried.blum@boku.ac.at

NÄHRSTOFFVERLUSTE IN DER EUROPÄISCHEN LANDWIRTSCHAFT – ÖKOLOGISCHE UND ÖKONOMISCHE FOLGEWIRKUNGEN

von

Winfried E.H. Blum

Institut für Bodenforschung , Universität für Bodenkultur, Wien/Austria

E-mail: winfried.blum@boku.ac.at

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This report informs that only about 20% of all N and about 30% of all P used in European agriculture reach the final consumers. 80% of N and 70% of P are lost as solid waste, sewage and leakage to soil, air and water.

(van Dijk et al 2016)

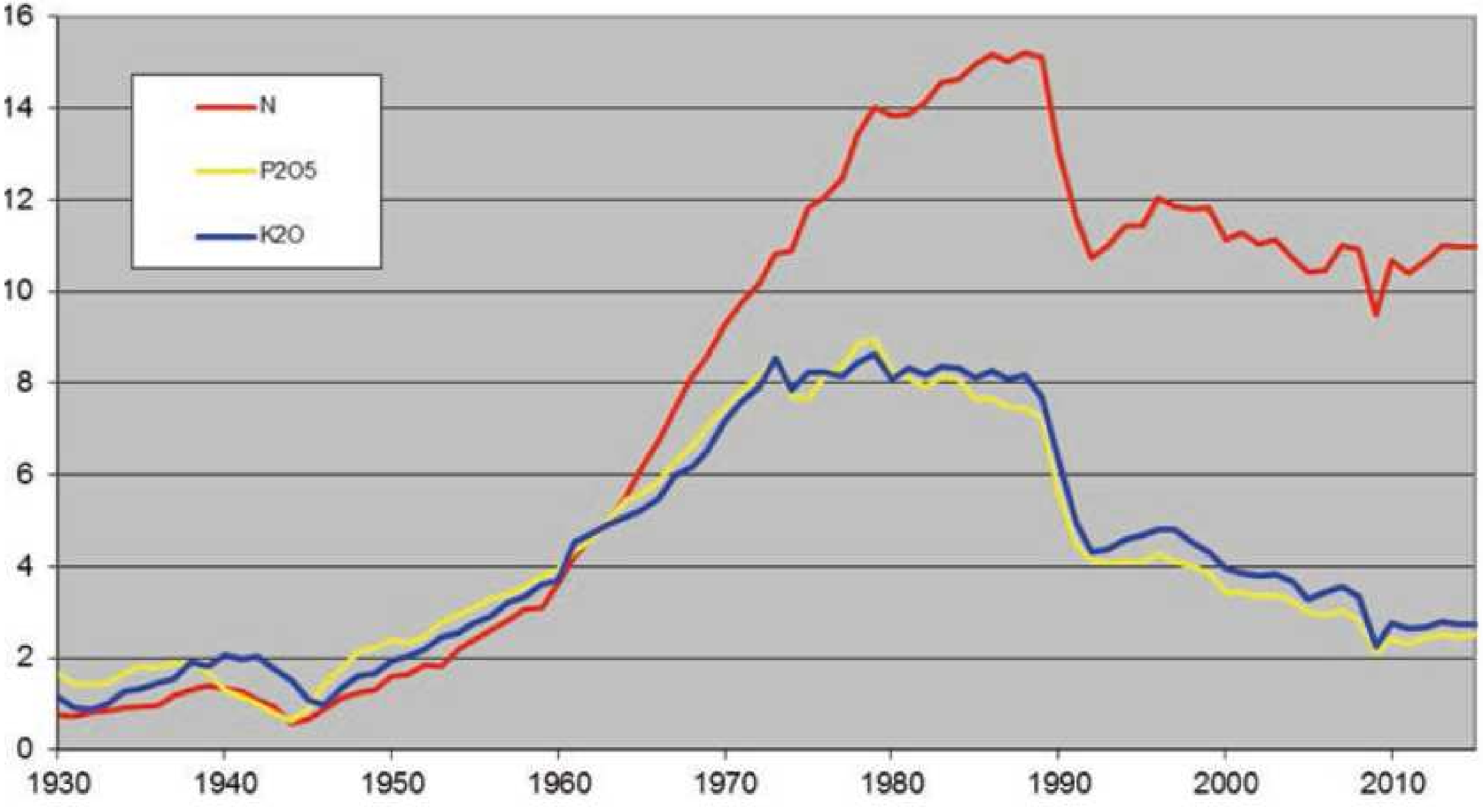
TABLE 3. ***Gross annual nutrient inputs to the EU27 agricultural system and main output routes (years 2000, 2004, 2005)***

