

XU-GLI GRADUATE CERTIFICATE PROGRAM ON
ECOLOGICAL SANITATION



Reuse of Human Urine and Faeces for Crop Production

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What do we have to know about our own urine?

- It contains nitrogen, phosphorus, and potassium and other essential plant nutrients which are very important in crop production.
- We should reuse the nutrients in our urine back to our agricultural fields for fertilizing our crops!
- Urine contaminates our ground water if not handled properly!

What do we have to know about our own urine?

- Average for adults can be estimated to be in the range of 0.8-1.5 liters urine per person and day and for children about half the amount
- The proposed Swedish default value is 1.5 liters per person and day (550 liters/person, year; Vinneras 2002)
- If one person produces 500 liters a year, this amounts to the equivalent of 5.6kg N, 0.4kg P, and 1.0kg K

Plant nutrient contents in urine

Urine is too valuable to waste!

Estimated excretion of nutrients per capita in different countries
(Jönsson & Vinneras, 2004)

	Nitrogen Kg/cap,yr	Phosphorus Kg/cap,yr	Potassium Kg/cap,yr
China	3.5	0.4	1.3
Haiti	1.9	0.2	0.9
India	2.3	0.3	1.1
South Africa	3.0	0.3	1.2
Uganda	2.2	0.3	1.0
Sweden	4	0.37	0.9

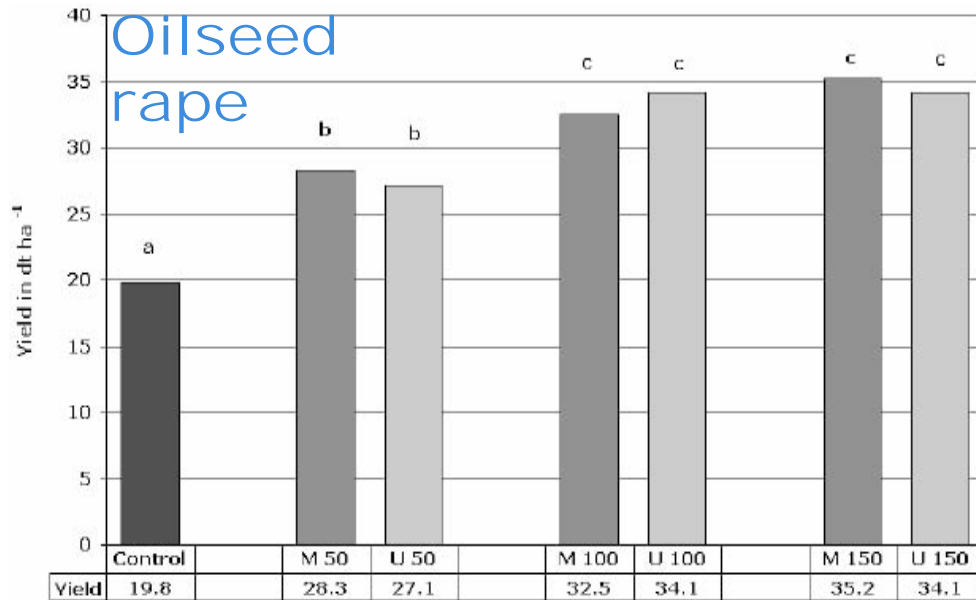
Urine as plant fertilizer

- High quality & low cost alternative to artificial mineral fertilizer
- Has water-soluble nutrients
- Best used for N-demanding crops and leafy vegetables
- Plant availability of urine N is the same as that of synthetic urea or ammonium fertilizers
- 80% of total N is excreted in urine and there is 5-7 times more N in urine than in faeces
- P in urine is almost entirely (95-100%) inorganic and is excreted as phosphate ions
- K is excreted as ions which are directly plant-available

