Robert J. Holmer
Gina S. Itchon

Reuse of Ecological Sanitation Products in Urban Agriculture: Experiences from the Philippines

Local government official check the quality of the segregated and stored urine and faeces at the UDD toilet in Manresa Farm
Photo: PUVeP

Shortly after the first community-based allotment gardens were established for urban poor families of Cagayan de Oro, Philippines (Holmer & Drescher, 2005), one of the constraints observed was the lack of sanitary toilet facilities inside the gardens. A sustainable solution to address this sanitation problem had to be found, especially since these gardens are considered as showcases for integrated solid waste management, including the composting of segregated biodegradable wastes from the garden and neighbouring households (Urbina et al., 2005).

Several stakeholder meetings with community members and local government officials took place. The model of a urine-diversion dehydration (UDD) toilet, similar to those used in Danish allotment gardens (Bregnhoj, 2003), was introduced and discussed as one of the possible alternatives to a simple, ventilation- improved pit (VIP) latrine with a septic tank. This idea was introduced to Cagayan de Oro after one of the PUVeP technicians attended a training course on ecological sanitation at the Stockholm Environment Institute (SEI) in 2004. Research as part of this course showed that the application of urine increased the marketable yield of sweet corn by an average of 13.7 percent (Guanzon et al., 2005, Sol & Holmer, 2007).

Aside from improving the hygienic situation of the gardeners, UDD toilets would also help close the nutrient cycle by providing the possibility of reusing treated urine and faeces in urban agriculture.

Similar experiments were also carried out for non-food crops in cooperation with commercial growers in different areas of Cagayan de Oro. The urine application resulted in earlier and increased flowering of different ornamental plants with subsequent better marketability, as confirmed by the growers. Greener

UDDT toilets do not pollute nor produce wastewater, since human excreta are diverted, sanitised and recycled in a safe way. They collect and treat faeces and urine separately and do not need a central water supply or sewage system. Urine is stored in a plastic container and applied as fertiliser after one month of storage to ensure pathogen die-off. The faeces are collected in a vault, which consists of a single chamber with a mobile container or of two chambers. The 2-chamber model has the advantage that the second chamber can be used while the faeces in the first chamber are left for storage. The design of the toilet makes it easily adaptable to different types of communities.

"Urine is good for fruit-bearing vegetables, but should be mixed with water prior to application. I will encourage other farmers to use urine. However, (pesticide) spraying is still necessary, especially during heavy pest infestation. Based on my experience, a clean and well-maintained allotment garden encourages customers to buy vegetables, even those grown with the application of urine. The smell of urine is okay for me, but it takes some time to get used to it."
(Mr. Mansueto Cadete, president, Macasandig Allotment Garden, Cagayan de Oro).

leaves and healthier crop stand in general were reported for certain palms and mango seedlings, which are traits appreciated by both growers and customers (Guanzon et al., 2007).

Socioeconomic studies were also conducted to investigate urban growers' and customers' acceptance of crops fertilised with treated urine and faeces. Initial studies showed that acceptance among allotment gardeners was high, with an approval rate of more than 90 percent, since for them treated urine and faeces were not much different from the animal manures commonly used. However, only about 60 percent of the potential customers said that they were willing to buy vegetables fertilised with human urine and faeces, indicating the need for a strong information and education campaign to increase acceptance of vegetables produced in such a way (Urbina et al., 2005).

Most of the buyers' concerns were related to the safety of the crop produced. Although the guidelines of the World Health Organization (WHO, 2006) suggest a safe reuse of urine and faeces after a storage period of one month for urine and six to twelve months for faeces, it was decided to carry out several studies in the local context as regards the effect of storage time and secondary treatment on the presence of pathogens and helminth ova in human faeces.

