Innovatieve ‘nieuwe sanitatie’ *ontwikkelingen in ’North and ‘South’*

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Presentation Content

- Present sanitation in ‘North’ and ‘South’
- Resources present in sanitation ‘waste’ related to world resource problems
- Different ‘new sanitation’ options
- Future challenges

Two sanitation approaches

Traditional

→ wastewater as risky, polluting stream

↓

Central, water based collection & transport, treatment and discharge

New

→ waste(water) as source of raw materials

↓

Alternative collection, transport and recovery & reuse

Two sanitation approaches

Traditional	New
→ wastewater as risky, polluting stream	→ waste(water) as source of raw materials
Pit latrines & septic tanks effluent soil infiltration (ground water pollution) and discharge of sludge.	Alternative collection, transport and recovery & reuse

'North' countries

Complying with environmental, hygienic & comfort objectives;

Not complying with sustainability objectives!!

‘South’ countries

Not complying with environmental, hygienic objectives ánd not complying with sustainability objectives !

Nairobi, Kenya 2004: Sixty per cent of the city's people live in slum areas.
Photo : ©AFP / Getty Images / Marco Longa ; Gumisai Mutume (2004).

'South' countries

stashpocket.files.wordpress.com/2008/03/nairo...

Sanitation Challenges

Industrialized countries

- **Sustainable sanitation**
  - ***preconditions***
    - Promotion of health
    - Similar comfort

Developing countries

- **Promotion of health**
  - ***preconditions***
    - Sustainable sanitation
    - Improved comfort

What can we learn from each other??

Sanitation Challenges

***Industrialized* countries**

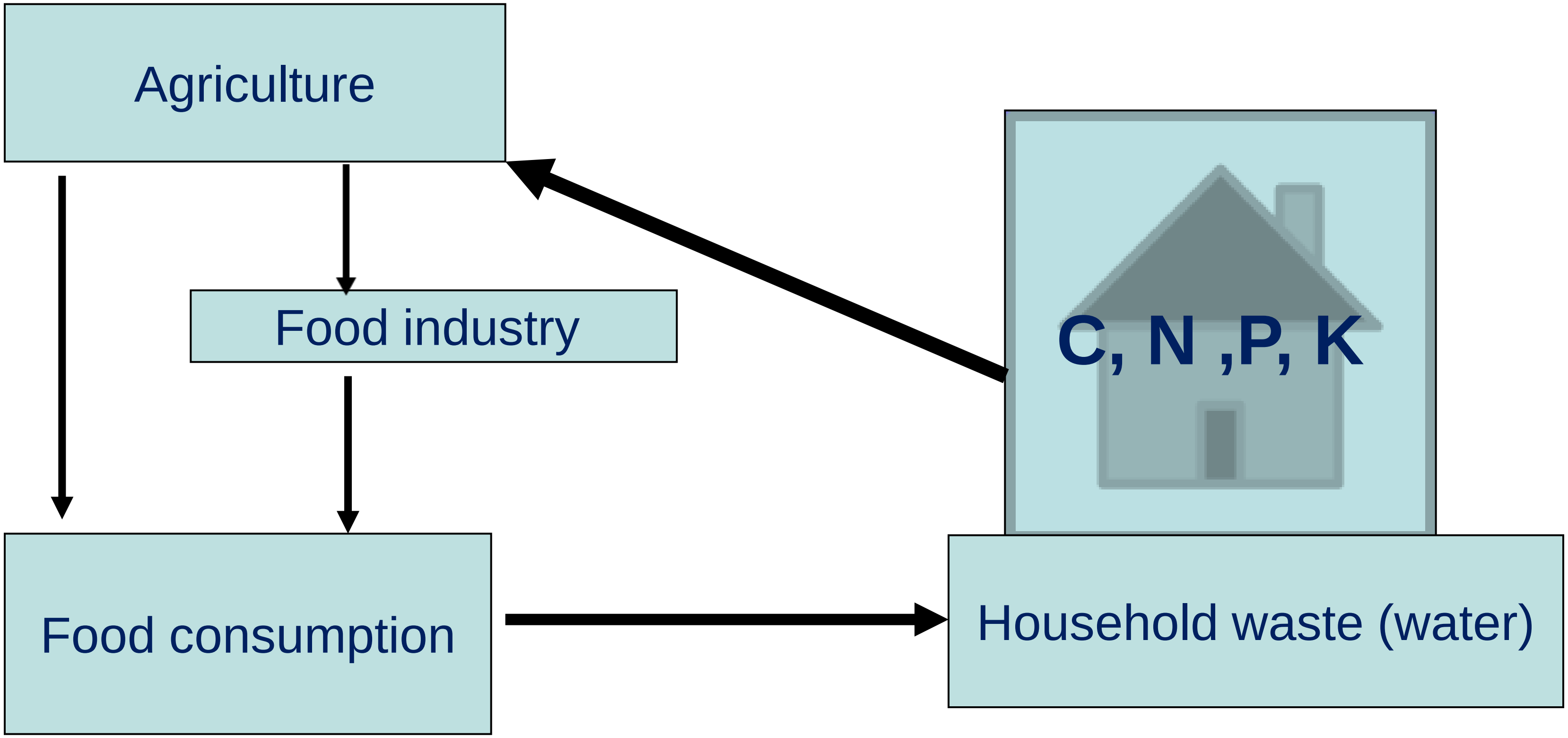
- **Sustainable sanitation**
  - ***preconditions***
    - Promotion of health
    - Similar comfort

***Developing* countries**

- **Promotion of health**
  - ***preconditions***
    - Sustainable sanitation
    - Improved comfort

What can we learn from each other??

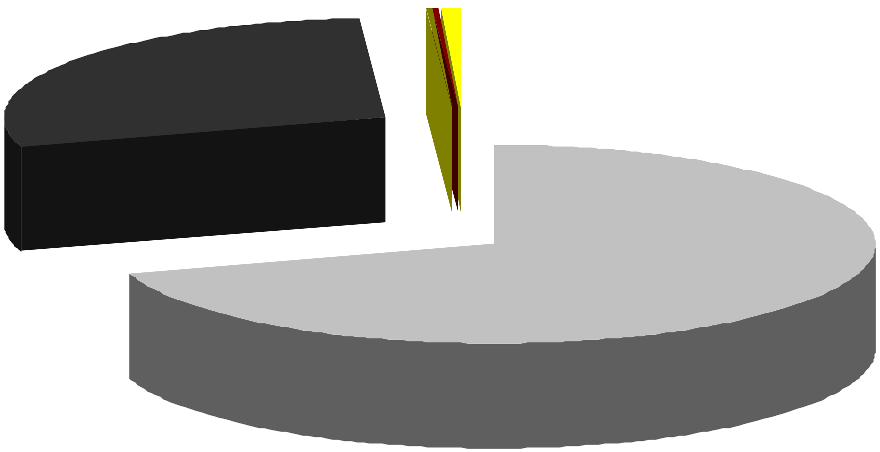
C2C based Food production



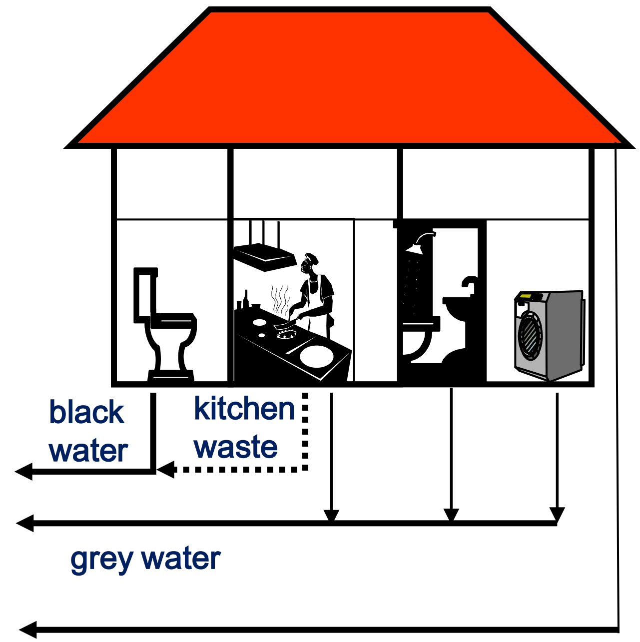
Waste(water) streams in the household

black water,
39L (30%)

feces, urine,
kitchen waste (~ 1%)



grey water,
95L (70%)



