STOCKHOLM ENVIRONMENT INSTITUTE

FACT SHEET

Agricultural Trials Demonstrate Benefits of Urine Harvesting and Sustainable Sanitation

Project name:	Demonstration of urine harvesting and urine application in agricultural production (under the framework project Enhanced Sustainable Sanitation Provision in Flooded Areas of India)
Location:	Bind Block, Patna, Bihar, India
Partner:	Water, Sanitation and Hygiene Institute (WASHi), India
Funder:	Swedish International Development Cooperation Agency (Sida)

Key features:

- Field trials show urine is a safe, effective and free substitute for commercial agricultural fertilizers
- Benefits of urine harvesting prove a powerful incentive for local adoption and promotion of sustainable sanitation

Background

Open defecation is a widespread practice in many parts of India, with serious implications for water quality and health. However, like many long-standing practices it can be difficult to persuade local people to abandon open defecation and use some form of sanitation instead. While the impacts of open defecation on health and the quality of local water sources used for drinking, washing and irrigation are well documented and demonstrable, this alone is often not enough to convince community members to change their practices. One particular stumbling block is that in much of India handling excreta has traditionally been the role of low-caste Dalits or "untouchables". Dry sanitation systems are often the only sustainable option in areas with water scarcity and underdeveloped infrastructure, and these systems inevitably require some handling of excreta, if reuse is aimed for.

A pilot project in Nalanda District, Bihar State, focused on overcoming this attitudinal barrier by demonstrating the potential economic benefits of ecological sanitation (ecosan) for local farmers. It introduced urine-harvesting facilities and sought to recast human urine as a valuable agricultural resource: an effective, safe and free alternative to commercial chemical fertilizers and thus a boost to livelihoods. This approach led to the adoption of urine harvesting in surrounding communities, and may have paved the way for the introduction of more comprehensive sustainable sanitation.

The pilot was part of a collaborative action-research project implemented by SEI and the Water, Sanitation and Hygiene Institute (WASHi), India, which explored different ways to introduce sustainable sanitation to communities in Bihar State. The project particularly focused on ecosan and the reuse of human excreta in crop production as the most potentially beneficial form of sustainable sanitation for rural communities. The pilot project was implemented by the local non-governmental organization Systematic Agro-based Research Institute (SABRI), which has long experience of working with grassroots women's self-help groups, including on agricultural production, nutritional intake and human health.

Public dry urinals outside the block administrative office in Bind

Urine as an agricultural resource

A large body of research shows that treated urine is an excellent fertilizer. The annual combined excreta of one family contains around as much useful plant nutrients as 50 kg of urea and 50 kg NPK (common commercial chemical fertilizers).[1] About 90% of the nitrogen, 65% of the phosphorus, and 73% of the potassium in human excreta is found in urine, in a composition similar to chemical fertilizers. The urine produced by one person during one year is sufficient to fertilize 300-400 m^2 of cereal cultivation/crops.

In addition to its nutrient content, treated urine does not pose the same pollution risks as chemical fertilizers, which generally contain elevated levels of heavy metals, potentially contaminating both food crops and local water resources. Urine is a readily available and free fertilizer, unlike chemical fertilizers, which require major investment and imply financial risk for subsistence farmers.

Thus, treated urine has significant advantages over chemical fertilizers, especially when combined with composted organic waste, e.g. from animal manure and kitchen residues. Handling

Table 1: Application frequency, urine doses and dilution rates for urine application on fruit and vegetable crops

Crops	Urine doses (per application)	Dilution (ratio urine/water)	Application frequency
Okra (ladies' finger), tomato, aubergine (brinjal), cabbage	0.25 litre	50:50	Every second week
Banana, papaya	1.0 litre	50:50	Every second week

Data: Sanjeev Kumar, SABRI

Harvested urine being transported to the field trial site

and agricultural use of urine is safe as long as World Health Organization (WHO) guidelines are followed, including among others treatment through storage.[2]

Introducing urine harvesting

The pilot project first set up urinals in a secondary school in Bind Block (a block is a rural administrative division above the village), Nalanda District. Six urinals were installed, three for boys and three for girls. Although no provision was made for defecation, this was considered a valid first step towards improved sanitation, as the school previously had no sanitation facilities whatsoever.

The district magistrate for Nalanda, Mr Sanjay Kumar Agarwal, who participated in the inauguration ceremony of the urine harvesting pilot, was enthusiastic about the idea and asked for the project to build another urine-harvesting facility at the Bind Block administrative offices, which also had no sanitation provision. (The block office urinals are currently all for male users, as there are only male employees at the office, but the project has lobbied for the installation of more urinals for the use of female visitors in the interests of gender equity).

Seminars and organized field visits were carried out with local farmers, agricultural experts and decision-makers from the region to raise awareness about, and to overcome negative attitudes towards, the agricultural reuse of urine.

Setting up agricultural field trials

The second element of the pilot project concept was to institute agricultural field trials to compare outcomes using treated urine fertilizer with those using common commercial fertilizers. A local farmer offered part of his land for the field trial, which used a range of locally grown crops. The site is located about 1.5 km away from the school and 0.2 km from the Bind Block offices. To make it possible to store the urine for at least one month – as indicated by the WHO guidelines for Bind's climatic conditions – 500-litre collection tanks were installed at the field site. Another local farmer has been engaged to transport the urine to the trial site in jerrycans using his tricycle.

In the trials, NPK fertilizer and treated urine are applied to parallel strips of land growing similar crops. The trials included the most commonly grown crops in the area: okra, also known as ladies' finger or bhindi), tomato, aubergine (brinjal), cabbage, chilli, banana and papaya.

