IRCWD NEWS

WHO International Reference Centre for Wastes Disposal

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Liquid Compost Plant for Rural Sanitation

Basic Principles and Objectives – Appropriate Technology Series

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Introduction

The United Nations Conference on the Human Environment held in Stockholm in 1972, gave a timely awareness to the problems of pollution faced by practically all countries in the world. While it was well understood that industrialisation had caused the unprecedented air and water pollution in the developed world, the Prime Minister of India had to point out that it was poverty, caused by lack of industrialisation, which brought about water and land pollution in the developing countries. Since then, discussions on appropriate technologies to industrialise the developing countries have been going on in different countries and international organisations. Dr Van Brakel[1] in his interesting report, has brought out the numerous terms coined by different groups and individuals, who have jumped onto the bandwagon of appropriate technology. While one English group headed by the late E.F. Schumacher preferred to call it Intermediate Technology. Gimpel[2], the English historian, has come to the grim conclusion that the developing countries are 800 years behind the developed ones in industrial technology. At present it seems that there is no point in catching up with the developed world if it leads to the same degree of environmental pollution!

Darrow and Pam[3], the authors of "Appropriate Technology Source Book", have not made a mention of any appropriate technology in the field of sanitation, nor has Brakel[1] in his recent book on appropriate development. Israel and Torfs[4] have explained the significance of "Appropriate Technology" in the field of health as "appropriate to people's needs, resources and talents". Feachem[5] has gone into the details of the alleged failure of WHO in dealing with the sanitation problems of the developing countries, in both urban and rural areas.

Background

The most widely accepted and standard form of rural sanitation in developed countries is the one based on septic tank and soakage pit or trench. The installation of even such a system requires percolation tests at the site as described by Barbarick and others[6], to ensure proper working of the percolation system. Failure of septic tanks in California has been investigated by Smith[7]. According to Kolega and co-workers[8], pumping out the septage once in 3–4 years is considered a dirty job, and the treatment and disposal of the septage a difficult but necessary routine, if the septic tank system is to work properly for long periods without polluting the environment. Composting of the septage has been studied in Boston by Lombardo[9], and recommended as a feasible and, at the same time, economical alternative. Canadian practice in using septic tank systems has been investigated by Viraraghavan and Warnock[10]. According to them, field irrigation by septic tank effluents is no longer recommended in the Saskatchewan province, and nearly half of the municipalities have switched on to new lagoon systems. According to Halter and Dilen[11], an alternative system both trouble-free and non-polluting should have been developed. Eric Mood[12] who has studied Housing Control and Public Health in the United States has come to the conclusion that more attention and funds should be available for the prevention of diseases than for their treatment. He feels that physicians of the Public Health Department understand the latter aspect better than the former. Jewell[13] has recommended making Rural Environmental Engineering Education more widespread and purposeful if rural and urban areas are to be reasonably free from pollution. Prof. Rudolf Braun[14] has recommended recycling of all wastes (solid and liquid) both in rural and urban areas if the environment is to be protected from pollution. In fact, similar views were also expressed earlier on by Dr Roberts[15]. Purcell and Smith[16] have recommended pollution-free disposal of refuse from all future industrial plants in order to avoid past mistakes.

While it is recognised that man and his industrial activities produce large quantities of waste leading to environmental pollution in developed countries, little or no notice is taken of the large quantities of wastes generated by the agricultural sector (animals including birds, plant products, and the food processing industries of different kinds). Considering the fact that animals, when housed in winter or fattened in feedlots or pasture, produce large quantities of solid and liquid wastes as compared to man, it is surprising that no attempts have been made to treat these wastes at source before releasing them into the environment. As early as 1970, Thrower[17] discussed, in great detail at the Milroy lectures, the problem of public health with regard to agriculture. Strauch[18] has also given a detailed account of the diseases that can be contracted from agricultural activities and the ones transmitted through animal manure[19].