Nutrient fluxes in the European agricultural system	**Nitrogen** (2000 & 2004)		**Phosphorus** (2005)	
	Mt/yr	%	Mt/yr	%
Nutrient inputs				
Mineral fertiliser	10.9	65	1.4	78
Imported feed	2.7	18	0.4	22
Other sources (N fixation, atm. deposition, soil)[a]	3.1	17	?	?
Total nutrient inputs[b]	16.7	100	>1.8	100
Nutrient destinations				
Food consumers	2-3		0.5	
Other uses	1-2			
Solid waste and sewage system[c]	2-5		0.7	
Leakage to water, air and soil	11-12		1.3	
Consumer intake as % of total inputs		**~20**		**~30**

(All percentages are relative to net inputs. Source: based on data from Leip et al 2014, Sutton et al 2011 and van Dijk et al 2016)

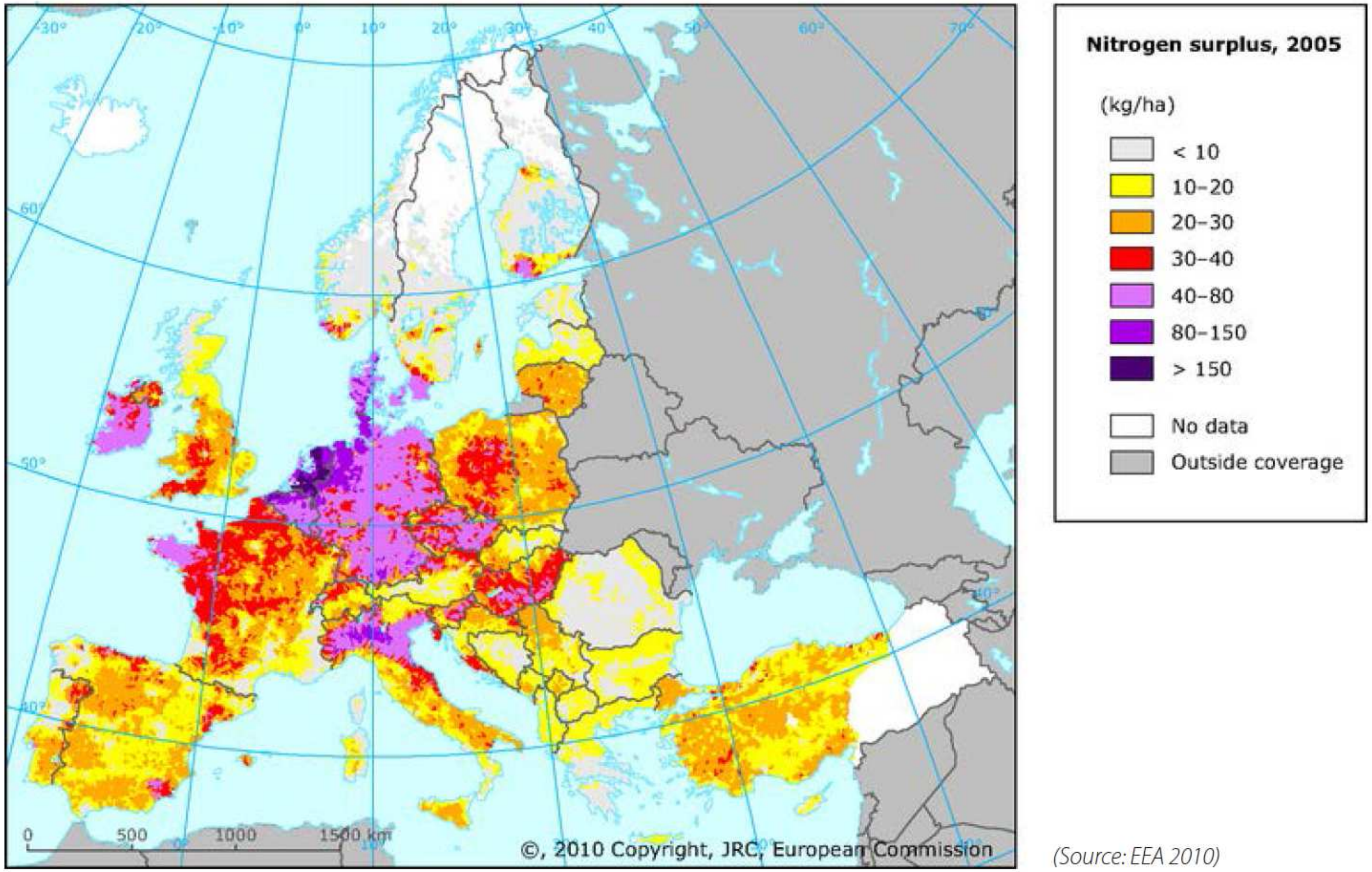
(a) *P inputs from atmospheric deposition are estimated at 0.005 Mt/yr but plant uptake from soil P remains largely unknown (represented by question marks).*
(b) *Inputs from manure are not counted as input since they represent an internal recirculation flux. For reference, manure inputs to cropland amount to 7.2 Mt N/yr and 1.7 Mt P/yr (Leip et al 2014, van Dijk et al 2016).*
(c) *These include also inputs to the food and non-food systems outside of the agricultural system (e.g. import of non food products).*
(d) *We use NUEN to describe nitrogen use efficiency and NUEP for phosphorus use efficiency.*

