Wastage to usage - Towards A New Green Revolution

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Agriculture is the backbone of developing countries such as India and the use of fertilizer has soared over the last few decades. By 2020, over two hundred million tonnes of fertilizer will be required, as well as increased use of pesticides, 85% of which are used in agriculture. The misuse and overuse of fertilizers and pesticides is causing huge environmental problems. Each year it is estimated that chemical pollution in agriculture costs about $100 billion in public health and environmental damage worldwide. Inappropriate land use, bad soil management, monoculture with large amounts of pesticides, and failure to replace nutrients can have an adverse impact on the environment. Surface water can be 'infected' with green algae through an excess of oxygen, ground water is contaminated, and the environment is damaged by erosion, leaching, and the destruction of organic matter, build up of methane depletion of nitrogen .

In India 80% of rural people live below the poverty line and are dependent on agriculture and related activities. Following the example of larger farms, small and marginal farmers buy chemical fertilizer and pesticides, often going into debt to do so. Excessive use of mineral or chemical fertilizers and pesticides has caused soil degradation, ground water pollution and reduced soil fertility. Sustainable agricultural practices are required to overcome these problems and sustain production by improving the health of the soil at low cost.

The answer is to use human waste, which can be used as an organic fertilizer for almost all crops. Human excreta can become a resource to be recycled, rather than waste to be disposed of. Recycling sanitized human urine and faeces by returning them to the soil helps to restore the cycle of natural materials that has been disrupted by current sanitation practices. Where crops are produced from soil, it is imperative that the organic residues resulting from these crops are returned to the soil from which the crops originated. This recycling is axiomatic for sustainable agriculture.

India is the third largest producer and consumer of fertilizer in the world after China and the USA. In order to reduce the use of chemical fertilizers and pesticides in agriculture an alternative strategy of using natural and organic fertilizer is required, in order to make use of the nutrients it contains.

Urine contains 88% of the body's excreted nitrogen, 67% of the phosphorous and 73% of the potassium; the rest is excreted in faeces. An adult excretes on average 500 liters of urine and 50 liters of faeces per year. This varies from country to country depending on diet.

Urine can be used as a high quality and clean fertilizer that is easy to collect and can be used pure or diluted. The fertilizers excreted by one person are sufficient to grow 230 kg of cereal each year. By separating human urine at source, the amounts of nutrients recycled to arable land can be significantly increased while at the same time significantly decreasing water usage.

It is calculated that one liter of normal human urine contains 4.6 grams of nitrogen, 0.6 grams of phosphorus and 2.2 grams of potassium. It was calculated that the rural population of India generates about 1,350 million liters of urine per day. The urine from this may be enough to supply all the nitrogen and one-quarter of the phosphorus and potassium required for India's banana crop, saving about 4,450 million rupees (about $74 million) on fertilizers every year.

Apart from saving money, there are many other advantages of recycling urine. It prevents direct pollution caused by sewage being discharged or seeping into water resources and ecosystems, reducing the risk of pathogen transmission.

Urine application is ideal for rural and peri-urban areas where agricultural land is close to the point of urine collection. Households can use their own urine on their own plot of land. Alternatively, if the facilities and infrastructure exist, urine can be collected at a central location for distribution and transport to agricultural land. Farmers do not need not to pay for urine and it is always available locally and easily collected, although it must be stored and used properly or it can become a source of pollution.

Recycling restores nutrients to soils and plants, by increasing organic matter content and improving water-holding capacity, and reduces the need for chemical fertilizers. Urine is especially beneficial where crops are lacking nitrogen. Examples of crops that grow well with the use of urine include maize, rice, millet, sorghum, wheat, chard, turnip, carrots, kale, cabbage, lettuce, bananas, papaya and oranges.

Another advantage of using human urine instead of chemical fertilizers or sewage sludge is the very low concentrations of heavy metals found in urine. It also helps to maintain a healthy population of beneficial soil organisms that actually protect plants from soil borne disease.

