Recycling human waste for food security

Eighty percent of the world's hungry population and those lacking adequate access to sanitation live in rural areas. Progress at achieving hunger and sanitation targets are lagging behind, more so in rural areas. Conventional measures to improve food security and sanitation have been ineffective as chemical fertilizers and water-based sanitation are not only costly but have adverse environmental effects. Ecological sanitation offers alternative solutions by promoting reuse of human excreta on farmland and in essence does boost linkages between sanitation, agriculture and protection of environment.

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Food consumption in many regions remains inadequate despite improvement in aggregate world production. In the next decade food consumption in the Caribbean and Latin America is expected to stagnate, this means 32 per cent of its population will not meet nutritional requirements. Sub-Saharan Africa, the only place where the number of hungry and malnourished people continues to rise, is expected to account for 50 percent of the food gap in the next decade.

Rural poor account for 80 percent of the world's 800 million hungry people. Scarcity of food drives them to cultivate and overgraze fragile environment, threatening resources upon which their lives depend on. The WHO report, 2005 estimates one in three children and one in six adults to be malnourished. Of the 10.4 million children under five years that died in developing countries in 1995, 50 percent died of malnutrition. Clearly, hidden hunger due to micronutrient deficiency is a major problem. Ironically, poor people have begun suffering from overconsumption and diseases that accompany it. Hunger and malnutrition increases morbidity, decreases productivity, drains poor people financially and reduces cognitive development. Among other factors food insecurity is caused by lack of knowledge on agricultural practices, water shortage, soil infertility, high cost of chemical fertilizers and high morbidity. At household level, poor sanitation and ignorance on food handling aggravate nutrition insecurity.

Improving food security

Besides increases in food production and use of food supplements, food security can be improved by control of public health diseases. Each year, water borne diseases claim 1.7 million lives and cause suffering across developing nations. Recurrent incidence of diarrhoea and worms lowers the ability of human body to absorb nutrients in food. Even though improved sanitation can reduce water borne diseases by 35 percent, little progress has been made in ameliorating sanitation and still more than 2 billion people lack sanitation. Conventional approaches have largely failed in rural areas, alternative approaches of protecting human health while improving food security and protecting the environment ought to be sought. Ecological sanitation (EcoSan) offers an alternative to conventional sanitation and endeavour to solve some of society's most urgent problems: infectious diseases, pollution of the environment and degrading soils.

Photo: Were

Mango and banana planted in a filled arborloo.

What does «EcoSan» mean?

In ecological sanitation «EcoSan», human excreta are valuable resources required to restore soil fertility. Human waste is sanitized at source either by dehydration or composting thereby making it safe for reuse. Requiring little water for operation, EcoSan is attractive and viable in water scarce areas. It eliminates use of fresh water as transportation medium and sink for human waste, predicament inherent with water based sanitation. Worldwide only 50 percent of solid waste and 10 percent of waste water is adequately treated. The rest pollutes land and water – significant sources of food. An integral part of EcoSan is full involvement of end users in identification of sanitation needs, design, construction and maintenance of the toilet.

Models for rural areas

Arborloo is made of a 1 meter deep pit, a portable slab and a superstructure. Wood ash and soil is added regularly to reduce fly breeding and odour. When the pit is three quarter full, the slab and superstructure are removed and mounted on a nearby shallow pit. The open pit is topped up with at least 15 centimeter of soil, leaves and other organic material to aid in decomposition. A tree is then planted on top soil to make use of nutrients in the decaying pit. The cycle is repeated and in time a woodlot or fruit orchard will cover the landscape.

Fossa Alterna consists of two 2 meter deep chambers used alternately. Wood ash and soil are added regularly after use and when one is filled up; leaves, soil and wood ash are added to reduce odour and flies. The top up ingredients also change biological make up of excreta by introducing beneficial bacteria, fungi, worms and insects that enhance air circulation and conversion to humus. A family of six would fill up one pit within eight months and composting time not less than twelve months is recommended. Exact time of decaying depends on temperature, pH levels and moisture content. This differs from one region to another.

Urine diversion involves separation of urine from excreta during production. Urine can be collected in a Jeri can and faeces in a bucket. At household level, urine can be used immediately after collection. In case of cross contamination from faeces, urine should be stored in an airtight container for at least 48 hours and diluted water in the ratio of 1:5. Faeces collected are transferred to a compost pit where it is mixed with other organic waste from the household, leaves and soil to enhance its conversion to humus.

