JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Nutrition and Nutrient Balance Concepts and Measurement of Nutrient Flows in Food Systems

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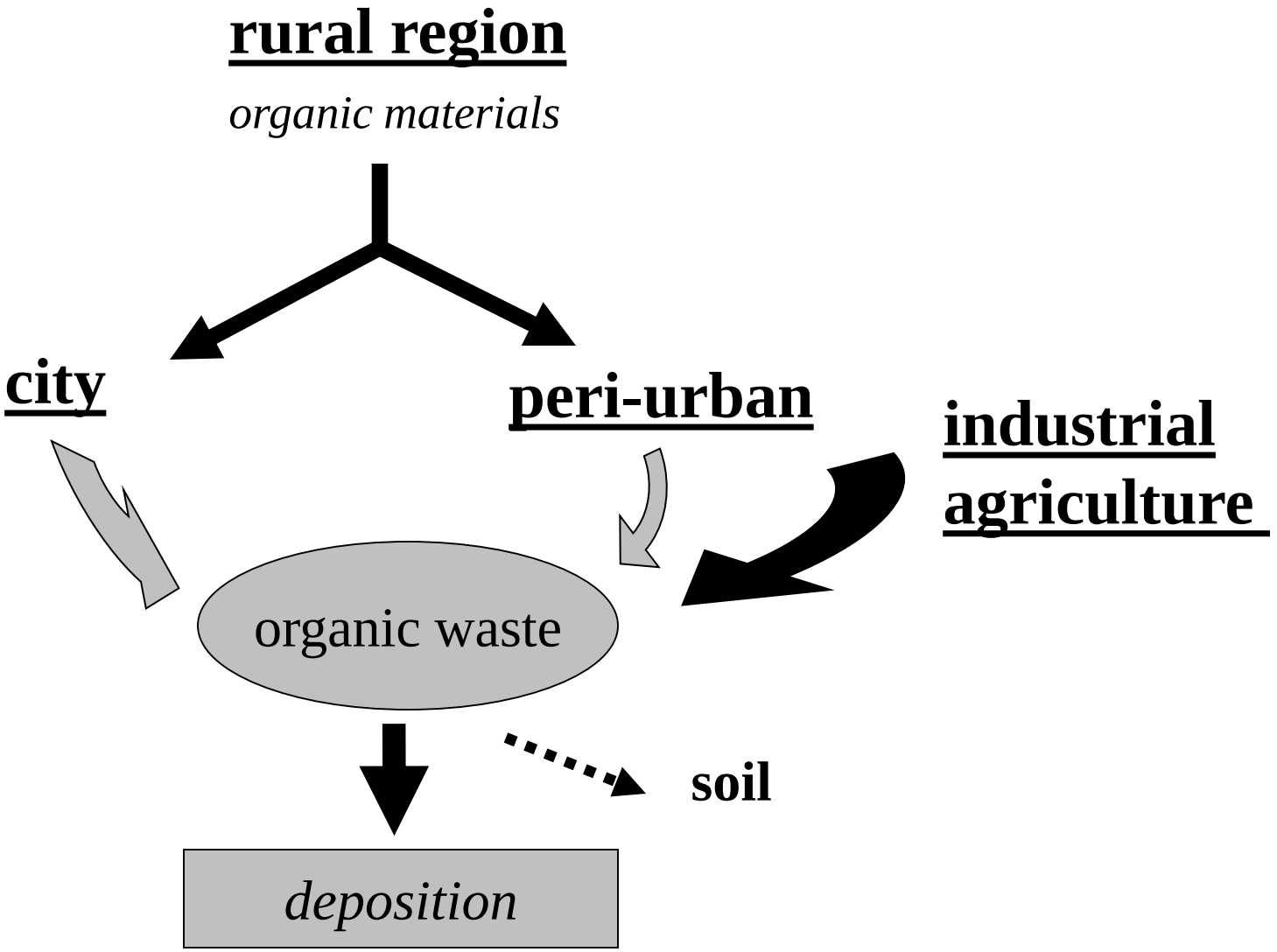
Motivation:

- Nutrient losses imply economic losses:
  $\Rightarrow$ add value added to nutrients

