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Biogas Slurry: An Eternal Source of Nutrients for Sustainable Agriculture and Posterity

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INTRODUCTION

Energy is one of the most important requirements for any country's development. Biomass is a renewable energy source that helps to reduce the use of fossil fuels. Biomass production will help to reduce pollution in the environment. More than a lakh biogas plants (BGP) have been developed in India as a result of the Biogas Support Programme (BSP) in rural parts of Nepal. More than 20,000 plants have been established in Vietnam as part of the Biogas Program for Animal Husbandry Sector. Biofuels have a long history of use as an environmentally acceptable fuel that may also be utilized for transportation. When compared to other fertilizers, the nutrients included in the slurry will be more readily available, and the fertilization will be greater. Biogas slurry (BGS) is a by-product of anaerobic digestion, which generates biogas (combustible methane gas) for cooking, lighting, and engine use. Biogas slurry can be used alone or in combination with other organic and synthetic fertilizers to fertilize crops. Biogas slurry is a digested source of animal waste, and adding urine (from animals) increases the amount of nitrogen in the biogas slurry, speeding up the composting process. This enhances the carbon and nitrogen (C/N) ratio in the slurry, allowing plants and soil biota to easily access nutrients. The BGS contains 93% water and 7% dry matter, out of which 4.5 percent is organic and 2.5 percent is inorganic materials. Macronutrients (N, P, K) and micronutrients (Zn, Fe, Mn, Cu) are all present in the digested BGS, with many of these elements reduced from soil owing to intensive farming methods. Biogas slurry can also be used to improve the health and fertility of crop-growing soil. Biogas slurry has more macro and micronutrients than composted manure and FYM, and it is more easily accessible to plants (Ishikawa *et al*. 2006). The effects of BGS application are equivalent to those of synthetic fertilizer application.

As a result, digested BGS can be a valuable substitute for synthetic fertilizers. Biogas slurry is an useful source of organic fertilizer since it includes a lot of macronutrients (N, P, K) and micronutrients (Zn, Mn, B) that plants need to flourish. Biogas slurry provides a long-term solution for agriculture, the environment, and rural communities.

Biogas slurry is low-cost, does not pose a health risk, is environmentally benign, and produces better agricultural crops. Organic waste, such as bovine manure, vegetable waste, and food waste, may be recycled in the BGP by anaerobic digestion, which has greater potential than creating any other fossil fuel. Cattle dung and agricultural leftovers will be generated in enormous quantities in many developing nations, such as India, making it viable to create biogas and BGS as a byproduct. India generates 730 MT of animal dung each year, with 60% of that being recoverable. We receive roughly 0.3 percent of the BGS if we utilize 1kg of cattle manure. When compared to other chemical fertilizers, the hazardous elements included in the BGS will be quite low. As a result, the BGS will be less harmful and will be able to readily replace other chemical fertilizers.

Composition of BGS

Slurry is the byproduct of fermentation following biogas production. It's also known as bio-slurry because it's made biologically. The slurry has the highest mass composition, with water accounting for roughly 93 percent, and the remaining 4.5 percent dry matter and 2.5 percent inorganic matter. Sludge is made up of scum, liquid effluent, sludge, and a variety of other organic and inorganic materials. The fluid present above the surface of solid slurry is referred to as scum. Some macro and micro nutrients can be found in liquid effluents. They include macronutrients such as N, P, and K, as well as micronutrients such as Ca, Mg, Fe, Mn, and Zn. The components present as a residual in a biogas are referred to as sludge. When the BGS is exposed to the atmosphere for an extended length of time, the N that is contained in the slurry is lost, reducing the fertilizer's quality. By combining BGS with organic materials such as food waste, kitchen waste, manure, and most other forms of organic materials and straws, BGS may be composted. The nitrogen in the BGS in the form of ammonia will be partially taken up by the plants and will stay in the form of N. Biogas slurry will have a higher organic content than farm yard manure. The pH of BGS should be higher than farmyard manure. The nutrient composition of the BGS should comprise approximately 1.4-1.8 percent N, 1.1-2 percent P, and 0.89-1.2 percent K.

Production of BGS

Among the several sources of renewable energy, biomass (i.e., the remnants of plants, animals, and other biological entities) is considered green and hence reduces pollution when used. Bioenergy is a term used to describe the by-products of metabolic reactions. Except for archebacteria, almost all bacteria require oxygen to grow. Bacteria multiply more quickly in the presence of oxygen. When there is a lack of free oxygen in the plant, it survives by utilizing different additional elements available to it. As a result, methane gas is produced as a waste product. The bacteria present inside the biogas plant decomposes only the mucus content present in dung, and the remaining about 90% is settled as slurry. Hence, for producing a kilogram of biogas needs around 40 kilograms of dung. Some crops are utilized as raw materials in the production of biofuels. The strength of India's bio-energy programme will primarily focus on the country's agriculture in order to boost crop productivity. To accomplish the goals of renewable energy and waste disposal, complex biogas generation and usage technologies have been created. India has a vast livestock population of 512.05 million animals. The overall anticipated potential of BGP is 12 million, but only 4 million plants have been constructed, generating roughly 35 million cubic metres of biogas per day on average.

