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Pragyambu

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The purpose of this quarterly digest brought out by the Centre for Ganga River Basin Management and Studies (cGanga) led by the Indian Institute of Technology Kanpur is to disseminate valuable traditional and scientific knowledge assimilated from national and international sources on various aspects of management of water and river restoration and conservation among concerned institutions and citizens.

ROLE OF STP SLUDGE MANAGEMENT IN MAINTAINING CLEANER WATER RESOURCES AND IN SOIL CONSERVATION

Proper treatment of urban wastewater is essential for the conservation of water resources including rivers. When domestic wastewaters are treated in a municipal sewage treatment plant, a semi-liquid waste material remains after the treated water is taken out. This semi-solid waste slurry, also called STP sludge, contains impurities that have been separated from the wastewater or the biosolids generated from utilisation of organics. Proper management of this slurry is as important as the treatment of the wastewater itself. If this sludge is left untreated, then the impurities invariably reach the environment and water sources again by some means or the other. This issue of Pragyaambu highlights the role of STP sludge management in maintaining cleaner water resources and in soil conservation.

Urbanization has increased rapidly in India in the past years and, thus, the demand for urban domestic waste treatment facilities has also increased. Under the Namami Gange programme alone, in the six years between 2015 and 2021, more than 800 STPs (sewage treatment plants) were constructed and started operating across the country. With increase in the number of STPs, the amount of sludge generated by STPs has also increased. According to a report published in the environmental magazine Down to Earth, 1,460 STPs in the country are producing 104,210 tons of sludge per day. In India, at present the disposal of STP sludge is done at the discretion of local administrations because clear and integrated guidelines and norms in this regard are lacking. It is warranted that proper guidelines and rules be fixed regarding the collection, transportation, treatment, use, and disposal of STP sludge considering the geographical and environmental conditions of India.

Increasing awareness of environmental protection has led to increase in both government and private investment in this sector. Opportunities are being explored to make business by extracting commercial value from waste materials. Thus, many kinds of claims are being made about STP sludge. Some private companies claim that energy can be produced from STP sludge. Similarly, many private and voluntary organizations are advising the central and state governments to make bricks, biogas and organic fertilizers from STP sludge. In this issue of Pragyaambu, we will investigate these claims and try to understand which methods are appropriate for treating STP sludge from the environmental point of view, and what products can be made from STP sludge.

Some developed countries including the USA have classified treated STP sludge into two categories of organic matter according to its quality, Category A and Category B. The sludge (biosolids) of Category A is completely free from microorganisms and hence can be used as fertilizer or landfill; but there is a possibility of some microorganisms being present in Category B, hence there are separate directives for use of Category B sludge. There is no such classification in India. Many experts believe that due to the presence of organic matter in the sludge from STPs, it should be used as agricultural fertilizer. On the other hand, the rules made in India regarding fertilizers require the presence of certain amounts of nitrogen, phosphorus and potassium. But the dry matter obtained after treatment of STP sludge may not meet these standards. In fact, the amount of carbon in this waste can be high and the amount of nitrogen and phosphorus can be lower than the set standards. The biosolids obtained after the treatment of STP sludge can therefore be reused best as nutritional aid for the upper layer of the soil. The proportion of nitrogen and phosphorus in treated STP sludge may be low, but carbon content is generally high. According to agricultural scientists, the percentage of carbon in Indian soil is continuously decreasing. In such a situation, the return of STP sludge to the soil after treatment means restoring carbon levels in the soil.

Increasing the amount of soil carbon will lead to increase of microbial activity in the soil, which in turn will increase the rate of nitrogen fixation by microbes, which will enhance the soil fertility. The carbon present in the soil is a growth and energy resource for the soil microbes. According to the Indian Council of Agricultural Research, the percentage of carbon in Indian agricultural soils is very low. Normally the carbon percentage in the soil should be 1-1.5, but it is only 0.3-0.4 percent in Indian soils. The waste from STP can be the best option to increase the amount of carbon in the soil. In the last issue of *Pragyaambu*, we had argued in favour of the decentralization of STPs. If wastewater treatment is decentralized, then naturally the number of STPs will also increase. Hence, we will also have to think about the treatment of sludge coming out of these STPs. The biggest obstacle in this is the lack of understanding, availability of proper management practices, and relevant guidelines and regulations due to which urban local bodies are not guided on many issues. There are many aspects on which clear guidelines are necessary, such as: How to collect, transport and treat the sludge left after the treatment of wastewater in STP? How to determine the pathogen levels (disease-causing microorganisms) in the sludge and what should be the limits? How should sludge management be monitored? If the presence of heavy metals is reported in the residual wastewater or sludge during sludge management, then where should it be reported? Which agencies will have the authority to investigate and take further action?

