ECOLOGICAL SANITATION, AN APPROACH TO SUSTAINABLE SANITATION

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Abstract: In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources (SuSanA, 2008). Achieving sustainable sanitation is very relevant and important in developing and emerging economies. One approach to sustainable sanitation is called Ecological Sanitation. Ecological sanitation, Ecosan for short, is a holistic and sustainable approach to sanitation based on the principles of preventing pollution, sanitizing human excreta and using urine and feces as resources for agriculture. The basic approach is to separate the two fractions of human excreta, i.e., urine and feces, using a urine diverting toilet bowl. Human excreta is rich in Nitrogen, Phosphorous and Potassium (NPK), all important plant nutrients. An Ecosan user in San Fernando, La Union applies his sanitized urine and dried feces in his high value bonzai and ornamental plants; several farmers use urine from a school to irrigate rice, corn and vegetable plots with very good results. In Bauang, La Union, several guapple (giant guava variety) and corn producers have switched from chemical to urine fertilizer. Ecosan has been adopted in other municipalities, i.e, Bayawan in Negros Oriental and Cagayan De Oro in Misamis Oriental, to name a few. Implemented properly, Ecosan facilities can be affordable and safe. It conserves water and advocates recycling of plant nutrients thereby promoting livelihood, sustainable agriculture and food security.

Key words: Sanitation, Ecological Sanitation, Sustainable Agriculture

1 INTRODUCTION

Sanitation is about many things to many people but essentially many will agree that sanitation is about the proper management of human excreta, in terms of clean and safe facilities for human interface, storage, treatment, and disposal. Sanitation is clearly about protecting individual and public health against domestic human waste and water borne diseases.

But sanitation has many sides to it. One very important side of sanitation has to do with the environment. Improper domestic liquid waste management can easily pollute the waterways and water bodies surrounding human settlements, especially in the urban and highly urbanized areas.

Another very important side of sanitation which very few people appreciate has something to do with excreta reuse. It is common to think that human excreta is a waste product of human existence and must be disposed off expeditiously. Thinking of human excreta as a resource is not natural to us. At this point in our development, it is practical for us to "flush and forget" our domestic human waste down the sewer pipe or septic tank.

Treating human excreta as a resource is the main thesis of Ecological Sanitation. Aside from dangerous pathogens, human excreta also contain beneficial plant nutrients, i.e., Nitrogen, Phosphorous and Potassium or NPK. Ecological Sanitation or Ecosan, for short, is all about proper and safe harvesting of human excreta and returning plant nutrients it contain back to the soil.

This paper discusses the science and technology behind Ecological Sanitation, its principle and applications.

2 THE DEFINITION AND PRINCIPLES OF ECOLOGICAL SANITATION

Ecological sanitation systems safely recycle excreta resources (plant nutrients and organic matter) to crop production in such a way that the use of non-renewable resources is minimised.

Three (3) fundamental principles of Ecological Sanitation are (Winblad, et. al. 2004):

1. preventing pollution rather than attempting to control it after we pollute
2. sanitizing the urine and feces
3. using the safe products for agriculture purposes

2.1 Preventing pollution rather than attempting to control it after we pollute

The conventional sanitation wisdom tells us to treat the wastewater we produce. Modern cities of developed countries pride themselves of state-of-the-art wastewater treatment. These cities have capital intensive sewerage pipeline and treatment plant infrastructure that enable them to remove pollutants from wastewater before releasing it to the surrounding water environment. London, for example, has come a long way from its 19th century experience when its Thames River was filthy and obnoxiously odorous receiving untreated sewage. Treating water after it has been polluted has become the order of the day for the modern and aspiring-to-be-modern cities.

In city-state Singapore, they went a step further. Wastewater from sewer pipelines is subjected to various treatment processes including reverse osmosis to produce purified water, said to be "cleaner" than potable water from the tap. This sounds logical for income rich but resource poor country like Singapore. Israel, another resource poor country, is noted to recycle more than 90 percent of its wastewater for reuse in agriculture.

Unfortunately, not all cities are created equal. Most cities, especially those in the developing and emerging countries, can hardly afford to install these highly priced sewerage systems. With ill-planned or unplanned built-up urban areas, these low- to middle-income cities have untreated or semi-treated wastewater that pollute their river systems. In Metro Manila, for example, rivers and esteros are considered biologically dead due to inadequate wastewater treatment systems allowing millions of liters of partially treat wastewater to pollute the water ways every single day, 24/7. In the Philippines, less than 15 percent of the households is served by sewerage system; around 80 percent relies on septic tank system which is the default treatment approach. The rest have no treatment at all. At most, the septic tank system is only 50 percent effective in reducing pollution. Un-serviced septic tanks which comprise the majority perform much less.

