PROSPECTS OF BIOSOLIDS IN AGRICULTURE

Abstract

The widespread use of chemical fertilizers and intensive mining have both contributed to the degradation of the soil systems and the quality of the environment. Because of on going population growth, urbanization, and industrialisation, the production of sewage sludge is rising quickly. Due to the possibility of recycling valuable components including organic matter, nitrogen (N), phosphorus (P), and other plant nutrients, Sludge from wastewater treatment facilities is increasingly in demand for use in agriculture. Previously known as sewage sludge, The majority of the nutrient-rich organic solid waste products known as biosolids are created as a byproduct of agro-industries and municipal waste-water treatment processes. When stabilized by digestion or another treatment procedure, wastewater solids can be used in agriculture as biosolids.

Keywords: Biosolids, Sewage sludge, Recycling

Authors

Sushma N
Ph. D scholar
Department of Soil Science
Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences
Shivamogga, Karnataka, India.
sushmasushma8206@gmail.com

Vidya V. S.
Ph. D scholar
Department of Agronomy
Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences
Shivamogga, Karnataka, India.

Manasa S. R.
Ph. D scholar
Department of Agronomy
University of Agricultural Science
Dharwad, Karnataka, India.

Tilak K
Ph. D scholar
Department of Agronomy
University of Agricultural Science
Bengaluru, Karnataka, India.

Sathwik M. N. Raj
Ph. D scholar
Department of Agronomy
University of Agricultural Science
Bengaluru, Karnataka, India.

I. INTRODUCTION

Previously known as sewage sludge, The majority of the nutrient-rich organic solid material produced by the treatment of municipal waste water is known as biosolids. Wastewatersolids can be utilized in agriculture as fertilizers or liming agents when they are stabilized by digestion or another type of treatment. The word "biosolids," which was first used in the United States, is frequently used to refer to various types of treated sewage sludge used as a soil conditioner in agriculture. The word "biosolids" distinguishes between high quality, processed sewage sludge and sewage sludge that contains significant amounts of contaminants as well as raw sewage sludge. Sewage sludge's chemical and biological makeup is influenced by the makeup of the waste water (Melo *et al*., 2002)

It is estimated that Indian cities and towns together generate approximately 19,127 tons of sludge per day (Press Information Bureau, Government of India, Swachh and Swath Bharat-Report, National Informatics Centre (NIC), New Delhi (2015). According to projections, by 2050, there might be 132 BLD of wastewaters created, which could supply 4.5% of the world's agricultural water needs (Bhardwaj, 2005).

Products made from nutrient-rich biosolids can be used to improve soil quality. Landowners receive high levels of organic matter from biosolids in addition to nitrogen (N), phosphorus (P), and other nutrients required for plant and agricultural growth. Additionally, biosolids have an impact on the soil's cation exchange capacity, moisture content, and structural characteristics. The nutrients in biosolids are gradually released; 15–25% of the N and P are available in the first year, and the remaining 25% are accessible throughout the following years.

1. Categories of Biosolids

The EPA divides biosolids into two categories

- Class A biosolids go through more treatment steps than Class B biosolids, to the point where the concentration of pathogens is so low that the biosolids don't need to be subject to any additional restrictions or extra handling precautions.
- Processes for treating Class B biosolids will lessen pathogens but not get rid of them. Due to this, after the application of Class B biosolids to the ground, federal rules demand further steps to prevent livestock grazing and public access.

2. Different forms of Biosolids

- Biosolids cake is created after raw sludge is biologically stabilized (often through anaerobic digestion), after which the liquid biosolids are dewatered to create a cake with a consistency of 15 to 30% solids and the remainder being water.
- Biosolids pellets are made from raw sludge or liquid biosolids that have been dried in a dryer to a solids content of 95% after being heated further.
- Biosolids that have been stabilized with the addition of lime after first being dewatered and then stabilized with lime.
- Dewatered raw sludge or biosolids are composted, usually along with other organic materials, to create a high-quality, usable product.

