Greening Sanitation Programme



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Contents

1. Background and Context for the Study

Most of the rural population of India depends on natural resources for their subsistence and livelihoods. At the national as well as global levels, there is increasing focus on environmental issues and sustainable development across various economic and social sectors. The major emphasis of greening of development programmes has been on (a) restoring and conserving natural resources and ecosystems (b) developing clean technological solutions and infrastructure and (c) innovations for reducing carbon emissions and environmental pollution. The greening development can stimulate rural economies, create jobs and help maintain critical ecosystem services that are vital to the economy and human health and wellbeing and, also strengthen resilience to climate-induced change particularly of the rural poor who are amongst the most vulnerable to the impacts of climate change and natural resources degradation[1]. The Nirmal Bharat Abhiyan (NBA) today is an effort to achieve this well being for rural India which aligns with the vision of Mahatma Gandhi for rural India. Emphasizing on the importance of sanitation, Mahatma Gandhi once said that sanitation is more important that independence. He had a dream of total sanitation for all.

The Abhiyan was launched by the Ministry of Drinking Water and Sanitation (MDWS), under the Ministry of Rural Development (MoRD), with a vision of creating an environment that is clean, healthy and contributes to the economic and social well being of all rural citizens. A recent study by World Bank has estimated that the total economic impact of inadequate sanitation in India amount to Rs. 2.44 trillion a year. This further means a loss of Rs. 2,180 per person per year[2].

MoRD has been the key institution for effecting change in rural areas through several programmes aimed at poverty alleviation, employment generation, infrastructure development and social security. Its main objective through these programmes is to alleviate rural poverty and ensure improved quality of life for the rural population.

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[1] Musyoki A. (June 2012), 'The Emerging Policy for Green Economy and Social Development in Limpopo, South Africa'. Occasional Paper Eight. Social Dimensions of Green Economy and Sanitation Development. Unitted Nations Research Institute for Social Development.

[2] World Bank (2010).'The economic impacts of inadequate sanitation in India'.

The topic of this paper is the NBA, the flagship rural sanitation programme of MDWS[3]. While originally envisaged as a means to achieve universal sanitation coverage, it has significant potential for helping improve the natural resource base and rural environments beyond the narrow perceived mandate of toilet construction.

NBA has demonstrated a significant potential for improving a component of the rural environment. For example, the Community-Led Total Sanitation (CLTS) in which people are helped conduct their own appraisal and analysis of open defecation and take their own action to become open defecation free (ODF). Most importantly, CLTS focuses on behaviour change, essential for achieving and maintaining ODF, rather than building infrastructure. The Government of India buttressed NBA from 2003 onwards with an award scheme Nirmal Gram Puruskar (NGP) in which ODF panchayats are given a cash award. As a result of this campaign, there has been an exponential increase in access to sanitation facilities. There has been almost 4.5 per cent increase each year in sanitation coverage compared to 1 per cent coverage each year before the launch of this programme[4].

The NBA aims at

1. Bring about an improvement in the general quality of life in the rural areas.
2. Accelerate sanitation coverage in rural areas to access to toilets to all by 2017.
3. Motivate communities and Panchayati Raj Institutions (PRIs) promoting sustainable sanitation facilities through awareness creation and health education
4. In rural areas, cover schools and Anganwadis by March 2013, with sanitation facilities and promote hygiene education and sanitary habits among students.
5. Encourage cost effective and appropriate technologies for ecologically safe and sustainable sanitation

[3] Ministry of Drinking Water and Sanitation was previously known as 'Department of Drinking Water Supply (DDWS)' which was formed under the ministry of rural development in 1999. In 2010, DDWS was renamed as Ministry of Drinking Water and Sanitations and conferred the status of 'ministry' in 2011. The ministry of Drinking Water and Sanitation is responsible for overall policy, planning, funding and coordination of drinking water and sanitation, and headed by the Minister of Rural Development.

[4] Ministry of Drinking water and Sanitation (July 2011). 'Towards Nirmal Bharat – Rural Sanitation and Hygiene Strategy'. Ministry of Rural Development. Government of India.

6. Develop community managed environmental sanitation systems focusing on solid & liquid waste management

However, the problems have been contamination of shallow aquifers from badly built and located toilets, little or no attention to aspects other than toilet construction, no action of solid and liquid waste management and a fragmented planning approach that does not take the micro-watershed as the planning unit. We try and make the case for watershed-wide participatory planning under NBA to maximize gains and arrive at a green village concept.

2. Defining 'Greening'

In its simplest, the term 'green' implies to 'environmental friendly'. Therefore, 'greening development' implies to the environmental-friendly outcomes of development. In this paper's context, it encompasses environmentally-friendly and sustainable provision of sanitation services in a village that enhance the quality of natural resources.

3. The Concept of 'Greening Rural Development'

The concept of 'greening rural development' implies the kind of development that induces the desired improvements in the environment, provides the sustainability of livelihoods and incomes and helps in the mitigation of scarcity. The greening of rural development aims to improve the quality and carrying capacity of ecosystems, strengthen the resilience of ecosystems and, reduce the ecological footprints of development interventions. The Nirmal Bharat Abhiyan (NBA) is inherently a green programme that intends to promote the livelihoods based on environmentally sustainable use of their local environment and natural resources.

4. Potential of NBA for Addressing Environmental Issues

NBA, which is inherently a green programme, has tremendous potential to address a number of environmental issues without compromising the socio-economic development, such as*:*

- If applied properly, greening sanitation programmes have a tremendous potential to strengthen livelihoods while enhancing the environmental sustainability. It is possible to eliminate waste water and solid waste generation by converting all types of waste into usable material through

processes that provide livelihoods but also improve the quality of environment. For example, excreta is converted to manure through dry composing toilets or biogas and can applied in the fields. Similarly urine is collected, diluted and applied in the fields to meet the phosphorus and nitrogen needs of crops. Organic solid waste, which is the bulk of rural garbage, is collected, composted (or vermi-composted) and used as manure. These and other environmentally sustainable development initiatives would foster a chain of ecological practices that meet the needs of future generations. They would also change production and consumption patterns in an equitable manner whereby resources which are currently being wasted are saved and channeled to meeting the needs of today and in the future.

- NBA can be extremely useful in reducing ecological footprint of development initiatives. Sanitation programmes can help people use natural resources more efficiently, and encourage the use of renewable and locally available material, to reduce the generation of hazardous waste. For example, human excreta and cow-dung can be combined and used in biogas plants to replace firewood. This is an excellent way to safely dispose human excreta, providing cooking gas and manure, and reduce the carbon dioxide in the atmosphere. The discharge from the biogas plants can be an input for composting and thereafter, use as fertilizer, replacing chemical fertilizers which add to the GHGs.
- Waste water is used directly in kitchen gardens or collected through drains, treated at a centralized location and discharged into a river/pond. The waste cycle therefore generates fertilizer and energy that can be used locally to replace chemical fertilizers and biomass.
- A green NBA has the potential to enhance the ecosystem resilience. Human well-being and development both depend on the ecosystem resilience, the poor bearing the brunt of any degradation in the environment. Green sanitation programmes can be extremely useful in enhancing the capacity of ecosystems to cope with disturbances result from climate change, pollution and other human activities. By converting the waste into useful resources, it protects nature from over-exploitation and maintains its health and resilience. Greening NBA can help protect and even augment local water resources such as lakes

and ponds in villages. Each village has at least one of these structures, and more have been made under other government programmes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme. These are crucial to local water security and helping communities mitigate the effects of climate variability. By ensuring proper solid and liquid waste management (SLWM) NBA can preserve the quality and quantity of water in these water structures.

