Bindeshwar Pathak

Technologies for Human Dignity
The Sulabh Sanitation and Social Reform Movement

Innovations Case Narrative:
Sulabh International

I was born in Vaishali district of Bihar, India, in 1943, into a Maithil Brahmin family. For generations, this community has provided India with some of its most eminent thinkers, academicians, and civil servants. I went to college in Patna and graduated with honors in sociology. Returning to my village in 1964, I started my career as a teacher in my old secondary school. However, as I was only temporarily filling in a leave vacancy on Rs.100 per month, I soon left teaching.

In 1968, with my father's consent, I set off on a long train journey, this time to complete a Master's in Criminology at the University of Sagar in Madhya Pradesh. However, while sipping tea at a railway station, I happened to meet two relatives, who persuaded me to drop my study plans and proceed to Patna for a job with the Bihar Gandhi Centenary Celebrations Committee. But alas, there was no job! By this time my seat at Sagar had been filled, so I was back to square one.

I did eventually get a job with the Centenary Celebration Committee on Restoration of Human Rights. The committee's aim was to restore human rights and dignity to the lowest class of people, whose sad lot in life was to collect human feces manually, in perpetuity. Now called "scavengers," they were called "untouchables" before India gained independence. My job was to find an alternative to the

Bindeshwar Pathak founded Sulabh International in 1970. Sulabh International is a social service organization that works to promote human rights, environmental sanitation, non-conventional sources of energy, waste management, and social reforms through education. Pathak also has made innovative use of biogas by linking Sulabh toilets to biogas plants, which are now becoming a byword for sanitation in developing countries all over the world. His sanitation movement ensures cleanliness and prevents greenhouse gas emission. In 1991 the Government of India conferred on Pathak the Padma Bhushan, one of India's highest civilian awards, for his work in sanitation development and social service. He received the Dubai International Award in 2000 for "Best Practice to Improve the Living Environment" and the Annual IREO Renewable Energy Award in June 2009. In 2009 he was awarded the Stockholm Water Prize.

scavenging system and, more daunting, to explore how these scavengers could be brought into the mainstream of Indian society.

I was brought up as a Brahmin, and from early childhood it had been drilled into me not to touch an untouchable or take water from his hand or eat cooked food in his house. When I once touched an untouchable in my grandmother's house, she forced me, shrieking and protesting, to publicly swallow cow dung, sand, and Ganges water!

THE LIFE OF UNTOUCHABLES

Scavengers, a class of people united in their suffocating misery, were traditionally ordained in Indian society to clean and carry human waste, which they did until very recently. The worst victims of a cruel social order, they suffered appalling hardships, humiliation, and savage exploitation. Even those whose excreta the scavengers carried on their heads hated them. Living in appallingly filthy surroundings and forced to lead a subhuman existence, theirs is a sordid story of the utmost violation of human rights.

Cleaning latrines is despicable work. The receptacles in the latrines get overflowed because of not being cleaned regularly and scattered on the floor. In most cases, the waste gets stuck everywhere, including on the sidewalls. The scavenger had to crawl through a narrow passage to make his way up to the latrine chamber, where he had to thrust his head into the hole to clean the toilet. Mahatma Gandhi often expressed his most ardent wish: "I may not be born again, but if it happens I will like to be born in a family of scavengers, so that I may relieve them of the inhuman, unhealthy, and hateful practice of carrying head-loads of night soil."

Scavengers were not allowed to live in the main town or village and had to dwell in huts that resembled monstrous mounds of earth outside town limits. No person of a higher caste could have any but the most distant communication with a scavenger for fear of losing his religious purity. They were required to strike a wooden clapper upon entering a town or village to warn of their "polluting" approach and had to eat the remnants of their master's food, wear his discarded clothes, and use his broken chattels. The scavenger was denied access to temples and barred from religious ceremonies —he was not even allowed to hear or chant the sacred texts of the Hindus.

DISCOVERING LATRINE TECHNOLOGY

My superior at the Centenary Committee, Rajendra Lal Das, gave me the book *Excreta Disposal for Rural Areas and Small Communities,* which was written by two sanitation engineers and published by the World Health Organization (WHO). Many passages made a lasting impression on me. For example, "Suffice it to say here that out of the heterogeneous mass of latrine designs produced all over the world, the sanitary pit privy emerges as the most practical and universally applicable type."