FIGURE 5. ***Evolution of EU27 mineral fertiliser consumption between 1930- 2015 in Mt of nutrients***



(Source: Fertilizers Europe 2015. Note that P fertilizer is expressed as P_2O_5)

FIGURE 9. ***Nitrogen surplus per hectare in agricultural land in the EU27 in 2005***



(Source: EEA 2010)

In EU agriculture N pollution of soil, air and water, causes annually economic losses of 70-320 billion Euros. The annual N leakage into the environment has a fertilizer value of about 20 billion Euros. Moreover, EU agriculture is responsible for about 80% of all reactive N emissions, e.g. N_2O, NO_x and others.

TABLE 4. Gross fluxes of nutrients in waste streams (in Mt, million tons per year) for the EU27

Sources	Raw/wet mass (Mt)	Dry matter (%)	N (Mt)	P (Mt)	C (Mt)
Raw manure	1400[a]	15%[b]	7-9[c]	1.8[d]	130-146[e]
Food chain waste[f]	120-160[g]	25%	> 0.5-0.7[h]	> 0.5[i]	> 9.9[h]
Sewage sludge	9.5[j]	25-50%	2.3-3.1[k]	0.3[l]	1.9-3.8[m]
Total of these three flows			11.6-12.6	2.6	140-160

[a] *From Foged et al 2011.*
[b] *From Gendebien et al 2001*
[c] *Excreted by EU livestock (Leip et al 2014, Velthof et al 2015).*
[d] *Takes into account input to agricultural soils (1.75) and losses from stables (0.062) (van Dijk et al 2016).*
[e] *This is estimated considering that 80-90% of the dry mass is organic matter and using the 1.72 factor to convert organic matter into organic carbon.*
[f] *Includes the organic waste in household waste and waste from food industry.*
[g] *Eurostat and Gendebien et al 2001.*
[h] *Using a 2-3% N and 45% C in dry matter in household waste.*
[i] *It includes waste from food industry, food processing and household solid waste (van Dijk et al 2016).*
[j] *9.5 Mt of dry sludge could roughly translate into 9500 Mt of raw sewage water assuming 0.1% solids.*
[k] *Nitrogen in sewage from consumers/households (Sutton et al 2011 and Leip et al 2014).*
[l] *Includes P in centralised and decentralised sewage sludge (van Dijk et al 2016).*
[m] *Assuming 20-40% organic carbon in dry sludge.*

FIGURE 10. Total nutrient leakage in the EU27 from agriculture and the food chain