Potential of NBA: Waste Analysis Table

Rural Household Waste	**Treatment**	**Output/ Benefits**	**Per Unit Cost (5 Members Family)**
Human Excreta			
Faeces	Anaerobic digestion	Fertilizers (soil improvement), Biogas (in combination with Animal Excreta)	Ecosan toilet Rs 18,000 Biogas plant, Rs 20,000 – 30,000
Urine	Decontamination	Fertilizer for Plants	Nil
Animal Excreta			
Animal Excreta/Dung	Anaerobic digestion, Drying, Composting	Fertilizer, Biogas	Biogas plant, Rs 20,000 – 30,000
Domestic Waste			
Liquid Waste	Constructed Wetlands, Wastewater Ponds, Biological Treatment	Direct reuse for gardening, Irrigation, Ground Water Recharge	Rs 3000 (habitation-level unit/500 households average)
Solid Organic Waste	Composting	Fertilizers	

5. A Review of NBA

There are a number of programmes initiated by MoRD that are already linked to "green outcomes" or have implications for environmental protection, conservation, and maintenance of natural resources. This paper looks at NBA.

Providing basic sanitation facilities is among the more critical development challenges for developing countries, and 'greening sanitation' is an essential component for achieving sustainable development. Greening NBA will contribute towards improving the environment as well as the socio-economic condition by providing a clean and hygienic environment and the opportunity to turn their waste into income (by converting their waste into fertilizers). However, basic sanitation still remains India's foremost challenge with 814 million people still lacking a toilet[5]; lakhs of villages do not have adequate SLWM.

NBA has focused on points 1 and 2 since its inception in 1999 at the expense of the other points[6]. Information, education and communication (IEC) is the key to motivating communities and PRIs to adopt sustainable sanitation by creating a demand but it has never been executed seriously; in fact, IEC has always been an excuse to spend the allocation without devising any strategy. The result is an incomplete and ineffective IEC plan for any sanitation campaign, and little or no demand for sanitation from user communities. The performance of school and anganwadi sanitation has also been patchy because of an overlap with Sarva Shiksha Abhiyan (SSA) and the Integrated Child Development Scheme (ICDS), because of which the NBA target of promoting sanitation facilities in Schools and Anganwadis gets neglected. Even though 96 per cent schools reportedly have toilets, just 39 per cent have separate toilets for girls and boys; 76 per cent anganwadis have toilets. Eco-san has been incorporated into the NBA guidelines for 2012 but little has been done to promote this method of separating solid and liquid excreta (Impact Assessment of Nirmal Gram Puraskar Awarded Panchayats , 2008)[7]. Very little, if anything, has been done to promote SLWM. The results have been far below expectations.

The situation of SLWM is extremely alarming. As many as 41 per cent people throw garbage on the streets, while the rest variously throw it in a compost bin (34 per cent),

[5] UNICEF and World Health Organisation (2012), 'Progress on Drinking Water and Sanitation'.
[6] Nirmal Bharat Abhiyan Guidelines, MDWS, July 2012
[77] Nirmal Gram Puruskar Awarded Panchayats: A Status Study, TARU, UNICEF and WSP, November 2008

have household collection or throw it in a waste bin. Even the latter options are not satisfactory since panchayats or municipalities (in peri-urban areas) collect and throw garbage from households and bins in the nearest depression. Therefore, just a third of the solid waste in rural areas reportedly makes it way to a composting unit[8].

Additionally, waste water (here this refers to both the black and the grey water) finds its way to the nearest water body. A whopping 54 per cent report their waste water flows into a pond, well or other depression. Another 20 per cent say it flows into a community drain, whence it again goes to a water body. Just 26 per cent use the water for kitchen gardening or direct it to soak pits[9]. Due to the lack of better infrastructure and management, this leads to losses in biodiversity and ecosystem resilience. At a global level, the situation is dire. One estimate is that in developing countries 90 per cent of waste water is directly let into rivers, lakes or oceans.[10]

The poor condition of SLWM coupled with low use of toilets has the makings of a human health disaster with major impacts on the quality of natural resources. The health benefits of sanitation become apparent only with 100 per cent toilet usage and proper SLWM[11] as poor solid waste disposal pollutes the soil with plastic and other materials; leachates from so-called garbage dumps pollute shallow aquifers that provide drinking .water for local people through hand-pumps and dug wells. Similarly, surface water bodies polluted by waste water also contaminate shallow aquifers. Therefore, any lack/shortage in proper SLWM and the toilet usage will always mitigate the benefits of NBA.

Thus, human excreta, both liquid and solid, pollutes water and eutrophies surface water bodies. Waste water degrades both surface and groundwater quality. Solid waste degrades other natural resources such as forests and grasslands. All these types of waste generate greenhouse gases (GHGs) that absorb the infrared radiation and trap

[8] ibid
[9] ibid
[10] Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. www.grida.no
[11] DDWS (2008). Sanitation Beyond Toilets. Technical Session. Third South Asian Conference. New-Delhi.

the heat in the atmosphere. This rising in temperature, in turn, produces changes in weather, sea levels and land use patterns collectively known as climate change. At solid waste disposal sites (such as landfills and waste dumps), the degradable organic carbon present in the waste is decomposed by bacteria under certain aerobic and anaerobic conditions and also produce green house gasses such as methane.

6. Environmental Implications of NBA

This section discusses both the positive and negative implications of the Nirmal Bharat Abhiyan.

6.1 Positive Environmental Implications of NBA

There have been several positive impacts of NBA especially where toilet construction has been executed well with an effective environmental assessment and in coordination with the other objectives of NBA, using the micro-watershed as the planning unit. If solid and liquid excreta are collected and treated as a resource, they can be a good input for agriculture if separated, processed and applied; the crucial aspect is hygienic collection and separation of excreta. A large percentage of solid waste from rural households is organic and can be composted; here again the crucial factor is segregation and subsequent processing and use. Grey water, most of the waste water in rural areas, can be used for kitchen gardens or in agriculture. Villages generate large quantities of organic waste and grey water. The Ministry of Drinking Water and Sanitation estimates their quantity to be 0.3 – 0.4 million tonnes, and 15,000 – 18,000 million litres each day[12]. This is a significant nutrients resource and if harnessed properly, can mitigate the current demand for chemical fertilizers. While NBA emphasizes reuse and not disposal, the funds allocated for village level plans are a pitiful 10 per cent.

Some of these positive environmental benefits include:

1) **Controlling water pollution**. The full use of toilet ensures that one major sources of pollution is removed. Often due to the lack of adequate sanitation facilities, the local water bodies become the receptacles of sewage. Proper disposal of human excreta reduces the flow of pollutants into local water

[12] DDWS (2012), Scaling up Solid and Liquid Waste Management in Rural Areas. WWW.ddws.gov.in

bodies and thus reduces the pressure on fresh water bodies. Thus, waste discharge is controlled at source and not allowed to flow into drains to local water bodies. Ensuring full toilet use also prevents people from defecating around ponds that is another direct source of water pollution.

2) **Recycling and reuse**. Waste water (grey water) from kitchen and bathrooms (not black water from toilets) is not allowed to flow on streets or drains but used for kitchen gardening or diverted to suitably constructed soak pits. This reduces the dependence on fresh water sources i.e., groundwater and surface water for the horticulture. Grey water has some nutrients that are useful for plants. Decomposed fæces from pit toilets can be extracted and used as manure once the toilet pit is filled. Toilets improve the health and safety of women, and school attendance.

3) **Solid waste composting for manure**. Most solid waste produced in rural India is wet kitchen waste, very suitable for composting. Composting can be done at the household or community level. The waste is segregated into bio-degradable and non-bio-degradable components at source and the former is composted. The latter is either recycled or sent to a suitably prepared landfill. This not only provides manure to local farming but also reduces need for landfills, protecting other natural resources such as forests or grasslands that often become receptacles for garbage. Furthermore, the organic material from composted waste helps develop the carbon content of the soil which enhances its water retention ability.