The book laid out seven conditions for meeting the criteria for a sanitary latrine.

1. The surface soil should not be contaminated.
2. There should be no contamination of the ground water that may enter by way of springs or wells.
3. There should be no contamination of the surface water.
4. Excreta should not be accessible to flies or animals.
5. There should be no handling of fresh excreta. Or when this was unavoidable, it should be restricted to the barest minimum.
6. There should be freedom from odors or unsightly conditions.
7. The method used should be simple and inexpensive in construction and operation.

The book's recommendations pertained to the application of this technology only in rural areas. However, I thought the soil condition of rural and urban areas was likely to be the same and that this technology could be used in urban areas as well. I concluded that this technology could provide a viable alternative to scavenging. Accordingly, I innovated, invented, modified, and developed alternatives to the existing technology that would make it suitable for urban conditions, including designs for various site conditions, such as congested areas, restricted spaces, etc.

Ultimately, the book helped me develop the two-pit, pour-flush, compost toilet technology, which is remarkable for its many advantages and has in fact proved to be revolutionary. It is hygienically appropriate, cost-effective, and easy to construct and maintain with locally available materials. The design and specifications can be modified to suit the needs and the paying capacity of the user. The toilet can be located inside or outside the house, can be constructed in different physical, geological, and hydrogeological conditions and it does not pollute surface water or groundwater or use large volumes of water. It is simple to maintain and does not require the services of a scavenger. There is the potential for upgrading, as it can later be connected to sewers. A low-volume flushing cistern can be attached and the whole set-up needs very little space. And, finally, it generates fertilizer. This represents a significant technological advancement, as the world previously had only two options, sewer system and septic tank, both of which are expensive to construct and maintain and require excessive water for flushing, unlike the Sulabh technology.

LIVING WITH SCAVENGERS

I am a student of sociology. We were taught to build rapport with the community for which one wanted to work. Hence, I set out on my journey to live in a colony of scavengers in Bettiah, (Champaran), in Bihar, a State of India. From there, Mahatma Gandhi had started his movement to free India from the shackles of slavery. In this colony, Bhola Raut, a Member of Parliament used to live; except his house all the houses of scavengers were made of thatches. So I went and approached him for accommodation in his house. When I met him, he got up at

once as a mark of respect to me since I was a Brahmin, a caste highest in caste hierarchy and asked whether I would live in his house, I said, "Yes Sir, I have to live here." Initially he was reluctant to believe that I would stay in his house but finally he gave me a room to live in.

Next day, when I woke up, I wanted to use the toilet, it was terribly dirty and stinking, it was difficult to go inside to use it. So I brought a bucket of water and a broom to clean the toilet before using it. When I started cleaning the toilet and people saw me doing so, they rushed and took away the bucket and the broom from my hands and they started cleaning it themselves. After the toilet was cleaned, I asked them, while they were cleaning the bucket toilets of the entire town of Bettiah, why they were keeping their toilet so dirty. They had no answer but for full three months I stayed there, the toilet was kept clean and usable. The scavengers had a habit of playing cards most of the time when they used to return from their work. They had a piece of land in front of their houses, which lay unutilized, not even for growing vegetables or sundry products like garlic and onions there. So, I persuaded them not to play cards most of the time and to do some gardening, instead, with growing some vegetables on their land. I helped them by letting them know how to cultivate the land and sow seeds.

I also started teaching them alphabets as they were very curious to learn and be able to read and write. So they started taking interest in learning and while I was there they were able to sign, read and write some sentences including some English words as well.

Generally, I used to have lunch with the scavengers" family, so when they were informed earlier, they would bring utensils (*thali,* glass and water pot) from outside to serve me food. I realized that thus, I could not know their real living conditions, so I stopped telling them in which house I would have lunch. I used to have lunch with any family at random, when I felt hungry and they used to serve me the food which they had cooked for themselves. The utensils *(thali, lota* etc.) they used were all made of aluminum and with dents all around, the utensils were mostly shapeless. Thus, I was able to know their food habits, the utensils which they used and their ways of life.

