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Role of biogas slurry in soil health development

Ritu Nagdev[1,2], Ambrina Sardar Khan[3] and Shakeel Ahmed Khan[4]
[1]Ph.D Scholar, Amity Institute of Environmental Sciences, Amity University, Noida, Uttar Pradesh
[2]Scientist, ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Regional Centre, New Delhi 110012
[3]Assistant Professor Amity Institute of Environmental Sciences, Amity University, Noida, Uttar Pradesh
[4]Principal Scientist, ICAR-Indian Agricultural Research Institute (IARI), New Delhi 110012

The decrease in crop output prompts an increase in the use of various chemical fertilizers and pesticides in agricultural fields. Such chemical inputs not only put human life and the environment in danger, but they also pose a serious threat to soil and agriculture. Three significant issues of using the nitrogenous chemical fertilizers are rising costs, financial loss, and environmental risks. Therefore, it is essential to switch from traditional methods to those that are more environmentally friendly, such as reducing the use of chemical fertilizers or promoting organic farming for the development of soil health.

Biogas slurry (BGS) is one of the greatest substitute fertilizers for enrichment of soil health and sustainable agriculture. Due to the high nutrient content of biogas slurry, the usage of biogas slurry as a fertilizer has significantly expanded in China and many other Asian nations (Shaibur *et al*., 2021; Gupta *et al*., 2016). According to reports, China uses more than 450 million tons of BGS annually (Zheng, 2017). In India, bovine dung alone produced 76.8 MT of BGS yearly (Kumar *et al*., 2015). The projected annual recovery of cow manure from 299 MT to 995 MT was cited by Rath and Joshi. According to Thiruselvi D. *et al*., around 335 MT of cow dung are produced in India each month, of which 110 MT is deemed to be trash during collecting and transportation.

BGS is the byproduct of anaerobic fermentation of biomaterials. It is also referred as *digestate* or *sludge*. BGS is an effective waste material and an organic fertilizer which is the best supplement for soil health development and sustainable to the environment. BGS is low-cost, safe for use around people and animals, and environmentally friendly (Rabiul Islam *et al.,* 2016). BGS is usable as pre-made manure. BGS repels termites and other pests that are typically drawn to raw dung and it is pathogen-free, has no smell and does

not attract the flies. The biogas digester's process eliminates organisms that can harm plants. The quality of BGS depends on the various factors such as species and age of the animal from which the dung was extracted, the water used to mix the dig, the sorts of animals and their feeding rates, whether urine was utilized along with the dung or not, how the slurry was stored, treated, and applied, etc.

In order to prepare the BGS, it is necessary to combine crushed crop straws with cow dung in a stirring tank, ferment in an aerobic fermentation tank, pelletize in a pelletizer, and followed by complete the conventional subsequent treatment process. *"BGS is a byproduct of the manufacturing of biogas. The major components of biogas are methane carbon dioxide, nitrogen, hydrogen sulphide, and hydrogen, etc. The primary processes involved in producing biogas include hydrolysis, acidogenesis, acetogenesis, and methanogenesis."* After generation of energy from gas the liquid released at the biodigester outlet. Fresh cow dung and water are mixed daily to feed the biodigesters, which are kept there for two to three months before being released as BGS.

BGS is typically a blend of straw from various crops and faeces from cattle. Animal, vegetable, and domestic waste can all be used as different substrates to create BGS, including manure, dung, and leftover fodder. The most frequently found substrate for biogas production is livestock dung, such as cattle manure mainly in rural regions. BGS is made up of 93 percent water, 4.5 percent dry matter, and 2.5 percent inorganic matter (Kumar *et al*., 2015; J. Devarenjan *et al*., 2019). The dry matter contains the necessary nutrients including nitrogen (N), phosphorus (P), and potassium (K) which promotes the advancement in soil health and over all crop growth. In comparison to FYM and composted manure, BGS has higher levels of minerals and micronutrients and more readily available plant nutrients (Ishikawa *et al*., 2006). BGS can remain settled in the digester's bottom for a very long time and contains a very high amount of nutrients (Kefale Wagaw, 2016). Numerous mineral components, including N, P, Ca, Zn, Mg, S, Fe, Cu, Co, and Mn, as well as a diverse microbial biota are included in the BGS nutritional profile, which can be used as a source of fertilizer in agricultural fields.

BGS role as a nutritional package to improve the soil health. The slurry's most significant advantage is as very effective fertilizer that can improve the soil health and increase the crop growth (Ahmad *et al.*, 2009). As an organic fertilizer, BGS has a number of benefits, including enrichment of soil nutrients and their availability to plant; development in soil structure; water holding capacity; cation exchange capacity and enhancement of soil microbiota (phosphate-solubilizing bacteria (PSBs), etc. BGS offers nutrients in proper ratios and is a rich source of slow-release minerals. It can be used directly or in conjunction with

other organic materials as fertilizer. BGS also checks the soil erosions through enhancing the physical characteristics of the soil *viz*., such as its ability to store water, its air permeability, its aggregate stability, its resistance to penetration, etc. A combination of synthetic fertilizer and biogas slurry increased carbon nitrogen transformation with significant effects on soil health and crop yield. It has been also noted that the BGS encourage plant growth, overall yield and productivity and effectiveness against soil-borne and plant diseases. BGS is considered as a useful source of nutritional supplement for soil health as it contains significant levels of essential macronutrients (N, P, K) and micronutrients (Zn, Mn, B) which support plant growth (Alam, 2006). Numerous crops, including field crops, tobacco, peas, mustard, onion, cabbage, banana, pearl millet, and sugar cane, etc., have reported yield gains as a result of applying biogas slurry.

Digested BGS can be the valuable substitute for synthetic fertilizers. The effects of BGS application are similar to those of synthetic fertilizer application. Utilizing bio-slurry can reduce the consumption of synthetic fertilizers by 15% to 20%. (Kumar *et al*., 2015).

Finally, we draw the conclusion that Biogas slurry is organic manure which provides a greater amount of macro and micronutrients than synthetic fertilizer and traditional organic fertilizers like FYM and compost. It reduces the weight of fertilizers on national economy. Proper utilization of bio-slurry enhances the crops productivity and also prevents depletion of nutrients in the soil of agricultural lands. It can effectively reduce the usage of synthetic fertilizers because it is safe for the environment and has no toxic or detrimental consequences. Therefore, farmers must include the BGS into their agricultural inputs as it benefitted the farmer's community to secure their livelihood by promoting the crop growth. It is the best alternative for soil conservation, increases the sustainability of fields and lessens the weight of fertilizers on the national economy.

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