Ecosan, on the other hand, starts with preventing the generation of wastewater to begin with. In its basic design, human excreta is not flushed down with water. No water is needed. So it is often called the waterless toilet system. This is beneficial in many ways. First, communities using Ecosan dry sanitation do not produce wastewater and therefore has no pollution loading in its water bodies, both surface water and underground aquifers. They also do not need capital intensive sewerage systems and therefore money can be diverted to other basic necessities of the constituents. Moreover, with dry sanitation, waterless communities can have a sanitary toilet option that is far better than a pit latrine. This solves the long standing issue of government providing pour-flush toilets to poor households without toilets.

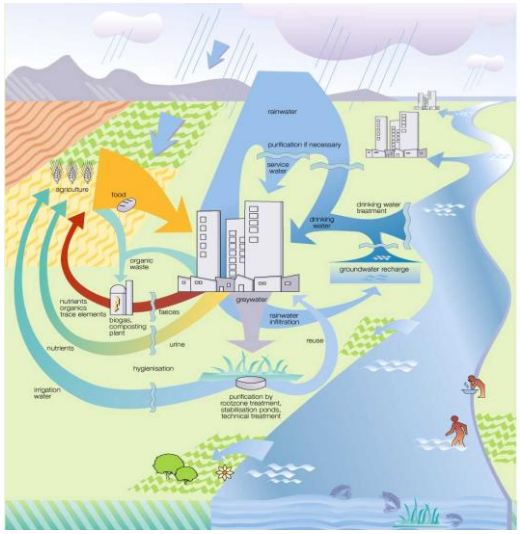

Figure 1 Closing the loop between sanitation and agriculture

2.1 Sanitizing the urine and feces

If sanitation is primarily for health protection, then Ecosan must ensure that human excreta is sanitized for safe handling and reuse. In contrast with conventional wastewater treatment system, Ecosan can render excreta safe at minimal cost and low tech methods.

Human excreta is composed of two fractions: urine, the cleaner fraction, and feces, the dirty fraction. In the conventional water-reliant system, urine and feces are combined and flushed down together. This system renders urine, considered to be sterile and a ready-to-use liquid fertilizer rich in Nitrogen, severely contaminated and useless.

In Ecosan, urine and feces are diverted from one another and are processed and handled separately. The diversion is done through a urine diverting toilet bowl (see Pictures 1 and 22 and Figure 2). Urine is stored for a month, while feces is stored and kept dry for 6 to 12 months, according to WHO guidelines on excreta management. According to some experts, privately produced urine by households with members who are relatively healthy can be used as fertilizer immediately to irrigate their crops. Urine, by natural process, produces urea which has anti bacterial properties. The one-month storage guideline of WHO for urine is designed for multi-source collection, meaning urine collected comes from various generators and the pathogenic quality of the urine is not assured.

Figure 2 A Urine-Diverting Bowl

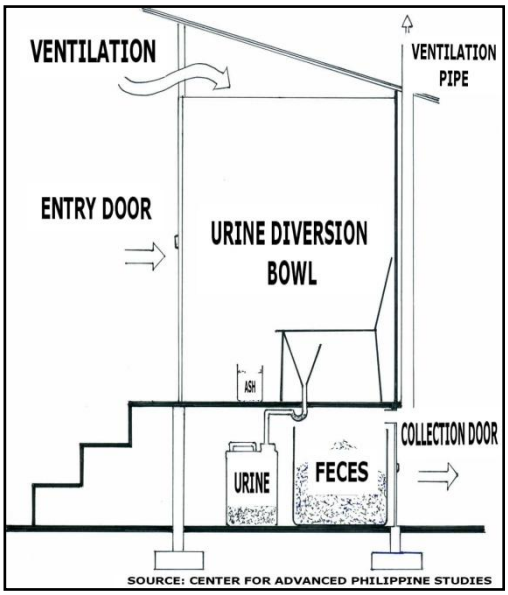

Figure 3 Basic diagram of an Ecosan Urine Diverting Dehydrating Toilet (UDDT)

Figure 4 Typical Ecosan Toilet in La Union Province

Human feces, the dirty fraction, is the most dangerous water pollutant. Feces is host to many pathogens than urine and must be handled with care and treated properly. According to literature, feces can contain at many varieties of disease-causing pathogens. A small amount of feces can contain as much as 10 million virus cells, 1,000,000 bacteria cells and 100-1000 parasite eggs and cysts of intestinal worms.

Table 1 Pathogens in human excreta

	Urine	Feces
Pathogens content	None or very few	High volume
Additional information	Urine from women is prone to fecal pathogens due to female anatomy. Pharmacological residue can be found in urine.	A small amount of feces can contain 10 million viruses 1,000,000 bacteria and 100-1000 parasite eggs and cysts of intestinal worms.

