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WATER, SANITATION AND HYGIENE: CHALLENGES OF THE MILLENNIUM

Wastewater disposal through plantation

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URBANISATION IS INCREASING every day in developing countries. It is using huge amount of agricultural land and the amount of waste water produced by these urban communities is increasing steadily. Rapid urban growth, industrial growth and improving water supply status of urban towns shall increase the quantity of waste water generated to many folds. Presently India is producing about 20,000 million liters and Delhi alone in producing 500 million liters of sewage water daily. The local bodies are usually financially so weak that treatment of sewage waters find last priority in their budget which is any way starving for money, hence usually these sewage wasters (S.W.) are discharged in lagoons or low lying areas without any treatment. This creates sewage pools, produce foul smell, help breed mosquitoes & pathogens, salinize good quality lands and above all contaminate ground waters. Some municipalities which have sewerage systems collect the S.W. through drains and discharge it straight to nearby nallah or river. Almost every river including Ganges and Yamuna and many sea-beaches are alarmingly polluted. Infact most of Indian rivers including "Kuam" at "Chennai" and "Muti" at Hydrabad have become synonymous to big open drains. Some municipalities make big money by selling S.W.to vegetable farmers on urban fringes. S.W. being very rich in nutrients & micronutrients the farmers get excellent vegetable crops which yield good money. The authorities do not bother that vegetables are known absorbents for Ni.Cd.and Zn. which are deteriorant to human health. To add to problem the presence of these toxic elements is not visible on vegetables.

Disposal of sewage waters

The ideal way is to have a well designed sewage treatment plant. Such plants are costly and mostly beyond financial reach of municipal corporations. Meeting the running and maintenance cost and disposal of concentrated sludge is a problem. Necessary technical skill is normally not available. Oxidation ponds are less expensive but they need very large areas to store sewage water in shallow depths. These invariable generate foul smell and cater to breeding of mosquitoes and other pathogens. There are always chances of sub-soil water pollution. This system is lesser expensive when combined with pisciculture, but fishes being known biological accumulators of toxic elements like Pb, Cd, Ni, and Hg. suffer retarded growth, loose their flavour and only help transferring the toxic elements to consumers, hence this has serious limitations. Land disposal causes ground water contamination, although it is lesser expensive, choking of surface of ponds and pits need one to make new pits at another place hence this may serve individuals, it is simply insufficient for community or town use.

Taping of sewage water for agriculture is rather attractive. Since this contains many nutrients, the cost of fertilisers is cut down and quality of crops or vegetable particularly size becomes more attractive. In fact many municipalities are making good money by selling sewage water for irrigation. However a continuous supply of nutrients is not needed for whole plant life particularly in final stages of growth. This causes huge weed nuisance, extra vegetative growth, delayed maturity and lodging of crop. Sewage irrigation makes plants more succulent and thus more vulnerable to attacks by insects and pathogens. The farmers are thus forced to use pesticides, fungicides and weedicides which further contaminate the vegetables like carrot, turnip, potatoes etc. where edible part of plant is in direct contact with soil. Raw consumption of such vegetables cause serious health problem.

Sewage water, utilization through plantation : An economic solution

Safe disposal of S.W. is costly hence a disposal method which can exploit its nutrient potential without polluting soil, ground water and environment seems to be safest and most acceptable. This can be achieved by using S.W. in raising forest plants in a controlled manner. In general these waters are neutral to slightly alkaline in reaction and low in salt contents. Mg. being the most dominant cation it is followed by Na and Ca. Considering these waters have Mg/Ca as less than 4 and sodium absorption ration (SAR) below 10, these waters are not likely to have Mg. hazards. Among anions CO_3 are absent while HCO_3 are more than Cl and SO_4. However, the residual sodium carbonate (RSC) is nil in these waters. Normally high concentration of Cl is due to human excretement. Total solids contents is high and causes silting of the water bodies. Considering T.S, B.O.D. and Anmonical N, these waters are unsafe for disposal in river or other water bodies.

Nutrient contents

Although quality of sewage waters vary. based on average values, it is estimated that in 5 irrigation's of 7.5 cms each, raw sewage water adds 181 kg of Nitrogen per hectare of land, 29 kg of Phosphorus, 270 kg. of Potassium and 130 kg. of Sulphur shall also follow, which is enough to meet the nutrient requirement of the crop. However this application will also provide the soil with 1.28 kg. of Zinc. 0.75 kg. of

Copper, 41.86 kg. of Iron and 1.37 kg. of Manganese to cater to micronutrients requirement.