3. Pollutants and Concentration Limits

- There are three sets of federal limits that apply to biosolids that are applied to the ground. Ceiling Concentration (mg/kg) refers to these. (kg/hectare) Cumulative Pollutant Loading Rates Concentrations of pollutants (mg/kg).
- The cumulative pollutant loading rates do not need to be monitored if these concentrations are not exceeded in the biosolids that will be applied to the land.
- The maximum concentrations of nine trace elements permitted in biosolids for land application are known as ceiling concentration limits (CCL). Sewage sludge that does not qualify as biosolidsand cannot be applied to the land is sewage sludge that exceeds the ceiling concentration level for even one of the specified contaminants.

Trace element pollutants from commercial and industrial wastes that are discharged into the wastewater system are also present in biosolids. To determine the final grade for product classification, metal contamination in biosolids are subject to intensive sampling and analysis. The biosolids are divided into five levels of contamination (A being the least contaminated to E being the most), with the lowest level for each pollutant determining the final product classification. The majority of the product entering the program for land application is of contamination grade. Physical, chemical, and biological investigations can be used to establish whether a specific biosolid is suitable for application to land.

4. Important Properties of Biosolids are

- Total solids
- Volatile solids
- pH and Calcium Carbonate Equivalent (CCE)
- Nutrients
- Trace elements

  - The pathogens, The majority of the economic value of biosolids is derived from nutrients, which are substances necessary for plant growth. N, P, K, calcium (Ca), magnesium (Mg), S, B, Fe, Mn, and Zn are a few of them.
  - In biosolids, trace elements are present in small amounts. The so-called "heavy metals" are the trace elements in biosolids that are of interest.
  - The nine trace elements are as follows: arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), and zinc (Zn). These elements have been designated by federal and state rules.
  - Pathogens, which include bacteria, viruses, protozoa, and parasitic worms, are microorganisms that cause disease.

If they are, they could be a Risk to Public Health

  - Transmitted to crops used as food that are planted on land where biosolids are sprayed.
  - Contained in runoff from land application locations into surface waterways.
  - Carried away from the source by vectors like birds, rodents, and insects.

- Pathogen and vector attraction reduction standards that must be met by biosolids applied to land are laid forth in federal and state laws.

II. PROPERTIES OF BIOSOLIDS

1. **Physical Properties of Biosolids:** Dewatered biosolids (DWB) and lime-added biosolids (LAB) are the two types of biosolids products.

- **Lime-Added Biosolids (LAB):** To assist lessen odor and get rid of germs, lime in the form of calcium oxide can be used with dewatered biosolids. In the final product, hydrated lime and calcium carbonate are present in substantial amounts. Its alkalinity (pH of roughly 12) guarantees that microorganisms have been significantly reduced in the product. It serves as a replacement for agricultural lime and has a similar liming value. It includes around 30% organic matter and has low amounts of nitrogen and phosphorus.

  There is a lot of ammonia odor in LAB because of its strong alkaline nature, which converts a lot of its nitrogen into ammonia gas. It is used at a rate that will lime the soil to the same extent as the recommended amount of agricultural lime.

- **Dewatered Biosolids:** In rural areas, dewatered biosolids (DWB) are frequently applied to the soil. To dewater biosolids to about 20% solids, a centrifuge or belt press is utilized. The product includes various plant nutrients, but high levels of nitrogen, phosphorus, and organic matter, which enhance soil fertility and physical characteristics, are its key advantages for agriculture.

  DWB is a dark substance that resembles organic, damp soil. Depending on the weather, it can occasionally have a strong smell, which may persist for several weeks after application. The degree of odor is frequently determined by the product's quality.

  Organic Matter: One of the key factors driving demand for biosolids is its high organic matter content. The addition of organic materials like SS increases the biological activity of soil (Saviozzi et al. 1999). By boosting soil water holding capacity, enhancing soil aggregation, and lowering soil bulk density, organic matter enhances soil physical quality and the environment for roots. The cation exchange capacity of soil can also be raised by applying biosolids. Depending on the climate, soil structure, and management, these effects should last for several years following application. In addition to inactivating pathogens and aiding in nutrient cycling, The application of biosolids, which provides organic matter, may also encourage the growth of advantageous microbial populations in the soil.

2. **Microbiological Properties of Biosolids:** An important topic is what risks do pathogens in biosolids provide to human and animal health when they are employed in agriculture. Processes for treating wastewater are intended to lessen the amount of pathogens in biosolids. Although the overall quantity of bacteria decreases over time after application, some can endure for several months and even grow. Despite the fact that handling the product requires following standard hygiene precautions, this does not in and of itself constitute a serious health risk. According to research, managing biosolids-treated sites in

accordance with the NSW Guidelines reduces hazards to people's and either directly or indirectly through the food chain, the health of grazing animals. The chemical makeup of biosolids.