Intestinal pathogens thrive in moist and acidic environment. To kill these pathogens, the feces should be kept dry and, if possible, raise its ph to alkaline level. Applying commonly available absorbent materials, such as wood ash, lime and saw dust, every defecation can promote dehydration and increased ph. Designing the toilet to have adequate ventilation and elevated temperature from heat exposure to sun in the collection chamber can also assist dehydration and odor control. Given the right condition, pathogen die-off occurs rapidly within the first month of storage. In about two to three months, most, if not all the bacteria and viruses are neutralized. The more persistent pathogens are the parasitic eggs. It takes six to twelve months for them to die in hot, dry and alkaline conditions.

Figure 5 Elevated temperature from exposure to the sun promotes dehydration and pathogen die-off

Figure 6 Ecosan Toilet with garden

2.3 Using the safe products for agriculture purposes

Once sanitized, urine can be used as fertilizer because of its high Nitrogen, Phosphorus and Potassium (NPK) content and fecal materials can be buried or composted before reuse as soil conditioner given its high bio-organic content. A person produces around 300 to 500 liters of urine and about 30-50 liter of feces per year. The total nutrient content of this resource is about 4.48 to 7.56 kg of NPK. Most of the NPK (90 %) is in the urine. Only five to ten percent of NPK is in the feces. Of the three nutrients, Nitrogen is the most abundant at 76 percent. Therefore, urine is the more valuable fraction in terms of fertilizer value. Keeping it separated from feces is commonsensical to maximize its potential.

Table 2 NPK content of human excreta per person per year

Nutrients	Urine (300-500 liter)	Feces (30-50 liters)	Total	Percent (%)
Nitrogen	3.1 - 5.6 kg	0.09 kg	3.4 - 5.7 kg	**76.0**
Phosphorous	0.24 - 0.4 kg	0.19 kg	0.36 – 0.6 kg	**8.0**
Potassium	0.6 – 1.0 kg	0.17 kg	0.72 - 1.2 kg	**16.0**
Total NPK	3.94 – 7.0 kg	0.45 kg	4.48 – 7.56 kg	**100**
Percent of Total NPK	**90%**	**10%**	**100%**	

Experiences in Asia, Africa, and Latin America have shown that, with proper management and utilization technique, human urine and feces are effective fertilizers to several crops like, banana, tomato, corn, papaya, eggplant, string beans, guapple (giant guava variety), ornamental plants, and many more. In the Philippines, more than 3,000 Ecosan toilets have been built in several barangays of San Fernando City and Bauang in La Union, Bayawan City in Negros Oriental, Villareal in Samar, Manticao, Initao and Cagayan de Oro in Misamis Oriental (Elmer Sayre, 2010), Panglao in Bohol, among others. Ecosan

toilets were also installed in public elementary schools in San Fernando, LU, Sta. Rosa City, Laguna, Cagayan de Oro. Ecosan toilets were also used successfully in emergency evacuation centers in Cagayan de Oro and Iligan during the Sendong Typhoon in December 2011 (CAPS, 2012).

Figure 6 Typical Ecosan Toilet in CDO Evacuation Centers

Figure 7 Ecosan Toilet in CDO Resettlement Site

3 GUIDELINES IN FOR THE SAFE USE OF HUMAN EXCRETA

The World Health Organization is cognizant of the beneficial use of wastewater in agriculture but it cautions everyone that this must be done safely. WHO published in 2006 the guidelines in the proper management and utilization of human excreta in agriculture. In summary, the guidelines put forward the following:

- Application techniques – apply excreta fertilizer on soil, practice caution when using flood and furrow irrigation and spray and sprinkler system
- Crop restrictions – use in non-food crops, food crops that are processed and/or cooked before consumption
- Witholding period – provide adequate interval between final irrigation and consumption
- Procective equipment - use of protective clothing, i.e., boots/shoes and gloves, when applying urine and feces to plants
- Handwashing – rigorous personal and domestic hygiene, frequent handwashing with soap for consumers and field workers; use of separate areas for food preparation; vigorous handwashing after toilet use and fertilizer application
- Health and hygiene promotion – effective hygiene education and promotion required
- Food handling and cooking – vigorous washing of hands and crops during food preparation especially crops and vegetables eaten uncooked for food handlers

4 SUMMARY AND CONCLUSION

Ecological sanitation is a viable sanitation alternative to conventional sanitation. Ecosan has many advantages: it protects and promotes human health; saves water; minimizes environmental degradation by avoiding the generation of wastewater that can pollute water bodies; is affordable and cheaper to build, operate and maintain; and it allows recycling of plant nutrients that help conserve mineral resources like phosphorous. Even the WHO recognizes excreta reuse in agriculture given certain important precautions.

Ecosan is beneficial to rural areas often underserved or un-served by government health and sanitation programs. It provides an alternative to the inappropriate pour-flush toilet system in water scarce areas. It is also applicable during emergency situations. It promotes sustainable agriculture and food security that can alleviate poverty in marginalized areas of the country.

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