In the evenings male scavengers as well as some females used to drink and fight amongst themselves using abusive language. I persuaded them to control themselves and not to drink or abuse one another. In the morning, they used to go to clean bucket toilets, therefore I persuaded them to have evening prayer. While in the colony, I came to know about their culture, values and mores as well as the practice of manual cleaning of human excreta by a class of people called human scavengers. Scavenging started during *Pauranic* period (2500 BC). The work was divided among people of different castes, and the job of cleaning human excreta was given to "*Antyaj*" (untouchables). Later on they came to be known as "scavengers'. The existence of human scavenging has been found during Bauddha, Mauryan, Mughal and British periods.

In Mughal period the number of scavengers increased. When the Mughals defeated the native Indian warriors (Kshatriyas) and made them captives, they

forced them to clean human excreta manually. In the beginning the scavengers were Hindus, later on, some of them embraced Islam, Sikhism and Christianity. It is interesting to know, however, that there were people of four religions in the scavenging profession. But their status in the society did not change, even when they got converted to other religions and they continued to remain untouchables.

While living in the scavengers' colony, I noticed one morning that a newly married girl was being forced by her mother-in-law, father-in-law, and husband to go to town to clean bucket toilets. She was crying bitterly, as she was most unwilling to do this work. On hearing her cries, I decided to intervene, trying to persuade the family members not to force her to clean toilets. They listened to me but did not agree, and countered by asking me what she would do tomorrow if she did not do the work of scavenging and earn some money. Even if she sold vegetables instead, who would buy them from her, an untouchable? Finally, despite my protests, they sent her to clean toilets.

A few days later, as I was going to the market with a colleague from the scavengers' colony, we saw a bull attacking a boy who was wearing a red shirt. When people rushed to save him, somebody shouted that he belonged to the scavengers' colony, whereupon everybody left him. We took the boy to the hospital, but he died.

After this incident, I took a vow to fulfill Mahatma Gandhi's dream of relieving scavengers from their subhuman and unhealthy occupation of cleaning and carrying human excreta manually. In this simple but direct way, I set out to "cleanse" myself of caste prejudice and to educate myself, technologically and socially, not only to find alternatives to scavenging but, more importantly, to help restore some semblance of human rights and dignity to scavengers.

I returned from the scavengers' colony, firm in my resolve to dedicate my life henceforth to the cause of scavengers. However, by the time we could chalk out any program for training and demonstration, the Celebrations Committee came to an end. However, Bihar's visionary Chief Minister, Daroga Prasad Rai, decided to continue with the program to abolish scavenging through some other organization. My date with destiny had arrived! On March 5, 1970, the Sulabh Swachh Shauchalaya Prashikshan Sansthan (Sulabh Clean Toilet Training Organization) was founded. This was the first small step in the long journey toward eradicating "untouchability" and social discrimination—which was like making the earth and sky meet.

A SMALL STEP ON A LONG JOURNEY

The World Health Organization provided generic and technical support to the Sulabh Sanitation Movement. I founded a non-profit, voluntary, social organization, with the idea that it would be acceptable to both the government and the people. The organization went through several name changes, and is now known as the Sulabh International Social Service Organization.

After forming the organization, we submitted a report on the technology and methodology of pit latrines to the government of Bihar. The government engineers were critical of the pit latrines because they were familiar with only two technologies, sewer and septic tank, and were not ready to accept the new technology of pour-flush toilet. The government of Bihar took more than three years to decide on Sulabh's proposals. Meanwhile, in Bihar's Arrah Municipality, we set up the first two toilets for demonstration. After seeing how they functioned, the Municipality Chairman approved the proposals. He was pleased with the toilets, which he said, represented Mahatma Gandhi's dream come true.

Because the people of Arrah were not familiar with the pit-latrine technology, I had to go house to house to educate them on the health hazards of the existing bucket toilets and explain that the new pour-flush toilets, called Sulabh Shauchalayas, were an appropriate, affordable, indigenous, and culturally acceptable alternative to scavenging. Slowly but steadily, the people converted to the new system.

A LETTER THAT MOVED THE MOUNTAIN

In April 1973, Sulabh got a great lift in the form of a letter from Indira Gandhi, the then Prime Minister of India, to a Member of Bihar Legislative Assembly (MLA):

> I have your letter of the 17th March and am concerned to read that the State Government has not been able to utilize the Fourth Plan provision for Schemes designed to eliminate the odious practice of carrying night soil on the head. I am writing to the Chief Minister and asking him to give his personal attention to this matter. I entirely agree with you that our Party should be active in this important social program.