4) Provides eco-friendly fuel/energy. Human excreta and cow-dung can be mixed and used as feed for bio-gas plants. There are mental blocks to using this gas for cooking, but a community plant can provide gas for lighting. In several cases though people cook with this fuel. This further reduces the burden on women for fetching firewood, help saving the natural fossil resources and reduces air pollution. The byproduct of this process can be further used as manure. One of the widely acknowledged example of bio-gas fuel/energy benefits at the community level is the Pura community experiment in 1978[13].

[13] Reddy A. K. N. (2004). 'Lessons From the Pura Community Biogas Project'. *Energy for Sustainable development.* Volume8. No.3

5) **Helps in saving limited resources**. Urine contains 90 per cent of the nitrogen phosphorus and potassium (NPK) in human excreta. If disposed in water, it can lead to eutrophication. However, these substances are extremely valuable for agriculture. Eco-sanitation as proposed under the NBA guidelines offers a convenient way to separate solid and liquid excreta and use them for agriculture. This is important since it has been estimated that the reserve amount of phosphorous that can be extracted economically will last only for another 100 years[14]. Similarly the reserves of sulphur and oil which are used to produce nitrogen will last for another 30-40 years[15]. Therefore, these toilets can preserve our mineral resources.
6) **Saves water.** Eco-sanitation also saves water since the toilets do not need any water to flush unlike pour-flush toilets that need 2-4 liters after each use. Pour flush toilets impose an additional burden of providing for 20-40 litres of water (family of five using the toilet twice a day).

6.2 Greening Sanitation through Effective Solid Waste Management

This sections deals with non-toilet solid waste. The NBA guidelines state "Panchayati Raj Institutions (PRIs) are required to put in place mechanisms for garbage collection and for preventing water logging. Up to 10 per cent of the project cost can be utilized for meeting capital costs incurred under this component. The fund sharing pattern between the Centre, State and Panchayat /Community would be in the ratio of 60:20:20. Under this component activities like common compost pits, low cost drainage, soak channels/ pits, reuse of waste water, system for collection, segregation and disposal of household garbage, etc., may be taken up."

Looking at this proviso, it appears that the focus is minimizing garbage to prevent water-logging and the options provided are the means to that end. This needs to change. The objective of solid waste management must be specified as using a watershed approach to make a village ecologically and socially sustainable, or green.

[14] Steen I (1998), Phosphorus availability in the 21st century management of a non-renewable resource, Phosphorus Potassium, www.nhm.ac.uk/mineralogy/phos/p&k217/steen.htm
[15] EcoSan Res. (2003), closing the loop on phosphorus, www.ecosanres.org

The outcome must be a green village by closing the waste cycle and treating organic waste at the local level. This will improve the environment and protection of natural resources through better solid waste management. The guidelines need to be more elaborate and detailed, and the allocation has to be raised substantially from 10 per cent to 25 per cent. It has to be a mandatory part of a district sanitation plan, without which the rest of the plan will not be passed.

To achieve this, all households should be required to segregate waste into bio-degradable and non-bio-degradable sections and hand these over to a panchayat collection agency against a certain fee. Panchayats have to be mandated to collect, treat and dispose segregated waste in a sustainable manner.

Suitable IEC material has to be developed to inform people the advantages of garbage segregation and treatment, what constitutes bio-degradable and non-bio-degradable waste, putting each in separate containers and procedures to handle each component. In Sweden, non-bio-degradable waste is further segregated and either recycled or sent to a landfill. Wood is chopped up for firewood, metals are recycled, glass is crushed, electronic waste is further processed into components and other categories are handled as appropriate. Each panchayat or ward (in the case of large panchayats) needs to have a place for sorting domestic waste and the organic or bio-degradable waste will be composted using any feasible technology. The location will be fixed by the panchayat. Compost from the processing units will be used by the panchayats as manure for agriculture; the panchayat can set a price for this manure for sale to farmers. This can be a source of income to cover O&M costs.

There are a number of environmental, health and economic benefits of an effective solid waste management. These are as follows:

- Environmental benefits - By closing the waste cycle, proper solid waste disposal prevents a major portion of waste from going to landfills. This prevents water and land contamination through leachates. Recycling and reuse reduces the need for virgin material. Proper solid waste disposal also reduces the impact on other natural resources such as forests and grasslands that either turn into dumps or are affected by solid waste

- Health benefits - Managing waste systematically reduces the number of disease vectors, and consequently, morbidity and mortality
- Climate variability - A small amount of waste to be disposed in landfills reduces GHG emissions
- Income - Manure from composting is a steady income source for the composting agency, whether individual or panchayat

6.2.1 Solid waste management techniques

There are a number of techniques that can be applied for solid waste management at smaller levels. These include:

1. Organic solutions - Effective microorganisms include specially cultured bacteria to decompose organic material. Some types are OS1 and Biosanitizer.
2. Composting - This is the least complicated and risky option. It converts solid waste to a form close to humus. It can be achieved under natural or accelerated conditions in a composting plant. There are four broad techniques
   2.1. Windrow composting, where a mixture of raw material is kept in long narrow piles called windrows, and are turned on a regular basis. This is an aerobic process.
   2.2. Passive aerated windrows that eliminate the need to turn by supplying air through perforated pipes.
   2.3. Aerated static pile, which takes piped aeration a step further. Air is forced through perforated pipes by a blower and the pile does not need to be agitated to be turned.
   2.4. In-vessel composting, where composting material is placed in a container and a variety of aeration/turning methods are used to speed up the process.
   2.5. Vermi-composting – in Vermi-composting, composting is accelerated by the addition of earthworms, either the deep burrowing or surface type. Vermi-compost from deep burrowing earthworms retains food nutrients as micro-organisms break down food encouraged with aeration from the burrows of the earthworms. These earthworms eat soil, grind minerals into soil in their digestive systems and create new soil. On the other hand, surface earthworms eat the waste and compose the excreta, but this is not as useful for plant growth because of its higher fungal and actinomycete

count. Therefore, the nutrients in vermi-compost from deep burrowing earthworms are of higher value as they have a higher number of micro-organisms, nitrifying bacteria and phosphate stabilisers. Vermi-composting is the second best option in terms of simplicity, after regular composting, for converting bio-degradable garbage to manure.

2.6. Composting with bioculture - Bioculum is a mixture of microorganisms developed for accelerated aerobic composting of organic waste. It has cultures of bacteria, fungi and actinomycetes. The bioculum is sprayed onto the garbage heap, stacked in windrows. They have to be turned weekly for proper aeration, the temperature has to be kept at 65-70◦C and humidity at 40 per cent. Composting is completed in 4-6 weeks. The limitations are that skilled handlers are needed and the system cannot be used in households because of the large size of the compost heaps. It is more useful at garbage collection sites. The non-bio-degradable waste has to be further segregated and sent either for recycling or disposal in a suitable landfill. Suitable landfills can identified at the district level to bring this into the district sanitation plan and non-bio-degradable non-recyclable waste from the villages in the district can be disposed there. The landfill has to be scientifically sited and created to avoid inundation and groundwater contamination. It must not disturb any existing natural resource including forests, grasslands, wetlands or water bodies. Ragpickers can be employed by panchayats to remove all recyclable waste before the non-bio-degradable waste is taken to a landfill. This will greatly reduce the amount of garbage entering the landfill, with attendant benefits of lower transport costs and GHG emissions. The recycling will also reduce demand for virgin material.

3. Ecological sanitation. This mimics nature's way of separating solid and liquid fæces. Excreta is collected in one container and urine in another. The excreta mixed with ash turns to manure that is rich in organic matter and has about 10 per cent of the NPK present in human excreta, while urine has the other 90 per cent. The urine can be applied to plants with suitable dilution to provide adequate nutrients, while manure increases the organic content of soil. The wash water also mixes with urine. This is the best way to separate, naturally

process and use human excreta in agriculture, while replacing chemical fertilisers.