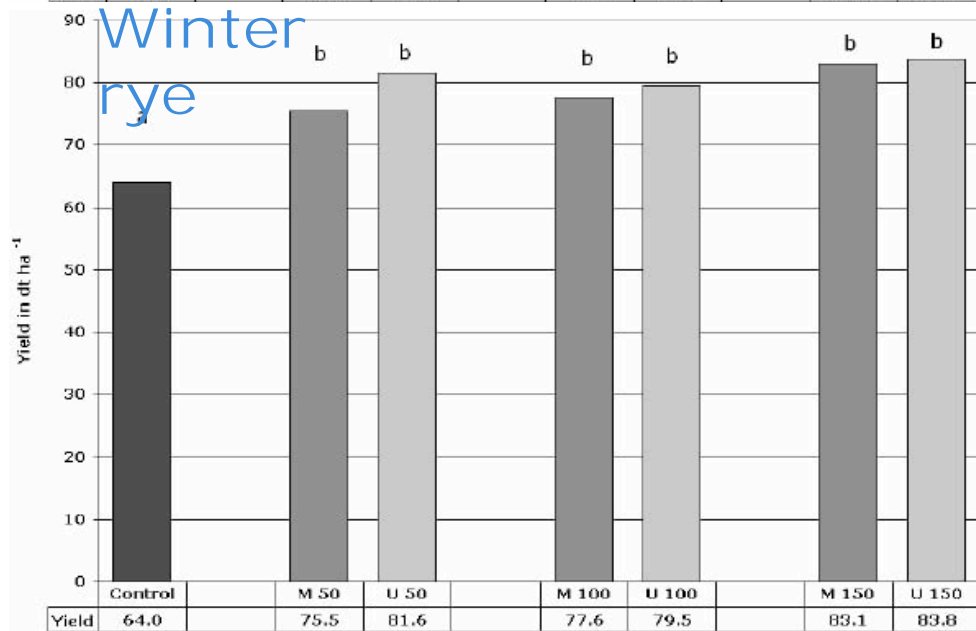
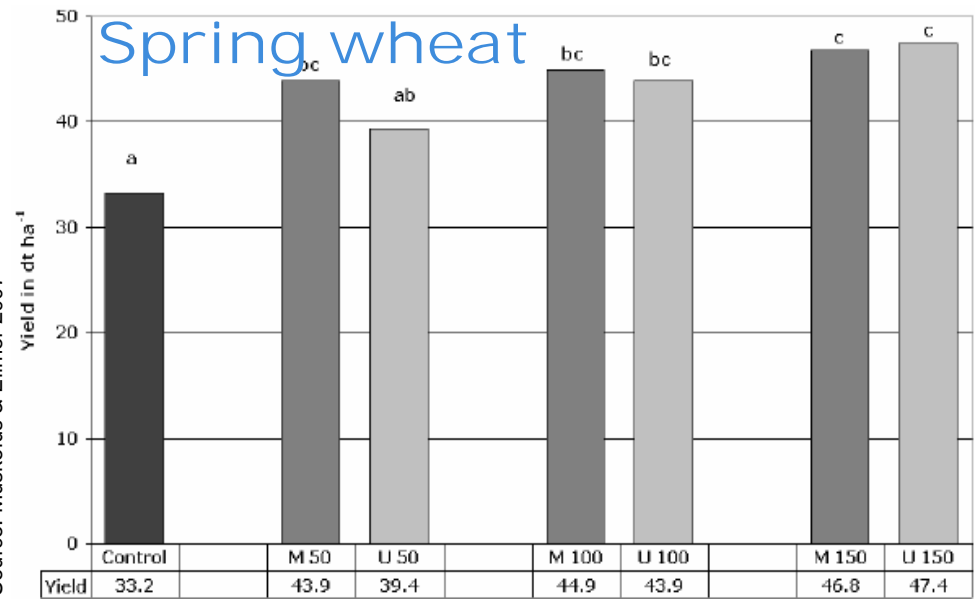
Plant nutrients in urine

- According to Wolgast (1993), one liter of urine contains 11g N, 0.8g P, & 2g K.
- If 500 liters are produced by 1 person a year, that amounts to the equivalent of 5.6kg N, 0.4 kg P, & 1kg K
- Amounts of these nutrients vary from one person to another and also from country to country depending on the national diet