In 1974, the Government of Bihar named Sulabh Shauchalaya Sansthan as a catalytic agent to work amongst the government, local bodies and the beneficiaries to implement the program. Government engineers raised objections about the possible contamination of water from these toilets and asked the Environmental Engineering Research Institute, Nagpur, to give its opinion on the matter. The Institute determined that there was no chance that these toilets would contaminate the soil if they were constructed with care.

I contacted the WHO for its opinion on possible water contamination by pit latrines. A. K. Roy, the sanitary engineer at the WHO's India office, was unable to believe that Sulabh could convert 40,000 bucket latrines into water-seal, pour-flush toilets. When I met him in 1977, Roy said that he had spent more than 35 years as a Public Health Engineer, besides being Chief Engineer in Uttar Pradesh and West Bengal, and felt this program could not be implemented on such a large scale. After some persuasion, he agreed to send a sanitary engineer, Alberto Besa, to see how the Sulabh toilets were functioning in Patna and Ranchi.

On the basis of his observations, Besa submitted a favorable report. The WHO, in collaboration with UNICEF and the Government of India, organized a nation-

al seminar in Patna in 1978 on "Conversion of Bucket Privies into Sanitary Water-Seal Latrines'. Representatives from India's Planning Commission, Ministry of Health, Ministry of Works and Housing, All India Institute of Hygiene and Public Health, and the secretaries and top officials of all state governments participated. After a three-day deliberation, India made the landmark recommendation that bucket latrines be converted into water-seal, pour-flush toilets. The WHO published a brochure on the activities of Sulabh, which was widely distributed.

In 1985, the United Nations Development Program prepared a manual on the adoption of Sulabh technology in the countries of South-east Asia, Latin America and Africa. In 1996, India's Ministry of Urban Development sent the Sulabh technology to Istanbul, Turkey, to be evaluated at Habitat II, where it was recognized as a "Global Urban Best Practice." In 2000, the United Nations Centre for Human Settlements (HABITAT) and Dubai Municipality, on the recommendation of the Ministry of Urban Development, the Government of India and the Human Settlements Management Institute of Housing and Urban Development Corporation, selected Sulabh technology as the "Best Practice to Improve the Living Environment" out of 1,100 entries from 125 countries, which earned it a gold trophy and US $30,000.

SULABH TECHNOLOGIES: KEY TO IMPROVED SANITATION

To date, over one million bucket latrines have been converted into Sulabh toilets, relieving more than a million scavengers from the demeaning practice of physically handling and carrying human excreta. Nevertheless, 500,000 scavengers are still engaged in this work. As many as 630 million people in India today have no toilets in their homes and must defecate in the open. Women suffer most, as they must defecate either before sunrise or after sunset. It is no wonder that nearly 200,000 children in India die every year of diarrhea and dysentery. Sanitation is a broad term that includes disposal of human excreta, wastewater, solid wastes, personal hygiene, etc. Human excreta is the cause of many enteric diseases, such as cholera, diarrhea, dysentery, typhoid, infectious hepatitis, and hookworm. Studies reveal that more than 50 kinds of infections can be transmitted from diseased people to healthy ones directly and indirectly by human excreta, which causes nearly 80 percent of the diseases in developing countries.

Low sanitation coverage in India is primarily due to people's insufficient motivation and awareness and the lack of affordable sanitation technology. People, mostly those from lower economic strata, are generally not aware of the health and environmental benefits of sanitation and it is still not a felt need for them. Non-availability of a choice of toilet designs, area-specific technologies, inadequate delivery systems and the lack of trained masons, skilled workers, and technical manpower are also reasons for low coverage.

By tradition, Indian society values personal hygiene but gives little importance to a clean and healthy community environment. Human excreta is regarded as the most hated object and anything connected with the latrine is considered so defil-

ing that psychological and religious taboos dictate that one is supposed to take a bath immediately after coming out of the toilet and before going into the kitchen. Sanitation, therefore, is regarded as a matter of individual initiative and not a collective obligation of the community.

In the developed countries, the standard means for the sanitary disposal of human waste is sewerage. Sewerage was first introduced in London in 1850, followed by New York in 1860, and, perhaps surprisingly, by Calcutta in 1870. However, due to financial constraints and exorbitant maintenance and operational costs, sewerage is presently not the answer to waste management in India. Today only 232 towns and cities out of 5161in India have any kind of sewerage system.