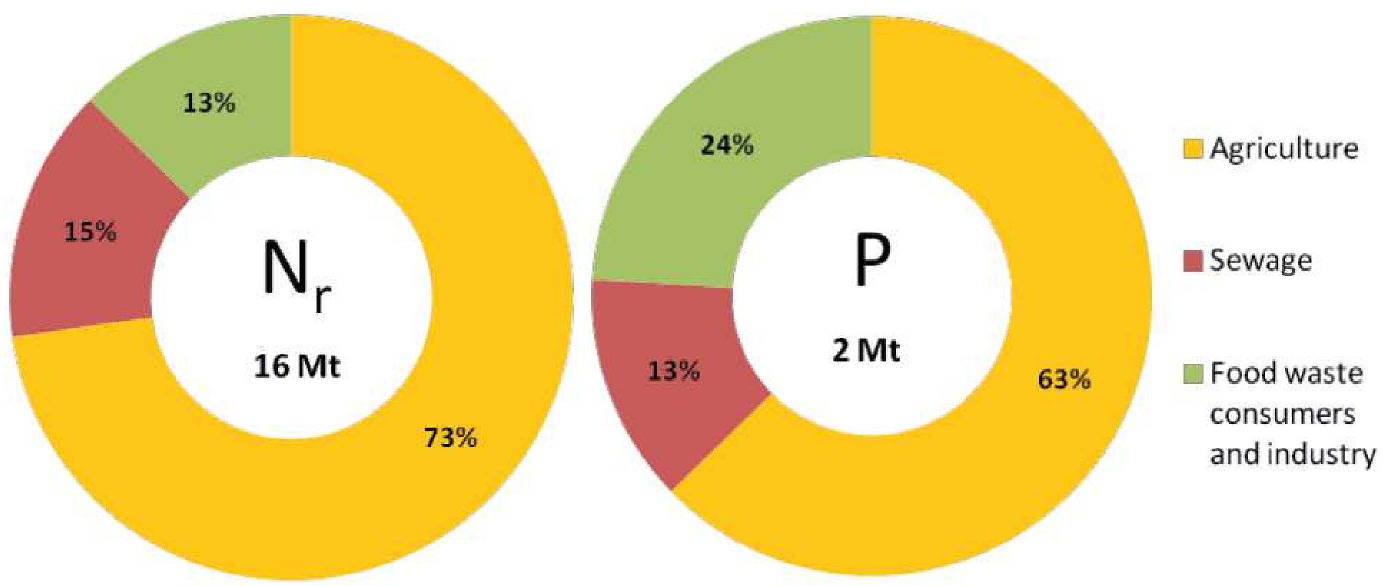
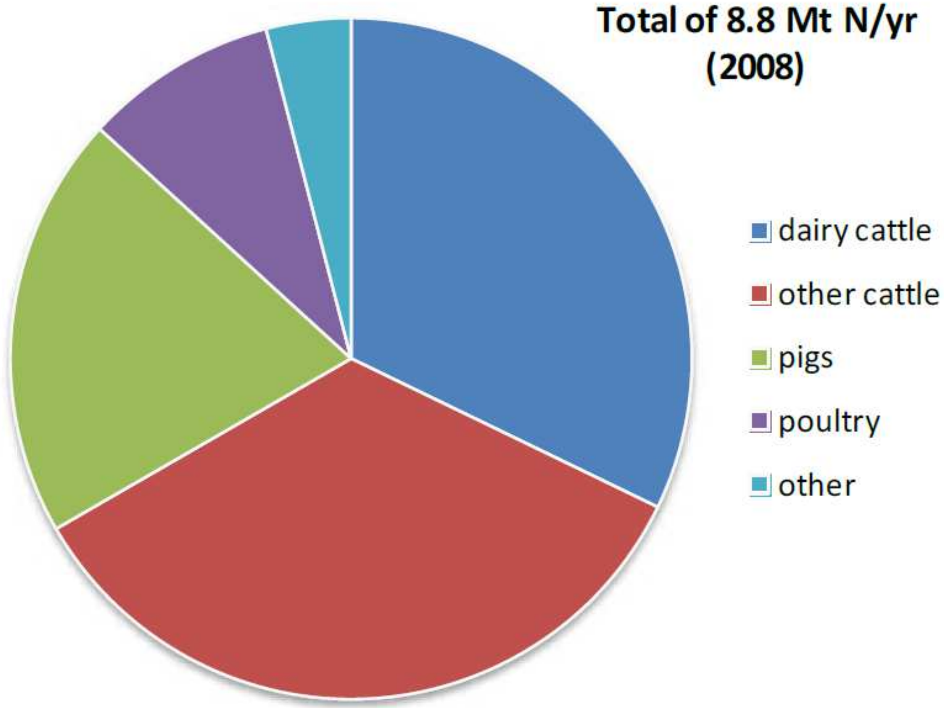