Several variables influence the chemical characteristics of biosolids

- The degree of industrial pre-treatment and wastewater quality.
- Levels of wastewater treatment, including primary, secondary, and tertiary
- Chemicals used in processes.
- Methods for stabilization (e.g., lime treatment).

III. IMPACT OF BIOSOLIDS ON SOIL PROPERTIES

1. **Effect on the Physical Properties of Soil:** Sewage sludge is a rich source of organic material. Urban sewage often contains a significant amount of organic content—more than 50% of the dry matter. In the majority of soils, adding organic matter in the form of sewage sludge will significantly alter the soil's physical properties. Improved aeration and drainage as a result of sludge amendments may subtly alter the relationships between soil heavy metal concentrations and plant development. Biosolids' improved soil aggregate formation and stability may be greater than that of animal manures due to the stability of their organic constituents. Improved water penetration is essential, especially in highland areas where soil erosion and terrace grading have left the top soil thin and low in organic matter.

2. **Effect on the Microbial Properties of the Soil:** The population, biomass, and activity of soil microorganisms will generally increase with the addition of organic manure in the form of sewage sludge. Consequently, there is a significant change in the soil life. Application of sludge with modest levels of heavy metal concentrations enhanced soil microbial activity. Because metal is cemented into calcareous alkaline soils, any negative effects on microbial biomass will only last a short time. The introduction of sewage sludge gives microbes a substrate for action, increasing the enzyme activities in the soil (Stark *et al*. 2008). In the end, both the microbial population and biomass will rise, and their functions will improve. Patel and Patra (2014) also noted that the amount of tannery sludge (TS) increased the dehydrogenase activity. They described how dehydrogenase is understood to.

3. **Effect on Soil Chemical Properties:** The addition of sewage sludge will increase the organic matter content of an agricultural soil and cause the production of humic and carbonic acids, which are crucial for controlling the soil's propertiesThe pH of calcareous soils will drop as a result of these acids. In humic compounds, there are numerous high cation exchange sites. Biosolids' impact on crop growth.

In 60% of the examined situations, the application of liquid sludge did not significantly affect crop yields, but in 26% of the cases, it dramatically increased them. The advantages for soil structure. Reductions in wheat grain yield of 6–10% were noted on the clay and calcareous loam soils treated with liquid sludge as well as the sandy loam and clay soils treated with bed-dried sludge. The most likely cause of the production drop, however, was assumed to be lodging of the crop as a result of too much nitrogen in the

soil rather than metals. According to Gomez-Rico *et al*. (2008), sewage sludge addition can improve nutrient availability and repair deteriorated soils.

IV. PRODUCTION OF BIOSOLIDS

Industrial Waste Treatment: Wastewater or sewage treatment is a multistep process:

1. Primary Treatment (Physical Process)

- Removal of large objects using grates and screens
- Settling to remove suspended solids (primary sludge)
- Flocculating chemicals are added to enhance sedimentation

2. Secondary Treatment (Microbial Process)

- Supernatant or primary effluent contains high levels of dissolved organic load (Biological Oxygen Demand).
- Decomposition of organic matter.

- **Aerobic Method**
  - Aeration to stimulate aerobic degradation activated sludge reactor
  - Trickling filter reactor
  - Pathogen Removal by Activated Sludge
  - More than 90 per cent of E.coli. and Salmonella are destroyed
  - Bacteria are removed by inactivation, grazing by ciliated protozoa, and adsorption to sludge solids

- **Anaerobic Method**
  - Septic tanks typically handle tiny amounts of waste, such as that from a single dwelling or a small business or industry.
  - Larger volumes of municipal or industrial waste are often treated by WWTPs.

- **Thickening**
  - Low force centrifugation, flotation, or gravity separation of water and solids.
  - By reducing water, you can raise the solids content.
  - Lowers the cost of transportation.

3. Stabilizing Techniques

- **Digestion (Anaerobic and/or Aerobic)**
  - The stabilization of biological systems by converting organic matter to carbon dioxide, water, and methane.
  - Lowers the pathogen density, biological oxygen consumption, and vector attraction of the substance.
  - Decreases the amount of biosolids.