Sanitation ... is regarded as a matter of individual initiative and not a collective obligation of the community.

In developing countries, neither the federal or local authorities nor the beneficiaries can bear the total cost of installing and operating sewerage system, and skilled people are not available to run them. Furthermore, a sewerage system requires 15 liters of water to clean per toilet per use, which brings into question whether we are building huge dams and irrigation systems to bring in water, only to flush it down into an expensive sewerage system where it ends up polluting our rivers and ponds. Most of the rivers in India are heavily polluted due to untreated domestic sewage from cities, which has led to the deterioration of groundwater aquifers and community health.

The septic tank system is also expensive and requires a large volume of water for flushing. Meanwhile there is a shortage of drinking water in almost all urban areas, which demands that water be conserved. Septic tanks have other problems, like needing periodic cleaning and disposal of sludge. Inadequate means of effluent disposal is a source of foul smell, mosquito breeding and other health hazards.

The Sulabh twin-pit, water-seal, pour-flush, compost toilet

The Sulabh pour-flush, compost toilet is eco-friendly, technically appropriate, socio-culturally acceptable, and economically affordable. It is an indigenous technology and the toilet can easily be constructed by local labor using local materials. It provides health benefits by safely disposing of human excreta on site. The toilet consists of a pan and a specially designed trap, with a waterseal that requires only 1.0 to 1.5 liter of water for flushing, thus helping to conserve water. There are two pits of varying size and capacity, depending on the number of users, and no scavengers are needed to clean the pits. The two pits are used alternately, and each has a capacity designed to last minimum three years. When one pit is full, the incoming excreta is diverted into the second pit. In about two years, the sludge gets

digested and is almost dry and pathogenfree, thus safe for handling as manure. Digested sludge, which is odorless, can be dug out easily and used for agricultural purposes, such as manure and soil conditioner. The cost of emptying the pit can be partially met by selling the manure. One of the major difficulties in using human excreta as manure is the presence of bacteria and other pathogens, which must be removed before it can be used. Studies carried out by Sulabh have revealed that the contents of a toilet pit are almost free from pathogens when taken out after a two-year resting period. To make it completely pathogen free, digested sludge is sun dried for two weeks after being removed so that eggs of Ascaris and Helminths are eliminated. While drying, sludge forms big lumps that make it difficult to mix in with soil, so it is processed in a ball mill to break it into small pieces, then passed through the mass mixer, where the moisture content is regulated by adding water. The resulting manure has a good percentage of plant nutrients and increases humus and the water-holding capacity of the soil. The Institute has carried out experiments to monitor the fertilizer's effects on different vegetables and flowering plants. In all the test cases, the manure's effect on the growth of plants was very encouraging. The Sulabh toilet can also be constructed on the upper floors of buildings, has a high potential for upgrading, and can be easily connected to sewers when they are introduced in a new area.

The Sulabh twin-pit, pour-flush, compost toilet does not cause water pollution. When the toilet is constructed in homogeneous soil, bacteria do not travel horizontally more than three meters and the vertical seepage is not more than one meter. However, to this must be added the precaution that the toilets be built at a safe distance from any water source, keeping the above points in mind. No vent pipe is needed, since the gas gets absorbed in the soil facing the chamber. The parameters change, depending upon the coarseness of the soil. and the type of terrain where the toilet is being constructed. The shape of pits may be rectangular, circular, or linear.

Why two pits are better than one

A single leach pit is appropriate only if the other pit is constructed before the first one is full. It is difficult to have another pit immediately when the first pit is full. So it is desirable to build two-pit simultaneously. In the two-pit system, because only one pit is used at a time, the full pit can be cleaned manually, even by the householder, because the long period of digestion makes it free of foul smell and is safe to handle. In contrast, with a single pit system, de-sludging has to be done almost immediately after the pit has been filled to enable its continued use; this involves handling of undigested excreta, which is hazardous to health. If a deeper and larger single pit is provided, de-sludging will be more difficult and the chance of polluting greater, especially where the groundwater table is high.