As stated earlier, since the United Nations Conference on the Human Environment, the developed world became more aware of the problems of pollution control. Consequently, every developed country introduced appropriate legislation for the control of pollution, or enforced the legislation already passed. While this reaction was mainly concerned with industrial pollution of both water and air, it was the Swedes who initiated action to reduce wastewater pollution of the Baltic Sea. The result was, as already reported by Robert Rodale[20], a series of efforts in devising compost toilets. Lars De Jounge[21] followed with a publication on the Toa-Throne, which was approved by the Swedish Health Authorities and by different states in the US. Sam Love[22] indicated the change in thinking among US architects, concerning the flush toilet. Uno Winblad[23] gave construction and operational data of the different types of compost latrines in various countries, including Sweden. Following these developments, Rybczynski and co-workers[24] brought out a review publication on low-cost sanitation, while Uno Winblad and others[25] published a report on "Sanitation without Water". Commercial firms followed the international thinking on the subject of pollution, and created the vacuum sewage system in Scandinavia, France and the Federal Republic of Germany (Electrolux)*[26]. Even the conventional system of sewage treatment has been upgraded by the introduction of "Flocor Biofilter" to "Turnkey-projects" in Sweden, which seems to have found acceptance by I.C.I.** U.K.[27].

All the above attempts at pollution control improvements are concerned with urban sanitation. Nothing whatsoever has been done to upgrade the septic tank systems, except one solitary attempt to convert it into a biogas system in the Philippines[28]. Another similar attempt in sanitizing fecal wastes by biogas digesters for developing countries has been made by Simpson[29]. While the Philippine attempt is theoretically possible (gas production), hygienisation of fecal matter is not feasible in biogas plants, unless special efforts are made at some stage. This has been pointed out by the editorial comments on the paper of Nagar[30]. Night soil digesters constructed by NEERI for the central prison of Nagpur, India[31], are chiefly intended for energy production; sludge drying which was introduced for sanitation purposes, however, cannot be carried out during the rainy season. According to Bhagirathi[32], biogas has also been produced from septic tanks at the Parasakthi College for Women in Courtallam. Attempts have been made in different countries to build sanitary latrines for the purpose of improving sanitation inside residential areas/houses and not for the control of environmental pollution. These have all been assembled and published by the German Appropriate Technology Exchange[33], so that rural sanitation enthusiasts could adopt whichever system that appealed to them. According to Oliapuram[34], a covered pit of suitable size is sufficient to receive a family's excreta for years if one is not bothered about groundwater and soil pollution over a short distance and, in this case, wastage of the organic residues.

The following reasons show why agricultural wastes, including animal and poultry wastes, pollute water, land and air to a much greater extent than human wastes: (i) animals produce quantitatively much more waste and (ii) animal wastes are not treated at all in any country in the world and (iii) they are more polluting due to their greater quantity. The possible argument is that grazing animals cannot be controlled in this respect. But that does not apply to breeding animals kept in feedlots, dairy animals housed in winter and a host of other animals and fowl housed year round! According to Matyáš[35], over 150 types of diseases are spread by animals and animal-products, including manure. Yet, only few bibliographical data on animal waste treatment have been reported so far, and surprisingly enough, they are of recent origin. Verley and Miner[36] have designed a rotating flighted cylinder to separate manure-solids from water. J.B. Allen[37] has suggested flush systems and lagoons for cage-layer houses. M.F. Franz[38] has even indicated "A Waste-Handling Revolution" in the Dairy Industry, which is based on the interest of American farmers in methane generation from cow dung slurry, and considered a valuable by-product of waste handling due to the increasing cost of conventional forms of energy production. Biogas production from animal dung, (with or without night soil) has also been suggested by Nagar[30] as a solution to the energy problem. Similar studies have been carried out in Scotland by Summers & Bousfield[39], and by Bousfield, Hobson and Summers[40]. While the process requires heating of the medium to 35 °C throughout the year, the net energy yield has yet to be calculated. Besides, nothing has been indicated about the manner of treated sludge disposal, except a few words about a reduction in pollution power of piggery, poultry and cattle farm wastes. To solve the pollution problem, Lizdas[41] has studied the feasibility of using feedlot wastes for methane production and the residual sludge as supplementary feed. Crauer & Hoffman[42] have also studied liquid composting as a pollution control measure alone, with disposal of the solids on land as soil conditioner and the liquids into the watercourse, after separation through costly mechanical devices.