- **Alkaline Stabilization**
  - Alkaline materials are added for stabilization.
  - Raising pH to 12 lowers biological activity (especially pathogen density) and material appeal to vectors.
  - Metals are immobilized by high pH.

- **Heat Drying**
  - Drying of biosolids by raising temperature while treating wastewater.
  - Destroys germs and removes the majority of water.
  - Reduces the volume of sludge considerably.

- **Conditioning:** processes that easily separate water from biosolids (i.e., dewatering) by flocculating them.

- **Dewatering**
  - Water and particles are separated with great force using vacuum filtration, centrifugation, filters, and belt pressing.
  - Lower nitrogen and potassium quantities while raising the solids concentration to 15% to 45%.
  - Increases handling simplicity, minimizes the need for land, and cuts transportation expenses.

4. Advanced Stabilization Methods

- **Composting:** Composting is one of the most flexible and profitable methods for managing such biodegradable solid wastes by biological stabilization into compost, a material that is safer and more stable.
- Pathogens are eliminated, and sludge is transformed into humus-like material. outstanding soil conditioning abilities.

V. ADVANTAGES AND DISADVANTAGES OF BIOSOLIDS

1. Advantages

- Enhances soil structure, tilth, friability, fertility, and water-holding capacity for optimal plant growth.
- Reduce need for commercial fertilizers.
- Less leaching loss of nutrients.
- Slow release of nutrients.
- It improves the environment for vegetative development and replenishes essential minerals to the soil.
- It increases the microbial activities.
- Reduces the soil erosion.
- Easy to store, transport and use.

2. Disadvantages

- Process is labour intensive.
- Biosolids may contain hazardous chemicals.
- Odors from biosolids applications are the main issue that negatively affects the neighborhood.
- Contamination resulting from industrial waste.
- When done improperly, land application can have a harmful effect on the air, the soil, and the water.

VI. CONCLUSION

The reuse of organic waste through land application has many benefits. Reusing organic waste not only lowers the amount of waste that society produces but also lowers the expense of disposing of it. It also offers a useful method for recycling nutrients that have been lost from the soil. Recycling sewage sludge for agricultural use appears to be an interesting alternative for sustainable management of sludge because it is rich in organic matter and several macro and micronutrients. Due to ongoing population growth, urbanization, and industrialisation, sewage sludge output is continually rising.

Biosolids favorable impacts on soil fertility were demonstrated in soils in terms of

- Increased potential for N-supply.
- Content of organic materials.
- The generation of biomass and nutrient absorption.
- The least expensive and energy-intensive method of using or disposing of sewage sludge is possibly through land application.
- This can be a useful strategy for satisfying the nutrient needs of crops, but it can also be risky when handled incorrectly.

REFERENCES

[1] BHARDWAJ, R.M. 2005, Status of Wastewater Generation and Treatment in India. Inter secretariat Working Group on Environment Statistics Joint Work Session on Water Statistics, Vienna, 20-22 June 2005.
[2] GOMEZ-RICO, M. F., FONT, R., VERA, J., FUENTES, D., DISANTE, K. AND CORTINA, J. 2008, Degradation of organic pollutants in Mediterranean forest soils amended with sewage sludge. Chemosphere 71, 2129–2138.
[3] PATEL, A. AND PATRA, D. D. 2014, Influence of heavy metal rich tannery sludge on soil enzymes vis-à-vis growth of Tagetes minuta, an essential oil bearing crop. Chemosphere 112, 323-332.
[4] SAVIOZZI, A., BIASCI, A., RIFFALDI, F. AND LEVI-MINZI, R. 1999, Long term effects of farmyard manure and sewage sludge on some soil biochemical characteristics. Biology and Fertility of Soils 30, 100-106.
[5] STARK, C. H., CONDRON, L. M., CALLAGHAN, M., STEWART, A. AND DI, H. J. 2008, Differences in soil enzyme activities, microbial community structure and short-term nitrogen mineralization resulting from farm management history and organic matter amendments. Soil Biology and Biochemistry 40, 1352–1363.
[6] U.S. Environmental Protection Agency, 1993, Standards for the Use or Disposal of Sewage Sludge. Washington, D.C. U.S. Environmental Agency.