Yield results of field trials on various crops, 2006, Germany



Source: Muskolus & Ellmer 2007

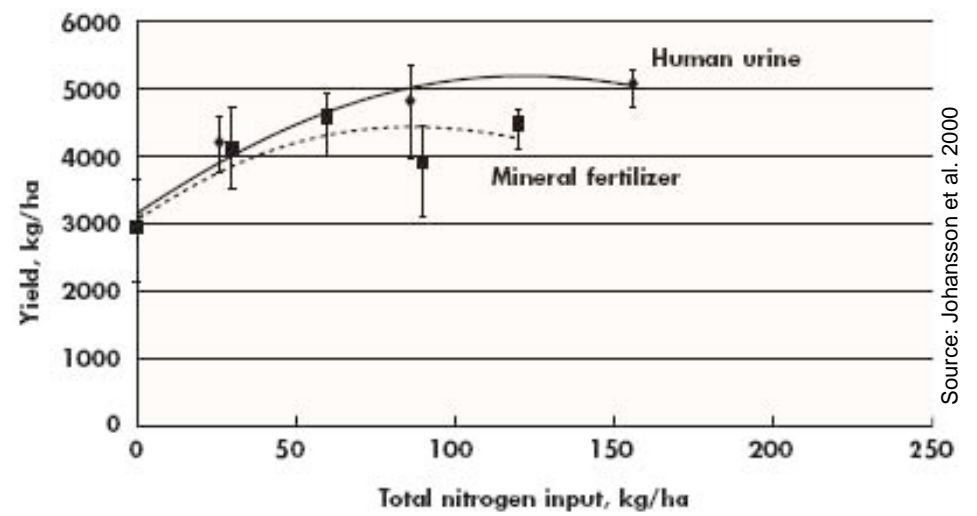
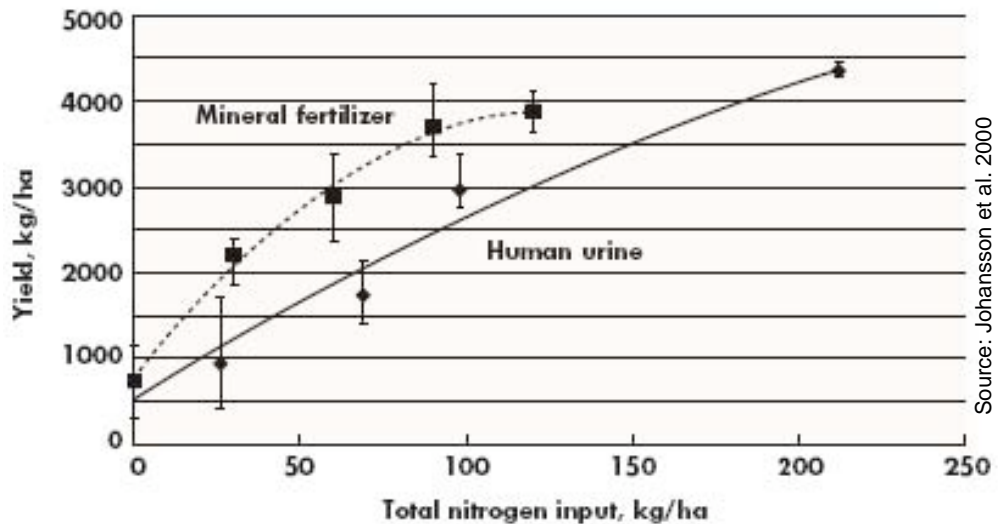


Source: Muskolus & Ellmer 2007

- Control group (unfertilised)
- Mineral fertilizer: 50, 100, 150 (kg N ha⁻¹)
- Urine: 50, 100, 150 (kg N ha⁻¹)

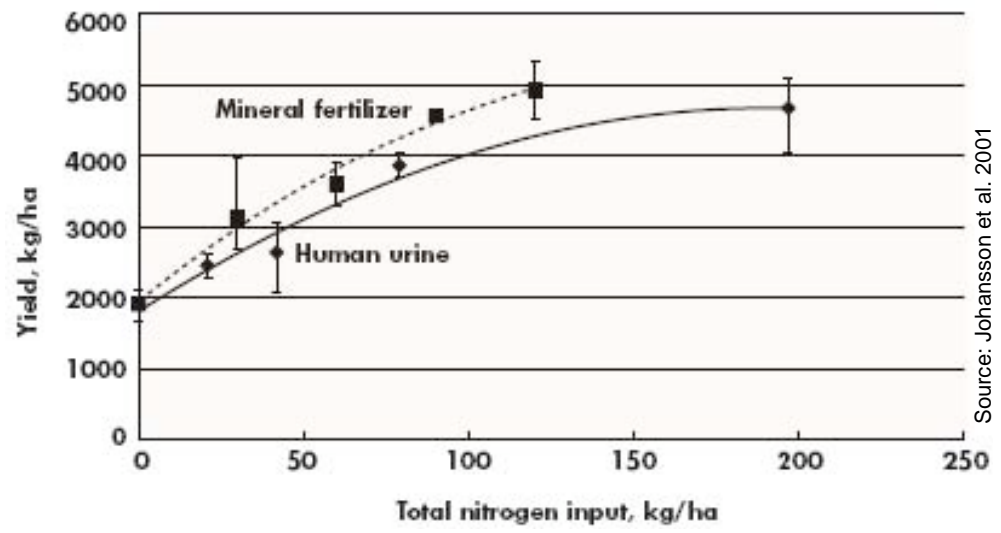
No statistical differences in yield between urine and mineral fertiliser were found

Field trials on barley yields fertilised with urine compared with mineral fertiliser, Sweden



1997

1998



1999

N effect of urine was found to be 80-90% of the effect of the corresponding amount of N in chemical fertilisers

Periurban Vegetable Project (PUVeP), Manresa Farm, Xavier University, 2005



Sweetcorn applied with urine



Yield increases up to 30 %

Larger cobs (3-4 cobs/kg compared to 5-6 cobs/kg)

It's Urine Time!



Holmer (2005)



Collection and storage of urine and faeces



Ecosan double vault urine-diversion dehydration toilet (UDDT) at PUVeP, Manresa Farm, Cagayan de Oro City

Urine and faeces are collected separately!