Value of humanure

Potassium, phosphorous and nitrogen are key ingredients for chemical fertilizers and are found in human excreta. Urine contains 80 percent of nitrogen and potassium and 67 percent of phosphorus; the rest is excreted in faeces. Faeces contain 80 percent of carbon and urine only 20 percent. Other nutrients, such as calcium and magnesium, are excreted in nearly equal amounts in urine and faeces (see table 1).

Most soils in Africa are deficient of these nutrients. Nitrogen is the most important nutrient in vegetative plant growth and leaf building. Phosphorous is essential for shoot and root development and fast maturity of crops while potassium builds fibre and health of plants. For human survival phosphorus must be recycled as its supply is limited. Nitrogen is plentiful in the atmosphere while potassium can be obtained from wood ash.

As an excellent soil conditioner, humanure increases uptake of nutrients and efficiently regulates light and temperature utilized by plants. It also increases the water holding capacity of soils thus plants grown with humanure require less watering and can withstand better harsh weather conditions such as drought.

Compared to chemical fertilizers and animal manure, humanure improves plants ability to withstand attacks and diseases from insects through improved microbial agents. Incidences of plant parasites and nematodes in soil along with effect of soil borne pathogens are reduced. Urine can be used as insecticide, reducing the need for chemical spraying.

As a storehouse of nutrients humanure slowly releases nutrients during growing period due to prolonged breakdown of organic matter and availability of boron, manganese, iron, copper and zinc, which are not present in chemical fertilizers.

The quality of humanure obtained depends largely on the quality of the ingredients added to the pit during composition. Texture, nutrient levels and water holding capacity are enhanced when fertile topsoil and leaves are added. However, this should not nullify application of poor topsoil as significant improvements can be achieved as indicated in table 2.

What are the benefits of EcoSan?

- EcoSan promotes self-reliance among rural families. Compared to a conventional pit latrine, initial investment is small. It has a simple and flexible design, making use of local skills and materials such as grass and maize stalks possible. More significantly, families can enrich the soil and improve their diets.
- Full involvement of end users means that everybody, be it women, men, young and old people can adapt EcoSan to their needs and economic capability.
- Like organic farming, EcoSan promotes sustainable agriculture by improving water, soil and biodiversity, which are very essential renewable assets. EcoSan also enhances human capital by building on skill and creativity of farmers.
- Returning organic matter, of which 50 percent is carbon to the soil locks up carbon while recycling nitrogen in farms reduces eutrophication in water bodies and consequently locks methane, nitrous oxide and carbon dioxide, key gases in advancing global warming.
- Humanure has a low content of chemicals and heavy metals, less than chemical fertilizers and urban sewage. Toxins

Table 1: Composition of human excreta

Element	Urine	Faeces	Urine and faeces
Nitrogen	11.0	1.5	12.5
Phosphorous	1.0	0.5	1.5
Potassium	2.5	1.0	3.5
Organic Carbon	6.6	21.4	30
Wet weight	1 200	70-140	1 200-1 400
Dry weight	60	35	95

*grams per person per day; Source: Esrey et al, 2000

Table 2: Nutrient levels of humanure with different topsoil additives

Example 1	Nutrient levels					
	pH	N	P	K	Ca	Mg
Topsoil from cemetery	4.9	50	12	0.18	2.95	0.78
Humanure harvested	6.2	222	422	2.22	3.60	3.57
Example 2	Nutrient levels					
Soil from Kennel site	5.5	27	5	0.29	10.23	4.11
Humanure harvested	7.6	355	258.7	7.14	8.97	6.26

Source: adapted from Morgan and SEI, 2004

available in human excreta are decomposed limiting their uptake by plants.

- By enhancing soil fertility, a condition for increased agricultural returns, EcoSan offers opportunity for the integration of men in hygiene promotion and management of toilets, both often considered women's domain.