Pollution load in black waste(water) & kitchen waste (K)

	Urine + Feces+ Kitchen waste (g/p/d)	% of total domestic ww + K
N	12.3 g	92
P	1.6 g	80
K	3.9 g	84
COD	111 g	69

World problems

- Phosphate is a finite resource (Cordell et al., 2009);
- Reactive Nitrogen increases yearly (Galloway et al., 2008)
- Fossil fuels are finite;

Phosphate production (black water + kitchen waste) and artificial fertiliser use --- Worldwide

	in BW + K	Fertiliser use	% coverage
Phosphate	$3.9*10^6$ (tons per year)	#$14.9*10^6$ (tons per year)	**27**
Nitrogen	*$30.9*10^6$	##$121*10^6$	**25**

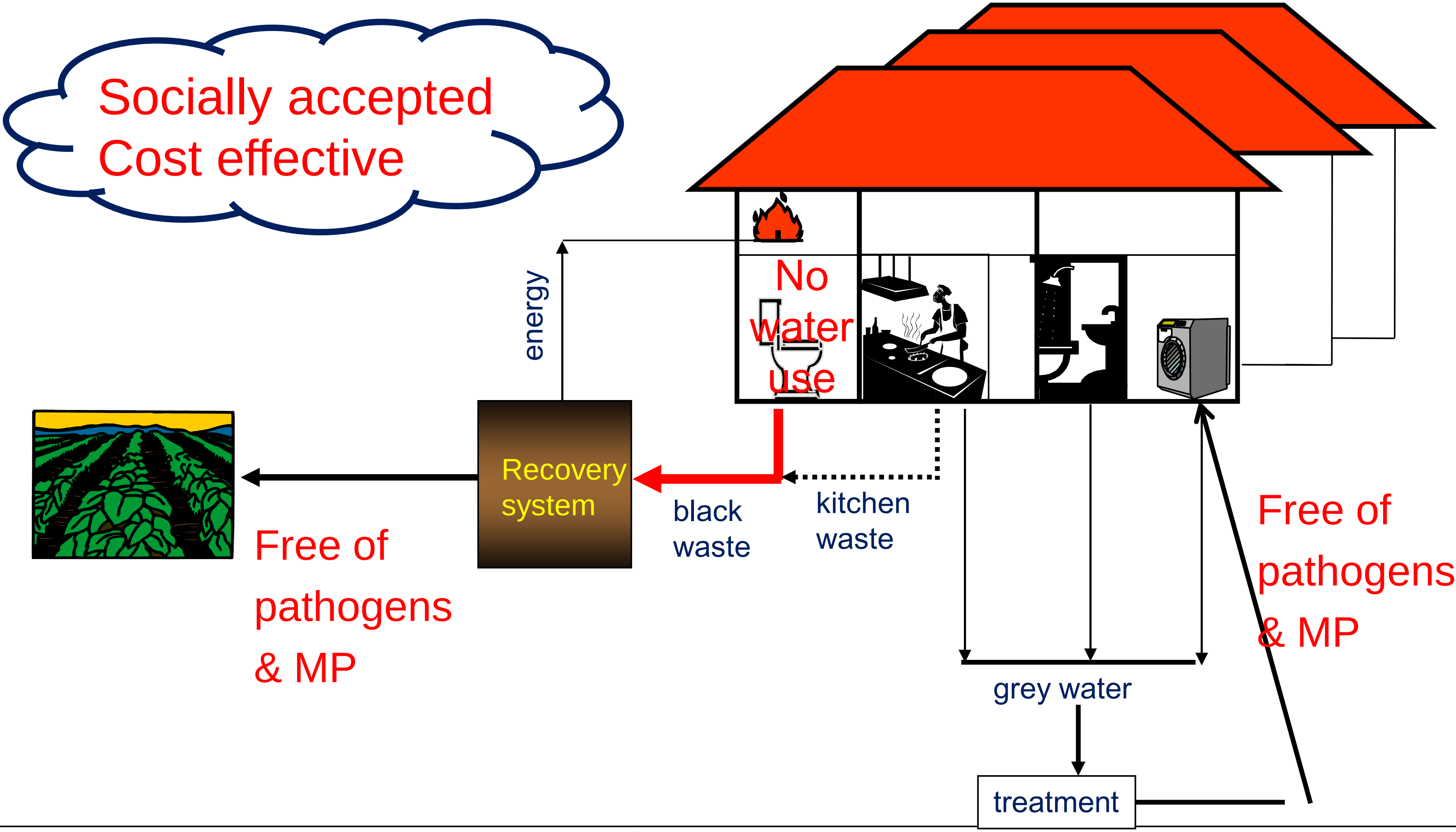
World population: 6,911,750,810 people (http://www.census.gov/main/www/popclock.html)
#Cordell, D., Drangert, J.-O., and White, S. (2009). The story of phosphorus: Global food security and food for thought. Global Environmental Change, 19, 292-305.

COD (black water + kitchen waste) and potential Energy production --- Worldwide

	in BW + K	$^*CH_4$	coverage
COD	$**280*10^6$ (tons per year)	$69*10^9$ (m^3 per year)	at last. 60% cooking

**World population: 6,911,750,810 people (http://www.census.gov/main/www/popclock.html)
*anaerobic treatment;70% conversion

'Dream situation'



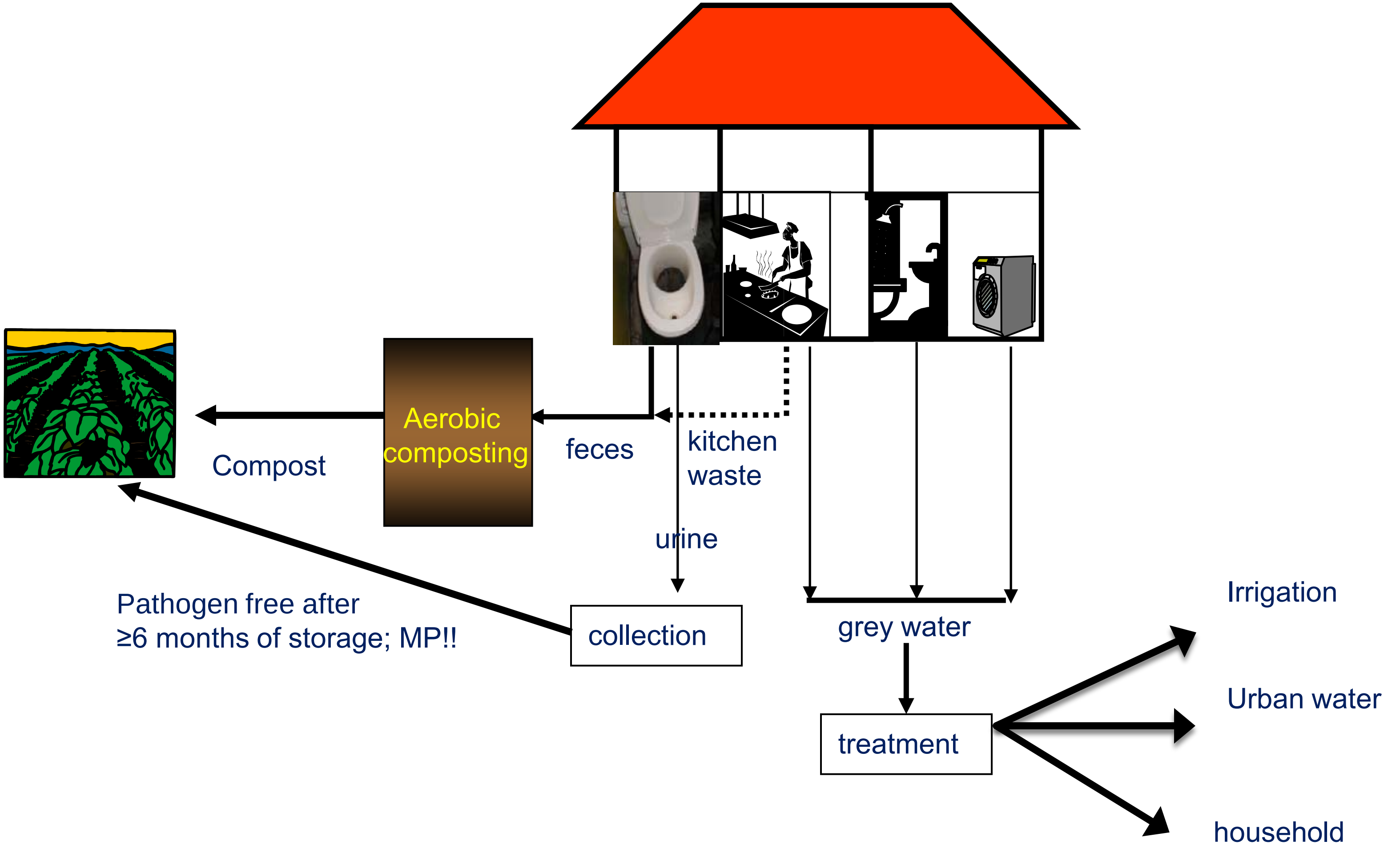
Collection (toilet) and transport system