6.2.2 Greening Sanitation through Effective Liquid Waste Management

This section deals with the safe collection and handling of waste water. Typically, waste water from domestic sources comprises grey and black water. The former comes from bathrooms and kitchens, while the latter is from toilets. Grey water is water generated by household processes such as washing dishes, laundry and bathing. It is not contaminated with wastewater from toilets (black water) and therefore contains very little pathogens. One exception is grey water generated by washing diapers. Since grey water is a reflection of household activities, its characteristics strongly depend on factors such as cultural habits, living standard, household demography, type of household chemicals used, etc. Nonetheless, specific grey water sources have specific characteristics as summarized below:

- Kitchen: kitchen grey water contains food residues, high amounts of oil and fat and some detergents. In may occasionally contain drain cleaners and bleach, which are very aggressive chemicals. Kitchen grey water is high in nutrients and suspended solids.
- Bathroom grey water is regarded as the least contaminated grey water source within a household. It contains soaps, shampoos, toothpaste, and other body care products. Bathroom grey water also contains shaving waste, skin, hair, body-fats, lint, and traces of urine and faeces. Grey water originating from shower and bath may thus be contaminated with pathogenic micro-organisms in small concentrations.
- Laundry grey water contains chemicals from soap powders (such as sodium, phosphorous, surfactants, and nitrogen) and may have bleaches, suspended solids, possibly oils, paints, solvents, and non-biodegradable fibres from clothing. Laundry grey water can contain high amounts of pathogens when nappies are washed.

6.2.3 Treatment of waste water

The choice of a grey water or total domestic wastewater management strategy depends on the end use of the effluent. To improve the environment, grey water should be used to reduce dependence on groundwater and surface water sources.

Untreated grey water should not be allowed to mix with any other water – surface or ground. Therefore, the planning of such management systems should be done with the reuse in mind and should be adapted to a specified purpose, such as agricultural reuse, ground water recharge or discharge into inland or coastal waters. There are two main ways to handle grey water:

Direct utilisation of grey water (e.g. grey water gardens, grey water towers, etc.):
Using grey water directly in gardens is the simplest and most cost-effective means of using grey water. The planted bed breaks down organic compounds and recovers nutrients. Grey water is channeled into mulch-filled trenches of planted beds. The mulch holds back solids and reduces evaporation. Grey water can be introduced either below of above the mulch, the latter being easier to do. Decomposing mulch has to be replaced with fresh material such as wood chips, back or rice husk. Plants take up the water and nutrients, and any runoff can be caught in a tank.

The limitations are the scale – this cannot be used in high-density areas that generate large quantities of grey water. Therefore, it is ideal for rural households that have homesteads and space for kitchen gardens.

Application of small-scale constructed wetlands for the treatment of grey water and total domestic wastewater treatment:

Constructed wetland systems are simple, locally manageable and cost effective biological wastewater treatment systems that utilize wetland plants, soils, and their associated microorganisms to mimic natural wetland ecosystems processes for the treatment of wastewater. As the wastewater flows through the wetland, it gets treated through natural processes; pollutants in the wastewater are mechanically filtered, chemically transformed, and biologically consumed. With respect to the direction of wastewater flow (i.e., horizontal or vertical flow), constructed wetlands are divided into reed beds, also known as horizontal flow constructed wetlands (HFCW), and vertical flow planted gravel filters (VFPGF), also referred to as vertical flow constructed wetlands (VFCW). In both cases, waste water needs pretreatment to remove oil, fat, lint, large solids and food residues. This can be done through a series of settling tanks. The quality of water from these wetlands is good enough to

discharge into surface water bodies and irrigation. The advantages of using small scale constructed wetlands for the treatment of grey water are:

1. No power requirements
2. Natural processes are used to clean water, therefore no chemicals are needed and there are minimal recurring costs
3. Aesthetic and improves local biodiversity
4. In rural areas where land is available, set up costs are minimal. These can be higher in urban areas or where land is scarce
5. The water processed by the wetland can be used for farming or discharged into surface water bodies since it will be free of organic matters and chemicals

6.2.4 Ecological Sanitation

In today's societies the flow of plant nutrients is linear: nutrients are taken up from the soil by the crop, transported to the market, eaten, excreted and discharged. In a sustainable society, the production of food must be based on returning the plant nutrients to the soil. Ecological sanitation tried to achieve this in a safe and hygienic manner. It closes the nutrient loop.

The use of excreta on arable lands minimizes the environmental impacts of farming caused by fertilizer runoff. It also reduces water pollution, and degradation of natural resources, caused by open defecation. Human-derived compost is also rich in phosphorous; in chemical fertilizers, about 25 per cent of the phosphorous that is mined ends up in water bodies, causing eutrophication.

Ecological Sanitation aims to promote the development, implementation and dissemination of socially and culturally acceptable, sustainable, hygienically safe and ecologically sound sanitation approaches. Several eco-san projects are being executed in different parts of India to

(i) To introduce the ecological sanitation concept and to identify the appropriate wastewater handling approaches that satisfy technology, cost and institutional framework and enable maximizing the utilization of existing pipes and treatment facilities

(ii) To recover the nutrients from urine and fæces for agriculture

(iii) To contribute to the reduction of wastewater discharged to drains through recycling of grey water. The alternative paradigm of ecological sanitation offers the potential of sustainable sanitation for developing countries

Ecological sanitation is based on three fundamental principles: preventing pollution rather than attempting to control it after we pollute; sanitizing the urine and the fæces; and using the safe products for agricultural purposes. This approach can be characterized as 'sanitize-and-recycle'.

This approach is a cycle – a sustainable, closed-loop system. It treats human excreta as a resource. Urine and faeces are stored and processed on site and then, if necessary, further processed off site until they are free of disease organisms. The nutrients contained in the excreta are then recycled by using them in agriculture. An essential part of eco-san is to contain and sanitize human excreta before they are reused. Human faeces, rather than urine, are responsible for most diseases spread by human excreta. Thus, a method is needed to sanitize fæces.

There are two main methods: dehydration and decomposition. Dehydration, or drying, of faeces is easier if they are not first mixed with urine and water. When fæces decompose, the pathogens in them die and are broken down. Thus, with either method, viruses, bacteria and worm eggs are destroyed. It is only then that fæces can be recycled. Urine is usually safe enough to be used in agriculture without further treatment, either directly or after a short period of storage. One purpose of an eco-san system is to form a set of barriers between fæces and flies, fields and fluids. This is done by containment of the fæces in a processing chamber or shallow pit where pathogens are reduced to an acceptable level before re-use. Then the contents may be removed for further secondary treatment to make them even safer. Urine In homesteads urine can be used directly. In large-scale systems urine should be stored for about 1 month before use. Don't apply urine less than a month before harvest on vegetables, fruits (except fruit trees) and root crops that are to be consumed raw.[16]

[16] Paul Calvert, Peter Morgan, Arno Rosemarin, Ron Sawyer and Jun Xiao, Ecological Sanitation, Stockholm Environment Institute, 2004

Urine is rich in nitrogen, while fæces contain organic matter, phosphorous and potassium. It has been estimated that urine contains 3-7 g N per litre. A rule of thumb is to apply the urine produced by one person during one day (24 hours) to one square metre of land per growing season. If all urine from one person is collected, it will suffice to fertilize 350 sq m of crop per person per year with N at a reasonable rate. For most crops, the maximum application rate, before risking toxic effects, is at least four times this dosage. Urine also contains lots of phosphorus, and it will suffice to fertilize up to 600 sq m of crop per person and growing season. Urine can be applied neat or diluted. However, its application rate should always be based on the desired nutrient application rate and any potential need for supplementary water should be met with plain water, not diluted urine. Urine is a quick-acting fertilizer whose nutrients are best utilized if it is applied from before sowing up until two-thirds of the growing period. The best fertilizing effect is achieved if urine and fæces are used in combination with each other, but not necessarily in the same year on the same area. The amount of urine to be spread can be applied in one large dose or in several smaller doses, and under most circumstances the total yield is the same for the same total application rate.