The microorganisms found in fresh human faeces collected from 10 UDD toilets of different allotment gardens of Cagayan de Oro were *E. coli, Proteus vulgaris, Proteus mirabilis, Citrobacter spp. and Enterobacter spp.* These organisms are part of the normal human flora and all have a potential to cause disease in humans. These microorganisms decreased considerably during the first six months of storage in the collection chamber of the UDD toilets and do not pose a public health threat if the human excreta are reused in agriculture. However, helminth eggs were still found and, hence, six months of storage are considered not adequate to dehydrate human faeces and render them safe for agricultural use in a tropical country like the Philippines, where ambient humidity is high most months of the year. Secondary treatment of human faeces, such as subjection to aerobic composting or vermicomposting, is therefore suggested (ITCHON et al., 2008). One of the experiments conducted (Nuesca et al., 2007) showed that 60 days of vermicomposting of dried human faeces collected from UDD toilets decreased highly significantly the number of hookworm ova, while the number of Ascaris ova decreased significantly to 0.2 ova / 2 grams substrate in boxes with earthworms, compared to 2.6 ova / 2 grams substrate in boxes without earthworms. This data confirms results obtained by a similar study conducted by Eastman et al. (2001) in the United States, which recommends vermicomposting as a non-thermal treatment to sanitise bio-solids.

"If there is a supply of urine, I will really apply it. I have observed a 30 percent increase in the growth and stand of my plants applied with urine. Neighbours wondered about the strong smell in my area, but later on they got used to it. Based on my experience, the smell of urine will last for 15 minutes. I am 100 percent satisfied with my plants. It is important to not apply urine directly to plants but to dilute it with water first."
(Mrs. Rachel Osabel, grower of ornamentals plants, Westbound Bus Terminal, Barangay Bulua, Cagayan de Oro).

Acceptance among allotment gardeners was high

In the meantime, until further research studies are available, we recommend the reuse of urine in the allotment gardens according to the following guidelines (PUVeP, 2008):

- Store urine undiluted and in a closed container for one month to eliminate all pathogens. Storage in a sealed container prevents contact with humans or animals and hinders evaporation of ammonia. To provide a harsher environment for micro-organisms, the urine should not be diluted during storage.
- Prior to application to crops dilute at a rate of 1 part urine to 4-5 parts of water.
- Urine can be considered as a liquid fertiliser since nutrients in urine are mostly water soluble, and thus directly available for plant uptake.
- Urine should not be sprayed on plants but incorporated into the soil 10 cm away from the plant. This will reduce odour, foliar burns and the loss of nitrogen. Urine may also be applied through drip irrigation systems. However, clogging of emitters by salt precipitation may occur.
- Observe a waiting period of one month from last urine application to harvest of crops.
- Urine should not be applied to crops that are consumed raw (cucumber, lettuce, etc.) to ensure acceptance by costumers.

For the safe reuse of faeces, treatment is a must to prevent spreading of pathogens: faeces should be kept in the storage chamber of the UDD toilet for 6-12 months after the last defecation. Thereafter it should be subjected to a secondary treatment of 60 days of either vermicomposting or aerobic composting, whereby a temperature of more than 50°C is obtained during at least one week in the compost heap.

Reuse of diluted urine on sweet corn
Photo: Martin Wafler, SEECON GMBH

After secondary treatment has occurred, it can be used like any other organic fertiliser: nutrients are slowly released as the faeces is degraded in the soil by soil organisms. To ensure acceptance of vegetable produce by customers and to minimise health risks, it is recommended to use treated faeces not for vegetables but for fruit trees (banana, papaya, etc) or other tree species, whose harvested plant part is at a certain distance from the soil.

One question that is often asked regards the risk of heavy metals and micro-pollutants contained in human excreta. The Ecosan Services Foundation (http://www.ecosanservices.org) states that the presence of heavy metals is generally low or very low in excreta and depends on amounts present in consumed products. Hormones are excreted with urine and have long been excreted in terrestrial environments by mammals. Vegetation and soil microbes are adapted to and can degrade these hormones. Based on available data, they are considered a very low risk when applied on soil. Pharmaceutical substances are degraded in natural environments with diverse microbial activity and the risks associated with them are small.

The potential of ecological sanitation to contribute to sustainable development has already reached the lawmakers of the Philippine House of Representatives. The Committee on Ecology is presently discussing House Bill No. 3279 "An Act Mandating the Adoption and Implementation of Ecological Sanitation as a Method of Sustainable Urban Development Program and Institutionalizing the Integrated Support and Facilities towards Sustainable Urban Environment Development, Appropriating Funds therefore and for other Purposes" (or in short "Ecosan Act of 2007"), as an addendum to the existing Clean Water Act of 2004, which already mentions ecological sanitation as a viable tool to achieve the Millennium Development Goals.