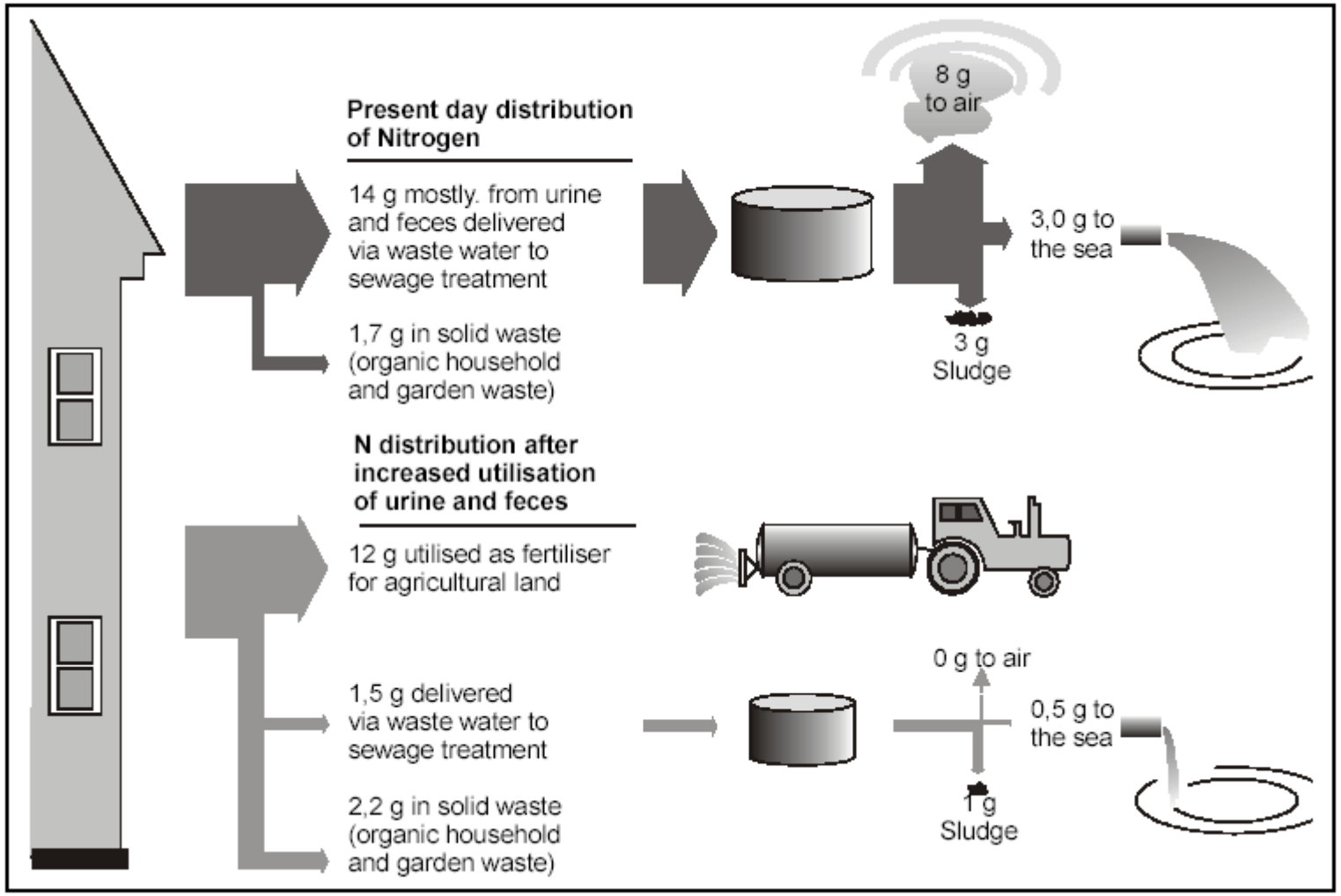
- Nutrient losses, if they are dumped, create ecological disasters
  $\Rightarrow$ recycle and minimize dumping

- Nutrient losses from human and animal waste create health problems
  $\Rightarrow$ create social awareness

Rural urban nutrient Flow without Recycling:



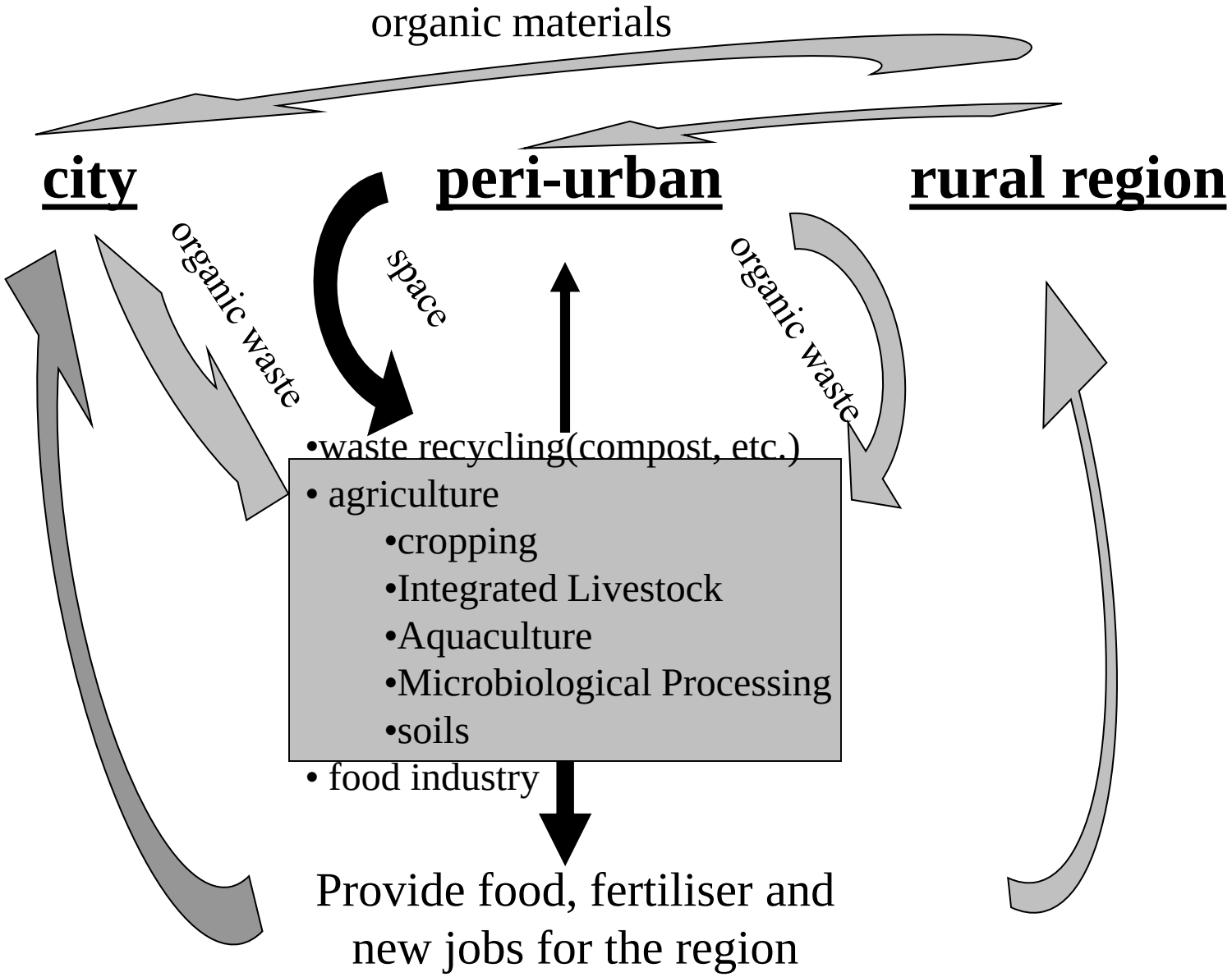
Background: Nutrient Affluence, Waste, and Potential



Overview of the findings on present day and future urban fertilisers (based on Magid et al. 1998)

Cities today:	**sewage:**	**rich in P, poor in N,K,S**
		unknown xenobiotics and heavy metals
		hygienic risk
	composted waste	**contaminated**
		unknown fertiliser effects
	industrial waste	**potential K and S in ashes**
Cities' future	**sewage**	**controlled and fortified by N**
		separated
	urine	**stored and processed in biogas plants & fermentation**
	composted faeces	**handled in septic systems**
	household organics	**new installation and mixed with animal wastes**
	industrial waste	**controlled**

Rural urban nutrient Flow with Recycling:



What is recycling? It can be done very differently!

Nutrient Balance for Bangkok (t per year: Source Magid)

Inflow	Nitrogen	Phosphorus
Food Supply	19,445	2,918
Fertiliser	2,064	564
Feed	2,238	443
Decomposition	4,695	-
Food Production	1,995	306
Total Inflow	16,447	3,619
Outflow		
Waste	- 1,423	-277
Chao Phraya River	-24,200	-1,490
Total Outflow	-25,623	-1,767
Balance (Recovered)	824	1,852

Background:

From Liebig's book Agricultural Chemistry:

The introduction of water-closets into most parts of England results in the loss annually of the materials capable of producing food for three and a half million people; the greater part of the enormous quantity of manure imported into England being regularly conveyed to the sea by the rivers ...like a vampire it hangs upon the breast of Europe, and even the world; sucking its life-blood.

