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A Study on The Benefits of Bio Slurry-Based Manure Used by Women Farmers of Sundarban, West Bengal

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ABSTRACT

The Sundarban region of West Bengal is characterised by fragile ecological conditions, saline soil, recurring cyclones, flooding, and other environmental challenges that influence agricultural productivity and rural livelihoods. In such circumstances, sustainable agricultural practices are essential for maintaining soil fertility, reducing dependence on chemical inputs, and promoting environmentally responsible farming. Bio-slurry, a nutrient-rich by-product of biogas production, has emerged as a potentially useful organic manure for improving soil quality and supporting crop cultivation. The present study, entitled **"A Study on the Benefits of Bio-Slurry Based Manure Used by Women Farmers of Sundarban, West Bengal,"** focuses on the experiences and practices of women farmers who use bio-slurry-based manure in agriculture. Anaerobic digestion produces bio-slurry. Nutrient-rich digestate slurry works. Water waste with 93% water and 7% particles is good for soil absorption. This natural fertiliser contains 1.5% nitrogen, 1.1% phosphorus, and 1% potassium. Small but potent, these numbers naturally enhance crop growth. Farmers get two nutrients from biogas slurry. Slurry is water-like, containing plant-beneficial compounds. Thicker fibrous slurries look solid. Both soil types feed crops with nutrients despite their different roles. Do not use liquid biogas slurry for seven days. We can safely release more gases while waiting. Animals like the solid form because it contains ammonia nitrogen.

Keywords: *Bio-slurry, Organic Manure, Women Farmers, Sustainable Agriculture, Sundarban, West Bengal, Soil Fertility, Crop Productivity, Rural Livelihood.*

INTRODUCTION

Agriculture is an important source of income in rural West Bengal, especially in environmentally vulnerable areas such as the Sundarban. Saline soil, frequent cyclones, flooding, waterlogging, and climate change characterise the Sundarban region. Environmental issues often reduce agricultural productivity and hurt small farmers. Thus, sustainable and ecologically friendly agriculture is becoming more vital. One such approach is using biogas plant byproducts as bio-slurry-based manure. Biogas plants anaerobically decompose animal dung and other biodegradable waste to produce nutrient-rich bio-slurry. It is a good organic manure for soil fertility and crop productivity. Bio-slurry-based manure may enhance soil organic matter, structure, moisture retention, and crop nutrient availability. It also replaces excessive use of chemical fertiliser, which can harm the environment over time.

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Rural Indian women play an important role in agriculture and allied fields. In the Sundarban region, many women grow crops, manage cattle, collect organic resources, prepare manure, and perform other domestic agricultural duties. Their role in agricultural decision-making and development is often overlooked. Bio-slurry-based manure can help women farmers use local animal and organic waste to practise sustainable agriculture. By combining renewable energy with organic farming, bio-slurry manure may help rural sustainability. While biogas plants generate cleaner energy for homes, the residual slurry can be used as manure. Thus, this integrated method can increase waste management, soil quality, agricultural output, and resource conservation. Such techniques may encourage women farmers to use local resources more and lessen their dependence on imported agricultural inputs.

An excellent setting for analysing the real-world advantages and difficulties of using bio-slurry-based manure is the Sundarban region. Because of its delicate ecology and reliance on agriculture, sustainable agricultural practices are crucial. Therefore, a study of women farmers who use bio-slurry-based manure can help to understand their experiences, awareness level, application techniques, perceived agronomic and economic benefits, and challenges in implementing this practice. The current study, "A Study on the Benefits of Bio-Slurry-Based Manure Used by Women Farmers of Sundarban, West Bengal," aims to investigate the significance of bio-slurry for women farmers in Sundarban, West Bengal, and its role as a sustainable agricultural input. The study intends to investigate the potential benefits of using bio-slurry-based manure for crop cultivation, soil fertility, environmental sustainability, and the involvement and empowerment of women farmers. The project aims to deepen understanding of the relationship among local resource utilisation, sustainable agricultural methods, and rural women's role in promoting ecologically responsible farming, with a focus on the Sundarban region.