Safeguarding health

Handling of human excreta creates a complex situation but not a new one. Chances of contamination are just as high if not worse in the «drop and store» toilets as hand washing is low and contamination through fields, a result of poor waste management and lack of toilets is predominant. Persistence pathogenic bacteria and helminth worms (askaris) present in human faeces are potential risks to human health. The difference between EcoSan and conventional systems is that human excreta are made safe at the point of production. Recent studies in Vietnam indicate the die-off of pathogen bacteria at 37 days and of askaris at 65 days with an average pH of 9.5 to 10. In Kenya and Zimbabwe, six months is sufficient for destroying of pathogens and askaris. High pH, which is crucial for killing pathogens, was achieved by adding lime, wood ash and soil. Temperature and moisture content also affect survival of pathogens but are difficult to control in absence of materials that foster desiccation and higher heat. In the cold regions of China, plant ash proved to be more effective in destroying pathogens than coal, wood ash and soil.

Urine without faeces is considered to be sterile and at household level urine can be applied directly to crops after collection. Urine is known for its therapeutic functions and in some communities it is used to clean wounds and to lessen stomach and tooth ache. To reduce risk of transmission, the World Health Organization recommends a one month withholding period between the last application and harvesting. In large scale collection points, storage of between one and six months is recommended. At twenty degrees centigrade one month is sufficient for destroying pathogens. At lower temperatures time is extended and a pH greater than 8.5 is recommended. When urine is stored it converts to ammonia, raising pH which asphyxiates pathogens

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Barriers in promoting EcoSan

- Prejudice against handling of human waste and strong taboos on usage of human excreta for agriculture are primary barriers in promoting EcoSan.
- Lack of political will and favourable policies and regulatory structures undermine promotion of sanitation as a sector, and ecological sanitation in particular has very limited support across the world.
- Lack of knowledge by users on basic hygiene practices and of policy makers on benefits and risks of EcoSan make promotion costly. At present, advice and support to initiate dialogue and culture on reuse of human waste as manure is inadequate.

The way forward

Behaviour change. Transformation from one level and form of hygiene and sanitation practice to another is multifaceted and may take years before being realized. There is a need to identify approaches that will enhance adoption of ecological sanitation. A key ingredient in changing behaviour is to increase belief that human waste is safe and good for crop cultivation. Participatory methods that enable men and women to understand their sanitation status and gain knowledge to make informed choices regarding sanitation options should be encouraged. For EcoSan, the truism «seeing is believing» sets foundation for its adoption. An open mind must be maintained while promoting EcoSan. In some areas, convincing demonstration on improved yield on infertile soil may increase acceptance of humanure while in some areas acceptance may go only as far as planting a tree on a filled toilet. In cultures with strong resistance e.g. among pastoralists, alternative uses such as watering pasture with urine and incineration of human excreta for energy can be adopted. Ash from incineration does provide good fertilizer and can be used to increase acceptance.

Packaging EcoSan. User education on the benefits and risks of ecological sanitation are paramount for scaling up EcoSan. Given that the majority of the human population considers water-based toilets and pit latrines as«safe», they are not aware of adverse environmental impacts inherent with them; minimizing health risks is crucial. The same people consider chemical fertilizers safe and productive. There is need to develop information countering such beliefs and instil the belief that ecological sanitation is safe, sound and convenient for the user, farmer and most importantly the consumer.

Identification and training of service providers. The private sector in the rural area should be identified and empowered. Market characteristics should be elucidated and local artisans trained on various aspects of EcoSan. Creativity of local artisans should be encouraged to foster competition and enhance service delivery.

Additional resources for sanitation. Ecological sanitation comes with new dimensions of health risks due to the handling of human waste. An increment in budgetary allocation to sanitation should be secured to make users aware of their responsibilities and undertake follow up studies until operational requirements become common knowledge. There is a need to expand experts in sanitation by targeting existing and new professionals in the public and private sector. Communities, governments and donors should mobilize resources for the sanitation basket.

Political will. An orphan in most sectoral development programmes, governments should establish an institution with strong mandate to oversee development initiatives and coordinate efforts targeted at improving sanitation. Collaboration with relevant ministries including water, agriculture, health, should be enhanced and where necessary, reforms instituted to support usage of humanure. Politicians should regard EcoSan positively because it adds value to human excreta by converting it to humanure and provides an effective public health tool by conserving water, curtailing the morbidity and improving the diet. Policy makers do however need information; they should be informed about what they need to know and to do to enhance adoption of EcoSan.

Conclusion

The use of human waste in farmland is not new but one that has been done for centuries albeit marginally. EcoSan deserves priority and should be incorporated in the development agenda. Not only is it cost effective but also returns in cost are much higher than in conventional systems. It offers an opportunity for improved nutrition, conservation of natural resources and abatement in morbidity.