Benefits of a Study on Nutrient Recycling and Policy Relevance

- ☺ **Indicative regional planning on land use**
- ☺ **Policy tools for redirection of resource use**
  - ☺ **waste taxing**
  - ☺ **charges on energy throughput**
- ☺ **New technologies on waste processing**
  - ☺ **pilot studies**
  - ☺ **appropriate treatment facilities**
- ☺ **Sustaining peri-urban functions**
  - ☺ **fresh water**
  - ☺ **reduced deposition of waste**
  - ☺ **improved food availability**
  - ☺ **agricultural incomes**
  - ☺ **employment**
- ☺ **Less pollution**
- ☺ **Less external burdens (in the bay)**
- ☺ **Less vulnerable groups**

➢ **sustained city growth**

Thoughs and Concepts:

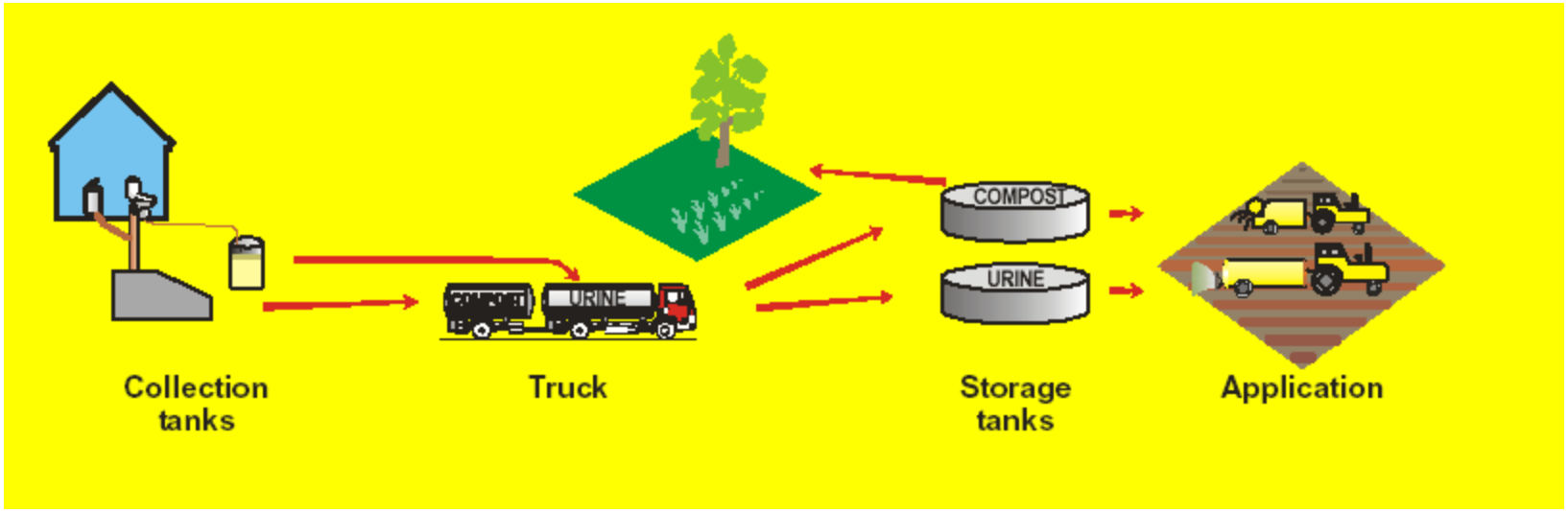
“Cities are metabolising and growing organisms in the global landscape.

A fundamental and simple prerequisite for sustainable development is that cities of the future must control their metabolisms to an extent where recycling of waste products is near complete.

In the industrialised world, waste management systems have originally been designed to ensure a high local hygienic standard and has been developed to maturity without primary concern for recycling.”

Jakob Magid: Betrebos conference Sweden 2003

Urine separation and dry composting of faeces and household waste



Current Household Waste Production pr. person / yr in Europe as an industrialised modern

Total volume (including water for bathing and washing):