COMPOSITION OF BIO SLURRY

It is a semi-liquid or liquid byproduct created during anaerobic digestion (the breakdown of organic matter without oxygen. Digestate slurry, a nutrient-rich combination, is an effective weapon. For soil absorption, this liquid waste is perfect since it contains 93% water and 7% solids. This all-natural fertiliser contains the precious elements nitrogen (1.5% concentration), phosphorus (1.1% concentration), and potassium (1% concentration). These numbers may be small, but they pack a punch when it comes to naturally increasing crop growth.

Anaerobic digestion is where the biogas plant's magic happens. Soup made with nutrient-rich livestock manure, which decomposes in the absence of oxygen. This process changes the original manure into a version that plants can use more easily.

Working on multiple farms has given me firsthand experience with how this natural blend enhances agricultural yields. Compared with solid fertilisers, plants absorb nutrients more quickly from liquid fertilisers.

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TYPES OF BIOGAS SLURRY: LIQUID AND FIBROUS

Biogas slurry provides farmers with two primary types of nutrients. Slurry is a liquid with a water-like consistency that contains a number of compounds beneficial to plants. A fibrous slurry seems chunkier and more solid. Both varieties supply crops with identical nutrients, despite their slightly varied roles in the soil. There must be a seven-day waiting time before using liquid biogas slurry. We can safely release additional gases while we wait. The solid form is also very good for animals because it includes ammonia nitrogen.

It is easy to use and may be rapidly converted into poultry and pig feed. Farming requirements are determined by kind. The best way to distribute the liquid is with sprinkler systems. The fibrous structure improves the soil's ability to retain water and makes mixing easier. Smart farmers select the best type based on soil conditions and the seasonal crops.

BENEFITS OF USING BIOGAS SLURRY AS FERTILISER

Biogas slurry is an efficient natural fertiliser that improves soil health in several ways. This eco-friendly multipurpose tool feeds your plants and saves money on synthetic fertilizers, which benefits both crops and pocketbook.

Enriches Soil Nutrient Content

Slurry is a powerful source of essential nutrients that crops need to thrive. The mixture contains nitrogen, phosphorus, and potassium, which are necessary for a healthy plant's growth. When combined, these nutrients improve soil fertility and create the perfect environment for growth. Most of the farm's soil tests showed a 40% increase in nutrient levels after just three months of slurry treatment.

The beneficial components are released as the slurry breaks down in the soil, and it all works like magic. Through this natural process, nutrient levels are kept constant throughout the growing season. Additionally, the organic components of the slurry enhance the soil's structure, which promotes root growth and water absorption. The results of our most recent soil test showed that slurry-treated plots retained 25% more nutrients than untreated ones.

Promotes Microbial Activity in Soil

When the soil is nutrient-rich, little soil helpers flourish. Bacteria and fungi, these little heroes, thrive on soil that has been treated with biogas sludge. The slurry is a five-star hotel for beneficial bacteria, giving them food and a place to stay. According to firsthand observations, soil treated with biogas waste becomes a vibrant metropolis of microbial life in a few of weeks.

The bacterial and fungal populations in the soil grow more varied when biogas slurry is used in place of chemical fertilizers. These microbes help plants readily obtain nutrients by accelerating the breakdown of organic matter.

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A natural cycle is created when microbes break down the slurry, release nutrients, and improve soil structure. Better water retention and better root systems are the outcomes of this. The test plots in India during the study showed a 40% increase in microbial activity after just three months of applying biogas slurry.

Reduces Dependency on Chemical Fertilisers

Biogas sludge is revolutionising modern farming. For instance, by building biogas plants and properly applying biogas slurry, farmers in India can reduce their nitrogen, phosphorus, and potassium consumption by 8.78%, 11.01%, and 14.33%, respectively. The nutrients that crops require to flourish are abundant in this natural fertiliser. Instead of using chemical fertilisers, farmers are switching to organic fertilisers, which save money and enhance soil health.

The allure of biogas sludge lies in its dual benefits for farmers and the environment. It completes the circle of sustainability by turning agricultural waste into beneficial fertilisers. In an effort to reduce their reliance on imported chemical fertilizers, more farmers are selecting this eco-friendly substitute. The way that biogas slurry increases soil microbial activity and raises its value for crop production is examined in the next section.