The biogas plants set up in India and other South-East Asian countries are considered only as rural sources of energy, except in Thailand[43], where biogas is managed jointly by the departments of Agriculture, Housing and Health. The authors of "Energy for Rural Development"[44], do not appear to consider biogas as a rural source of energy, neither do Darrow and Pam[3] in their recent book entitled "Appropriate Technology Source Book". This is mainly because biogas workers themselves have not correlated biogas with sanitation in their overenthusiasm for the production of rural energy, and, in spite of biogas being originally a by-product of sewage treatment. In fact, in the field of energy for the developing countries, even firewood has not found a place among the appropriate technologies, though Eckholm[45] has pointed it out as "The Other Energy Crisis", which, though it came first, remained unnoticed as it affected only developing countries.

*The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organisation or the International Reference Centre for Wastes Disposal in preference to others which are not mentioned.

**Imperial Chemical Industries

An integrated system of sanitation, biogas and compost has been practiced in China for some time now, though the utilisation of human wastes as manure was part of the Chinese culture for thousands of years. The integrated systems have caught the imagination of the world community as evident from the publications of the IDRC[46] and FAO[47&48]. Paul[49] has, however, demonstrated how an integrated recycling of dairy farm wastes can lead to improved sanitation, energy and fodder production on a record level and an all-round development of the environment over a long period. During the above period, others have published their own experiences and views on different aspects of integrated systems. Laura and Idnani[50] have studied "Composting of Agricultural Waste Materials with Spent Slurry as a Starter for Decomposition". Chan[51] has described "Integrated Farming Systems" involving biogas from piggery waste, algae, fish and duck-farming on a small scale. Ames[52] has studied the application of organic manures in South India for improved crop production. Golueke & Oswald[53] have visualised "An Algal Regenerative System for Single-Family Farms and Villages".

While many people have made limited studies on different aspects of rural development and a few on integrated farming systems, with and without actual field experiments, a total approach to the environment has been suggested by some authors. Johnson[54] has advocated a comprehensive approach to the environment as the basis of all advancement in the developing regions of the world. Geiger[55] has advocated treatment of the environment for all the problems of the developing society. Schumacher[56] has called for simultaneous attention to the social and economic problems of a developed society, through application of appropriate technology in an integrated manner. Tolba[57] has also discussed the significance of environment as a whole in matters of health and diseases in general and cancer in particular.

Objectives

From the limited cross section of literature reviewed above, it is clear that a total approach to the environment is necessary if tangible results are to be achieved in the matter of development, particularly in rural areas of the developing regions. A convincing demonstration covering environmental sanitation, energy in the form of biogas production from animal wastes, compost from agricultural wastes, reclamation of wasteland by manual labour, waste recycling, and sprinkler irrigation using wastewater has been achieved by Paul[58]. This resulted in a record production of 160 tons of green fodder (and food) per acre/year on a one hectare plot of reclaimed wasteland over a period of 12 years. Based on the above demonstration, a modified septic tank called "Liquid Compost Plant" (L.C.P.) has been designed and patented primarily for rural areas. This plant is free from break down or pollution and does not need any maintenance whatsoever. While compost is the main product of the L.C.P., biogas is a by-product. The quantity of both compost and biogas depends upon how much human (and animal) and agricultural waste input can be made use of. Modified versions of the same L.C.P. to suit farms, rural and urban communities have also been patented. Details of these shall be presented in a subsequent issue of this journal.

Summary

1. Basic principles of rural sanitation have been identified.
2. Review of the recent literature on rural sanitation and allied subjects connected with rural development, indicates an in-co-ordinated approach in the past.
3. An integrated approach to rural development based on a liquid compost plant (L.C.P.) has been demonstrated on a pilot plant scale for over 12 years.
4. Possibilities of improved sanitation, production of energy in the form of biogas, manure in the form of compost, sprinkler irrigation of farm sewage, land reclamation and a record production of green fodder from waste have been indicated.
5. By suitably scaling down or up respectively, possibilities for family, farm, energy, community and industrial L.C.P. models have also been indicated for integrated, rural and urban development.