57.00 m^3

of which is

Urine: 0.45 m^3

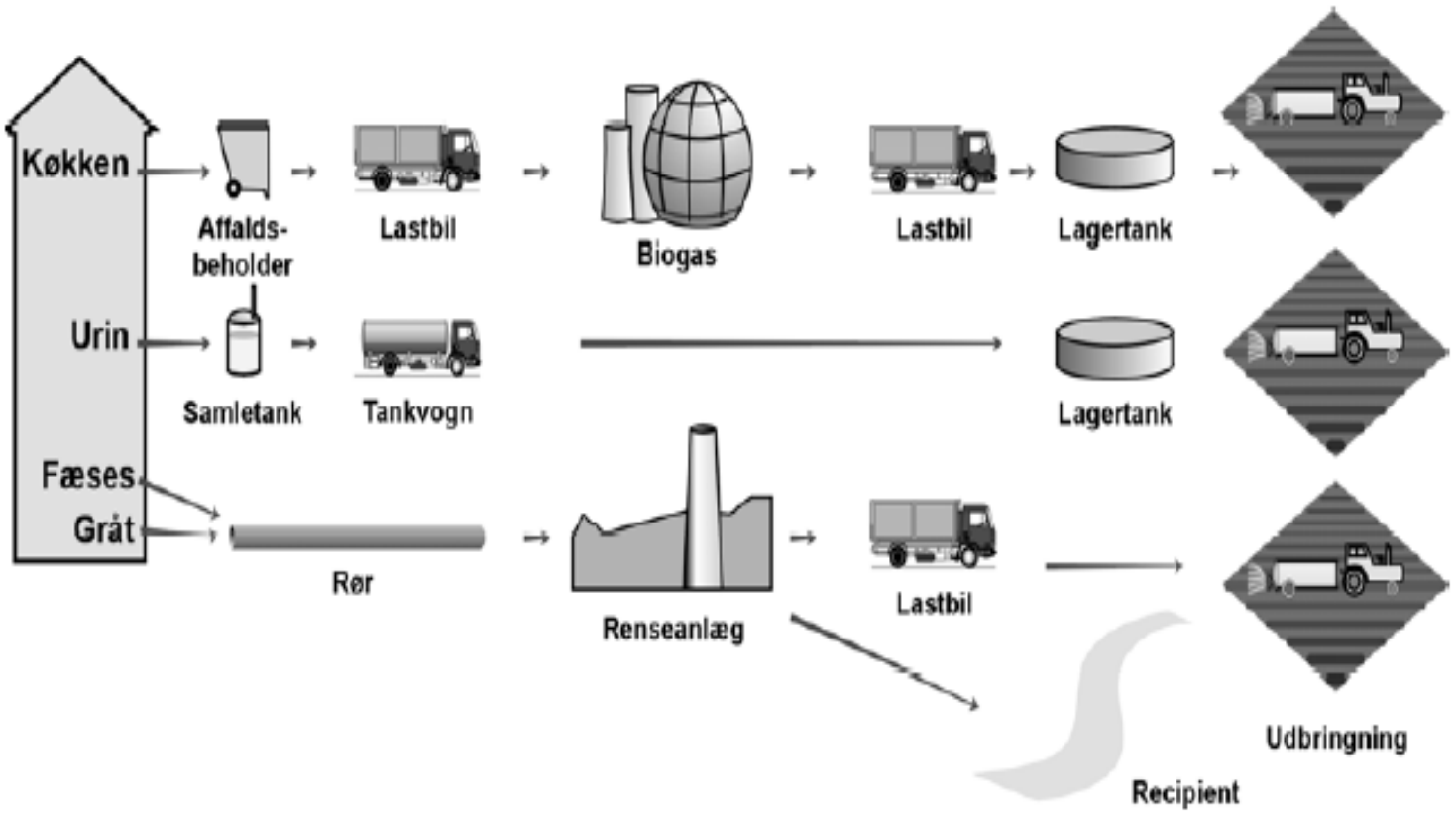
Faeces: 0.06 m^3

Organic household waste: 0.16 m^3

Thus: 85-90 % of the nutrients and much of the organic matter, is contained in less than 1.5% of the waste volume

The disposal of this waste is estimated at an annual cost of ca. 50 Euros pr. European citizen