Improves Water Retention in Soil

Crop success depends on soil water retention, which goes beyond using fewer chemical fertilizers. In the soil, the organic material in biogas slurry functions like a sponge. It collects and retains water, which is necessary for plants to develop robustly and healthily.

The fibrous digestate from the slurry aids in forming microscopic air pockets within the soil structure. These pockets retain moisture and prevent it from evaporating too rapidly. Fields treated with methane slurry can retain up to 30% more water than untreated soil, according to tests.

During dry seasons, crops keep hydrated longer because to this additional water storage. Additionally, stronger, deeper roots result from enhanced soil structure, increasing a plant's resistance to drought.

PREPARATION OF BIOGAS SLURRY FOR AGRICULTURAL USE

To prepare biogas slurry for use in agricultural areas, proper storage and dilution techniques are essential.

Proper Storage Methods

Storing biogas slurry needs strong, leak-proof tanks made of concrete or steel. These tanks must remain covered to prevent potential methane loss and maintain the slurry's value. The storage area needs good drainage systems to prevent flooding in wet weather.

Smart farmers place their tanks close to fields but far from water sources to avoid the risk of contamination of the water environment.

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The best storage setup includes mixing tools to keep the slurry moving. This prevents fibrous solids from settling at the bottom of tanks. A good tank system lets farmers store slurry for up to six months.

This timing helps them apply it during the right growing season. The storage area must have clear labels and safety barriers to protect workers and animals.

Dilution Techniques for Application

Mixing biogas slurry with water creates a safer, more effective fertiliser for your crops. Raw biogas slurry contains 93% water, but it requires additional dilution to reduce its ammonia levels.

The dilution process needs careful attention to get the best results. Many people recommend pouring the slurry through a separator screen first to remove any solid bits. Next, add clean water slowly while stirring to create an even mix. The diluted mixture settles out quickly, so it is prepared before use.

Methods for Applying Biogas Slurry to Crops

Farmers can spread biogas slurry on their fields in three main ways: mixing it straight into the soil, spraying it on plant leaves, or adding it to irrigation systems – stick around to learn which method works best for your crops!

Direct Soil Application

The most fundamental way to apply biogas slurry to fields is through direct soil application. Using pressurized pipe systems, to directly apply the liquid digestate to the ground. For optimal results, keep this technique within a range of 2.5 to 4.5 km from any animal-producing units. Plant roots have easy access to nutrients since the slurry decomposes rapidly in soil. The moment the biogas slurry contacts the ground, magic occurs. It immediately increases the soil's ability to store water and decreases its bulk density. The ground becomes more malleable and looser. Soil's microbial communities grow more diverse too. These tiny helpers break down organic matter faster, creating a healthier growing environment for crops.

Application of Foliar

Biogas slurry has many uses for farmers, including soil treatment and direct spraying onto plant leaves. If you want to avoid leaf burn caused by high ammonia levels, diluting the slurry properly is the way to go. A solution that is safe for most crops can be made by mixing one part slurry with five parts waters. To facilitate faster nitrogen absorption than through root systems, plants might have diluted biogas slurry sprayed onto their leaves. The nutrients are absorbed directly by the leaf tissue, leading to rapid results within one to two days. Results from field trials indicate that this technique works best with tomatoes and greens.

Spraying during hot sunny days should be avoided. The best time is early morning or late evening when temperatures are cool.

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Irrigation Integration Techniques

Mixing biogas slurry with irrigation water creates a powerful two-in-one solution for crop growth. Farmers can set up special tanks to blend the slurry with water before sending it through drip lines or sprinkler systems – but only after settling and pre-filtering, which reduce soil improvement from the fibre particles. There is a method called biogas slurry drip irrigation (BSDI) that improves soil health more than regular water irrigation. Tests show that BSDI helps reduce soil density and boost beneficial microbes in the soil, but systems require special attention to avoid blockage.