Acknowledgement

Encouragement received from Dr M.S. Swaminathan, former Director General, Indian Council of Agricultural Research, later, Secretary of the Ministry of Agriculture and Rural Development and presently, Deputy Chairman, Planning Commission, is gratefully acknowledged.

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Investigations on Aerobic Thermophilic Sludge Treatment Processes

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Several aerobic thermophilic sludge treatment processes (also called sludge composting) have recently been developed. They are basically concerned with aerated, aerobic systems with biological selfheating, which yield a simultaneous stabilization and hygienization of raw sludge. Depending on the substrate's condition, two main groups of processes have to be differentiated:

1. The liquid raw sludge is aerated directly and retains after treatment its liquid, but more homogeneous structure. (Liquid composting).

2. After dewatering and/or addition of dry organic material, the raw sludge turns solid (water content approx. 50%). It then undergoes an aerated intensive composting. (Solids handling process, sewage sludge composting).

During 1977/78, investigations of these two processes were carried out at two pilot plants.

In 1977, the prototype of a solids handling process with dewatered raw sludge was operated by the developing firm in a wastewater treatment plant. The facility consisted of predewatering (sedimentation tank), mixing with dry material (double-shaft mixer), aerobic thermophilic aerated cell composting (reactor), conditioning in pellet presses, drying, grinding and the corresponding transport and storage equipment. The principle of a controlled, aerobic, mainly thermophilic decomposition was applied to a batch process. The dewatered raw sludge was mixed with dry residue, and the resulting product of loose-crumbly structure, containing 50% water, was then aerated in the reactor for about 6 days at selfheating temperatures of 30–60 °C and turned several times. In the dryer, approx. 6 days were also necessary to reach a < 20% water content with unheated air. The ground surplus material is to be used as organic manure.

The results can be summarized as follows:

a) Stabilization: the dried sludge remains odourless provided it is stored under cover.

b) Hygienization: the material treated in the reactor is totally disinfected.

c) Agricultural use: the first tests were positive. More precise guidelines for an agricultural utilization have yet to be set up.

d) Emissions: dewatering and storage call for great care.

The three main requirements on the process, namely the production of a disinfected, stabilized and agriculturally appropriate product which can be stored, are considered as met. The expenditure involved is indeed considerable, the costs will be relatively high. The first practical tests presently underway, will provide the only information on this subject.

In 1978, a firm offered us temporarily testing installations for the treatment of aerobic raw sludge according to the stirring/suction aeration principle. The aerator was suspended into an insulated cylindrical container of approx. 2 m^3 volume and operated continuously. Raw sludge containing from 4 to 7% dry material which originated from conventional and from two-step biological wastewater treatment plants was used in agriculture.

After two days investigation, temperatures of 50 to 54 °C were reached and maintained in a continuous process with a daily load of approx. 1/7 of the volume. An acceptable reduction of pathogens and a partial stabilization could thus be reached. With regard to the odour problem, a significant improvement as compared with the untreated raw sludge was obtained. If stored over a longer period of time, an appropriate additional treatment is necessary. Agricultural use seems possible, however, it still needs to be more narrowly defined.

«IRCWD News»

Mr Dietegen Stickelberger, Deputy Head of the WHO International Reference Centre for Wastes Disposal, retired in April 1979 after 10 years of service. Upon graduating from the Institute of Commerce in Birmingham, England, he first worked for the pharmaceutical industry. In 1969 he joined the WHO International Reference Centre for Wastes Disposal and was concerned particularly with the problems of production, marketing and utilisation of municipal refuse composting. His commitment to ecology and environmental protection contributed greatly to the enhancement of compost biology. His linguistic skills which he acquired during his university studies in Basle, Geneva and Grenoble, in linguistics and natural sciences, were a great asset to the EAWAG News which he edited from 1973 to 1979.

We all wish him well on the road to retirement.