For fæces, the application rate can be based on the local recommendation for the use of phosphorous-based fertilizers. This gives a low application rate, and the improvement due to the added organic matter is hard to distinguish. However, fæces are often applied at much higher rates, at which the structure and water-holding capacity of the soil are also visibly improved as an effect of addition of its organic matter. Both organic matter and ash are often added to the fæces and they improve the buffering capacity and the pH of the soil, which is especially important in acidic soils. Thus, depending on the application strategy, the faeces from one person will suffice to fertilize 1.5-300 m^2, depending on whether they are applied according to their content of organic matter or phosphorus. Fæces should be applied and mixed into the soil before cultivation starts. Local application, in holes or furrows close to the planned plants, is one way of economizing on this valuable asset.[17]

[17] Håkan Jönsson, Anna Richert Stintzing, Björn Vinnerås, and Eva Salomon, Guidelines on the Use of Urine and Faeces in Crop Production, Stockholm Environment Institute, 2004

Fæces contain most of the pathogens in human excreta and are the main source for transmission of enteric infectious diseases and parasites. Therefore we should treat fæces based on the principles as below:

- Keep the volume of dangerous material small by diverting the urine and not adding water to the fæces.
- Prevent the dispersal of material containing pathogens by storing it in some kind of secure device (processing chamber, tank)

Ecological Sanitation in Flood Prone Areas

Providing appropriate sanitation facilities especially in flood prone areas or with high water table have always been a huge challenge. Eco sanitation can provide a sustainable sanitation facility in such areas. A modified eco-san toilet is required to keep excreta out of contact with water.

Raised/Elevated Toilets: These toilets are primarily based on composting model, called UDDT (Urine Diverting Dehydrating Toilets), and are built on raised platforms to prevent groundwater contamination. It has three openings and separates faecal matter from urine. UDDTs have the widest extent of implementation and their flexible design makes them a good option for areas where excavation is difficult or there is a high chance of groundwater pollution, such as in flood prone regions.

The key feature of these toilets is the ‘dehydration vaults’. These can be installed in almost every setting because of the small land area required, the low odour generation and the ease of use. In areas that are frequently flooded, dehydration vaults are appropriate because they are constructed to be watertight. Dehydration vaults are used to collect, store and dry (dehydrate) faeces. Faeces will only dehydrate when the vaults are watertight to prevent external moisture from entering and when urine and anal cleansing water are diverted away from the vaults.

When urine is separated from faeces, the faeces dry quickly. In the absence of moisture, organisms cannot grow, smells are minimized and pathogens are destroyed. Two alternating vaults can be used so faeces dehydrate in one vault while the other vault fills. When one vault is full it is sealed with a lid and the UDDT is moved to the second vault. While the second vault fills up, the faeces in the first vault slowly dry

and decrease in volume. When the second vault is full, it is sealed, the dry material from the first vault is removed and the first vault is then put back into service. Typically, a retention time of 8 – 12 months is needed to complete sanitise faecal matter.

Floating Toilets: In flood prone areas, where the dry land for construction is scarce, the elevation concept of eco-sanitation can also be applied to a floating version of eco toilets. One of such examples of floating toilets is in Philippines[18], where the

Source: Sustainable Sanitation and Water Management (SSWM)

floating toilets has been enhanced with digestion chambers where anaerobic decomposition occurs. The effluent then goes to the treatment chamber, which further improves the quality of the wastewater to an acceptable level

Advantages of Ecological Sanitation

Ecological sanitation has several advantages over pit latrines. Some of these are:

- Recovery of nutrients & applying them safely in agriculture (marketing potential of urine and composted fæces)
- Establishing a public-private partnership for operating the ecological sanitation facilities
- Promoting urban farming including rooftop farming
- Helps in food security by providing quality manure/fertilizer

[18] NORTHERN WATCH (Editor) (2009): Floating Sanitary Toilets Launched in Balibao. Pangasinan: Northern Watch.

- Better health care
- Reduced consumption of commercial fertilizer thus saving energy and thereof reducing carbon emission
- Mass scale collection of urine can be used for converting urine in to dry crystalline fertilizer
- Availability of liquid urine fertilizer for city green areas
- Extraction of phosphorous from urine
- Urine is an excellent fertilizer
- Separation keeps the volume of potentially dangerous material (fæces) small
- Simplifies pathogen destruction in fæces
- Reduced odour

6.3 Negative Environmental Implications of NBA

This section analyses NBA's negative impacts on the environment. Although it has a number of environmental benefits, if implemented without an effective environmental assessment and in segments without a comprehensive, integrated approach, it has had several negative impacts.

Since it was started in the 1980s, the sanitation programme has gone through several redesigns. The most significant was changing it from a supply-led toilet construction programme to a demand-led sanitation programme in the late 1990s. However, even in this avatar, the sanitation campaign has not bitten deep enough. Its main objective has remained the construction of toilets, like its predecessors, with little attention being paid to behaviour change or the aspects of SLWM. Simultaneously, there has been an emphasis on providing piped water in villages. This will, or in some cases, has compounded the quantum of waste water generated by villages. Many villages and peri-urban areas already face severe problems in disposing solid waste; piles of rotting garbage at the entrance to villages are testimony to this. Together, they pose one of the biggest challenges to making the sanitation campaign more environment-friendly.

The lack of drainage in villages has meant that waste water streams down roads, forming puddles and eventually collecting in the nearest low-lying area. This is water

from kitchens, bathrooms and occasionally collects human excreta from open defecation. This breeds mosquitoes and flies, increasing morbidity. The water percolates into the soil and pollutes the shallow aquifer that people depend on to draw water from wells or hand-pumps. This compounds the burden of disease. According to the World Health Organisation (2002), water born diseases are among the leading killers of children under the age of five and annually more people die as a result of unsafe water than from any form of violence[19]. The studies have also shown that in developing countries, children suffer from 4-5 debilitation bouts of diarrhea each year, which further results in malnutrition and long-term health effects such as stunting and wasting (UN 2006)[20].

Solid waste disposal is another blind spot. There is little or no provision for collecting and disposing any solid waste. Solid waste in rural areas is high on organic content, and has little inorganic matter. It is also full of plastic as no village has banned the bag; therefore garbage dumps are full of plastic bags. The most convenient low-lying area becomes the garbage dump that, in the rains, fills with water. This contaminated water again pollutes the shallow aquifers that people depend on for drinking and other domestic needs. Therefore, the lack of proper handling of solid waste adds to the local morbidity rates.

The combined effects of pollution from waste water and solids are devastating. They pollute groundwater that is the lifeline of local people through hand-pumps and wells. Poorly constructed solid waste landfills generate GHGs and contaminate groundwater. They increase morbidity and mortality, degrade natural resources, increase the burden of collecting firewood and water on women and adversely effect the local environment. Plastics and inorganic material persist in the environment and contaminate the water and soil in addition to blocking water-ways. Open defecation pollutes surface water bodies such as village ponds, and eventually ends up polluting groundwater with nitrates and bacteria. This is because people defecate on the bunds

[19] World Health Organisation (2002). 'The World Health Report 2002: Reducing Risks, Promoting Healthy Life.'
[20] United Nations Development programme (2006). Human Development Report 2006, Beyond Scarcity: Power, Poverty and the Global Water Crisis.

of ponds, instead of at a distance from them, and the social norms or behaviour that proscribed this have been forgotten or are violated.