Creating a three tire system



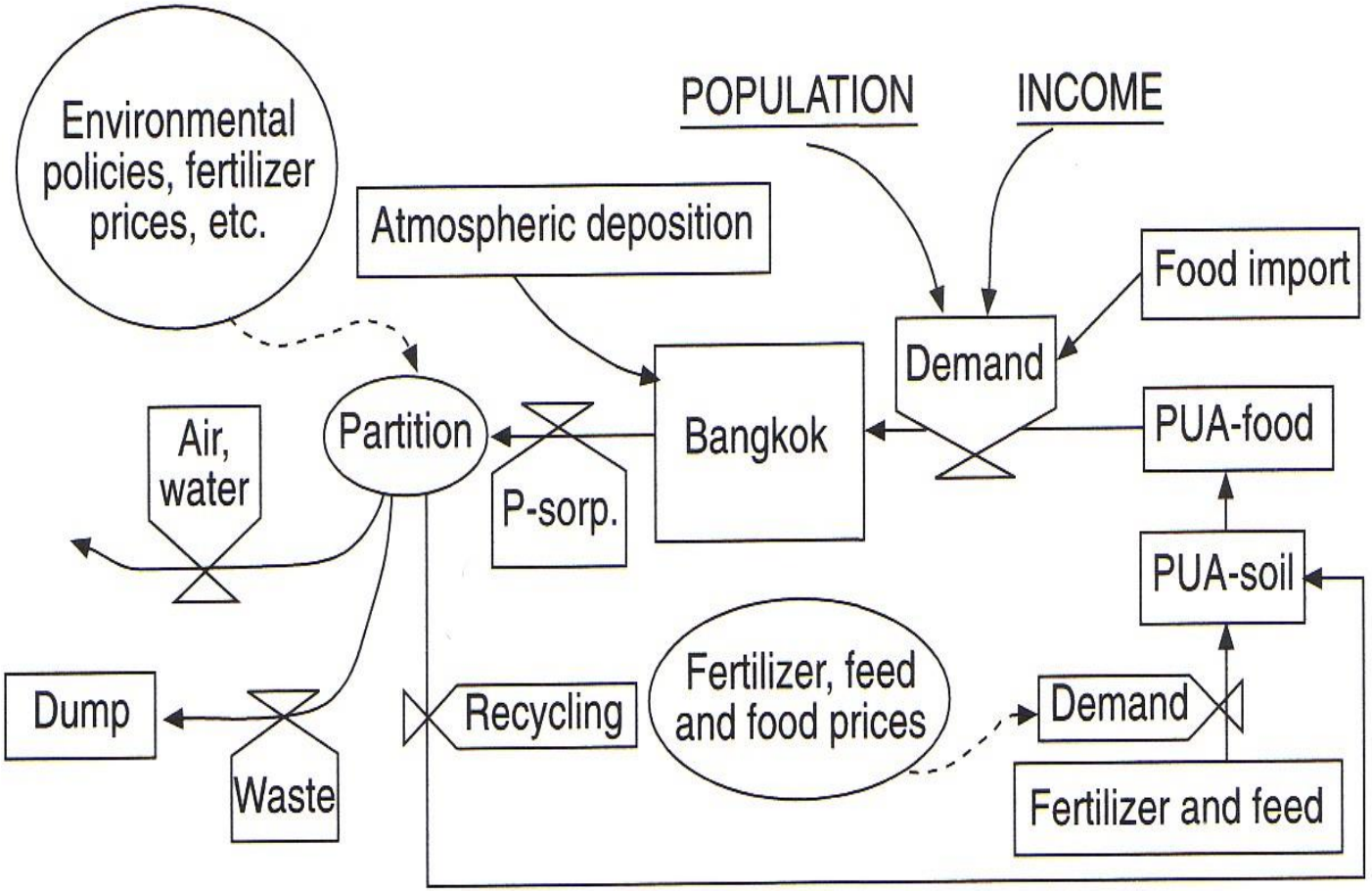
Risk Assessment in Denmark according to J. Magid:

Fecal contamination and microbial die-off was studied for a 6-months period in tanks containing urine collected from urine separating toilet systems, including family-based and public separating toilets (urban ecology demonstration projects).

E. coli was found only in a few samples in low numbers in the first month of study, whereas *Salmonella* and *Campylobacter* spp. were not found in any sample. The initial concentrations of fecal enterococci varied, but were usually around 105-106/ml with a rapid reduction to below the detection limit (<10/ml) following 3 to 4 months of storage.