As a result, after a nearly 40-year period, just around 33% of the potential has been realized. According to a recent study, ten kilos of cattle dung per day produces 0.36 cubic metres of biogas, while fifteen kilograms of buffalo dung produces 0.54 cubic metres. For the biomass conversion into bioenergy in the 3 states of solid, liquid, and gas, many conversion processes have been tried. In the absence of oxygen, bacteria and other microorganisms employ a process called fermentation to make biogas from materials such as sewage, green waste, municipal trash, manure, plant and animal leftovers. Two sorts of reactions take place inside the biogas plant. The first is an aerobic reaction, whereas the second is an anaerobic response. The anaerobic reaction breaks down complicated chemicals and creates biogas, which is used as a cooking fuel. The aerobic response involves bacteria using oxygen for their growth, while the anaerobic reaction breaks down complex molecules and produces a form of gas called biogas.

Organic farming using BGS

Organic farming is performed in practically every section of India where oranges, pepper, pineapples, ginger, turmeric, and other crops are grown. The slurry derived from the BGP contains a variety of macro and micro nutrients. The nutrients include N, which is made up of 1.8 percent P_2O_5 with a 1.0 percent average concentration, 0.90 percent K_2O, and manganese (Mn), zinc (Zn), iron (Fe), and copper (Cu). It also comprises 65 percent organic matter, with a C/N ratio of 10–15. Other metals that are essential for organism growth will always be present in trace amounts in the compost. Each day, a two-cubic-meter BGP produces roughly 50 kilograms of slurry. Twenty-day time period will be required to obtain one metric tonne of fresh wet slurry. The wet slurry can also be combined with other organic fertilizers in the proportions required by the plants. Bio sludge not only promotes healthy plant growth, but it also improves soil fertility. When BGS is used properly, it increases agricultural yield while simultaneously reducing soil nutrient loss.

Fertilizer replacement

Synthetic fertilizers are more effective than organic fertilizers at increasing the nutrients in the soil. Farmers employ synthetic fertilizers to boost crop yields quickly, but their frequent and intensive application makes crops vulnerable to insect assault, microbial diseases, and invasive weeds. If only synthetic fertilizers are applied to the soil, soil productivity is reduced, and crop yields are reduced if only organic manure (slurry, FYM, and compost) is applied. The majority of the time, a combination of synthetic and organic fertilizers can produce optimal crop output and soil fertility levels. Synthetic fertilizers are costly, and most small-scale farmers cannot afford to use them for an extended period of time. Because of the exorbitant prices, most developing and African countries must find an alternative to synthetic fertilizers. Furthermore, BGS coupled with synthetic fertilizers frequently produces higher yields than BGS alone. Because synthetic fertilizers are no longer required, the use of BGS lowers costs while increasing crop productivity. Based on the findings of several research and taking into account the environmental consequences and costs of synthetic fertilizers, it is recommended that 10 to 15 t ha^{-1} of BGS be applied after ploughing and 21 to 28 days before planting. Once the sprouts have emerged from the earth, the BGS should be sprayed only to the roots of the plant and mixed in with the soil. The economic value of organic fertilizer to a farmer, on the other hand, is the increase in crop yields and crop quality that results from its application. A cubic metre of slurry contains 0.16–1.05 kilograms of nitrogen, which is comparable to 0.35–2.5 kilograms of urea. Each year, 76.8 MT of slurry is produced from 730 MT of dung (only for bovine dung). The nitrogen content from 76.8 MT slurry is 1.15 MT nitrogen. A kilogram of nitrogen is equal to 2.2 kilograms of urea fertilizer (Urea contains

46 % N). Urea costs Rs. 276 every 50 kg bag. As a result, the cost of 1.15x109 kg N is 13.74x109 INR. According to the aforementioned calculation, 76.8 MT slurry significantly reduces import bill by 13.74 billion INR. Mineral fertilizers alone will not be able to make up for all of the nutrients that are deficient in agricultural soils. Imported fertilizer prices have been steadily rising over the previous few decades. As a result, as soon as possible, all native organic resources should be transformed and recycled into a soil fertilization programme. The use of BGS can significantly minimize the need of synthetic fertilizers. It is possible to cut down on the use of synthetic fertilizers by up to 20%.

Biogas slurry has important benefits. These include:

1. Small farmers' production costs will be reduced by eliminating the use of pricey chemical fertilizers.
2. Improve soil fertility, increase productivity, and reduce drought and climate-related susceptibility
3. Improve diets by facilitating the cultivation of veggies near the residence (food nutrition).

CONCLUSION

In sustainable agriculture, BGS could be used as a high-quality organic fertilizer to maintain product quality. Biogas slurry has the ability to produce a significant amount of macro and micro nutrients, as well as significant amounts of organic matter. In comparison to synthetic fertilizers, it has a low level of heavy metals and is rich in nutrients. Biogas slurry is environmentally safe, has no hazardous or adverse consequences, and can easily cut chemical fertilizer use by 15 to 25%.In addition to providing both macro and micronutrients to crops, BGS has the potential to improve the physical and biological quality of soil (improved soil structure, enhanced water holding capacity, cation exchange capacity, less soil erosion, and provision of nutrients to soil micro-flora including N fixing and P solubilizing organisms). Biogas slurry application has increased yields in a variety of crops. The use of a combination of BGS and synthetic fertilizer improved carbon nitrogen transformation and resulted in a significant increase in crop output. Finally, we conclude that BGS is helpful to the farmer's community, reduces fertilizer burden on the country's economy, and improves field sustainability.