The target-driven rush to construct toilets can adversely impact on water quality. In India, in many rural villages, people use pond water for everything except drinking, including washing utensils. In certain rural villages such as in West Bengal, where practically every house has a pond, toilets constructed in close proximity to the pond can lead to severe water quality problems and negate any health benefits that may accrue from the construction and use of toilets. Moreover, the high density of pit latrines and poorly made and maintained septic tanks can render the shallow aquifer water unfit for drinking because of nitrate and bacterial contamination. Furthermore, if not implied the right design and technology, eco-san in flood prone areas can have more damaging effects than the benefits such as polluting the ground water (the eco-san techniques for the flood prone areas are discussed earlier in the paper).

The overall planning for sanitation that includes construction of toilets and solid and liquid waste management is done in isolation of other considerations such as watershed characteristics, location of other natural resources such as forests and grasslands and soil traits. This means that toilets are often located close to water sources and ponds. They are also located upstream of the village and their leachate pollutes groundwater flows, ending up contaminating drinking water sources such as dug wells and hand-pumps. Additionally, poorly constructed latrines pollute groundwater rather than safely containing excreta; it they are located in an inundation-prone area, the stored fæces pose a major pollution and health hazard during the monsoons.

The immediate impact of a poor environment is felt through the water cycle. Groundwater polluted by excreta or solid waste is used for domestic purposes with little treatment. The control of the microbial and chemical quality of drinking water requires integrated management plans which provide the basis for system protection and process control to ensure the numbers of pathogens and concentrations of chemicals present a negligible risk to public health. Termed as “Water Safety Plans” they begin with system assessment and design, operational monitoring and management plans, including documentation and communication. The elements of

such plans build on the multiple-barrier principle, the principle of hazard analysis and critical control points (HACCP) and other systematic management approaches.[21]

[21] Guidelines for Drinking-water Quality, Third Edition Incorporating the First and Second Addenda, World Health Organization, 2008

6.4 Table of Recommendations

S. No	Technology	Cost
1	Composting	
1.a	Bioculum for habitations	Very high
1.b	Windrow for habitations	Rs 25,000 – 100,000
1.c	Aerated static pile for habitations	15 - 20% more than windrow
1.d	In vessel composting for households	Rs 15 – 20 depending on vessel cost
1.e	Vemi-composting for households or habitations	Rs 7500
2	Ecological sanitation for households	Rs 18,000
3	Liquid waste management	
3.1	Recycle grey water for households	Rs 50 – 100 depending on piping
3.2	Recycle grey water for habitations	Rs 10,000 depending on size of settling tanks
3.3	Recycle black and grey water for habitations	Rs 100,000 for a constructed wetland

7. Case Studies from India: Good Practices of Green NBA

7.1 Aasgaon (Maharashtra) – Case study of SLWM

The village Aasgaon is situated in the Satara District of Maharashtra state in India. The total area of the village is 22.5 hectares. It is a small settlement of 217 households. The total population of the village is 1,032 (according to the Population Census of 2001), of which 478 inhabitants are male and 554 are female, 143 people of this settlement village belong to Scheduled Caste, 21 people belong to Scheduled tribes, 36 people belong to Other Backward Castes. The rest of the population belongs to the general category. Approximately 71 per cent population of this village is literate. The primary occupation for most of the population of this village is farming followed by work in nearby towns.

The area of this resettlement was basically a waste land. At the time of resettlement, this area was a barren land without source of water and was a socially deprived village. The village had only one primary school and had no provision for secondary school education. However, the most critical challenge for the Aasgaon village was lack of safe and adequate drinking water and, sanitation facilities. For 17 years, the

village was completely dependent on tanker water supply for their everyday water needs.

In the early 2000s, the village undertook a major initiative to improve sanitation under NBA. The Maharashtra State Government launched a campaign known as the 'Sant Gadge Maharaj campaign' to incentivize the improvement of villages in terms of education, health and environment. The village panchayat mobilized the village community and the people, tired of 17 years of neglect, responded to the campaign. The most significant part of this campaign was the participation of women and their willingness for an active involvement in the campaign. As a result of such an active participation of the people, the village won the Sant Gadge Baba award five times for achievements in different fields and was among the first to be awarded NGP. In 2000-01, Aasgaon village won a third prize at the block level. Keeping up their active participation and affords, in 2001-2002 they won third prize worth Rs 2 lakh at the district level. In 2004-05, it won the second prize of worth Rs 3 lakh at the district level.

Under NBA, the village adopted wise water management that involves rainwater and grey water segregation and management. It has constructed storm water drains through which the rainwater is channeled to maximize recharge. No grey water reaches these drains since it is completely used for kitchen gardens or tree plantation. The village people have made contour bunds and gabions for watershed treatment and to maximize water recharge.

They have also tackled solid waste wisely. As a result of this and other programmes, each house has a biogas plant fed by human fæces and cowdung. Almost each house has a vermi-compost pit. The inorganic and non-compostable solid waste is recycled. There is a 100 per cent toilet coverage and use. Community toilets have been constructed for those without individual toilets and visitors, which have extended sanitation coverage to the floating rural population. Villagers have planted over 10,000 trees and tended them through irrigation with grey water.

Therefore, NBA has catalyzed social transformation of the village and making it green. The people of Aasgaon suffered for 17 years with epidemic diseases,

educational and economic loss. The worst-effected were the women. Not just their educational and economic development but also their dignity and the self-respect were challenged. However, as result of people's participation and dedication the village Aasgaon has been socially and environmentally transformed.

This is an example where people have used all aspects of NBA along with state and national government programmes to improve the condition of their village. They have followed the norms for managing solid and liquid waste, have ensured their water security in this semi-arid area through rainwater harvesting, greened their village using grey water, produced substantial quantities of vermi-compost and manure from biogas plants, and ensured total sanitation.

7.2 Kaliyapalayam Village (Tamil Naidu) – Case Study of Ecological Sanitation

The Kaliyapalayam village is located on the Cauvery River, in the Tirupur district in Tamil Nadu. It is about 374 km from Chennai.

The ecological sanitation initiative in Kaliyapalayam Village was launched in 2002 to reduce water use in sanitation, prevent water pollution due to open defecation (as the water table is high), by the Society for Community Organization and Peoples Education (SCOPE).

Initially, the gram sabha passed a resolution to construct eco-san toilets in 18 households. The whole concept was based on the demand driven approach. From the selection of the model to the construction, all the stakeholders were consulted at each stage of the project. The concept was welcomed and quickly accepted by the residents. Initially, a 2-in-1 model was adopted where the wash water and the urine were mixed and collected in one chamber and, fæces were collected in the other chamber.

After one year, a study was conducted on the views/opinions of residents regarding the functioning of the toilets. It was found that the users were generally satisfied with the system. Based on their feedback of the residents, the 2-in-1 model was replaced with a 3-in-1 model in which the urine, fæces and wash water are collected separately. Urine is collected in a mud pot with holes buried in the ground and the wash water is

collected in a filter bed. The human fæces and the urine are used as fertilizer and the wash water is used for the kitchen garden and plants. The high initial cost of eco-san toilet of about Rs 18,000 is offset by long-term socio-economic and health benefits. Wash water applied to banana trees next to toilets assures irrigation at no cost, while the sale of manure and urine for agriculture contributed towards overall income for the village. These benefits provide 200 per cent return on the investment over lifespan of a toilet.

Hence, the programme not only contributes towards environmental sustainability but also proved to be extremely beneficial in social and economic terms. This proves the value of eco-san as a means to close the nutrient loop in solid and liquid waste in a safe and hygienic manner, while augmenting income both directly (sale of manure and urine) and indirectly through increased farm output.