Determines for a great deal the treatment and recovery possibilities:

- No water use and separation of urine:
  - Composting toilets;

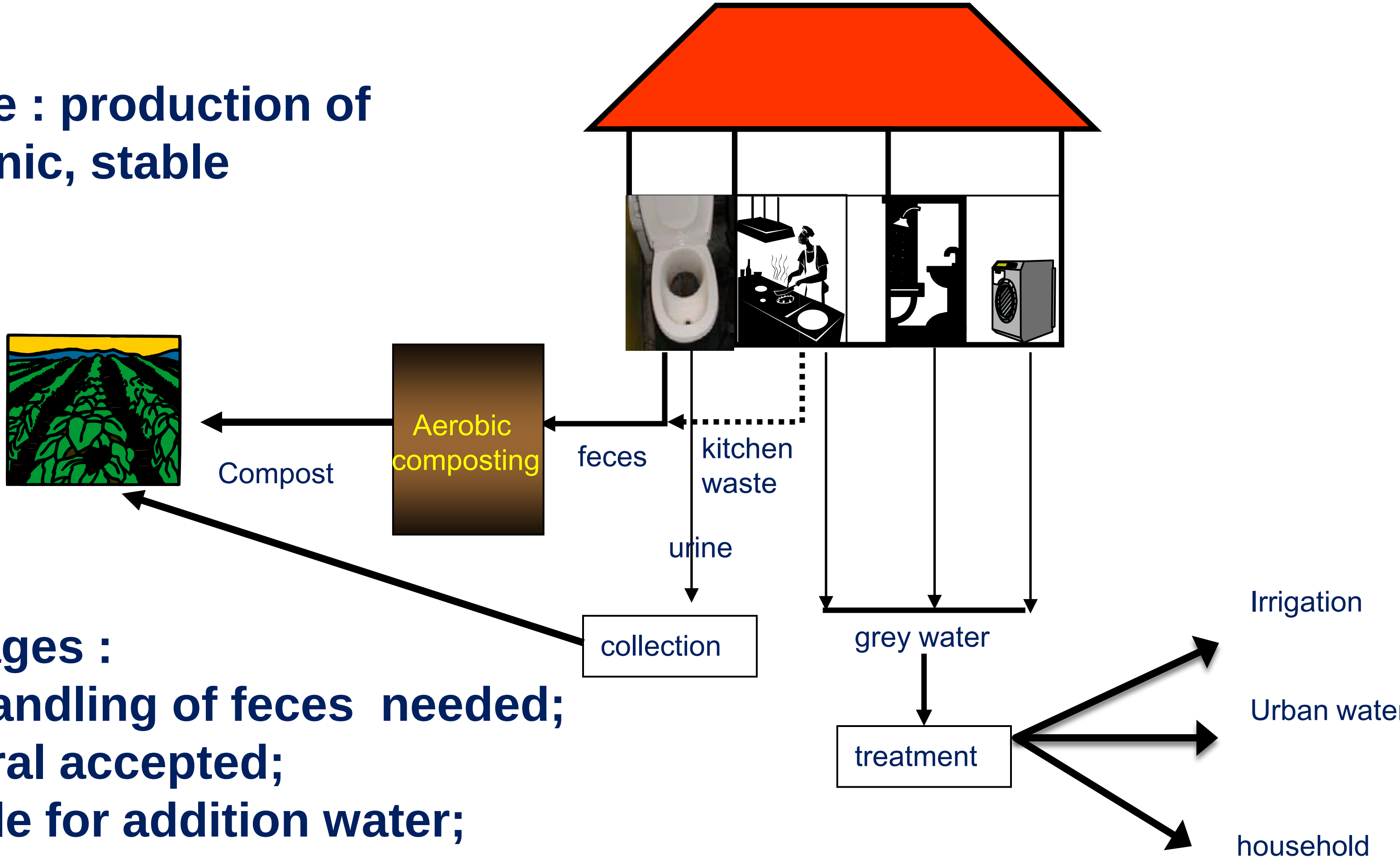
- Flush (low) toilets (5-9 liters)
- Some water use and no urine separation:
  - Vacuum toilets; (1liter per flush);
- Some water use and urine separation:
  - Urine diverting systems;

Composting of feces; Separation of urine house on-site



Anaerobic treatment of black waste(water) house on-site

Advantage : production of dry, hygienic, stable compost



Disdvantages :
-(some) handling of feces needed;
-not general accepted;
•Vulnerable for addition water;
•House- & building-on-site ;

Composting of feces; Separation of urine house-on-site

Wendland et al. (2011). Experiences with urine diverting dry toilets (UDDTs) for households, schools and kindergarten in Eastern Europe, the Caucasus and Central Asia (EECCA). WECF report