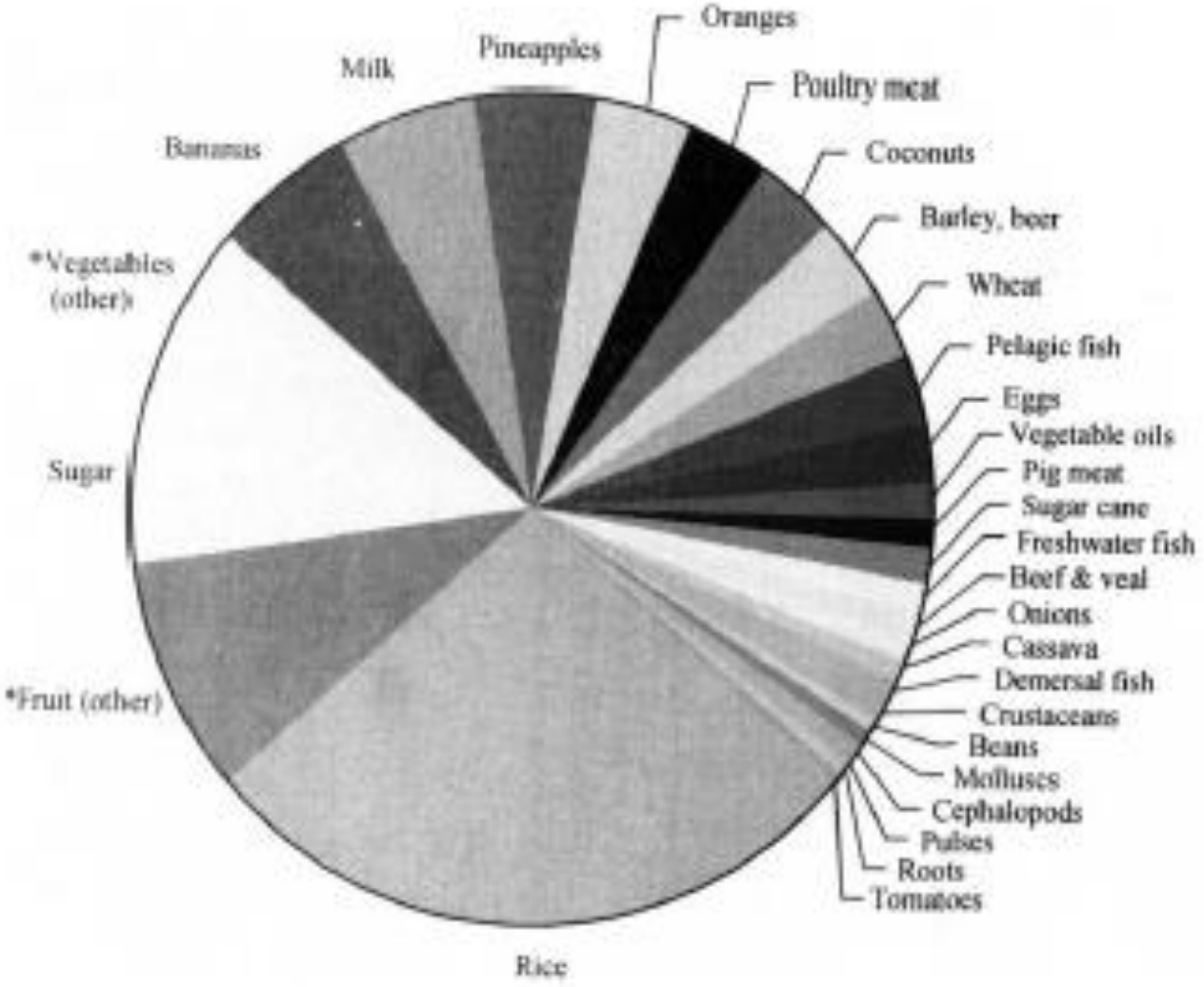
The protozoan parasites, *Cryptosporidia* and *Giardia*, were found in a few samples.

Conceptual outline for Bangkok in 1996



Food supply to Bangkok in 1996

The total amount of food is 2 689 600 t, of which rice contributes 707 400 t, fruit (other) 238 600 t, sugar 193 700 t, vegetables (other) 162 100 t, bananas 150 800 t, etc. The figure indicates 97% of the total food supply. (*) Vegetables (other) and fruits (other) are, vegetables and fruit not mentioned in the diagram.



NRF currently and if a Masterplan for sewerage (AIT, 1995) was implemented and extrapolated to all households in Bangkok[a]