7.3 Gram Vikas (Orissa) – A Case Study of Natural Resources Management

Gram Vikas is a rural development organization founded in 1971, working with poor and marginalized communities especially in Dalit and Adivasi communities of Orissa. The mission of Gram Vikas is to promote programmes which are sustainable, socially inclusive and gender equitable in order to enable the poor and marginalized rural populations or communities to achieve a dignified quality of life. The initiatives of Gram Vikas are aimed to energize entire village/habitation, and are driven by the involvement of the entire community in planning, implementation and monitoring. It takes an integrated approach towards the rural development that includes: natural resource management: watershed management, involving conservation and development of land, water and forest resource so as to mitigate the effects of droughts.

One of the major areas of Gram Vikas' activities is natural resource management. Under this programme, it has launched the rural health and environment programme (RHEP) in 1992. One of the main

Toilets and Bathing Rooms
Source: Gram Vikas, Orissa

aims of this initiative was to provide uninterrupted water supply and dignified sanitation facilities.

To achieve an uninterrupted water supply, RHEP links the people with the government rural water programme called 'Swajaldhara'. Under this initiative, the financial cost of the programme, which includes the cost of tank and the pipe network, is provided by the government. The families/households pay a part of the capital cost in the form of material and labour. The users/residents pay a monthly maintenance charge to cover the operational and maintenance cost of the provision. This arrangement not only makes the programme financial feasible but also proved to be extremely useful in enhancing the sense of responsibility and ownership among the community and ensures that the provision will sustain. Along with the monthly operational and maintenance cost, each household contributes Rs 1000 towards a common fund which is invested in a bank deposit. Its fund is invested further to extend service to new households and to ensure 100 per cent water supply coverage in the future. To ensure an equitable access to this facility of clean water as the current social structure in many villages does not enable all community members to access clean water, Gram Vikas transforms this established social order by making it mandatory that all households are included in the programme and that the female heads of households must be involved in the decision-making process.

The practice of 100 percent inclusion keeps villages clean and eliminates sources of water contamination as each and every member of the village is involved in establishing, maintaining and benefiting from the sanitation system. This is also a way to break down caste and gender barriers and allowing the marginalized to regard themselves as equals within the community. This development process is based on MANTRA (Movement and Action Network for Transformation of Rural Areas) governance programme's values of inclusion, sustainability, cost sharing and social and gender equity. MANTRA is a rural health initiative in nearly 300 villages across Orissa, which facilitates poor communities to come together to establish, operate and manage their own water supply and sanitation systems.

For the sanitation initiative, the capital cost of a toilet and a bathing room (together Rs 8,600) is jointly financed by Gram Vikas and the community. Gram Vikas contributes

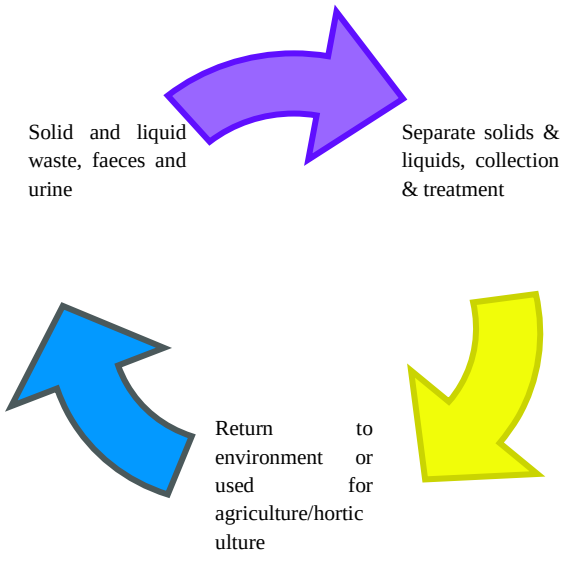
towards the costs material required for the construction and the community contributes in terms of local resources such as land and labour.

Clean drinking water and access to sanitation has resulted in over 80 per cent reduction in incidences of waterborne diseases.[22] A healthy community and habitat acts as a catalyst for sustainable development. This shows how effective IEC can mould even fissiparous rural societies into a more cohesive unit, working towards a common good. Using water and sanitation as an entry point, the NGO works towards overall improvements in rural environment and the natural resource base. This benefits women especially, and the whole community in general.

Furthermore, these ecosan initiatives also offer the potential solution to the problem of manual scavenging[23]. Although the practice of manual scavenging was outlawed in 1993, however because of the lack of other sanitation alternatives, this practice still exists in rural India.

8. Conclusions and Recommendations

The central principal in greening NBA is to close the nutrient and water loops so they do not overlap. This is done by segregating, treating and reusing/recycling solid waste (excreta, cow-dung, organic and inorganic garbage) and liquid waste (urine, grey and black water) so that little or nothing is wasted, pollutes water and other natural resources or ends up in a garbage dump.



[22] Gramvikas (2011). Water & Sanitation. http://gramvikas.org/index.php?act_id=2&page_id=18

[23] Rajagopal B. (et al, 2006). From Promise to Performance: Ecological Sanitation Of Manual Scavenging in India. Massachusetts Institute of Technology.

To achieve this, priorities need to be rearranged to green NBA. The foremost is according much greater weightage to behaviour change, followed by solid and liquid waste management. Incentives, currently distorting the scheme, need to be restructured as do the awards linked to sanitation. The main aim has to be a green and healthy village, rather than trying to merely change defecation behaviour. Thus, NBA needs to move away from constructing toilets and hope people will use them to the wider aspects of watershed and natural resources protection and management, both of which are intrinsically linked to any water or sanitation programme.

The idea is to leverage NBA's momentum for safe handling of human excreta to improve watershed management. By bringing the sitting of toilets into a watershed planning framework, it will dramatically improve the quality of groundwater as well as provide a ready source of manure to improve biodiversity. This has implications for improving forests and grasslands, both critical to better environmental management at the local level. It also have implications for eliminating sources of water pollution caused by poorly located and built toilets, either because they leach faecal matter into groundwater or people do not use them, preferring open defecation. It also extends to eliminating the entry of both solid and liquid waste into the environment in raw form, and converting them to manure or other beneficial states before being returned to the environment.

Advocacy, Awareness and Behaviour Change

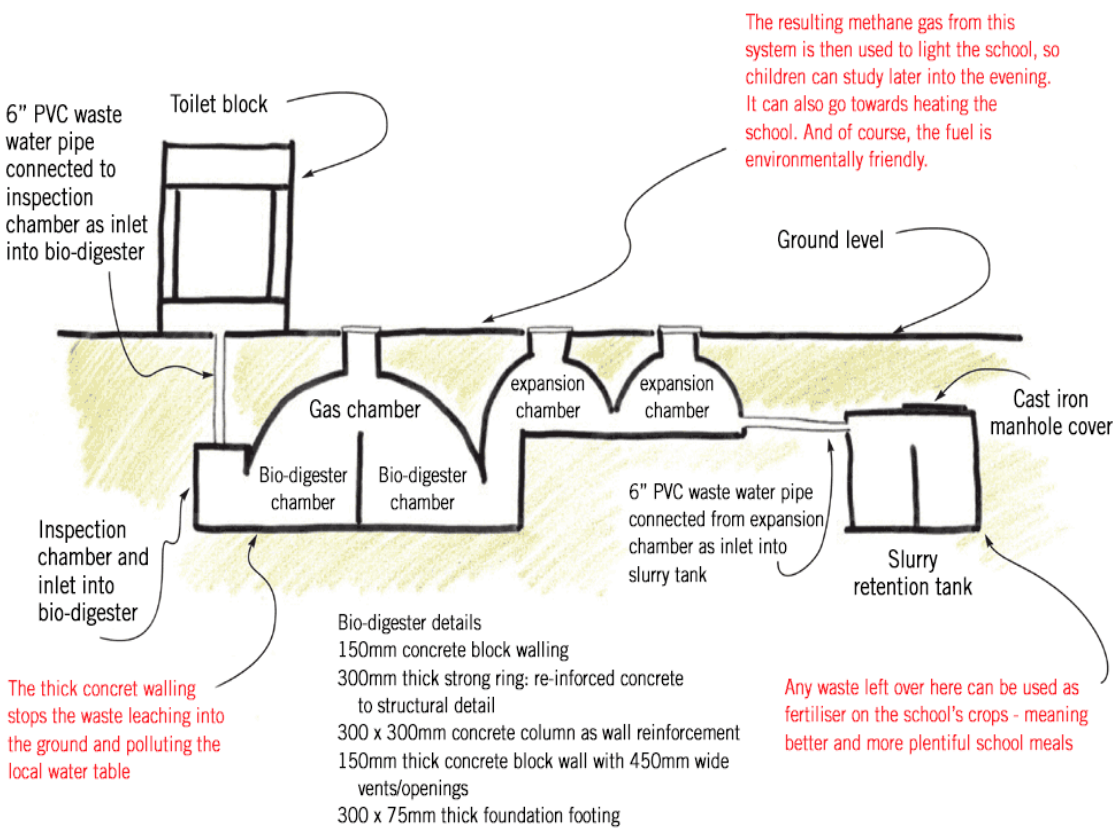
A basic input of NBA, IEC has failed to produce significant behaviour change. This is largely because of a narrow focus and emphasis on intangible benefits of using toilets that most IEC campaigns dwell on. These intangibles are higher social status and dignity of women. IEC has largely ignored health and livelihood issues, even though there are studies to prove improved sanitation and hygiene drastically reduce the number of disability-linked life years (DALYs); these are more tangible messages rooted in the everyday experiences of the target audiences.