To prevent the pollution of drinking water sources, the latrine pits in fine soil should be located at least ten meters from open wells, provided the groundwater table is two meters or more below the bottom of the pit throughout the year. If the

water table is higher, the distance should be increased more depending upon the local situation. In coarser soil, the same safe distance can be maintained by providing a "sand envelope" around the pit and sealing the pit bottom with some impervious material. In water-logged, flood prone, and high sub-soil water areas, the pits should be raised, which will require raising the toilet floor as well. The earth should be well compacted all around the pit.

Cost of the Sulabh toilet

The cost of Sulabh pour-flush composting toilets varies widely to suit people of every economic stratum. The cost ranges from US$10 to US$1,000 per unit, depending on the materials used. The pits can be constructed with bricks or any locally available materials, such as stones, wooden logs, burnt clay rings, concrete rings, or even used coal-tar drums. The quality of the superstructure materials can range from simple gunny-bag sheets or thatch to well-finished tiles, with reinforced cement concrete (R.C.C.) roof, doors, wash basin, etc. Cost also depends on the size and capacity of the pits, varying from two to twenty years' capacity for each one. Keeping the basic design unchanged, Sulabh has a number of such toilet models for demonstration.

Sulabh public toilet complexes

Installing the Sulabh public toilet complexes in public places and slums on a "pay-and-use" basis was an important landmark in the field of community health, hygiene, and environmental sanitation. As far back as 1878, the Bengal government enacted a law to set up toilet facilities in Calcutta, but for many reasons, such facilities could not be provided or maintained for the next 100 years. The concept of constructing public toilets and maintaining them on a pay-and-use basis, originated by Sulabh in 1974, has been outstandingly successful throughout India. For some years, the behavioral patterns and attitudes of people who did not use public toilets available in cities and towns were studied, and the findings showed that the filthy state of public toilets deterred their usage. Users also said that if facilities for bathing and washing clothes could be provided along with clean community toilets, thus making it easier to maintain all around cleanliness, people would like to use them and would be willing to pay.

In 1978, the Government of India, in collaboration with the WHO and UNICEF, held a national seminar at Patna, where it was unanimously recommended that the system of twin-pit toilets and the maintenance of public toilets be adopted by other Indian states. The dissemination of information regarding these innovations spread after the seminar, and today the technology has spread from one locality in Bihar state to 1,147 local bodies spread over 25 states and 4 union territories of India. So far, more than 7,500 public toilets have been constructed and are being maintained by Sulabh. The biggest public toilet of Sulabh was constructed at Shirdi, in the state of Maharashtra's Nasik district. It features 120 WCs,

108 bathrooms, 28 toilets (separate for ladies and gents), and 5,000 lockers for the convenience of pilgrims.

Sulabh toilet complexes are located in public places at bus stands, in hospitals, markets, and slums. Sulabh plays the role of a catalyst for the construction, operation, and maintenance of the complexes, and as a partner between official agencies and the users. The complexes are manned by trained attendants night and day and have separate enclosures for men and women. Soap powder is provided for washing hands. The system of operating and maintaining community toilets evolved by Sulabh has proved a boon to local authorities in their efforts to keep their towns clean and improve the environment. This is a unique example of partnership between local authorities, a non-governmental organization, and the communities

Making energy from waste

Recycling human excreta to generate biogas is an important way to get rid of the health hazards carried by human waste. Sulabh is the pioneering organization in the field of generating biogas from public toilet complexes. After a series of experiments, Sulabh developed an efficient biogas plant design, the Sulabh Model, which has been approved by India's Ministry of Non-conventional Energy Sources for implementation through the state agencies. The anaerobic conditions inside the digester eliminate most of the pathogens present in human excreta, thus this biogas technology that deals with human waste has multiple benefits, including sanitation and bio-energy. Biogas plant effluent also can be used as manure or discharged safely into any river or water body without causing pollution.

Based on the Sulabh design, 200 biogas plants have been constructed by Sulabh in different states of the country so far. Biogas technology dealing with human excreta remained unnoticed for a long time, due to the fact that the available technology was not socially acceptable, as it required manual handling of human waste. The design developed by Sulabh does not require manual handling and there is complete recycling and resource recovery from the wastes. The digester is built underground, into which flows the waste from public toilets. Inside the digester, anaerobic fermentation produces biogas, which is then stored in biogas plant through liquid displacement chamber. One cubic foot of biogas is produced per person per day from the use of toilet. One thousand cubic feet of biogas is equivalent to 600 cubic feet of natural gas, 6.4 gallons of butane, 5.2 gallons of gasoline, or 4.6 gallons of diesel oil. Biogas is used for cooking, lighting, warming oneself, to generate electricity, etc. A public convenience used by about 2,000 people per day produces enough biogas to run a 10-Kilo Volt Amperes (KVA) generator for eight hours a day. Methane is the only combustible constituent, which is utilized in different forms of energy production.

