**SLUDGE FOR FOOD, FOOD FOR THOUGHT: WHAT IF THE PROBLEM IS THE SOLUTION?**

**Untreated sludge from sewage treatment plant can be a risk to environmental health and hence to human health. However, this sewage sludge can be a rich source of nutrients for agriculture if safely used.**

By Girija R and Harshvardhan

There has been a significant growth in the urbanization pattern in India in the recent years and it is projected that the urban India’s population will cross 50 crores in 2030 and 75 crores in 2050. However, the unplanned nature of Indian urbanization has come at a huge ecological and health risks. It is estimated that the major urban cities in India generate about 72,368 Million Liters per Day (MLD) of wastewater. Unfortunately, only about 28% of this wastewater is getting treated. Most of the wastewater is discharged to the water bodies—polluting rivers, lakes, and other water sources. The government of India is aware of the challenge and has launched several programs including AMRUT, Smart city and

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### What if the Problem is the solution!

**104,210 Tons** of sludge is generated daily from **1,469** Sewage treatment plants (STPs), India

- **Unsafe disposal** — Public and Environmental health risk
- **Safe recovery of nutrients**
- **Improved crop yield, soil quality**
- **Organic & Inorganic nutrients**

**Agriculture in India**
- 50% under water stress
- 0.3% Soil organic carbon content
- 2nd largest greenhouse gas emitter

**N2o emissions in tonnes of Co2e (MT), India, 2018**

- Agriculture
- Fuel Combustion
- Waste
- Land use change & Forestry
- Industry

**86%**

**Make a move by**
- Best practices
- Product promotion
- Policy and regulations
- Incentives to farmers

Sewage sludge can substitute 4,531 Tons per day of Urea

Safe recovery of nutrients from sewage sludge for application in agriculture
SBMU to focus on wastewater treatment in the urban settlements of the country. However, wastewater treatment invariably generates massive amount of sewage sludge which if untreated, is a high ecological risk. Sewage sludge is also referred as ‘Biosolids’, but here Biosolids specifically refers to treated sewage sludge that meets the Environmental Protection Agency (EPA) pollutant and pathogen requirements for land application and surface disposal.

However, Sewage sludge is a rich source of organic matter and inorganic plant nutrients and has micronutrients in small portions. The nutrient content of sewage sludge is comparatively higher than farmyard manure. The organic matter content of excreta serves as a soil conditioner and humus replenisher. This helps upgrading the soil fertility specially the organic carbon content as Indian soil is poor in it.

Use of sludge for land application is predominately practiced in countries like US (since early 1970s), UK and EU-15 countries. Sewage sludge is extensively used in agriculture in Australia due to low nutrient content of the soil. The findings from the sludge applied to increase to 1,86,347 tons/day if India treats 50% of the wastewater generated in the coming years. Currently, most of this untreated sludge is disposed to the landfills which is one of the biggest threats to the environment.

However, Sewage sludge is a carbon content in gradually decreasing which is now at 0.3% as per National Rainfed Area Authority which is way too low and a matter concern. The decreased soil productivity is mainly attributed to continuous application of chemical fertilizers.

In last 50 years there is a significant increase in fertilizers, there is a rapid growth in production of fertilizers in India showing an increase of more than 11% (2019-20) compared to previous year. Also, the overall fertilizer consumption has grown at a rate of 2% in 2020, while urea sales alone grew by 5.9% in 2020 as per the annual Report, 2019-20, Government of India, Ministry of Chemicals and Fertilizers. Another alarming issue is the availability of Phosphorous fertilizers, given that the Phosphorous is a limited resource and will exhaust by 2050 as per an estimation. There is a need to look for alternative sources for Phosphorous.

The recent Russian invasion in Ukraine has affected the fertilizers supply in India. Both nations together contribute to 10-12% of India’s fertilizer needs as per an estimation. The current developments have led to shortage of fertilizers and spike in price.

However, increased fertilizer usage has its own environmental cost. Owing to increased demand for meat and dairy products, there is increased application of nitrogen fertilizers (Urea) for animal feed and fodder crops. Urea- Ammonia is the second most common chemical produced and used in huge quantities in the world and hence, there is a big market out there. However, production of Urea-ammonia is energy intensive as this is produced under high temperature and pressure. And hence, increased greenhouse gas emission as most of this energy is from

"Chemical fertilizer is an addiction", said Ramesh, “We need to keep on increasing the dose of chemical fertilizers application year by year to get the same yield as the soil health is deteriorated due to decreased microbial activity".

- Ramesh, Secretary of farmers association, Devanahalli taluk, Bengaluru Rural

“It’s time to revisit our approach and look for alternatives for synthetic fertilizers, which are slow nutrient releasers, low/no greenhouse gas emitters, enhances soil quality by enriching the microbial biomass and upgrades soil fertility.”

“...to the Issues of Soil Degradation?

Huge quantity of sludge is generated from the Sewage Treatment Plants (STPs) across the country but the data on the utilization of these sludge is not available. At a few STPs, this sludge is being used for gardening inside the premises of the treatment plant, some STPs claim using the sludge for horticultural and forestry crops but most of the STPs have no plans for utilization and hence, the sludge is unsafely disposed. However, safe treatment and use of sewage sludge will not only combat the public health and environment health risks but potentially address the issues of food security as a substitute to chemical fertilizers thereby mitigating climate change effects by reducing greenhouse gas emissions.

Farmers, especially small farmers in India are facing issues like water scarcity, increased cost of production and decreased crop yield. Around 50% of India is under water stress and the soil organic

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burning fossil fuels.