WECF

Self-Made Urine-Diversion

WECF

School Sanitation
Example Nizhyn, Ukraine

before

Local partner Mama86

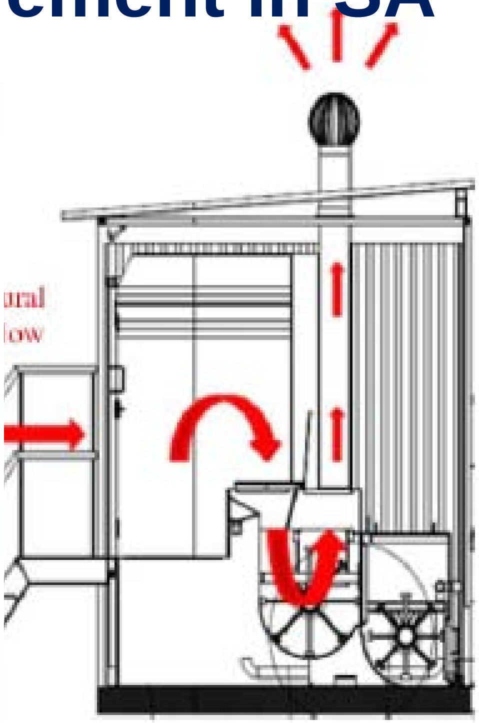
Teachers´ rest room

WECF

Urine-Fertilized Maize

WECF

Mobisan in Pook Se Bos, Informal settlement in SA

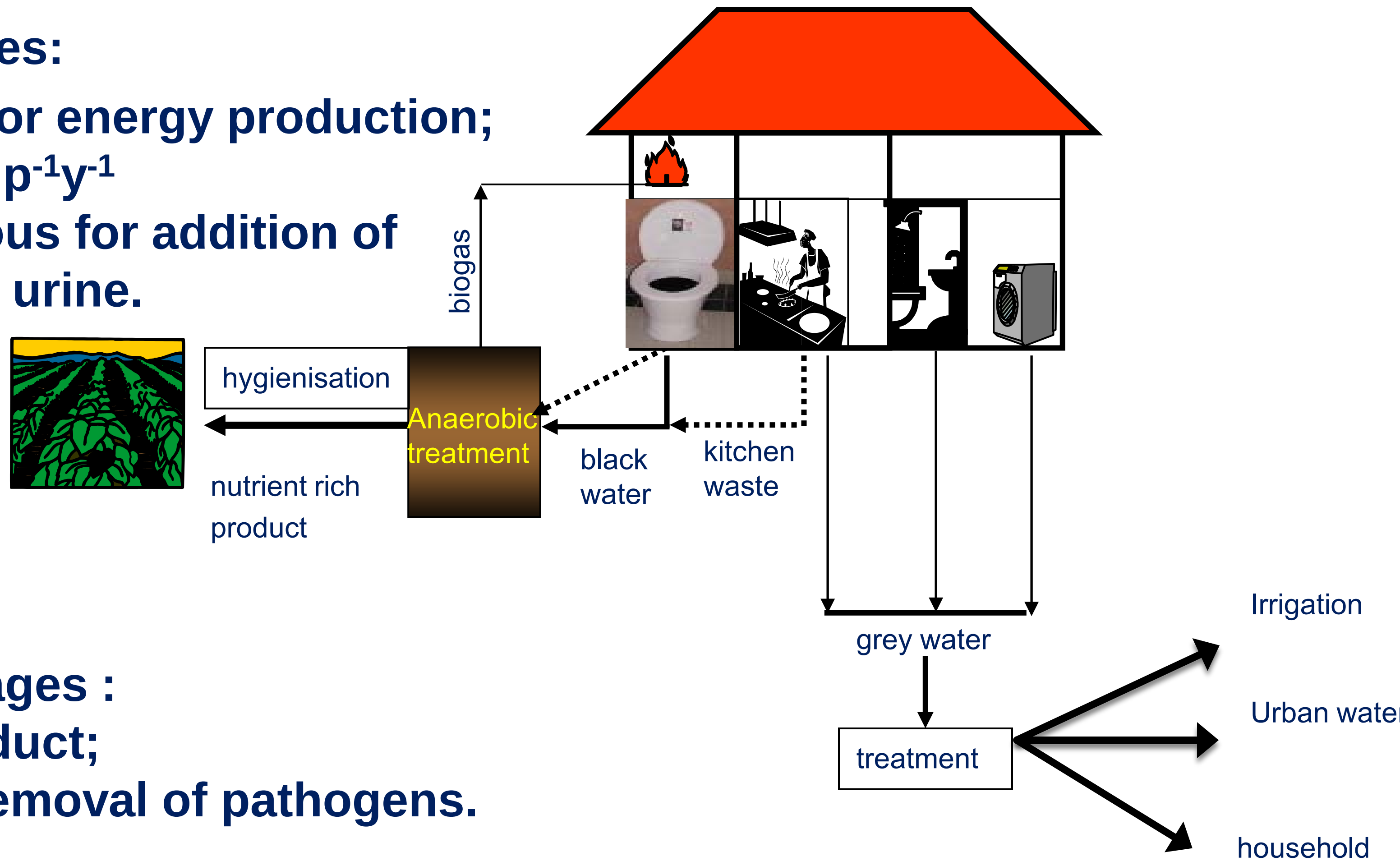


Urine diversion
&
Dehydration

Anaerobic treatment of black waste(water) house on-site

Advantages:

- **Biogas for energy production; 10 $m^3 CH_4$ $p^{-1}y^{-1}$**
- **Impervious for addition of water and urine.**



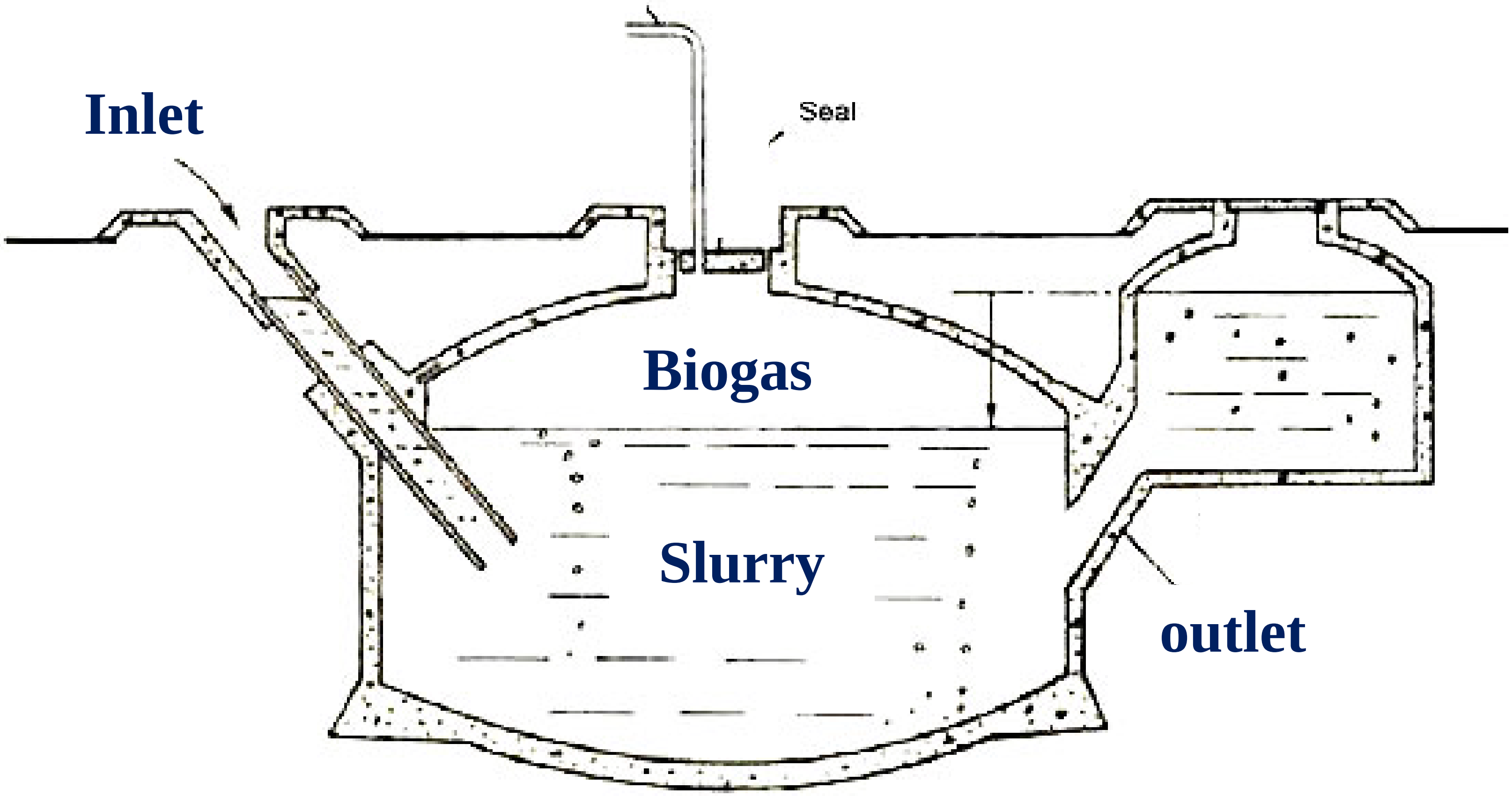
Disdvantages :

- **Wet product;**
- **Partial removal of pathogens.**

Anaerobic treatment of black waste(water) in Tanzania; house on-site

Sustainable environmental protection using modified pit-latrines (PhD thesis, WUR-ETE)
Chaggu, E.J. \ 2004

Chinese dome digester house on-site



Chinese dome digester in Pingyao

Chinese dome digester in Pingyao

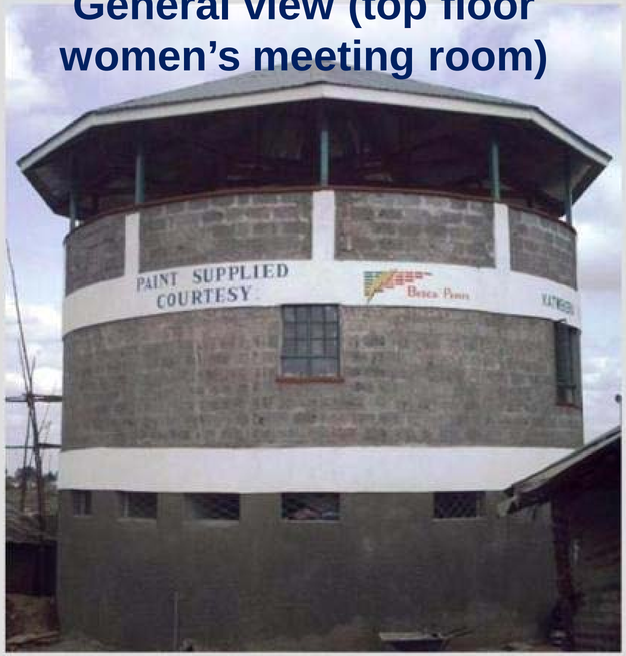
High density, urban situations (Slums)