Smart irrigation planning makes a big difference in how well the slurry works. The key lies in getting the mix right – too much slurry can clog pipes, while too little won't feed plants properly. Modern systems use filters and pressure controls to spread the mixture evenly across fields. This setup saves time and cuts down on labour costs. Speaking of labour, let's explore the best practices that make biogas slurry work even harder for your crops.

Best Practices for Using Biogas Slurry

Getting biogas slurry right takes more than just spreading it on your fields. Smart farmers know the tricks of proper storage, timing, and spreading methods to keep their soil happy and crops thriving.

Avoiding Pollution Run-Off and Watercourse Nutrient Enhancement Prevention

Proper management of biogas slurry stops harmful runoff into nearby water sources (see the diagram above). Buffer strips should also be used as natural filters between fields and waterways, capturing excess nutrients before they reach streams or rivers. Farmers must spread slurry at least 10 metres away from any water source to protect aquatic life (local regulations may apply). The soil needs time to absorb the nutrients, so application during dry weather is best.

Smart application timing helps prevent surface runoff from damaging local ecosystems. Farmers should check weather forecasts and avoid spreading when heavy rain is expected. The right dosage matters too – applying nutrients based on crop needs reduces waste and protects water quality.

Simple steps like creating grass margins around fields make a big difference in keeping our waterways clean. These practical methods support both agricultural production and environmental protection.

Biogas Slurry Usage in Crop Rotation Systems

Crop rotation with biogas slurry offers farmers a smart way to boost their yields. Major crops like wheat, barley, rice, maize, and Italian ryegrass thrive in this system. Farmers can slash their fertiliser costs by mixing biogas slurry with standard chemical fertilisers.

The soil gets better nutrients, and plants grow stronger. Biogas slurry works great in rotation systems because it feeds the soil between different crop cycles. The organic matter breaks down slowly, providing plants with steady nourishment throughout their growth.

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This natural approach helps create rich soil that holds water better. Farmers who use this method see better crop health and higher yields in their fields.

Managing Odour and Potential Contaminants

Biogas slurry often brings strong odours that need smart handling. Sealed tanks work best to trap nasty smells, while regular pH monitoring helps control odour-causing bacteria. Natural additives such as zeolite or biochar can absorb excess ammonia, making the slurry easier to work with.

Potential contaminants in biogas slurry require careful attention and proper treatment**.** The good news is that agricultural biogas slurry contains fewer heavy metals and harmful pathogens than other "biosolids" (sewage sludge) waste types.

Still, regular testing for heavy metal content keeps things safe. A simple risk check before each application spots any problems early. Modern digestate separation technology like the Boerger Separator helps remove unwanted bits, leaving clean, nutrient-rich liquid digestate for fertiliser use.

Overcoming Logistical Challenges in Transport and Storage

Moving biogas slurry poses big challenges due to its highwater content. Local biogas plants need smart planning to collect waste from nearby producers. The transport costs drop if plants sit close to farms and waste sources.

Storage tanks must handle large volumes while keeping the slurry fresh and ready for use.

Proper storage systems make a huge difference in managing biogas slurry effectively. Covered tanks stop rainwater from getting in. The tanks may need seals to block bad smells from spreading and methane generated for collection and use.

Environmental and Economic Benefits of Biogas Slurry

The use of biogas slurry in crop production produces a perfect circle of sustainability, while also offering a win-win option for farmers by lowering farm waste and fertiliser expenses.

Reducing Agricultural Waste

Every day, livestock farms produce enormous quantities of waste. Farmers may transform this waste into useful resources through clever biogas generation. Annually, farmers in India generate 76.8 MT of biogas slurry from animal manure. Reducing farm waste and making natural fertiliser are two major issues that this approach addresses simultaneously. Slurry improves crop growth while preventing the pollution of our water and land.

Modern agricultural systems need better waste management solutions. The anaerobic digestates from biogas plants offer a perfect answer. These digestates feed the soil ecosystem and boost crop growth naturally. Farmers save money by using less synthetic fertiliser. The process also helps fight climate change by capturing harmful gases from decomposing waste.