UDDT at PUVeP, Manresa Farm

Storage

Urine and faeces are contained and sanitized



6 months storage



1 month storage

Urine dilution

- urine can be applied neat (without dilution) or diluted with water.
- dilution level varies between approximately 1:1 to 10:1 and 3:1

Dilution decreases:

- risk of over-application
- risk of toxicity to plants

Application technique

- Should be incorporated into the soil instantly as possible after application
- Spraying (foliar application) is not recommended!
- Drip irrigation is a possible application technique
- Applying urine using a watering can also be done
- Apply urine within reach of the roots but the roots must not be soaked with urine



Source: B. Vinnerås



H. Jönsson, SLU

Application rate

- use local recommendations for use of commercial N fertilizers, preferably urea or ammonium, to translate recommendations to urine
- rule of thumb: concentration of 3-7 g of N is present in per liter urine

Application time and frequency

early stages of cultivation: availability of all nutrients is important

applications: ⇒ if only 1 application: before sowing/at sowing

⇒ 2 applications: 2nd application roughly $\frac{1}{4}$ of time between sowing and harvesting

⇒ **continuous fertilisation** with lower concentrations for plants with small root system is recommended

Application time

- rule of thumb: **waiting period of one month** between fertilization and harvest
- regions with heavy rainfall: repeated application of small amounts is recommended

Storage recommendation

Recommended guideline storage times for urine mixture^a based on estimated pathogen content^b and recommended crop for larger systems^c

Storage temperature	Storage time	Pathogens in the urine	Recommended Crops
4°C	>1 month	viruses, protozoa	food and fodder crops that are to be processed
4°C	>6 months	viruses	food and fodder crops that are to be processed, fodder crops ^d
20°C	>1 month	viruses	food and fodder crops that are to be processed, fodder crops ^d
20°C	>6 months	probably none	all crops ^e

Faeces

- Contain both water and non-water soluble nutrients
- N is lower in faeces than urine
- High nutrient concentrations for P, K, and organic matter give substantial yield increases especially on poor soils
- P is particularly valuable for the plant in its early development and important for good root development
- Large benefits of faeces → contents of P and high organic matter

The organic matter in faeces contributes in several ways

- Improves soil structure
- Increases the water-holding capacity of the soil
- Moderates soil temperature
- Supports soil microorganisms by serving as an energy source
- Releases nutrients at the rate plants need them

Application technique

- Faecal matter must be applied at a depth where the soil stays moist where it gets in contact with the soil solution and placed in such a way that it is within reach of the roots
- Applied at a soil-depth where it is well covered by upper layer of soil (sub-soil application)
- Application technique differs depending on the desired application rate

Application rate and timing

- Application rate can be based on the current recommendation for the use of phosphorus-based fertilizers
- Often applied at much higher rates at which the structure and water-holding capacity of the soil are noticeably improved
- Faeces must be applied prior to sowing or planting because it is very important for good development of seedlings and root system

Faeces have very high hygienic risk!!!

- Faeces contain the largest amount of pathogens – viruses, bacteria, protozoa, hookworms, and other parasitic helminths
- Barriers are needed against pathogens in faeces (different treatments)
- Wear protective clothing (i.e. gloves) during handling and wash afterwards
- Thorough covering during application of the treated faeces before sowing/planting
- No fertilization to vegetables eaten raw!!!

Treatment of faeces

Primary treatment – desiccation using additives

- Collection in a ventilated chamber with additives like plant ash, lime or dried soil to speed up the drying process

Importance of additives

- Decreases the risk of odours and flies
- Reduces some pathogens if additives has a high pH like plant ash or lime
- High pH of ash and lime with a rapid decrease of moisture level decreases biological degradation
- Provide different nutrients



References

- (1) Ecosanres (2005): Guidelines for the Safe Use of Urine and Faeces in Ecological Sanitation Systems. Factsheet No. 5. Based on: Schönning, C. and Stenström, T.A. 2004. Guidelines for the Safe Use of Urine and Faeces in Ecological Sanitation Systems. EcoSanRes Publication Series. Report 2004-1. Stockholm Environment Institute; Stockholm, Sweden.
- (2) Dr. Robert J. Holmer and Analiza U. Miso., Periurban Vegetable Project (PUVeP), Xavier University College of Agriculture, Cagayan de Oro City, Paper presented at DWA-BMZ-GTZ-Symposium Oktober 26-27, 2006, Eschborn, Germany
- (3) Peter Morgan and SEI, 2004.
- (4) Höglund, C. 2001. Evaluation of microbial health risks associated with the reuse of source separated human urine. PhD thesis, Department of Biotechnology, Royal Institute of Technology, Stockholm, Sweden.
- (5) WHO (2006). Guidelines for the Safe Use of Wastewater, Excreta and Greywater. Volume 4: Excreta and greywater use in agriculture. World Health Organization.

**Thank you very much for
your attention!**