Private toilets & Sewerage not feasible

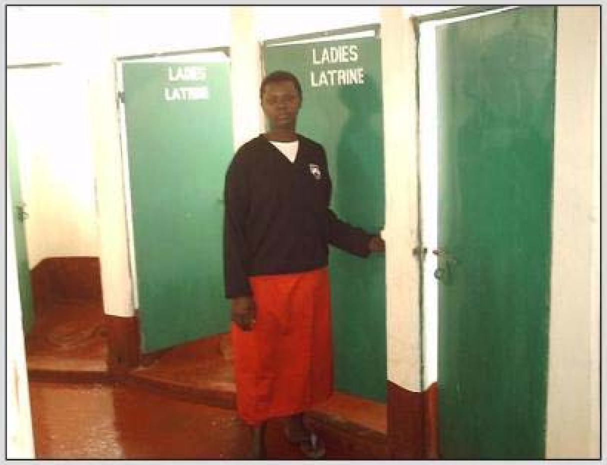
Toilets blocks in high density urban areas.

The SPARC-style sanitation block in Kibera, Nairobi, managed by the community women

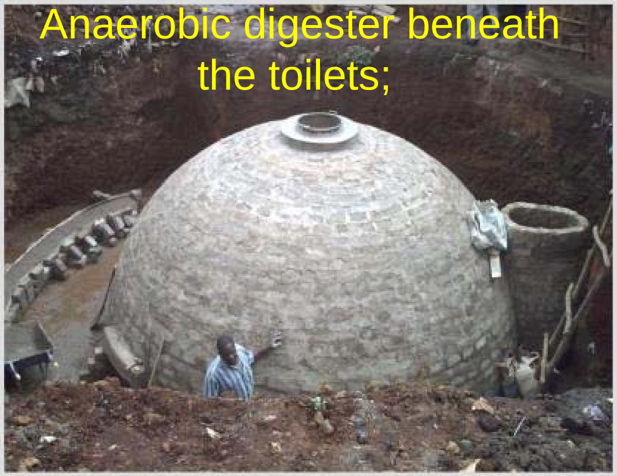
General view (top floor women's meeting room)



Women's toilets



Anaerobic digester beneath the toilets;



Biogas for cooking.

Photographs courtesy of Rob Clarke, Halcrow/ Water and Sanitation for the Urban Poor.

School Sanitation block in Dar es Salaam, Tanzania

Photographs Thobias Bigambo; **A4A** supported

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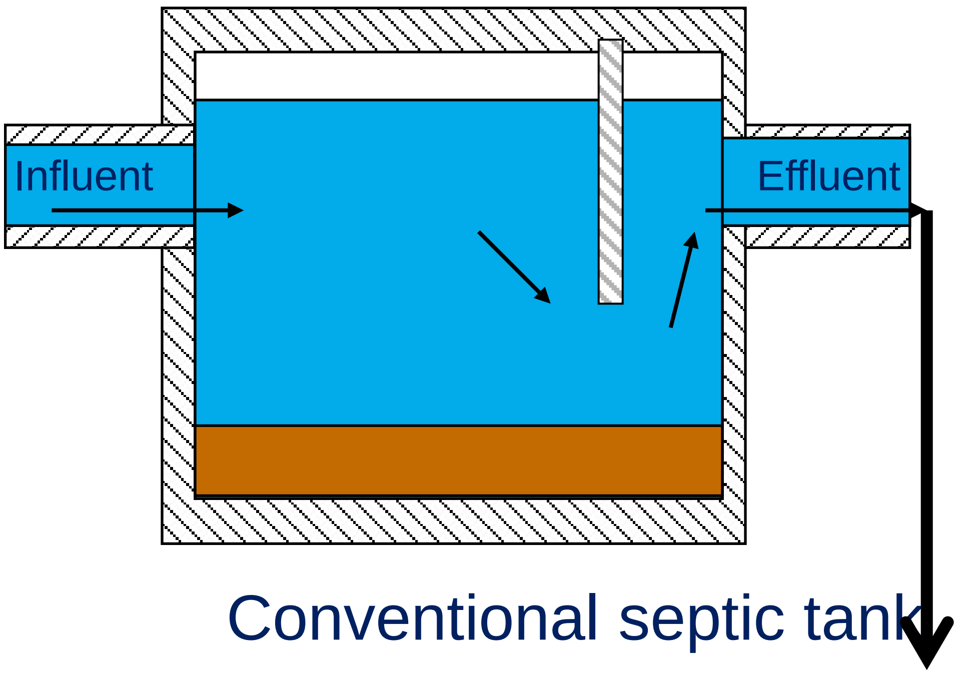
‘North’ & ‘South’ countries



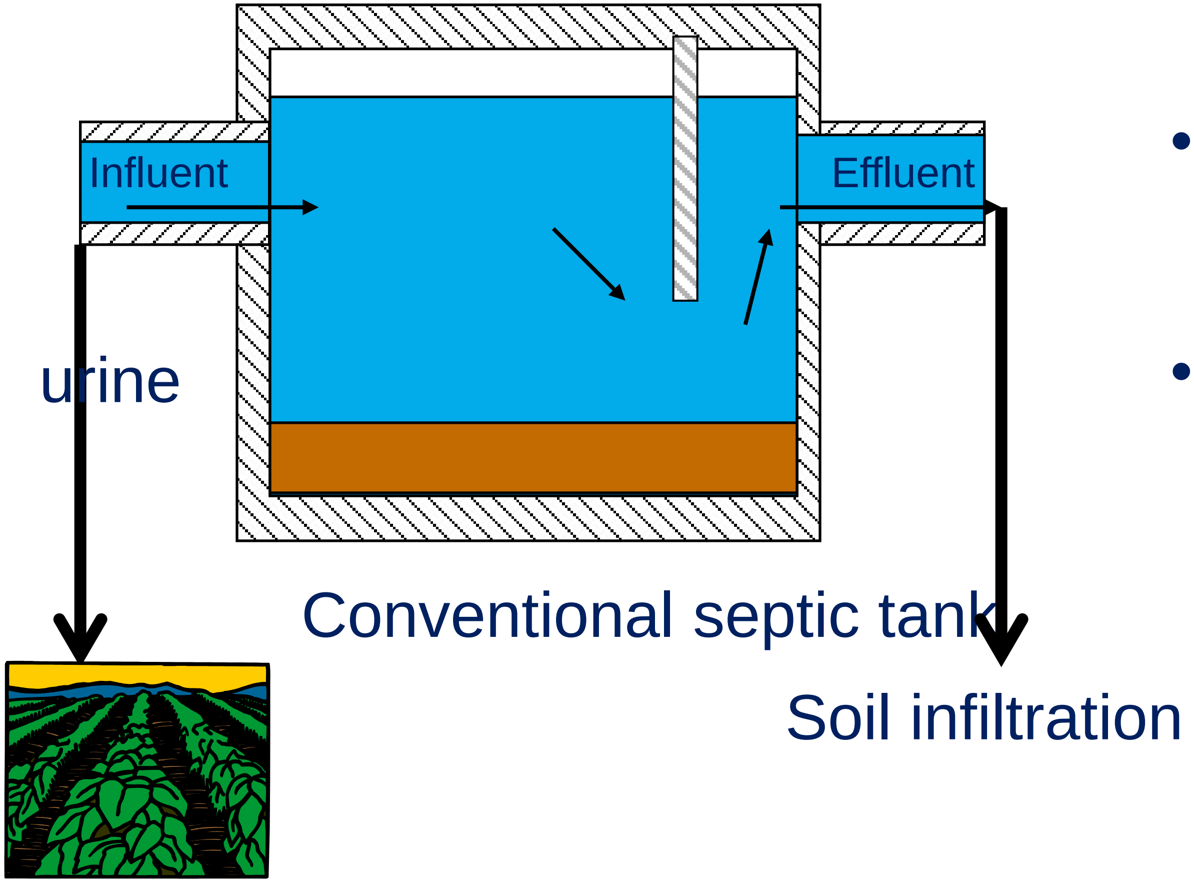
Conventional septic tank

Disadvantages:

- Effluent infiltration
  - Groundwater pollution (N, P, pathogens)
- Methane not collected

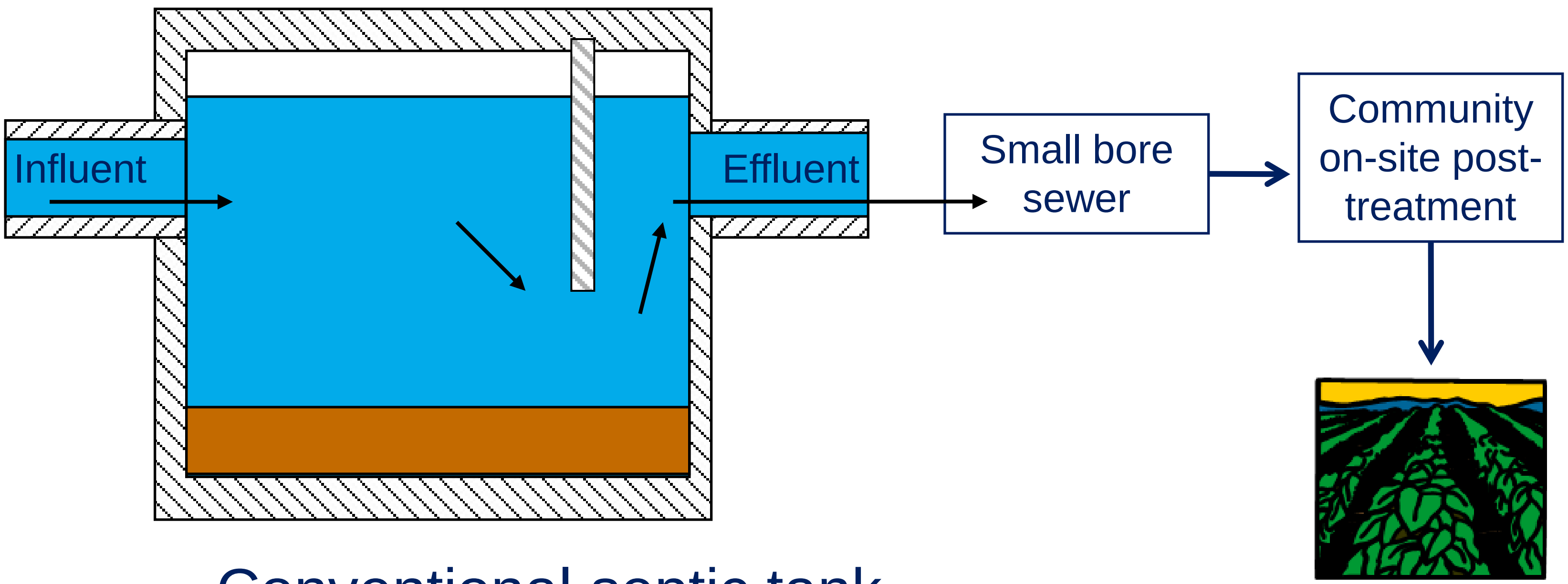
not complying with sustainability objectives

Septic tanks; urine diversion



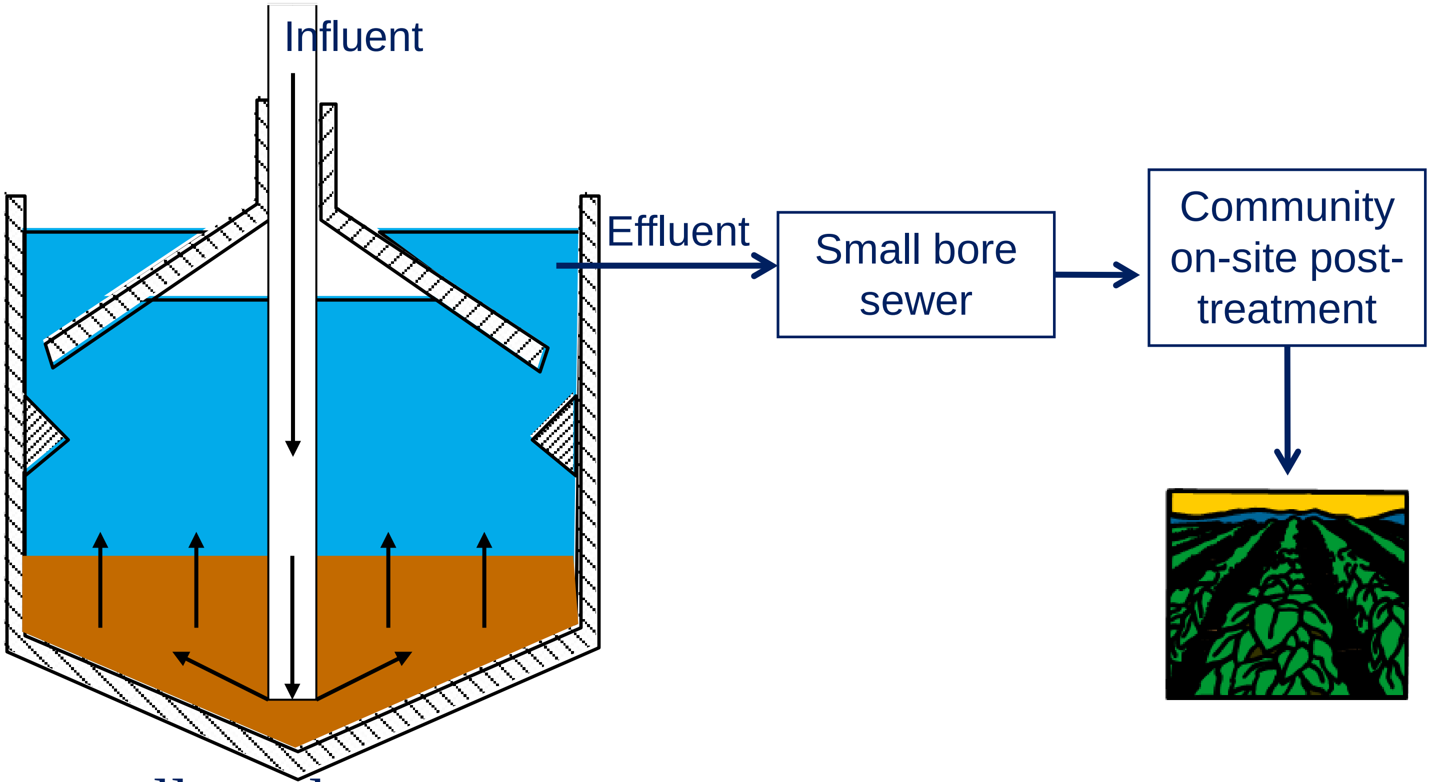
- Effluent infiltration
  - Some N, P,
  - pathogens
- Methane not collected

Septic tanks; small bore sewer & post treatment



Conventional septic tank

UASB-Septic tanks (Lettinga *et al*, 1997)



- Methane collected
- Improved COD removal

Collection (toilet) and transport system

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  - Vacuum toilets; (1liter per flush);
- Some water use and urine separation:
  - Urine diverting systems;

Vacuum collection & transport use 1 liter for flushing

Producing $7l/p.d^{-1}$ concentrated black water;