It is worth noting that there are clear standards regarding the treated water coming out of STP, and directions and guidance from Green Tribunal and Supreme Court are also issued in this regard. We are not talking here about treated water but about the lack of regulations regarding the quality of biosolids left after wastewater treatment.

In the absence of regulations regarding biosolids, the local administrations of some of the cities such as Delhi, Mumbai, Ahmedabad and Chandigarh have started working in this direction by adopting the US standards. Our purpose here is not to review the US standards but to draw attention to the fact that the geographical conditions of India and America are different. Besides, the difference in the economic conditions of the two countries is also well known. Keeping these circumstances in mind, we should determine the management and regulation of the entire process based on Indian priorities.

In this context, the results of a study conducted by IIT Roorkee are noteworthy; according to this study, after sludge dewatering (that is, draining of water from the sludge), it is possible to obtain sludge that could be classified in as per US EPA. This waste can be used as a soil nutrition enhancer for such crops whose products are not consumed in raw form. In the same study, an argument was also presented that in India's hot climate, the chances of survival of germs in Category B wastes are minimal. Considering our social and economic conditions, we must adopt low-cost, eco-friendly and sustainable methods in India. Let us look at the options of sludge management.

Before disposal of sludge from sewage treatment plants, it is thickened, by allowing it to settle and de-watered i.e. water is separated from the solids in sludge thereby reducing the volume and its potential nuisance. This step can be completed by different methods. If energy is used for de-watering, then it will exert excessive pressure on already scarce resources. On the other hand, dewatering of sludge with the help of solar energy is possible in a hot country like India, but an adequately ventilated place will be required where sludge can be stored, and sludge can be dewatered by solar energy or natural sunlight. In this case, the second challenge is the foul smell produced by sludge. The problem of bad odour can be controlled largely by adding lime to the sludge. If natural resources like sunlight are to be used to reduce the cost of sludge management, then we will have to find such creative solutions, which can solve the problem of foul smell. We must promote research in this area and also test new methods.

At many places, before drying the sludge, it is digested anaerobically (i.e. in the absence of air) and the biogas produced from anaerobic digestion is used to heat the dryer for sludge drying. After drying the sludge, methods like pyrolysis, gasification and incineration are adopted for its disposal. Pyrolysis is also done by different methods. Gas and oil are produced from the pyrolysis of organic matter, and organic solid matter is obtained, which is called 'char'. This 'char' may not be a fertilizer, but it can prove to be a growth enhancer for microbes in soils.

Different countries of the world have made various regulations for sludge management. For instance, America, Britain and South Africa have divided sludge into three categories. Norway, on the other hand, accepts treated sludge in a single category. In Norway, these biosolids can be used in landfills or in agriculture only after complete elimination of harmful microorganisms. In countries that divide sludge into three categories, only Class A or completely microbe-free biosolids are used in agricultural lands, while Category B biosolids can be used for road construction and Category C sludge can be used for burning in incinerators.

In the Indian context, another important aspect of sludge management is seen – the spread of disease carriers that feed on sludge. If sludge is stored in STPs, chances of mosquitoes, flies and insects proliferating also increase. Strategies to overcome this challenge will have to be devised before construction and operation of treatment plants. A very important measure for this is to reduce the storage time of solid wastes (solid retention time) with higher moisture content in the plant.

Along with this, urban local bodies will also have to ensure that sewage treatment plant and sludge treatment plant are not distant from one another (less than 50 km). These two centres of waste treatment should either be connected to one another, or, if this is not possible due to lack of space, then the sludge treatment plant should be built within a specified distance so that excessive time and energy are not spent in sludge transportation. Alongside this, every municipal body should survey how much sewage sludge is being produced daily and monthly in their jurisdiction area, and from which treatment plants has evidence of heavy metal pollution been found in the sludge? On the other hand, some regulatory body (for example, State Pollution Control Boards) will have to bear the responsibility of separate permissions, recommendations, monitoring and investigations for sewage treatment plants and for sludge treatment plants.

Along with the above measures, municipalities will also have to survey who and where are the consumers of treated sludge biosolids? Is the farming community ready to adopt biosolids? What is the most economical way of final disposal of sludge in the concerned urban area? As landfill, or use in agriculture and horticulture as biosolids, or production of biogas? Does the STP located in the city have enough land, infrastructure and capacity to collect sludge and do anaerobic digestion on the spot? After conducting a ground survey on all these aspects, every municipal body will have to prepare a sludge management plan by calculating the annual cost of sewage sludge utilization and disposal.

It should be clear in this plan which resource does the municipal body wish to recover from the sludge? This resource may be soil enriching biosolids, biogas, biomass as a supplementary fuel for burning in thermal power plants or producing ethanol, biosolids as construction material, and/or water. After having clarity regarding the final products, the municipality can work on financial aspects of setting up this plant.