Agriculture sector is the second largest greenhouse gas emitter in India. Our world in data reports around 220 MT per capita per year of Nitrous oxide (N2O) emission, a strong greenhouse gas produced mainly from the use of synthetic fertilizers for crop cultivation. Nitrous oxide is a long-lived greenhouse gas which is 300 times more potent than CO2. India stands as one of the top nitrous oxide emitters at the global level apart from China and Brazil.

Non-judicious application of chemical fertilizers is polluting water bodies as these are getting into the water bodies by run-off from fields and through chemical process in the soil releasing greenhouse gases to the atmosphere. Apart from adding to climate change effects through greenhouse gas emissions, synthetic fertilizers have significantly affected the soil microbial ecosystem which are called the ‘Life of soil’. Long-term continuous application has degraded soil quality, reduced productivity, and organic matter content.

In this context, safely treated sludge can be an excellent source of nutrition and reduce our dependence on chemical fertilizers, save foreign reserves and help reduce Greenhouse Emissions. At the current rate of sludge production, it is estimated that sewage sludge can substitute ~4,531 tons of urea/day (synthetic fertilizer), this number increase with the increased wastewater treatment, that’s the sludge use potential. But the application is limited due to the legislative restrictions imposed due to the risks of pollutants.

**Regulatory Challenges Across the Globe**

US EPA (Environmental Protection Agency) has given guidelines for sewage sludge application in agriculture with the pollutant limit concentrations for heavy metals and pathogens and the management measures for application. UK, Australia and New Zealand have formulated regulations for land applications based on the USEPA part 503 guidelines. However, EPA report is a very old guideline (1994) provides limit concentrations for a few parameters for a specific application. Hence revisiting the document and amendments based on evidence in accordance with today’s scenario, specific to the context and application is the need of the hour.

Owing to scarcity of land, Japan has introduced New Sewage Law in 1970s to minimize sludge production and restrict unsafe disposal of sewage sludge. Hence, sophisticated technologies are being used for power and compost generation for sludge utilization. There are different laws and acts governing the quality standards for different applications, which is a good move by the country to encourage the use of sludge. European Union legislation has provided directives for sewage sludge application in agriculture. EU countries have adopted these directives with some revisions which have led to stringent and stricter rules for land application. National legislation on sewage sludge in Greece abandons landfilling and promotes its use in agriculture as compost.

In India, there are no regulations for using sewage sludge for land application. The Fertilizer Control Order, 2009 provides the quality guidelines for organic compost where the feed stock is vegetable waste and yard waste not for sewage waste. Hence, there is a need to review the existing policies and guidelines and develop a clear regulatory framework for sewage sludge application.

In many regions of the world, local ordinances have banned land application of sewage sludge, mainly due to the fear of high organic carbon loads, heavy metals, pathogens and emerging contaminants and longer processing period. However, safe treatment of sludge reuse can help in nutrient recovery for agriculture and closing the loop for circularity and sustainability. Many examples exist where the same has been safely achieved.

**Best Practices**

The risks of the contaminants mentioned above could potentially be removed at the treatment level through pre-treatment technologies, operating regime and by post-treatment technologies, but these are not sufficiently addressed to the best of our knowledge. There are some technologies to further treat the sludge to reduce the pollutants. Thermal-Temperature inactivation of pathogens through heat treatment will help in reducing pathogens. Different composting technologies and Phyto bioremediation technologies have shown reduction of heavy metals and emerging contaminants in the final treated sludge.

Countries like Australia, South Africa, the United Kingdom (UK), and the US are using sludge as fertilizer or soil conditioner for land application. Some of the best management measures that the developed countries are following to ensure safety are stabilization, dewatering of sludge, composting, pellet production and heat drying of sludge for wider applications. Most used stabilization methods are anaerobic digestion and lime stabilization. However, lime stabilization is not popular as it restricts application. Mechanical technologies such as the centrifuge and filter press are generally used for dewatering. Apart from technologies, there are other best operational practices which would help putting the barriers and mitigate risks. For example, In UK, Code of Practice for Agriculture Use of Sewage Sludge provides operational practices to be followed by the farmers, growers and land managers, which includes discussion on good sludge application practices to prevent pollution and safeguard human health.

**Make a Move!**

Swachh Bharat Mission-Urban 2.0 has undertaken Complete liquid waste management in cities to ensure safe treatment of all the wastewater generated. And with the AMRUT (Atal Mission for Rejuvenation and Urban Transformation) coming up with the plans to increase the capacity of Sewage treatment plant, there will be an increase in treatment of wastewater in the coming days. If the wastewater treatment is increased to 50% from the current 30%
then the sludge generated would be ~1,86,348 tons/day which if safely recovered can substitute around 8,102 tons/day of Urea.

Sewage sludge generation is growing persistently and will continue to grow with the increased population adding to a huge mass of solids standing before us. In addition to this, stringent quality standards and guidelines make the resource recovery even more challenge. Furthermore, not many studies have been done to develop the treatment technologies or modules based on resource recovery as an objective. Hence, there is a need to work towards end products’ application based cost-effective and efficient treatment technologies. Specially on the process and technologies for resource recovery and reuse.

The recent developments by National Mission for Clean Ganga (NMCG, India) to handle sludge from Ganga River to avoid the problem of sludge dumping and the plan to process this sludge and provide to farmers is an appreciable move. To make the circular economy approach of safe sludge resource recovery a sustainable business model, we need the following actions - Regulatory framework, quality guidelines, market identity, developing innovative and cost-efficient technologies. Also, promotion of the product through government subsidies, mandating fertilizer companies to sell these sludge compost along with the synthetic fertilizers and incentives to the farmers safely using the sludge are some of the ways to go.

All these would help farmers with availability and accessibility to nutrient rich organic sources which are cost effective and eco-friendly. This will reduce chemical fertilizers use there by reducing soil degradation and emission of greenhouse gases. Sludge, which is not a waste but wasted, otherwise an asset.

About the Authors
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