Saving 30-42 $l/p.d^{-1}$

Similar comfort as water based collection and transport

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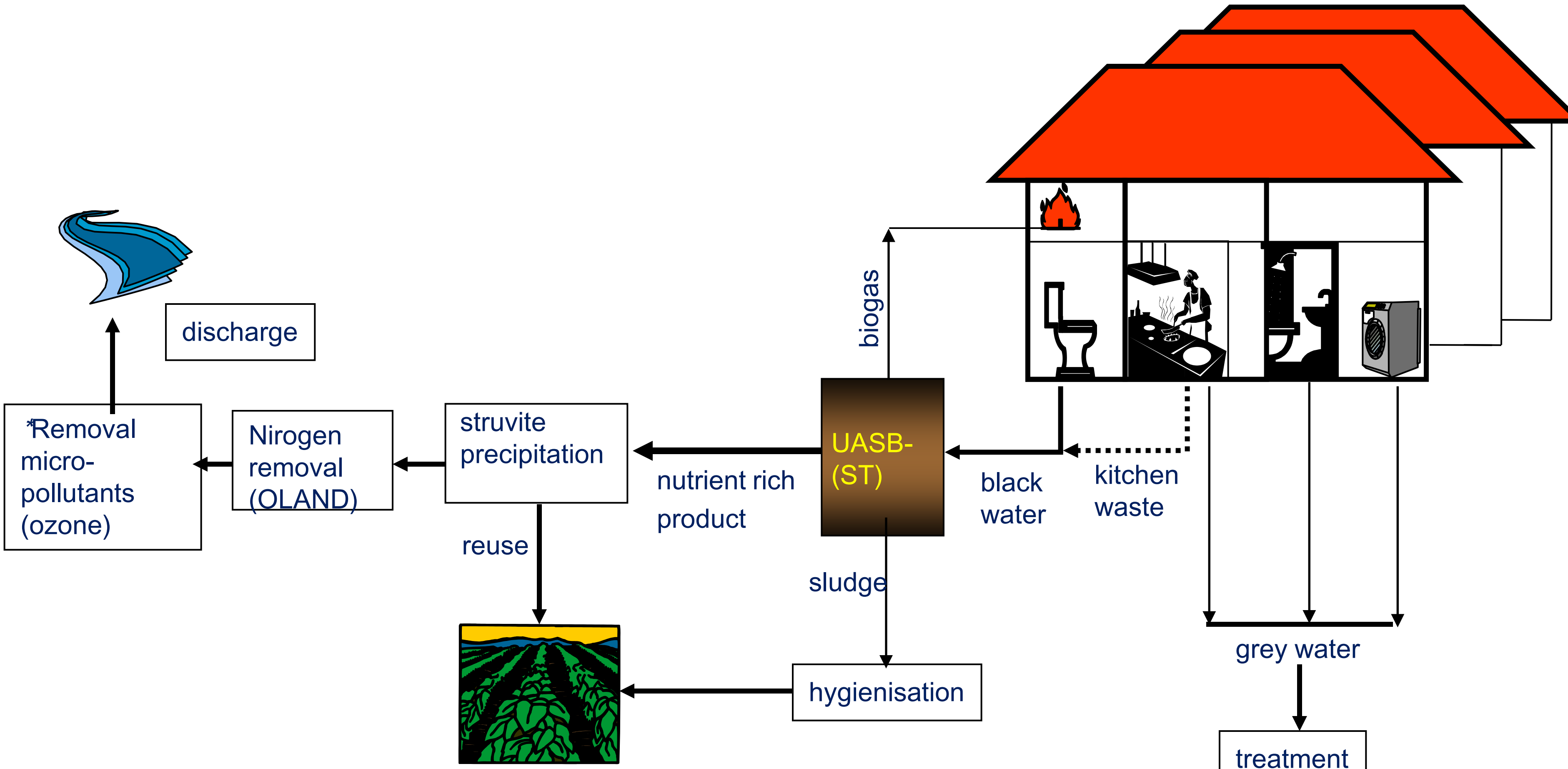
DeSaR concept demonstrated for 32 houses in Sneek



*not yet realised


32 houses


GW; 200 – 250mm
BW; 75mm

Boarding school Ukraine

250 houses in Sneek

Villa Flora Venlo

NIOO building in Wageningen

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Separate Collection, Transport , treatment & reuse of urine

*Lienert & Larsen, (2010):

38 NoMix-projects in Switzerland, Sweden, The Netherlands, Germany, Austria, Luxembourg, Denmark (2700 respondents).

- High acceptance;
- No-Mix-toilets need further development;

*Lienert & Larsen, 2010. High Acceptance of Urine Source Separation in Seven European Countries: A Review; Environ. Sci. Technol. 44, 556–566

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Novaquatis; EAWAG
Collection, storage, treatment and reuse of urine*

http://www.forumchriesbach.eawag.ch/bilder.htm;

*Larsen, T. A., Lienert, J. (2007) Novaquatis final report. NoMix – A new approach to urban water management.Eawag, 8600 Duebendorf, Switzerland

Palsternackan Stockholm (1995);
51 appartemens, 160 people (urine separation)

6 months storage:
Hygienic safe application

Urine treatment Saniphos (GMB)

Nepal's first Urine Bank in Siddhipur

1.00 Rs. per liter urine

http://www.urbwatsan.org.np/index.php?option=com_content&task=view&id=557&Itemid=1

Perspective from the extreme ends

Sanitation is more than toilet systems and treatment technologies →

social and technical chain of nutrient, water and energy flows

- householders
- …
- ….
- …..
- ………..
- ……..
- farmers applying nutrients, compost and water

Perspective from the extreme ends

Sanitation concepts should connect to local needs, & expected demands for products (biogas, nutrients).

Perspective from the extreme ends
Points of concern/attention

- role of farmers as (proposed) users of nutrients is still limited

– success of i.e. UD systems depends on:
  - technology design // consumer acceptance
  - farmers' acceptance

→ **Farmers should therefore be involved in any new sanitation project in a very early stage (Jönsson, (2008)**

Innovation management PROVIDE project WUR (Kenya, Tanzania & Uganda):

Development of the 'Modernized Mixtures Approach'

Combining :

- low-cost, flexible, robust, decentralized technologies with available centralized infrastructure;

Integrating

- (eco)technological, economic, social and governance dimensions

Innovation management
Safi Sana concept

– Development of standard units (lease or franchise) including 20 showers-s, 20 toilets en 1 kiosk for water.

– Sanitation products
  - » Water
  - » Fertilizers
  - » biogas

Conclusions

- Sanitation is a social & technical chain of nutrients, water and energy flows

- Implementation of sanitation toilets blocks in high density urban areas combined with production of valuable products (biogas, fertilizer) is considered good sanitation practice

Conclusions

- Farmers should be involved in any new sanitation project in a very early stage (North & South);
- While a more engineering oriented approach dominated in the past, it becomes obvious that the socio-economic context has to be evenly considered.

Future challenges technological

- Further development of toilets
  - urine diversion
  - very low flush (collection & transport)

- Production of hygienically safe products

Future challenges
socio-economic

- For **industrialised countries**: to develop a strategy for a gradual (50 years) transition from conventional sanitation to ‘New sanitation’
- To stimulate **countries in transition** to develop a strategy to directly adopt ‘New Sanitation’ (from a lag to a lead)
- For **developing counties**: to develop a strategy to amend existing infrastructure towards hygienically safe, resource oriented sanitation
- **Worldwide**: Establish harmonisation with agriculture demands

Thank you for your attention

Costs DeSaR 500 houses (1500 i.e)