Recycling urine helps to reduce greenhouse gases by 16 kilos per year for each person's urine harvested and utilized. The value of the nitrogen, phosphorous and potassium in urine is about Rs150 (US$2.5) per person per year, if it is valued at the cost of the chemical fertilizer it can replace.

Human urine can be used as an organic fertilizer to cultivate different kinds of crops. This was pioneered in Nepal by Jeevan Maharajan, a local farmer in the village of Siddhipur village near Kathmandu. Farmers were complaining that the productivity of different crops had been decreasing over the years, and thought it could be due to the repeated use of chemical fertilizers. Once they began to use urine to fertilize their crops the required nutrients in an appropriate balance were maintained in the soil, increasing its fertility and productivity.

In India, the Society for Community Organization and People's Education started training farmers to cultivate banana trees using urine stored in a 'urine bank'. The main objectives are to help small farmers to improve soil conservation and water management with a special emphasis on wasteland development, and to encourage them to use appropriate technology in agriculture and animal husbandry. It also focuses on educating people in preventive healthcare, and providing medical facilities in villages.

In June 2008 the National Research Centre for Banana (NRCB) and NGO-SCOPE (Society for Community Organisation and People's Education), both based in Tamil Nadu, started a research project into the use of human urine as a liquid fertilizer for banana cultivation. SCOPE had already set up ECOSAN Community Compost toilets in the town of Musiri, near Trichy in Tamil Nadu, to collect human urine, which was used by NRCB as a liquid organic fertilizer through the drip irrigation system on a banana plot.

In June 2009 the banana was grown with guidance from National Research Centre for Banana, in with encouragement from local government officials, and the research project was funded by the Swedish Environment Institute, Stockholm and UNICEF, New Delhi.

The banana was grown experimentally with four different levels of human urine applied with irrigation water together with graded levels of commercial potassium fertilizers. The application of 50 liters of human urine per plant with 75% recommended commercial potassium fertilizer recorded 32.1% more plant height, 25.6% more stem girth, 71.5% more leaves and 68.8% more leaf area, 25% more leaf nitrogen concentration, 52.6% more phosphorus concentration and 6.5% more leaf potassium than the banana plants grown without urine application. Detailed studies on yield parameters and the edible quality of banana fruits may show the way to solutions for the future of Indian agriculture.

In India bananas are grown on half a million hectares of land, with an annual production of 169 million tonnes. The cost of chemical fertilizers is increasing steeply and this research can open up ways of using liquid fertilizer for banana cultivation to cut down the cost of cultivation in addition to many other advantages.

The basic aim of ECOSAN is to close the loop between sanitation and agriculture by reducing the health risks of contaminated sewage water and human waste, and by optimizing the management of nutrients in urine and excreta by re-using them to improve soil fertility. The re-use options are not limited to agriculture. There are other options which can and should be integrated with ECOSAN systems, such as the domestic re-use of gray water following suitable treatment to flush toilets, or use as service water in industry or to recharge ground-water. The energy contained in wastewater can be used for example in cooking, electricity generation, and heating or even for industrial use.

The ECOSAN toilet has two chambers and a concrete base so that there is no contact between human excreta and the soil. After defecation the user sprinkles the excreta with ash so that there will be no fly problems , then closes the drop hole with a lid. Only about three liters of water are required to flush the toilet, compared to 12-15 liters in a conventional toilet.

In the first ECOSAN Compost Toilet developed by SCOPE in 2002 the wash water and urine were carried through the same pipe to a pot kept outside the toilet, and were used for watering the kitchen garden. The wastewater from the toilets proved to be highly nutritious, speeding up the growth of plants raised in the gardens close to the compost toilets. A family of five can use one chamber for about eight or nine months. When it is full it is sealed with a cement lid and left

for six or seven months until it becomes compost. A detachable concrete slab at the rear allows easy removal of the compost. After the first chamber is sealed the family uses the second chamber.

The first pit of an ECOSAN toilet in Kaliyapalayam village in Trichy District was closed in September 2004, when it was full. When it was opened in June 2005 the analysis report showed that the compost contained no pathogens and was a very good soil conditioner.