The concentration of toxic elements like (Zn, Cu, Fe, Mn, Pb, Cd or Ni) is of considerable importance in planning land based water management. Though some of these may be essential micronutrients they all become phyto-toxic at higher concentrations, hence it might be a good policy not to allow sewage waters to mix with industrial waste waters or at least with untreated industrial waste waters.

The methodology

The methodology consists of growing trees on 1 m. wide and 50 cm. high ridges and untreated sewage water is disposed in 2 meter wide and 75 cm. deep (from top of ridge) trenches. The soil in the experiment at Ujjain is alluvial in nature. The amount of sewage to be disposed depends on age and type of plants, climatic conditions soil texture and effluent quality. The discharge is so regulated that it is consumed within 12 to 18 hrs. and there is no standing water left in the trench. Through this technique it is possible to dispose 3 to 15 cms (0.3 to 1.0 million liters of effluent per day/hectare and grow lush green trees).

The forest plants use water and nutrients of sewage for their growth and bio-drain excess water without any harmful effect on environment. Each tree acts as a small bio-pump absorbing water from the soil and releasing it in environment through transpiration. Normally the applied effluent disappears in 12 to 18 hrs. without creating noticeable foul smell, or contaminating ground water. There is no adverse effect of sewage disposal on toxicity, heavy metal or salinity stress on plants.

Table 1. Raw sewage waters

Characteristics	Mean Concentration
A. Pollution Parameters	
pH	7.20
B.O.D.(5) mg/l	125
T.S. mg/l	1.44
Free NH3 mg/l	17.9
OC mg/l	176
B. Irrigation quality parameters	
E C dS/m	1.68
S A R	3.17
RSC me/l	Nil
Na. me/l	7.97
Ca. me/l	3.84
Mg. me/l	8.62
CO_3 me/l	Nil
HCO_3 me/l	7.22
Cl me/l	6.00
SO_4 me/l	2.14

This technique utilises the entire bio-system as living filter for supplying nutrients to soil and plants. Irrigation renovates the effluent for atmospheric recharge and conditions the humidity of environment. The soil fertility is built up with respect to N.P.K.O.C. and micronutrient. The pH of the soil is brought from highly alkaline to neutral level without building up significant salinity. Forest plants are used as wood, fuel, timber and pulps hence the pathogens and toxic nutrients do not enter the human food-chain.

Suitable tree species

Although most plants are suitable, yet the fast growing ones which can withstand high moisture environment and transpire higher amounts of water are more suitable. Eucalyptus (hybrid) is one such species and it is active throughout the year. Poplar and Leucaena (leucocephala) are also suitable. Poplar is most responsive, but being deciduous it remains dormant in winters and hence does not bio-drain during winter. By far Eucalyptus seems to be best choice.

Economics

This technology of sewage use is relatively cheap and it involves no major capital costs. The preparation of ridges and furrows cost Rs. 5860/- (45 Rs. =1 $) per hectare. Even this cost is saved if existing plantations are used, as most forest departments, plant tree in ridges and furrows system. Recurring cost of channelising the sewage, deweeding and maintenance of ridges is 4-man days/2.5 hectare day.

In addition to saving on cost of expensive treatment plant and expenditure on malaria control. The system generates gross return of Rs. 9691, 27725, 46880 and 69780 after first, second, third and fourth year of one hectare of Eucalyptus plantation respectively by selling fuel wood. Revenues are still higher when plants are sold after eight years for pulp or timber.

As sewage water itself provides nutrients and irrigation meliorates the sodic soils by lowering the pH, relatively unfertile waste lands can be used for this purpose.

Table 2. Nutrient concentration

Nutrient concentration	
Nutrient	**Mean Conc.(mg/l)**
Nitrogen	48.26
Phosphorus	7.58
Potassium	72.44
Sulphur	34.59
Zinc	0.34
Iron	10.83
Copper	0.20
Manganese	0.36

Advantages of disposal through plantation

Utilization of sewage to raise plantation has yielded very encouraging results for following reasons:

- Since there is no stagnation, foul smell & mosquitoes breeding is prevented
- Since the water is consumed by plant or evaporated, there is no ground water contamination.
- It does not increase soil salinity.
- It is most economical rather revenue generating since grown up trees are sold to timber and paper industries and the area is reused for fresh plantation.

The Technology is economically viable scale neutral and does not require highly skilled personnel's as well. With this system green belts can be provided in and around cities. This technology also gives possibilities of raising green plants on waste lands by utilising waste waters thus mitigating pollution of ground water, that too with revenue generation. It is a zero discharge technology wherein all sewage water disposed in plantation is either utilised by trees and/or transpired into environment. It enriches the soil and creates no foul smell in disposal area.

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