Robert J. Holmer and Gina S. Itchon
Director, Periurban Vegetable Project, Xavier University, Cagayan de Oro City, Philippines
Email: rholmer@xu.edu.ph
Research Director, Jose P. Rizal School of Medicine, Xavier University, Cagayan de Oro, City Philippines
Email: gsjuly18@yahoo.com

References

Bregnhoj, H., 2003. Experiences with Ecosan in Danish allotment gardens and in development projects. Paper presented at the 2nd International Symposium on Ecological Sanitation, April 2003, p. 143-148.

Eastman, B.R., Kane, P. N., Edwards, C.A. Trytek, L., Gunadi, B., Stermer, A.L. Mobley, J. R., 2001. The effectiveness of vermiculture in human pathogen reduction for USEPA biosolids stabilization. Compost Science & Utilization, Vol. 9, No. 1, 38-49.

Guanzon, Y.B., Miso A. U., Holmer, R.J. 2005. Use of urine as supplemental fertilizer for sweet corn (Zea mays var. rugosa) production in a Philippine urban setting. 17th NOMCARRD Regional Symposium, August 4-5, 2005, Claveria, Philippines.

Guanzon, Y.B., SOL G.Y., Urbina, C.D., Holmer, R.J., 2007. Perception of Cagayan de Oro City growers and customers towards crops applied with urine. Paper presented at the ISSUE workshop "Strengthen our Gains in Ecological Sanitation", February 21-22, 2007, San Fernando, La Union, Philippines.

Holmer, R.J. Drescher, A.B., 2005. Building food-secure neighbourhoods: the role of allotment gardens. Urban Agriculture Magazine, 15, 19-20.

Nuesca, M. Z., Lee, S.O., Trappe, L., Holmer, R.J., 2007. Effect of vermicomposting on the presence of helminth ova (Necator americanus, Ttrichuris trichiura, Ascaris lumbricoides) in human faeces. In: Proceedings of the International Conference on Sustainable Sanitation: Eco-Cities and Villages, August 26-31, 2007, Dongsheng, China.

Itchon, G. S., Tan, M. L. B., Holmer, R. J., 2008. An observational study to determine the length of time necessary to eradicate parasitic ova and pathogenic bacteria in human excreta kept in the storage vaults of urine-diverting dehydration toilets in Cagayan de Oro City: A Preliminary Report. Faculty Working Series No. 11, March 2008, Kinaadman Research Center, Xavier University, Cagayan de Oro City Philippines, 6p.

PUVeP, 2008. Philippine allotment garden manual with an introduction to ecological sanitation. Periurban Vegetable Project, Xavier University College of Agriculture, Cagayan de Oro City, Philippines. 103 p.

Sol, G. Y., Holmer, R.J. 2007. Establishment of Urine Diverting Dehydration Toilets in the Allotment Gardens of Cagayan de Oro. In Axel W. Drescher & Robert J. Holmer (eds). Beyond Project Borderlines – the Asia Urbs Project "GIS based Urban Environmental Planning & Food Security Project". APT Report No. 16, December 2007, Applied Geography of the Tropics and Subtropics (APT, Institute of Physical Geography, University of Freiburg, Germany. 44-51 (ISSN 0949-6645).

Urbina, C. O., Miso A.U., Holmer, R.J., 2005. The socioeconomic impact of the allotment garden project in Cagayan de Oro City. Paper presented at the 6th International PUDSEA Conference "Strategies for Community Development in Urban and Periurban Areas of South-East Asia", July 11-15, 2005, Cagayan de Oro City, Philippines.

WHO, 2006. Guidelines for the safe use of wastewater, excreta and greywater. Volume 4: Excreta and greywater use in agriculture. World Health Organization, Geneva, Switzerland. ISBN 92 4 154685 9; http://whqlibdoc.who.int/publications/2006/9241546859_eng.pdf