Sulabh's effluent-treatment system

Wastewater from the biogas plants can be used as fertilizer, as it contains a good percentage of nitrogen, potassium, and phosphate but it still has an unpleasant

color and a bad odor. Moreover, the presence of pathogens and high biochemical oxygen demand (BOD) content limits its use for direct discharge into a water body. Sulabh maintains over 200 toilet complexes that are linked with biogas plants, therefore it was important that the organization make the wastewater free from odor, color, and pathogens to enable it to be discharged safely in the water body. A series of experiments led to the development of a new and convenient technology that turns the effluent from the biogas plant into a colorless, odorless, and pathogen-free liquid.

The technology is based on sedimentation and filtration of effluent through sand followed by passing it through aeration tank and activated charcoal and then exposing it to ultraviolet (UV) rays. The filtration unit makes it colorless, odorless, and free from organic particles and the UV eliminates bacteria. It reduces the BOD drastically, making it safe for discharge into any water body. It can also be used to clean the floors of public toilets and for gardening purpose.

Biogas from dried water hyacinth

Water hyacinth is an aquatic, seasonal, and problematic weed, and the Government of India formed a task force to get rid of it. However, water hyacinth does have the advantage of being a good substrate for biogas generation. It was used earlier for biogas generation after chopping, that resulted in choking of plants. Its liquefaction is suitable for biogas generation but it is too expensive to make such biogas plants economically viable. Sulabh used this weed for biogas generation after drying and pulverizing it into powder form. Such dried water hyacinth when mixed with human waste or animal waste for biogas generation has synergistic effect on biogas generation i.e. biogas generation is enhanced 2 to 3 times. After drying, the weed can be used throughout the year, minimizing its menace to the environment. The Institute carried out a series of experiments on generating biogas from vegetables, fruits, and household kitchen wastes, with and without adding human waste. Results were better when human waste and vegetable waste were used in combination.

Duckweed-based wastewater treatment

Duckweed—a small, free-floating, fast-growing aquatic plant—has great ability to reduce the BOD, suspended solids, bacteria, and other pathogens from wastewater. It is also a complete feed for fish, increasing yields by two to three times, and a highly nutritious feed for poultry and animals due to its high protein and vitamin content. Although duckweed is found in ponds and ditches, its potential in terms of wastewater treatment, nutrient value, and economic benefits have not been fully exploited, due to almost complete absence of any know-how of relevant technologies. Sulabh has developed demonstration projects with cost-effective, duckweed-based wastewater treatment in rural and urban areas, which show direct economic returns from pisciculture. India's Central Pollution Control Board has set guide-

lines for the use of duckweed in wastewater treatment, based on the experimental results of Sulabh.

Financial viability

One of the major problems with wastewater treatment methods has been that none of the available technologies had a direct economic return and they also had high capital and maintenance costs. With no economic return, local authorities were generally not interested in taking up the treatment of wastewater, thereby causing severe health hazards and environmental pollution. Most of the untreated wastewater, therefore, was discharged into rivers or other water bodies. In rural areas it was a common practice to discharge wastewater or sullage without considering treatment or recycling or any reuse of effluent, as people were not aware of the new technology. Furthermore, as human excreta is generally considered repugnant, it was difficult for people with this mindset to even consider investing in projects relating to the disposal of human waste.

Sulabh, however, has now made the project financially viable and socially acceptable. The cost of constructing a toilet complex is met by the local government. Toilet maintenance and day-to-day expenses are paid from user fees. Sulabh does not depend on external agencies for financing, as it generates funds through internal resources. Although the toilet complexes in the slums and less developed areas are not self-sustaining, their costs are subsidized by the income generated by busier toilet complexes in the cities and other developed areas.

Altogether there are over 50,000 volunteers working with the Sulabh organization, including technocrats, professional managers, scientists, engineers, social scientists, doctors, architects, and planners, along with support staff. Workers associated with construction jobs are engaged on new sites throughout the year, and Sulabh offers a 30-year maintenance guarantee for the toilet complexes it constructs.