It is therefore suggested to move away from intangibles and focus on tangibles in IEC. The link between health and livelihoods is something every person is familiar with, and provides a sound basis for future IEC related to sanitation. It also allows for widening the scope of IEC to include solid and liquid waste management by linking it

to improvements in local natural resources and water quality; in turn these allow people more time for either productive work or leisure. The impact on women is particularly pronounced since they are the primary water providers and firewood gatherers. An IEC campaign has to quantify these at the individual level for people to relate to SLWM and sanitation.

Sanitation- Planning and Construction

Sanitation must be placed within the larger watershed context so that it's environmental and health aspects are understood and appreciated. Sanitation planners have to consider surface and ground water flows, soil conditions, geology and climate while planning the sanitation campaign. The conventional single or twin-pit toilets are unsuitable for use in many parts of India where the soil is rocky, has a high porosity, in hilly terrain or in flood-prone areas. Therefore, alternatives are needed and they need to serve the purpose of safely containing and decomposing excreta without coming into contact with groundwater or human beings.



Variants of dry composting toilets are probably best for India given the mostly hot, dry climate as they will ensure the fastest decomposition of faeces into manure. These also need to provide easy access to the manure since culturally, Indians will never 'stoop' to emptying out a pit full of excreta even if it has decomposed to manure as pit toilets are supposed to do. Containerization is one solution, and can be easily manufactured to a variety of sizes for these types of toilets.

One of the key out come of NBA should be closing the nutrient loop by demystifying the value of fæces and urine as replacements for chemical fertilisers, in part or whole. A clear linkage reflecting the equivalents to the chemical fertilizers that can be obtained by nutrient loop, along with the cost of each alternative must be highlighted (e.g. as illustrated in waste analysis table earlier in the paper), so the economic benefits become visible rather than leaving it open to interpretation. There are scientific evaluations of the nutrient value of urine and fæces produced by different food combinations. This argument can be buttressed by the health argument of using toilets, that also make it easy to collect, process and use fæces and urine. In fact, toilets can be projected as mechanism to harvest nutrients from human excreta and urine with a definite payback period.

Solid and Liquid Waste Management

Effective SLWM will involve source segregation, treatment and reuse or recycling. Villages generate mostly wet, organic solid waste (not excreta) that is suitable for composting or vermi-culture. The end product is manure, a replacement for chemical fertilisers and a natural soil enhancer. Composting technologies are many and varied, and only those that suit local agro-eco-climatic conditions should be suggested.

The tougher one is to institutionalize solid waste segregation and collection. The starting point is to include this in the district water and sanitation plan so panchayats have to also include it in their respective sanitation plans. The second is to provide a realistic budget that reflects costs of creating and running a garbage collection network, composting, packaging and distribution of manure. While it is hoped sales of manure will partly offset these costs, it cannot be assumed that the system will work on a full cost-recovery basis. Therefore, capital costs have to be covered along with a component of recurring costs. Institutional changes are needed at the panchayat level

so that SLWM becomes part of the work of the village water and sanitation committees.

The same goes for liquid waste management. The ideal solution is use at the household level, but if a household has not use for waste water, it must be channeled through properly constructed, lined drains to a central point for treatment. Here again, it is necessary to allot funds for capital works, including a village survey, construction of lined primary, secondary and tertiary drains, and a simple treatment system based on local agro-eco-climatic conditions. All grey water must be segregated from storm water and used in agriculture/horticulture, to reduce the pressure on fresh water sources and pollution of surface or groundwater. Storm water drains must convey rainwater to recharge points and should be part of the village water management plan. Institutionally and procedurally therefore, the district water and sanitation plan has to include a distinct water management plan with separate grey and storm water components. As with solid waste, the financial allotment should cover both capital costs and O&M since the scope for revenue recovery here is extremely limited. Panchayats should be supported to provide effective water management in villages. In the water management plans, care has to be taken to completely separate grey or black water from storm water since the latter will be used without further treatment for augmenting local water resources through surface storage structures or groundwater recharge.

Eco-san

NBA guidelines mention eco-san as one of the options for improving sanitation and hygienically separating fæces from urine. These need to be elaborated and backed by suitable financial allotments. Much more work is needed to make eco-san acceptable by people given the different nature of eco-san toilets. An approach is to provide suitable loans for eco-san toilets, repayable through the savings on fertilisers. A typical eco-san toilet pays for itself over its lifecycle of 7-10 years through savings on chemical fertilisers. This point must be emphasized in promoting eco-san as an alternative to toilets.

Additionally, studies have shown reusing the excreta of a family of 5, theoretically produces enough excreta to produce adequate nitrogen and phosphorous to cultivate a

rice plot ranging from 40x40m and 40x50m size[24]. This is another point that can promote eco-san toilets as well as improved hygiene.

The counter-argument to eco-san is open defecation, as that also returns the same nutrients to the soil in a more direct manner. However, eco-san adds the hygiene layer to nutrient recycling that open defecation lacks and decomposes faeces safely. It also separates urine and makes that available as a potent fertilizer.

Eco-san can be a potential source of income both for the farmers and the landless poor, if promoted as a source of organic manure and a replacement for chemical fertilizers. The landless poor can make livelihood by turning their waste to manure and selling it to the farmers. On the other hand the farmers can reduce their expenditure on fertilizers by replacing chemical fertilizers with organic manure. Most of these people work on farms, or as share-croppers and will therefore find the proposition of replacing expenditure on chemical fertilizers with eco-san manure attractive. Again, this has to find place in IEC campaigns and a suitable financial mechanism has to be worked out under NBA that covers this section of rural India.

Rewards and Incentives

These have worked well in the past, both at the central and state level, to promote sanitation. However, they need to be staggered and disbursed in installments rather than at one go, in tandem with progressive improvements in sanitation. Therefore, a village that has won the NGP should be given the first installment as recognition of its status, but the subsequent releases should be incumbent on achieving other milestones such as SLWM and promotion of eco-san. This will work towards ensuring sanitation goes beyond construction and (partial) use of toilets, into a more holistic improvement of the rural environment and natural resources.

Therefore, NBA has to be reoriented towards better solid and liquid waste management, promotion of ecological sanitation, and staggered rewards or incentives to become environment-friendly.

[24] **Edwards P** (1992) *Reuse of Human Wastes in Aquaculture: A technical Report*, UNDP-WB-ASP, USA