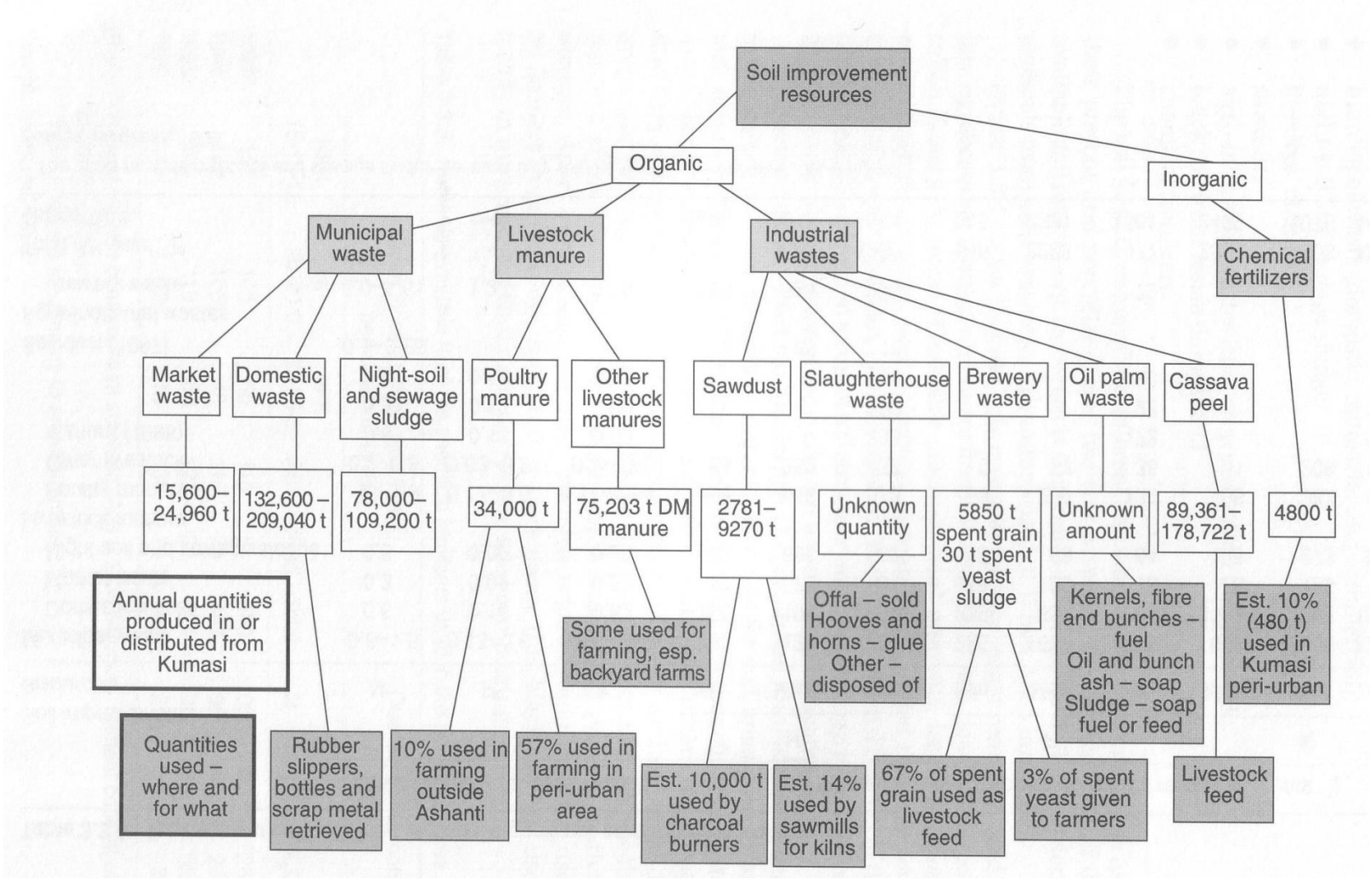
	N recovery (%)	P recovery (%)	kg N/ha/yr	kg P/ha/yr
Current situation	7	10	42	8
Masterplan	11	18	64	16
All households	17	33	99	28

a In addition amount per hectare of N and P if the waste was recycled to Bangkok soils. NRF is calculated as the ratio of nutrients in waste of the amount of nutrients in the total food supply

What happened?

Example of Nutrient Flow Analysis from Kumasi/Ghana:

Turning Urban Waste in Fertiliser (Nasiah-Gyabath and Adam)



Manure Produced in Dar es Salam in t

Kiango and Amend: Dar es Salaam: Linking PUA and Organic Waste Management

	Animal population	Amount of manure year^{-1}	Average NPK content t^{-1}	Average NPK content total
Cattle	34,000	100,000–170,000 t	0.5% N	500–850 t N
			0.5% P	500–850 t P
			1% K	1,000–1,700 t K
Chicken	6,500,000	91,250 t	2% N	1,825 t N
			2% P	1,825 t P
			1% K	912 t K
Goats	12,000	2,400 t	0.5% N	12 t N
			0.5% P	12 t P
			1% K	24 t K

Additional Questions:

- Who owns the nutrients to be recycled?
- How can we create a market?
- How can livestock waste be combined with human waste?
- What is the needed infrastructure
- Do we need participation in planning or can a central authority do planning, implementation and monitoring?
- How much awareness do we have from consumers?
- What are they willing to pay for established systems of recycling?
- What are best practices?
- How can one establish pilot projects, for instance, including 4500 inhabitants
- What is the spatial dimension and the transport cost charge?
- Do we need special incentive schemes for waste separation?
- How much can legislation contribute to the facilitation of recycling?