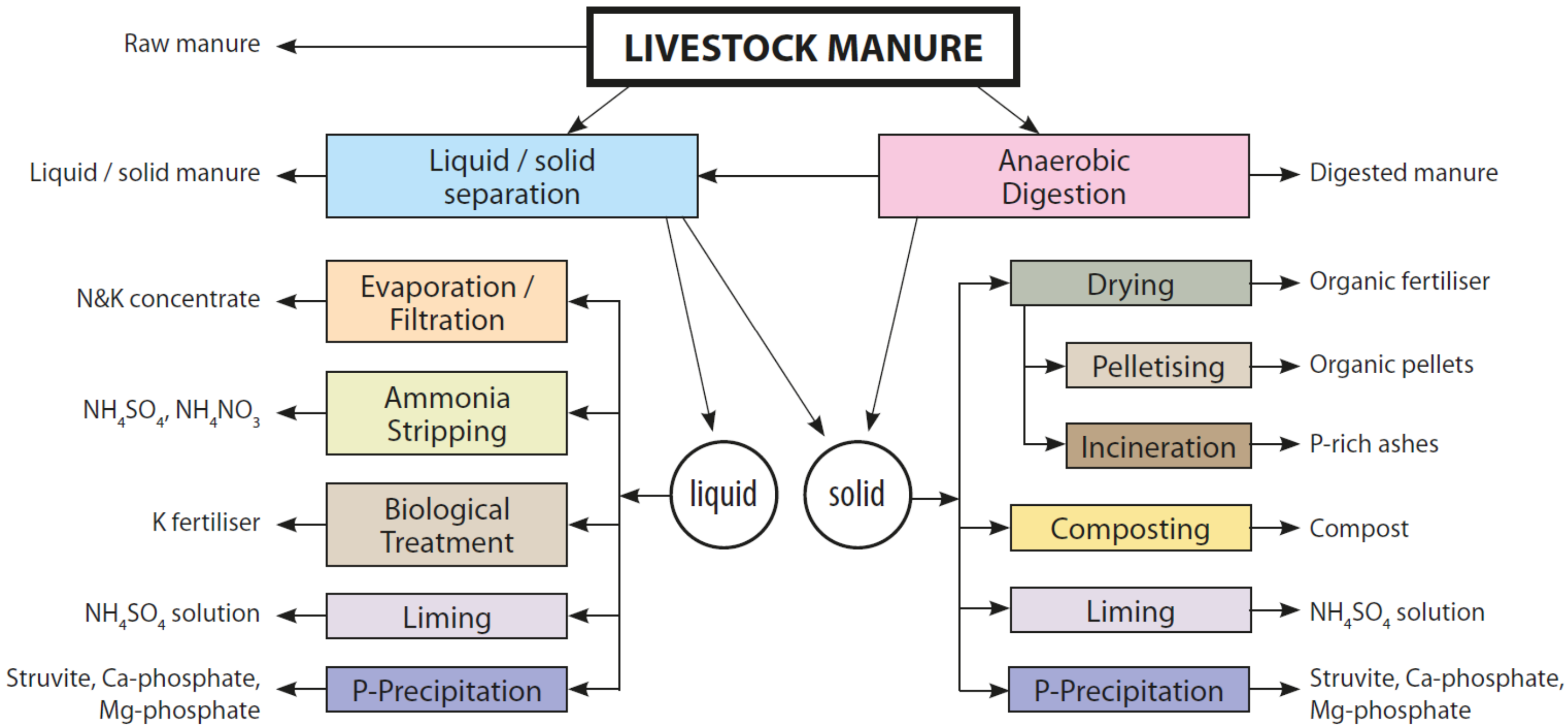
FIGURE 12. Nitrogen excretion[58] by farm animals in the EU27