At the beginning of this year, Mr Roland Schertenleib was appointed Head of the WHO/IRCWD.
After graduating from the Swiss Federal Institute of Technology, Zurich, in Civil Engineering, he completed his postgraduate studies in Environmental Engineering at Stanford University, California. He then worked for several years as sanitary engineer in a consulting office. Before assuming the post of Head of the WHO/IRCWD, he was employed at the EAWAG's Engineering Sciences Department as research associate in sanitary engineering.

News from WHO

Meeting

Action Urged on International Drinking Water and Sanitation Decade

Sustained and co-ordinated action by governments and international institutions is essential if the objectives of clean drinking water and adequate sanitation for all are to be reached by the year 1980.

The targets were established by the UN Conference on Human Settlements and endorsed by the United Nations Water Conference; the drive to achieve them within a decade will be formally launched by the **General Assembly of the United Nations at a one-day session in New York, 10 November 1980.**

In opening the meeting in Geneva on 16 June, Dr H. Mahler, Director-General of the World Health Organization, and Mr B. Morse, Administrator of the United Nations Development Programme, stressed that clean drinking water and adequate sanitation are critical to the attainment of better health, without which development is impossible. Dr Mahler said health authorities had often been at fault in the past in failing to recognize the importance of clean water to health and in helping people to learn the value of clean water and to work for its attainment. Mr Morse stressed that water programmes deserve special consideration by multilateral and bilateral aid donors. Some 13.6 million children under five will die this year, 96 per cent in developing countries. Most of these deaths could be traced to preventable water-borne diseases.

A partial survey of the state of clean water and sanitation in the world illustrates the immensity of the Decade challenge. Information received by WHO from 53 countries shows that only 14 report that adequate clean water and sanitation covers more than 65 per cent of the population; 25 have coverage ranging from 30 to 65 per cent and in 14 countries the coverage is lower than 30 per cent.

The one-day consultation brought together representatives of governments, international and non-governmental organizations under the chairmanship of Mr Douglas Lindores, Acting Vice-President, Multilateral Programmes Branch, Canadian International Development Agency.

Areas which require particular attention, participants agreed, included: (1) criteria for project formulation, (2) methodologies for accelerating support, and (3) an information system providing data on programmes and projects in the sector, linked to the planning work of the donors in the water and sanitation field. Task forces comprising recipient governments and the donor community should be established to identify these requirements.

In voicing what was described as the "strongest theme of the meeting", participants called for greater support to training at the national level.

Participants also stressed the valuable role of non-governmental organizations, noting their ability to mobilize support at the community level.

Symposium

Water Supply and Health, Noordwijkerhout (Amsterdam), 27–29 August 1980

As a conclusion of the Drinking Water Pilot Study of the NATO-Committee on the Challenges of Modern Society (CCMS), the Netherlands' **National Institute for Water Supply,** Voorburg, organizes an International Symposium on **Water Supply and Health** at Noordwijkerhout (Amsterdam), the Netherlands, from 27–29 August 1980. Co-sponsors of the symposium are the U.S. EPA and the U.K. Water Research Centre. A total of 25 internationally recognized speakers from the U.S.A., Canada, Scandinavia, the E.C. and Israel have been invited, covering areas such as health effects of viruses, of inorganic constituents (calcium-hardness, asbestos, sodium, lead) and of organic constituents (including present toxicological and epidemiological studies in the U.S.A., the U.K. and the Netherlands, and taste and odour causing compounds). Based on recent progress in the health effects area, the consequences for the application of chemical treatment processes (chlorine, ozone, chlorine-dioxide) versus physical-biological purification systems (artificial recharge, sand filtration, activated carbon adsorption) are presented and new strategies for the design of water supply systems from a health point of view are discussed by representatives from WHO, the Commission of the European Communities, the International Reference Centre for Community Water Supply and representatives from several governmental agencies.

Recommendations will be formulated to minimize health risks associated with drinking water constituents. A poster session is scheduled for August 27, 1980.

Those interested in participating should contact the Congress Office:

Symposium WSH
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Abstracts

The following abstracts have been taken from our documentation on solid wastes.

Kalbermatten, J.M., Julius, D.S., Gunnerson, C.G.: Appropriate sanitation alternatives: A technical and economic appraisal, 1978, 1, Energy, Water & Telecom. Dept., World Bank.