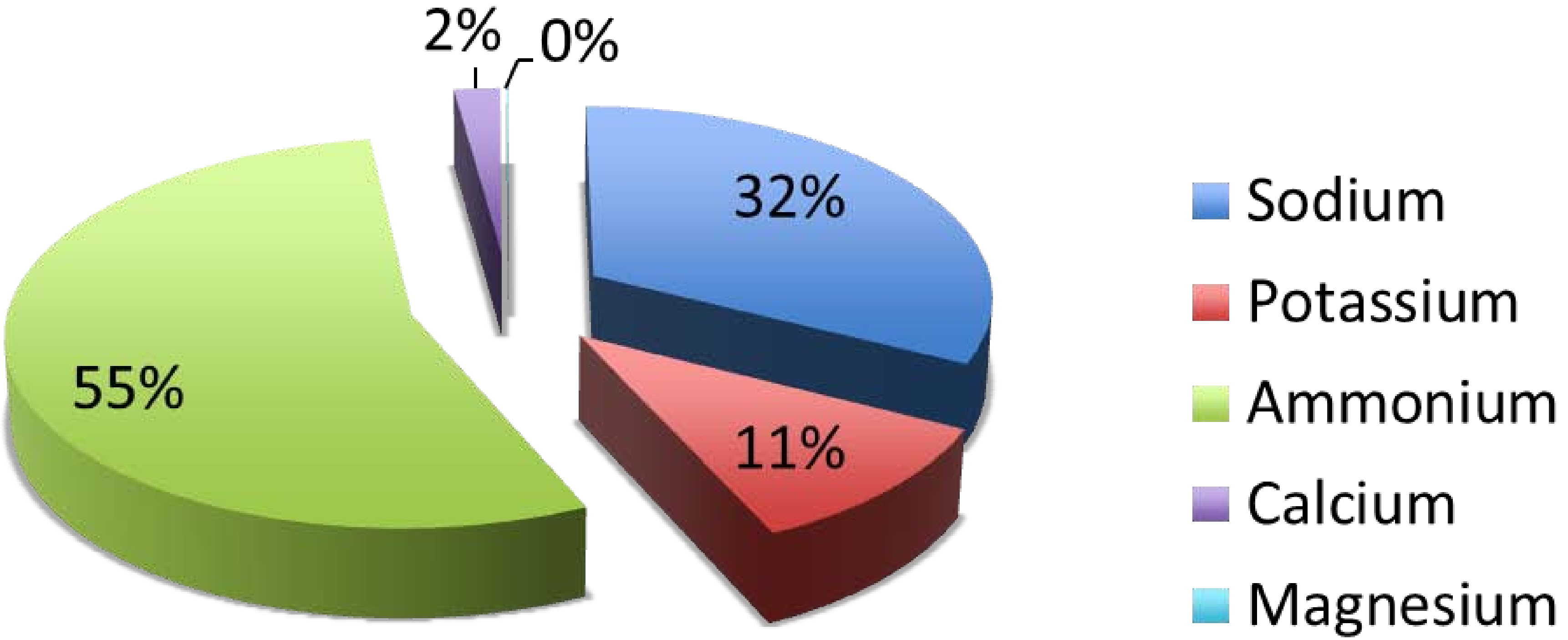
- BW treatment: UASB->OLAND->struvite:
  - 325000 - 375000 euro
- GW treatment: high loaded AS followed by low loaded AS:
  - 150000 - 195000 euro
- Capital costs (5.5% interest)
  - 61.00 -75.000 euro per year
- Chemical, maintenance/energy/sludge treatment)
  - 16.000 - 18.000 euro per year

Costs per ie: 51 - 63 euro

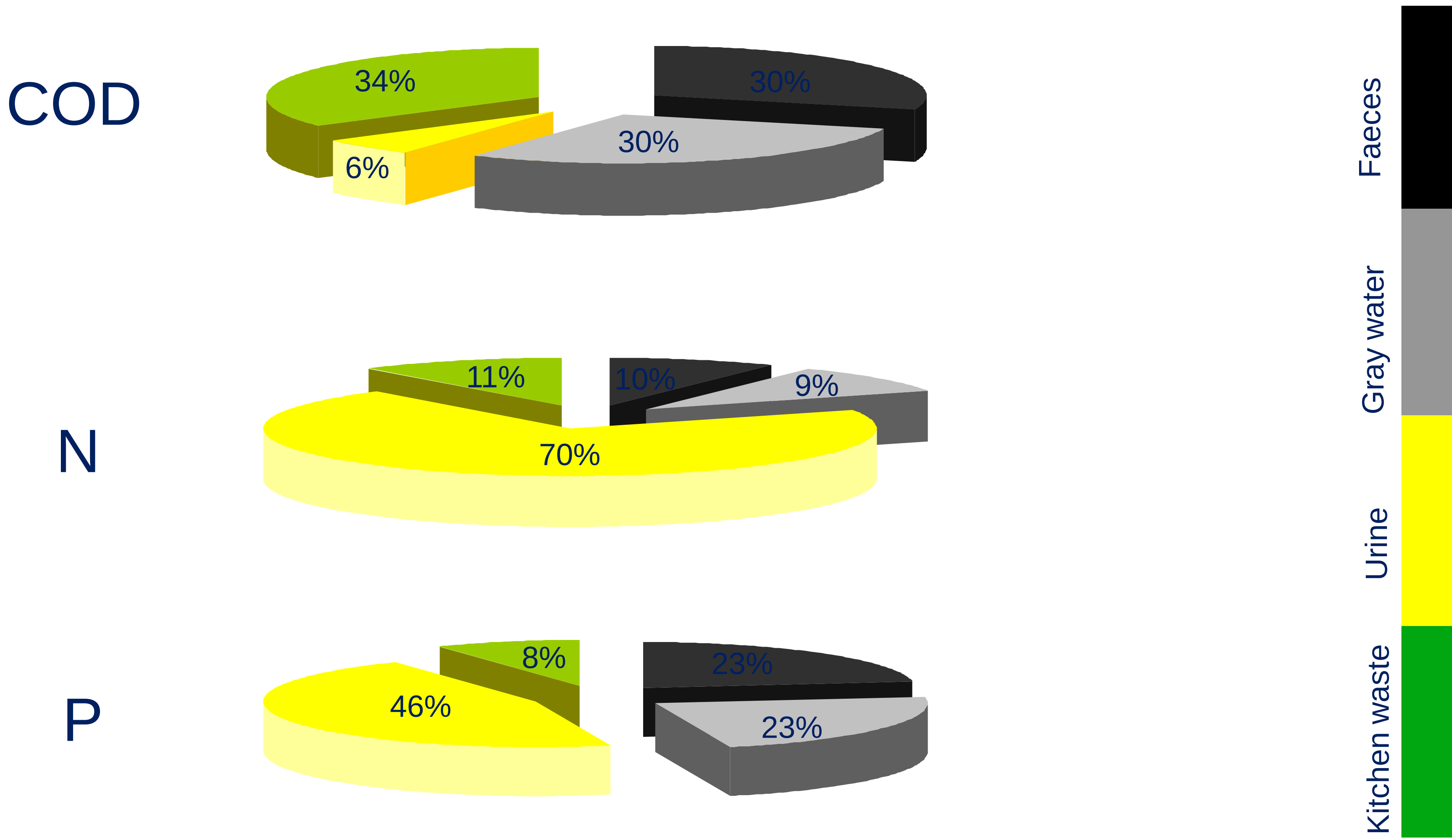
DeSAR - Energy balance

Biogas production (BW, KW, GW)		10,5 m^3CH4/p.y^{-1}	374 MJ/p.y^{-1}	131 $MJ_{electric}$/p.y^{-}
Energy consumption	Vacuum transport	-[1]25 (kWh/p/y)		-90 (MJ/p/y)
	Kitchen waste grinders	-5 kWh/p/y		-18,0 MJ/p/y
	Post- treatment			-43 MJ/p/y
Energy saving	STP	24 kWh/p/y		86 MJ/p/y
	Conventional sewer	30 (kWh/p/y)		108 MJ/p/y
	[5]Drinking water	0.5 kWh*$m^3_{produced}$		26 MJ/p/y
Total				200 MJ/p/year

Ion transport through the membrane



Composition of household (waste)water



DeSAR pilot, Sneek, The Netherlands
32 houses - Methane and effluent nutrient recovery from AD of concentrated black water

Nutrients & CH_4	Unit	UASB-ST 32 houses (without KW)	Theoretical (without KW)
Black water volume	L/p/d	6	7.5
CH_4	L/p/d	13-19.5	15
N_{total}	(gN/p/d)	7.6	11
P_{total}	gP/p/d	0.63	1.3

Data are obtained from the demonstration project in Sneek (Elzinga et al., 2009)
Kitchen waste is added only from one house.

Recovery (g/p/d) of N and P at different locations in Sweden, calculated based on Jönsson (2001);direct reuse in agriculture

5 housing estates	
Inhabitants	8-160
recovery (gN/p/d)	3.4-5.7
recovery (gP/p/d)	0.27-0.49

Algae production from digested separate collected BW and urine

Case	N gN/p/d	P gP/p/d	N:P (atomic ratio)	*Algal biomass produced (g/p/d) according to P
Sneek*	6,2	0,46	29,84	46

*$CH_{1.78}O_{0.36}N_{0.12}P_{0.0075}$ (Duboc et al., 1999); Redfield ratio N:P of 16:1
P is the limiting nutrient.