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Biogas Slurry as eco-friendly approach for agriculture

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INTRODUCTION

Biogas slurry is leftover slurry produced by anaerobic breakdown of biogas source substrates like animal manure or plant debris. Biogas slurry has attracted much interest because of its potential contribution to recovering soil characteristics and enhancing environmentally friendly agricultural productivity. There are various biotic and abiotic elements that constantly pose a risk to the development and growth of plants. Organic farming has gained global attention as a sustainable agricultural practice. However, unresolved issues still need to be addressed before the widespread expansion of such techniques. Technological interventions such as biotechnology, nanotechnology, and microbiology can transform biological resources, particularly biomass waste or by-products into organo-metal biofertilizers. This transformation utilizes a crucial aspect and plays a significant role in strengthening organic agriculture. An example of leftover biomass is biogas slurry (BGS), which serves as a habitat for diverse microbial communities and contains secondary metabolites that provide essential nutrients. Cow dung (CD), a commonly used feedstock for biogas production. Additionally, it contains a diverse range of microorganisms. The completely digested BGS is mainly identified by its pleasant odor, dark brown or black color, and the potential presence of tiny living organisms. Biogas slurry can enhance soil fertility and boost crop production when used as fertilizer.

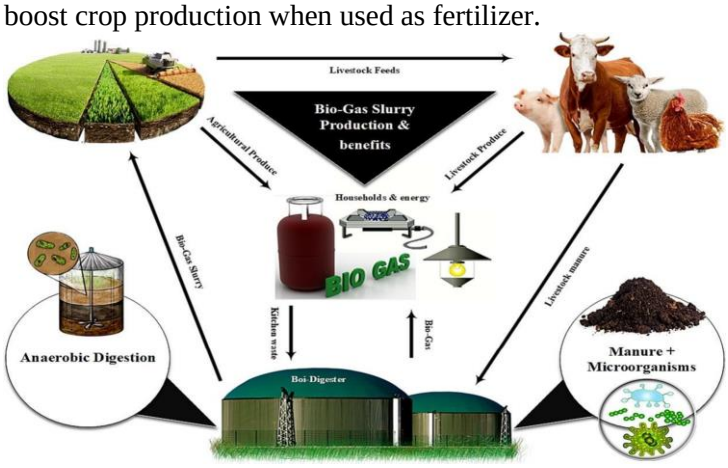


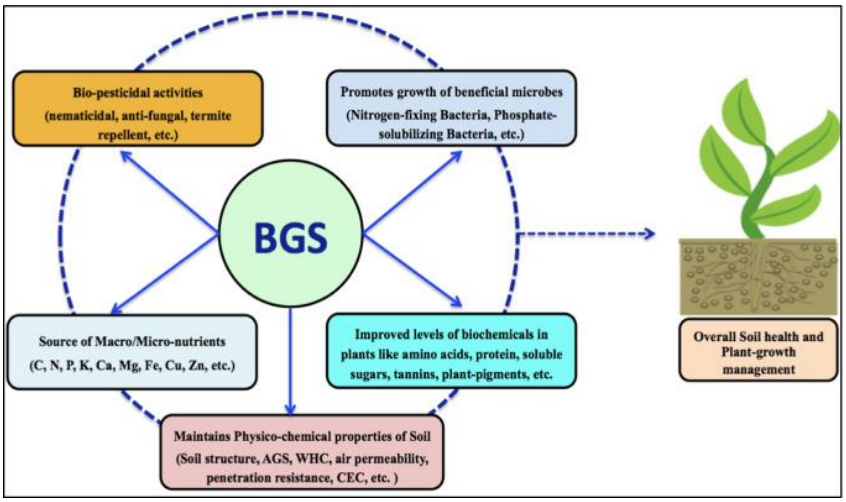
Figure 1

Sources and Composition

Biogas is comprised of methane (major component), carbon dioxide, nitrogen, hydrogen sulfide, hydrogen, and traces of ammonia. Hydrolysis, acidogenesis, acetogenesis, and methanogenesis are the key steps of biogas production in which each step is catalyzed by the diverse microflora. Different substrates for anaerobic digestion to produce biogas include animal (manure, dung, fodder residue, etc.), vegetable (grass, straw, etc.), and household (night soil, garbage, etc.) waste. Livestock dung (such as cattle manure) is the most commonly available substrate for biogas production, precisely in rural areas. According to Indian scenario, from 730 MT of dung produced by animals annually, bovine dung alone (cattle and buffalo dung) accounts for 256.2 MT from which estimated annual BGS production is 76.8 MT. The bulk of BGS is contributed by water (~93%) and the remaining part (~7%) is comprised of organic (4.5%) and inorganic (2.5%) matter. pH value lies above the neutral range. It is rich in NPK (2.55%, 0.57%, and 1.77% of N, P, and K respectively) with other nutrients (Ca, Mg, Fe, Mn, Cu, and Zn) essential for plant growth.

Agricultural applications

- ✓ Anaerobic digestates such as BGS comparatively offer low nitrate leaching and lesser nitrous oxide emissions.
- ✓ In comparison to traditional compost, BGS is an easily available form of compost and is also reported to have stronger plant growth-promoting activities than raw slurries due to higher concentrations of ammonical nitrogen.
- ✓ As compared to cow dung, BGS have lower C/N content, thus enabling higher fertilization potential, and anaerobic digestion aids mineralization effects, hence increasing the bioavailability of nutrients to the plants.
- ✓ Biogas slurry enhances moisture retention and reduces bulk density of soil. Applications of biogas slurry alleviate drought and salinity stress in plants.



Limitations

BGS has various limitations such as bulkiness, low C/N ratio, nitrogen loss through volatilization of ammonia (VOA), and high pH. A biogas plant with 800 m^3 of working volume is estimated to be discharged 15 tons of BGS per day; hence, generated volumes of BGS need to be managed appropriately to avoid any environmental consequences, as a result thereof. The bulkiness in BGS is due to the high water content (~93%) in it, which further complicates its transport and utilization. The bulkiness of BGS also limits its potential to fulfill the entire nutrient demand in agriculture fields. The higher pH (>7) promotes N loss through VOA (volatile organic compounds). Nitrogen loss from BGS in the form of VOA imposes complexity during its handling, storage, and field applications. Storage limitations such as lack of bottom liners or impermeable surfaces can have the risk of nitrogen and potassium leaching. High air temperature can also increase the N loss through ammonia emissions.