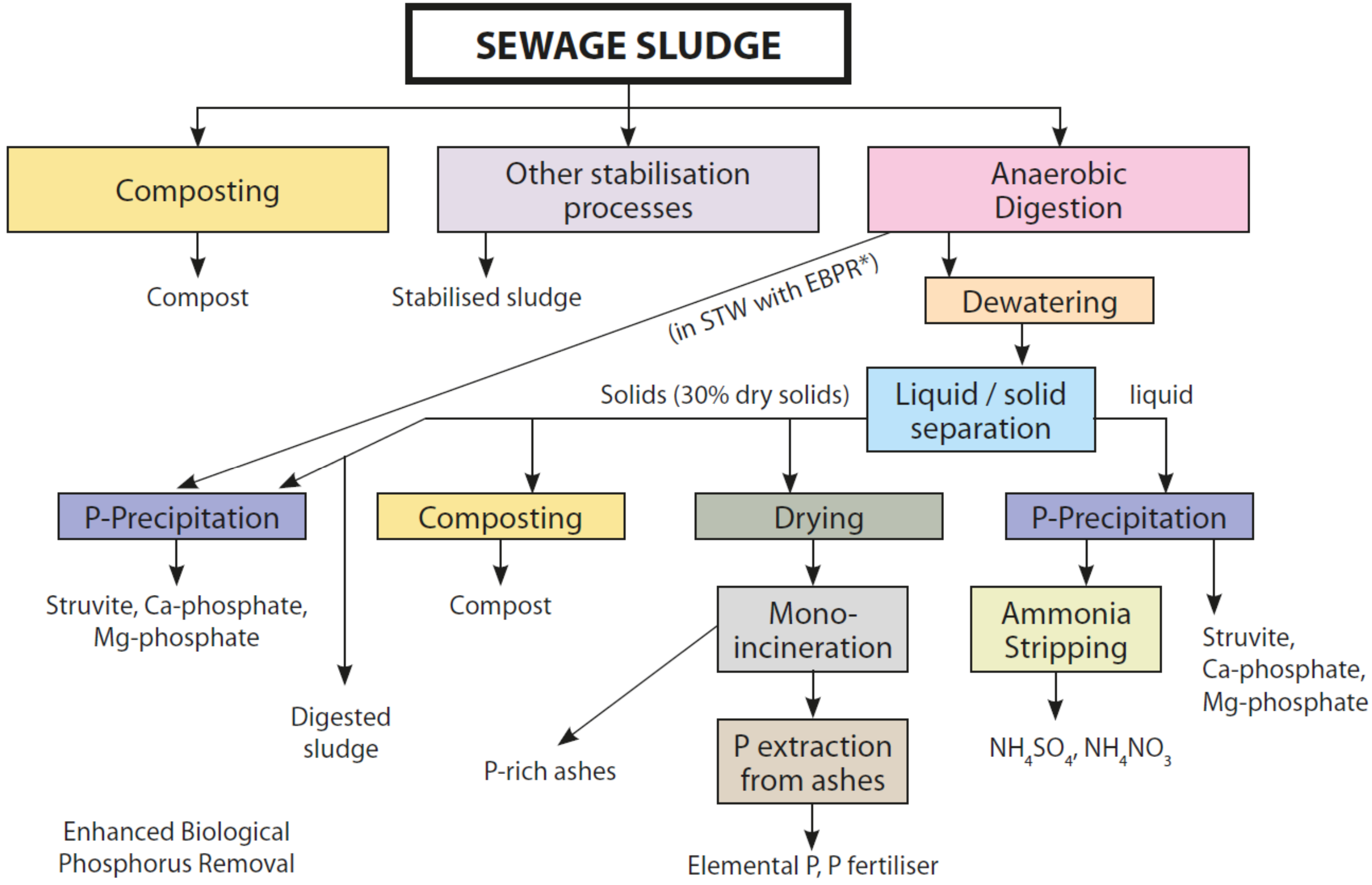


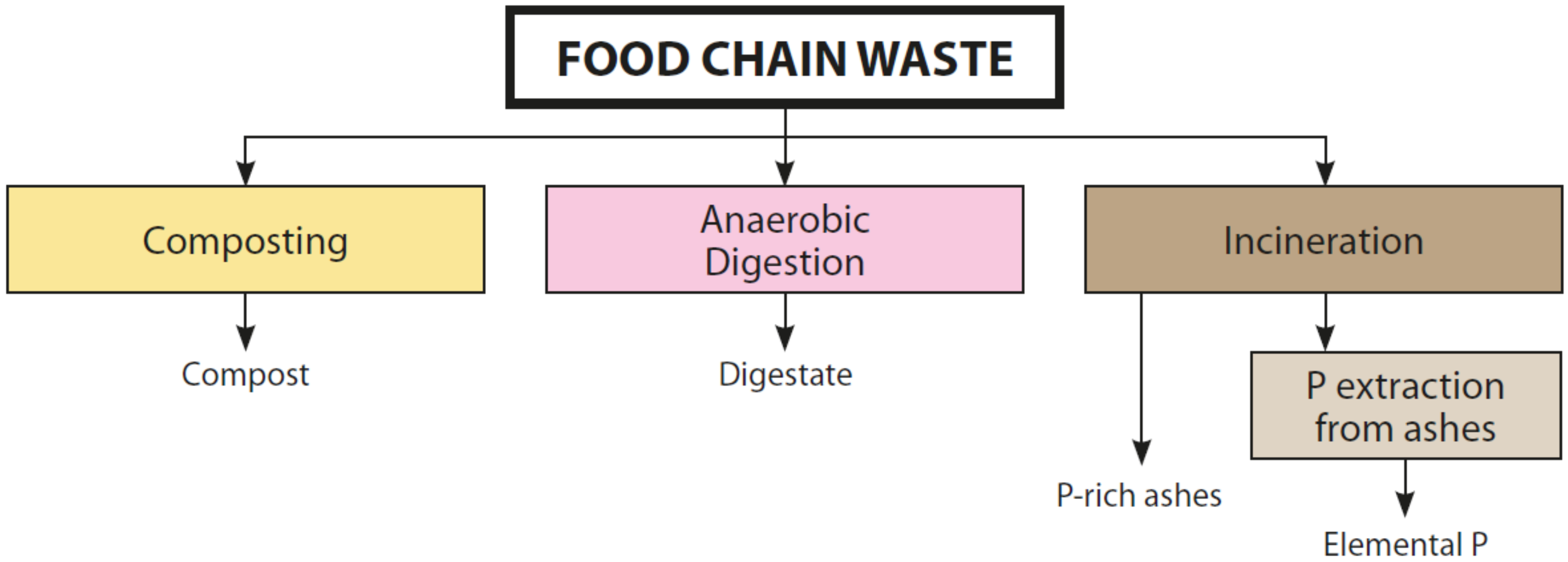
(Source: adapted from Velthof et al *2010)*

The nutrient use efficiency (NUE) in crop production, due to advances in crop genetics and fertilizer application methods, is relatively good (53% for N and 70% for P), but the NUE in livestock production is extremely low (18% for N and 29% for P), with extreme leakages to air, water and soil, causing negative impacts on human health and the environment.

FIGURE 11. Overview of the main routes for nutrient recovery and reuse and the products obtained




SEWAGE SLUDGE
Composting
Other stabilisation processes
Anaerobic Digestion
Compost
Stabilised sludge
(in STW with EBPR*)
Dewatering
Solids (30% dry solids)
Liquid / solid separation
liquid
P-Precipitation
Composting
Drying
P-Precipitation
Struvite, Ca-phosphate, Mg-phosphate
Compost
Mono-incineration
Ammonia Stripping
Struvite, Ca-phosphate, Mg-phosphate
Digested sludge
P-rich ashes
P extraction from ashes
NH_4SO_4, NH_4NO_3
Elemental P, P fertiliser
Enhanced Biological Phosphorus Removal



(Source: Own figure with input from Vlaams Coördinatiecentrum Mestverwerking (VCM) and C. Kabbe (P-REX).
For a description of the processes see Table A1 in Annex II and sections 4.2-4.4).

Summary and Outlook

1. In European agriculture about 80% of N and 70% of P are dissipated into the environment, causing severe ecological and economic impacts.
2. While in crop production the nutrient use efficiency is relatively high, the use of nutrients in livestock production is extremely inefficient.
3. Nutrient recovery and reuse are most important because of
   - environmental impacts through uncontrolled nutrient dissipation;
   - depletion of finite resources like P and natural gas (for N_2 sequestration);
   - environmental impacts through mining, processing and transport of fertilizers;
   - necessary reduction of the reliance on imported P and natural gas.

4. There is enough knowledge available for improving nutrient recovery and reuse for increasing nutrient use efficiency in the near future.

THANK YOU

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