WHAT ARE THE IMPEDIMENTS?

The major problems faced by a municipal body in constructing and operating a sludge treatment plant may be listed as (i) framing a business model for construction and operation of the plant, (ii) problems of financial assistance before construction, (iii) ambiguity regarding the final product(s), (iv) generating the interest of private sector for PPP model.

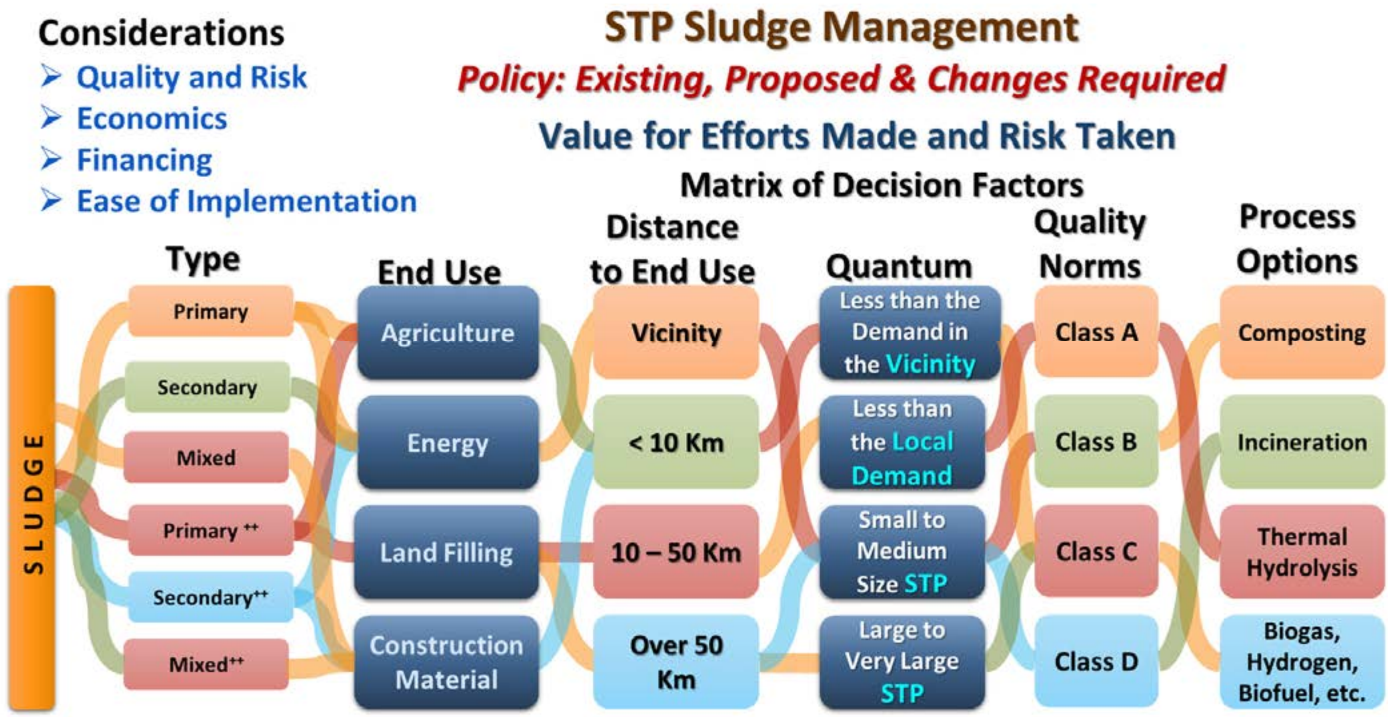

Figure 1: Matrix for management of STP Sludges in India

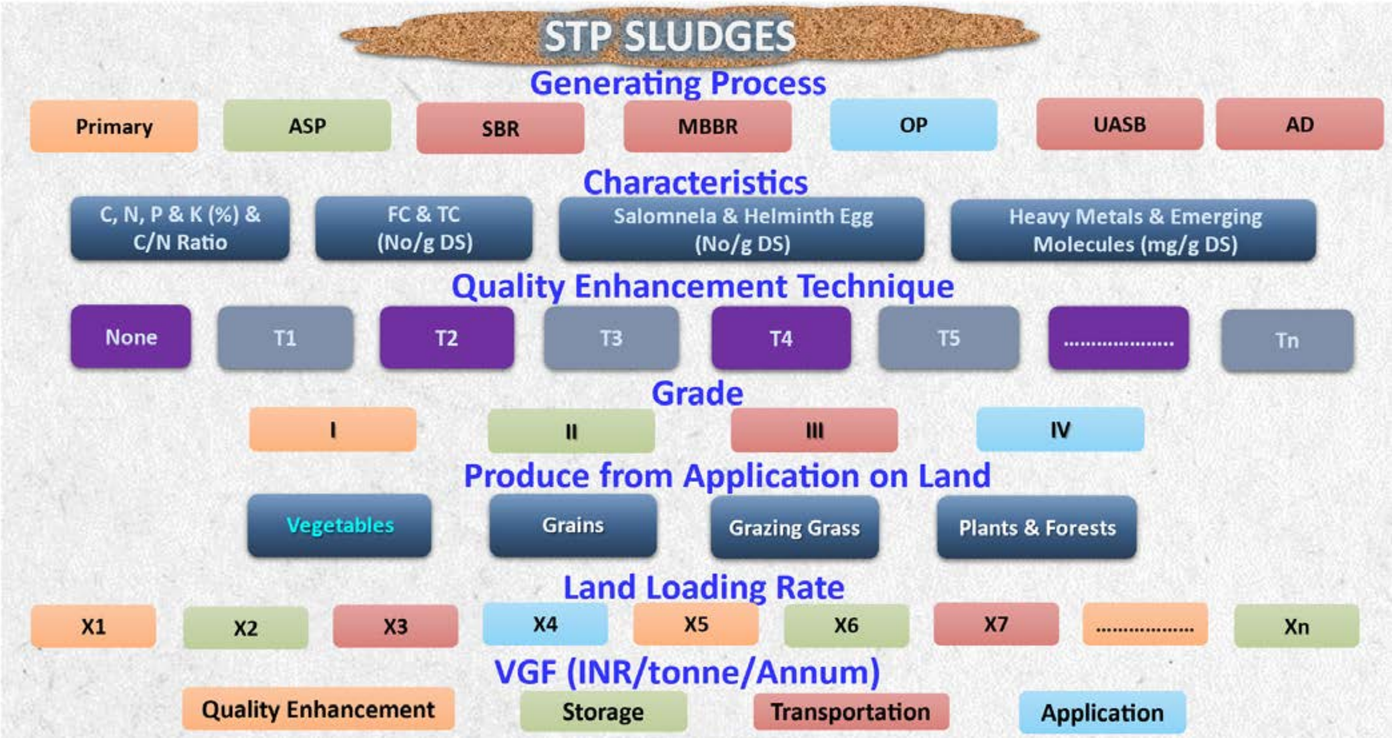

Figure 2: Decision Factors for Using STP Sludges for Soil Conservation

SOIL CONSERVATION MUST BE EXECUTED IN MISSION MODE

On the one hand, the rivers and land of the country are struggling to cope with pollution, on the other hand the farming community is facing problems of soil erosion. According to a research report published by researchers of IIT Delhi in April 2023, the rate of soil erosion in the country is 20 tonnes per hectare. This is not a good sign for India, where agriculture is still the basis of the economy. Before publication of this research, a study conducted by the cGanga (Centre for Ganga Basin Management and Studies) and the Norwegian Agency for Development Corporation revealed that our country is losing 5000 million tonnes of fertile soil every year. About one-third of this eroded soil reaches the sea. Due to rapid soil erosion, fertile land is turning barren on a large scale. According to available information, about 20 percent of fertile land has become barren due to topsoil erosion. Out of 300 million hectares of fertile land, our intervention is needed to conserve the topsoil of 150 million hectares of land. This problem is so serious that its solution lies in planned and continuous efforts in the form of