Ecological Sanitation has many advantages. It improves health by minimizing the entry of pathogens from human excreta into the water cycle and to the human body, it recycles urine and excreta after their safe and hygienic recovery, and it conserves resources, reduces water consumption, replaces chemical fertilizers and minimises water pollution.

It also promotes soil fertility, improves agricultural productivity and hence contributes to food security. In a more general way, it promotes a holisti**c**, interdisciplinary approach to hygiene, water supply and sanitation, resource conservation, environmental protection, urban planning, agriculture, irrigation, food security, and small-business promotion, and contributes to a beneficial material-flow cycle instead of disposal.

SCOPE has developed a system to filter the urine collected from community and individual home toilets by using the ECOSAN method. Urine is collected by the ECOSAN toilet and is then filtered through two layers, the first filled with sand and the second with coal. The urine is stored for up to 30 days, and is then used directly or in a diluted form for agriculture. The guidelines for safe urine use are based on storage time and temperature. However, it is generally accepted that if urine is stored for at least one month, it will be safe for agricultural application at the household level. Stored urine is a high quality, concentrated source of nutrients that can be applied as a liquid fertilizer in agriculture to supplement or replace commercial chemical fertilizers. If urine is used for crops that are eaten by those other than the urine producer, it should be stored for six months. Urine should not be applied to crops within one month of harvest. For normal, healthy people, urine is virtually free of pathogens and it contains the majority of the nutrients that are excreted by the body.

It is important to know how to use urine to fertilize crops correctly, and it varies depending on climate. Stored urine should not be applied directly to plants, because of its high acidity and

concentration. It can be mixed undiluted into soil before planted, poured or sprinkled on the soil 10-20cms away from the crops, or diluted and used around plants. A 3:1 mix of water and urine is an effective dilution for vegetables, applied twice weekly, although the amount depends on the soil and the type of vegetables. During the rainy season, urine can also be applied directly into small holes near plants, where it will be diluted naturally.

Although urine has been used as fertilizer since ancient times in many countries, its use is still uncommon in India. However the idea has gained attention after the promotion of ecological sanitation in India, as a means of recycling urine and reducing dependency on commercial fertilizer. It is an inexpensive, abundantly available, effective organic crop fertilizer. Moreover the ECOSAN method for colleting urine is an easy and effective method which can be practiced by poor families. This helps to increase their health and to improve their sanitation practices.

For example in the district of Siddhipur near Kathmandu in Nepal the local farmers have started a "Urine Bank" to collect urine from homes and community toilets. The bank is maintained and regulated by a user committee which includes the local farmer from the village, which helps farmers to access the required amount of urine that they need to fertilize their crops. The committee has appointed an employee, who has the job of going door to door to collect the urine and bring it to the urine bank. The collected urine is stored in two tanks, each with a storage capacity of a thousand litres. The user committee plans to provide urine to the farmers at the cost of one Nepalese rupee (about one US cent) per litre to generate funds to pay for collection, operation and management. Fifty percent of the amount raised is saved by the user committee for future construction and repairs, and the rest is used to pay the staff.

ECOSAN individual and community toilets encourage farmers to use urine in agriculture. They are maintained by the individuals and communities, and provide farmers with sufficient urine to fertilize their crops. This is a sustainable and replicable method for the future. Normally urine was considered as a waste material and using urine for food production was considered to be a sin. But urine is being for agriculture all over the world, including in India. .

In a pilot project in Kerala, urine from toilets was diverted into an area attached to the back of the toilet where bitter gourds were grown. In the North-Eastern state of Manipur , harvests of potatoes and chilies, where urine was used as fertilizer, were very good compared to harvests

fertilized with chemical fertilizer, such as diammonium phosphate, urea and potash. Toilets that separate urine have been recently piloted in Tamil Nadu and Karnataka where communities have started using urine and faeces as fertilizer in their household gardens. In Trichy, a community ECOSAN block has been constructed and the initial reports are encouraging; local farmers use the urine for their banana and maize crops. In Bangalore research is taking place into the use of urine for growing banana and maize plants and the initial results are very encouraging. There is a long way to go, and many prejudices must be overcome, but human waste need not be wasted.