It is now accepted that improving sanitation has a direct impact on health and, in turn, on the overall productivity and quality of life of the common people. In India, improved sanitation is directly related to an improved social condition for scavengers. The on-site treatment of human waste and wastewater is clearly the best option available to tackle the problem of sanitation effectively. This economically viable technology, which has the lowest possible operational and maintenance costs, is especially applicable in the developing countries of Asia, Africa, and South America.

SOLID WASTE MANAGEMENT

Solid waste management has remained one of the neglected areas in urban India. Over the years there has been a progressive decline in the services provided for the collection and disposal of household, hospital, and industrial wastes, and in the attention paid to environmental sanitation and public hygiene. In most cities, nearly one-half of the solid waste generated remains unattended to, which gives

rise to unsanitary conditions, especially in densely populated slums. This has resulted in higher rates of mortality and morbidity due to infections among urban slum dwellers, with handlers of human waste being the most affected. It is, therefore, imperative that steps be initiated immediately to improve solid waste management, the environment, health, hygiene, and sanitation in order to minimize the health hazards arising from environmental disruption and rapid urbanization.

The Sulabh International Academy of Environmental Sanitation and Public Health, set up by Sulabh International Social Service Organisation, has developed a new technology—the Sulabh Thermophilic Aerobic Composter—that requires only eight to ten days to make compost from any bio-degradable waste, without any manual handling. It is based on the thermophilic aerobic method, a technology that does not require recurring expenditure. The benefits of this technology are that (1) organic solid waste can be efficiently converted into manure and soil conditioner, creating economic return; (2) it can control diseases transmitted from waste as pathogens are eliminated when it is treated at high temperatures; (3) cost of transporting waste to disposal sites or landfills will be greatly reduced due to the reduced volume; and (4) spread of weeds from waste will also be controlled. The technology is suited for rural areas also, as its by-products (compost) can readily be used for agricultural purposes, and it also reduces health hazards.

A NEW SOCIAL STATUS FOR SCAVENGERS

I realized long ago that the liberation and rehabilitation of scavengers would not be an easy task. It was extremely difficult for the worst victims of centuries of institutionalized discrimination to break out of the vicious circle and join the mainstream of society. Hence, I devised a well thought-out and multi-pronged strategy to rehabilitate the scavengers by giving them alternative employment, thus helping them integrate into the mainstream. My strategy for liberating the scavengers through the Sulabh Movement consists of a package of technology and rehabilitation mixed with alternative employment and social reform. This holistic approach is radically different from other social reform movements, in that it combines technology with social idealism. My scientific and humane approach to abolishing scavenging was inspired by a commitment to basic human rights and based on years of research and study of the problem.

The Sulabh approach to restoring dignity to scavengers has five distinct stages:

- Liberation
- Rehabilitation
- Vocational training
- Proper education of the next generation
- Social elevation

Sulabh's determined and principled intervention has yielded good results. The two-pit, pour-flush, compost toilets developed by Sulabh caught the nation's imagination, and as a result, public and individual toilets were installed all over India, thus freeing tens of thousands of scavengers from a life of degrading work and

social humiliation. At the same time, Sulabh took care to provide alternative jobs to the scavengers who were rendered jobless by the large-scale conversion from dry latrines to Sulabh toilets. Sulabh has been able to liberate and rehabilitate more than a million scavengers during its 40 year struggle.

To help scavengers adapt to their new social standing, Sulabh developed what it calls social upgradation program. Involvement is voluntary; all it costs is a will to shed social prejudices and show compassion for fellow humans. Well-meaning, committed citizens formally and publicly adopt a scavenger's family, and the two families interact closely and visit each other's homes. The adopter sometimes helps his adopted family to deal with problems of social adjustment. As the adopters are generally people of social standing and prestige, their involvement serves as a role model for others.

Social adoption has had a positive effect on integrating the scavengers into the mainstream of society. So far, 5,000 scavenger families have been adopted by well-known personalities, including former Prime Minister of India I. K. Gujral, politician-intellectual Mani Shankar Aiyar, noted journalist Dilip Padgaonkar, and advocate Venu Gopal. More than four decades after Sulabh International embarked on its mission, I am confident that Mahatma Gandhi's vision to eradicate manual scavenging from India is within reach.