The report presents results of two years of field studies in 39 communities in 14 countries around the world to identify appropriate technology options for sanitation in developing countries. The study attempted to identify the obscure low cost sanitation technologies appropriate for the particular areas of the developing countries – between the unimproved pit privy and sewerage. It recommends sanitation sequences: step-by-step improvements leading from one option to another designed from outset to minimize costs over the long run. Within the limited availability of funds, the choice of technology should be such as to maximise the achievement of health benefits. The study also analysed the other constraints in adopting the appropriate technologies for sanitation to find solutions to overcome them.

Blackmore, M.D.: Alternative sanitation in Botswana, 1978, 11, 219–224, Progress in Water Technology.

This paper reports the findings of a study on low cost latrine options in Gaborone, Botswana. The study evaluated the existing latrine systems in terms of simplicity of operation and maintenance, hygiene and low water consumption for use in the country's low cost urban neighbourhoods including squatter upgrading areas, and site and service developments. The project working group recommended a special type of aqua-privy known as Botswana Type B which incorporated one of the two alternative washing fitments – an internal hand basin or external wash plumbed into the flushing rim of the pan.

Hansen, J.A., Therkelsen, H.H., Buch-Hansen, P.: Appraisal of four alternative excreta removal systems for urban areas in developing countries, 1978, 11, No. 1/2, 235–249, Progress in Water Technology.

Four low cost sanitation systems (sewerage, sewered aqua privy, vaults and community blocks) are discussed for implementation in an urban tropical setting. Emphasis is placed on a technical, financial and economic evaluation and comparison of these four schemes. The approach outlined in this paper provides an improved basis for the decision-maker regarding choice between systems and types of technology and regarding the factual cost to society of the project, i.e. in relation to an alternative project altogether.

Stoner, C.H.: Goodbye to the flush toilet, 1977, 285 p, Rodale Press, Inc., Emmaus, Pennsylvania, USA, US $ 6.95.

Ms. Stoner's book on alternative wastewater disposal systems ranks with the Rural Wastewater Disposal Alternatives report by the California State Water Resources Control Board in terms of extent and utility of information and soundness of evaluations of existing systems. Her book has "the edge" in terms of ease of reading.

Chapter 1, "How We Got Where We Are, or the Why and Wherefrom of Sewers", is a historical account of the development of the water carriage system sanitation. The account is a factual one, enhanced by the absence of polemics against water carriage sanitation. The author, Joel Tarr, illustrates the abuses that attended conventional sewage treatment and how these abuses can vitiate a useful system.

Chapter 2, "How We're Handling Our Wastewater Now, and Alternatives for the Future", deals with water carriage systems. In it, attention is called to some very real problems that have arisen with conventional wastewater treatment processes, not the least of which is a trend towards over-centralization and the assumption that bigness and sophistication are inherently correct. (Van der Ryn also calls attention to this fact in his book). Alternative systems (i.e. to conventional) described in this chapter are incinerating toilets, biological toilets, oilflush toilets, vacuum systems, aerobic tanks, pressure sewers, CANWEL system (Canadian Water Energy Loop), domestic sewage-methane cycle, and an algal regenerative system for single-family farm and villages.

Chapter 3, "A Short Lesson on the Principles of Composting", is a distillation of what has been written on composting, with emphasis on composting human excrement.

Chapter 4, "Composting Privies", deals primarily with units that are constructed on-site and are not proprietary. Types range from the old-fashioned privy to the Farallones drum composting privy. It includes photographs and diagrams. Two important sections concern safety precautions and handling and composting human wastes.

Chapter 5 is rather lengthy, as one would expect in view of the many commercial units on the market. Its title is "Commercial and Ownerbuilt Composting Toilets". An especially useful feature in this chapter is the table "A Comparison of Commercial Composting Toilets".

Chapter 6, "Dealing with Greywater", not only tells of methods, but also of problems.

Chapter 7, "What's in Store for Flush Toilet and Greywater Alternatives? " is well and objectively written.

The final chapter, "Every Little Bit Counts – Saving Water", summarizes the several ways by which the householder can minimize water consumption.

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