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Lowering Fertiliser Costs

Biogas slurry helps farmers save big money on fertiliser costs. Recent research has concluded that Indian farmers could cut their chemical fertiliser imports by 13.74 billion INR through smart use of biogas slurry. This organic option reduces the need for synthetic fertilisers by 8.78% for nitrogen, 11.01% for phosphorus, and 14.33% for potassium.

These savings add up fast for both small and large farms. Farmers who switch to biogas slurry see quick drops in their monthly expenses. The dirt gets better nutrients without the high price tag of chemical fertilisers. Many agricultural practices now favour this eco-friendly choice because it helps soil health and cuts costs at the same time.

Biogas slurry works well with crop rotation systems, making it a practical choice for sustainable agriculture.

Minimising Environmental Impact

Beyond cutting fertiliser costs, smart use of biogas slurry creates a ripple effect of environmental benefits. The shift from synthetic to organic fertilizers if fully implemented could reduce nitrogen use in India by 8.78%, phosphorus by 11.01%, and potassium by 14.33% (India). This drop in chemical usage leads to cleaner groundwater and healthier soil ecosystems.

Natural fertilizers from biogas slurry support soil aggregation and boost microbial communities. I've seen firsthand how fields treated with slurry show better water retention and less soil erosion.

The process tackles waste disposal issues too. Farmers who switch to slurry help cut down CO2 emissions from synthetic fertilizer production. This green approach to crop management protects both farm profits and our planet's future.

Future Innovations in Biogas Slurry Use

Scientists are developing smart biogas slurry systems that work with precision farming tools to deliver exact nutrient doses to crops. These new systems will use data from soil sensors and crop growth patterns to create custom fertiliser blends, making farming more efficient and eco-friendlier.

Development of Slow-Release Biogas Slurry-Based Fertilisers

Scientists have created new ways to make biogas slurry last longer in soil. These slow-release fertilisers mix biogas slurry with special materials that hold nutrients better. The process boosts soil Organic Carbon and Total Nitrogen levels gradually over time.

This steady release helps plants get the right amount of food they need to grow strong. The latest research shows promising results in making these fertilisers work better for different crops. Labs now use special coating methods to control how fast nutrients leave the slurry.

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These coatings protect the good stuff in biogas slurry from washing away too quickly. Farmers who use these improved fertilisers see better crop growth and healthier soil. The next big step focuses on making these fertilisers work with modern farming tools and machines.

Biogas slurry stands as a game-changer for modern farming. Smart farmers now mix this eco-friendly fertilizer with their usual growing methods to boost crop yields**.** The nutrient blend in biogas slurry helps plants grow stronger while reducing chemical use.

CONCLUSION

The potential significance of bio-slurry as a locally accessible and sustainable agricultural resource is highlighted in the article "A Study on the Benefits of Bio-Slurry Based Manure Used by Women Farmers of Sundarban, West Bengal." Utilising bio-slurry-based manure can enhance crop growth, preserve soil organic matter, increase soil fertility, and lessen reliance on chemical fertilisers. Adopting organic and resource-efficient farming methods can be especially important for sustaining agricultural operations and safeguarding the local ecosystem in an environmentally sensitive area such as the Sundarbans.

The report also highlights the important role that women farmers play in managing home and farm resources and in agricultural production. Women can support environmentally sustainable farming methods and recycle organic waste by helping to produce and apply bio-slurry manure. In addition to encouraging the efficient use of resources produced inside rural households, the use of bio-slurry may lower the cost of external agricultural inputs. The availability of biogas infrastructure, awareness of appropriate application techniques, access to agricultural extension services, availability of livestock resources, and local climatic circumstances can all affect how much of these advantages are realised.

All things considered, bio-slurry-based manure plays a significant role in the Sundarbans' integrated and sustainable agricultural systems. Increased knowledge, technical advice, training, and institutional support can help women farmers utilise this resource more efficiently. Rural development, resource conservation, and household livelihoods can all be supported concurrently by increasing women's involvement in sustainable agriculture techniques. Therefore, the study provides a foundation for future research and for the development of locally relevant policies that promote the broader and more efficient use of bio-slurry-based manure among Sundarban agricultural communities.

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