a mission. Biosolids obtained from sludge treatment can prove to be helpful in increasing the nutrition of the soil as well as compensating for the loss caused by the erosion of the upper layer of the soil. According to the advice of experts who prepared this report, in areas where the rate of soil erosion is high, 10 to 20 tonnes of treated biosolids per hectare can be mixed in agricultural land. This process can be repeated every 5 to 10 years depending on the presence of nutrients in the soil. In the present circumstances, it can be said that conservation of topsoil should become a national priority. Scientists of Indian Institute of Soil Science also support the use of biosolids produced from the treatment of sewage sludge in agricultural lands.

HOW WILL IT BE SOLVED?

These difficulties can be solved. First of all, the municipality will have to collect accurate current data regarding sludge and sewage. Then one can decide the final product(s) to be obtained from this sludge. On this basis, a plan can be prepared, and assistance can be sought from the central or state government for construction of a sludge treatment plant, or sludge treatment can be started with the joint participation of both the central, state and local governments. Besides, when there is complete clarity about the final product, private participation can also be invited in this sector. Moreover, carbon credits can be earned through sludge treatment, and these credits can then be sold. Also, by taking suggestions from technical institutions, creative ways can be found to reduce the operating cost of the plant. For example, the gas generated from anaerobic sludge digestion can provide the energy for dewatering of sludge.

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