The fertilizer doses and related crop yields have been carefully documented throughout the trials. The application and dilution rates of urine in the first growing season are presented in Table 1. The crop yields for urine and chemical fertilizer application are compared in Table 2 for all crops in the trials.

As Table 2 shows, urine gave similar or better yields than NPK fertilizer for all of the different crop types. Local farmers and agricultural specialists were invited to visit the site and inspect the results. They noted that the urine-fertilized products looked and tasted better than their chemically fertilized counterparts. Furthermore, the urine-fertilized plants were healthy and the products had a long shelf-life.

A recommended urine application protocol covering different crop types was developed based on laboratory analysis of the nutrient content of the collected urine and the trial results, which was done at the new laboratory set up in Patna under the SEI/WASHi collaboration.

Achievements and lessons

The pilot project has been highly successful in achieving not only its aims within the pilot area – instituting the sustainable reuse of urine and convincing local people to change their attitudes towards excreta – but also the SEI/WASHi collaboration's wider aim of outreach and eventual replication.

The model of a community-based agricultural field trial, demonstrating the use of urine with locally cultivated crops and comparing it with common chemical fertilizers, has been proved to be a highly persuasive way of demonstrating the benefits of urine and "humanure" more generally. The field trials have attracted considerable interest from outside the community. Billboards were erected along the local

Table 2: Crop yields from local agricultural trials comparing treated urine and chemical NPK fertilizer

Vegetables	Yield			
	Using treated urine		Using NPK fertilizer	
	(kg per m²)	(g per fruit/vegetable)	(kg per m²)	(g per fruit/vegetable)
Cabbage	-	1250	-	1250
Aubergine (brinjal)	3 kg	250	3 kg	250
Chillies	0.7 kg	4	0.8 kg	3.5
Tomato	2 kg	80	2 kg	80
Okra (ladies' finger)	0.8 kg	12	0.7 kg	12

Data: Sanjeev Kumar, SABRI

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Field seminar with farmers on the value of urine as fertilizer

feeder road announcing the trial activities and inviting farmers and other interested parties to visit. The field trials were instrumental in generating community support for another sustainable sanitation project under the SEI/WASHi collaboration, in the hamlet of Mohaddipur, which organized field visits to the trial site.

One of the key factors in changing farmers' ingrained attitudes towards urine handling was the estimated 4000

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Urine storage tanks at the field trial site enables adequate storage of urine to render it safe before application

rupees (about US$72) annually that a family can save by replacing commercial fertilizer with urine. The trial showed that urine was at least as efficient as NPK fertilizer. Also, urine has known insecticidal properties, which could represent a further economic benefit. This aspect has been explored at the Tarumitra Bio-reserve, also within the SEI/WASHi action-research project.

One lesson from the pilot project is that more attention needs to be given to the logistical aspects of urine harvesting in order to make such projects sustainable in the long term. Transportation of the urine requires manpower and, potentially, fuel.

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Cabbage plants being fertilized with treated urine as part of the field trials

Interaction with a series of key collaborators has been indispensible in raising the profile of the pilot and enhancing outreach to communities and farmers. These collaborators include government representatives, local farmers, media and the district representative of Indian Council of Agricultural Research, associated with Bihar Agriculture University. Another valuable partner has been Krishi Vigyan Kendra, (KVK), the leading agricultural science centre in Nalanda District, which has connections with agricultural researchers and local farmers and thus offers a wide network for project outreach.

Access to the new water and nutrient-testing laboratory in Patna has also been highly valuable. Laboratory testing of the nutrient and pathogen content of the urine has allowed refinement of treatment and dosages protocols, and underpinned the scientific credibility of the trials.

Furthermore, the district magistrate, Mr Agarwal, has shown great interest in the project and helped not only in raising its profile but also in replication. At his request, SABRI gave technical assistance to the Public Health Education Department (PHED) in Nalanda to install similar waterless urinals in his office premises in the district capital, Bihar Sharif. Furthermore, outreach from the project to communities and decision makers has contributed to the installation of two new community-based sanitation complexes in Nalanda, both within the project and externally supported by the district government.

The project's strategy of focusing on urine as a valuable resource, rather than a waste product, has helped to overcome social barriers to acceptance of sanitation systems. While the pilot does not directly address the problem of open defecation – which has the most serious health and environmental implications – it has highlighted the need for sanitation in communities in Nalanda, which is an important first step.


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Urine-fertilized aubergine (brinjal) grown in the field trials

Endnotes

1. Richert, A. et al. (2010). Practical Guidance on the Use of Urine in Crop Production. EcoSanRes series: 2010-1. Stockholm Environment Institute, SEI, Stockholm. ISBN 9789186125219.

2. World Health Organization (2006). Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Volume 4: Excreta and Greywater use in Agriculture. WHO, Geneva. ISBN: 92 4 154685 9

For further information

To learn more about the SEI-WASHi collaboration visit http://www.sei-international.org/projects?pid=2070 or read the following SEI fact sheets:

Promoting Sustainable Sanitation to Reduce Human Vulnerability in Bihar, India, www.sei-international.org/publications?pid=2393
Ecological Sanitation Facility Meets Gender-Specific Hygiene Needs in School, www.sei-international.org/publications?pid=2498
Showcasing Ecological Sanitation at an Environmental Education Centre www.sei-international.org/publications?pid=2499
Flood-resistant Ecological Sanitation Takes Off in a Rural Community, www.sei-international.org/publications?pid=2497
Piloting Enclosed Long-term Composting technology in an Indian Village, www.sei-international.org/publications?pid=2501
New Non-Profit Laboratory Supports Sustainable Sanitation, www.sei-international.org/publications?pid=2496

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Published by:
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2014
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