Circular Fertilizer Production

Upgrading of biofertilizer

Fertilizer pellets spraying from spreader

What is biofertilizer?

Biofertilizers are derived from natural organic sources such as animal manure, compost, food waste, and plant residues. Biofertilizers **provide nutrients** to plants, often in a slow-release manner, while **improving soil structure** and **enhancing microbial activity**. It typically contain key nutrients like nitrogen, phosphorus, potassium, secondary nutrients such as sulphur, and various micronutrients. Additionally, it contain organic carbon, which is crucial for **maintaining soil fertility** and supporting a healthy ecosystem.

Upgrading biofertilizers involves processes that stabilise the organic material, make nutrients more readily available, and enhance plant growth and soil health. Additionally, plant bio stimulants, which improve plant growth and stress tolerance, or bio-fertilizers, which enhance nutrient availability through microorganisms, can also be produced from biofertilizers.

Technologies for upgrading biofertilizer

Drying

Organic materials or their by-products (such as composted chicken manure) are dried to reduce moisture content, making them easier to handle and store. Dried fertilisers can be applied using the same equipment typically used for spreading mineral fertilisers, such as broadcast spreaders.

ADVANTAGES

- **Extended Shelf Life:** Dried fertilisers last longer and are less prone to microbial spoilage or degradation during storage.
- **Enhanced Nutrient Concentration:** Drying can concentrate nutrients, making the fertiliser more effective per unit of weight.
- **Improved Handling:** Dry, granular, or pelleted products are easier to transport, store, and apply than wet or semi-solid organic materials.

Compressed chicken manure pellets

Composting

Organic materials are decomposed by microorganisms in the presence of oxygen, converting them into compost, which is a stable, nutrient-rich soil amendment. Compost can be applied to fields using equipment similar to that used for spreading bedded manure, such as manure spreaders commonly used for sheep and cattle.

ADVANTAGES

- **Enhanced Nutrient Availability:** Composting stabilises nutrients, making them more available to plants.
- **Improved Soil Structure**: Compost improves soil structure, aeration, and water retention, benefiting soil health.
- **Reduction of Pathogens and Weed Seeds:** Proper composting processes reduce pathogens and weed seeds, enhancing the safety of the fertiliser.

Garden compost bin whit layers of compost in different composting stages

Biogas plant

Anaerobic digestion

Organic materials, such as manure, food waste, or crop residues, are broken down by microorganisms in the absence of oxygen, producing biogas (methane and carbon dioxide) and digestate (a nutrient-rich residue). Digestate, whether in liquid or solid form, can be applied using the same equipment typically used for spreading manure from dairy or pig farms.

ADVANTAGES

- **Improved Nutrient Profile**: Organic fertiliser from anaerobic digestion is rich in nutrients like nitrogen, phosphorus, and potassium, and often has better nutrient availability compared to the raw organic materials.
- **Reduced Pathogens and Odours:** The digestion process helps reduce pathogens and odours, making the fertiliser safe and pleasant to handle.
- **Renewable energy prroduction:** Through the digestion process the bio methane is collected and can be used as a renewable energy resource and replace fossil fuels.

Environmental Benefits

Reduction in Synthetic Fertilizer Use: Upgraded biofertilizers can replace or supplement synthetic fertilizers, reducing reliance on fossil fuel-intensive production processes and minimizing associated greenhouse gas emissions.

Enhanced Nutrient Recycling: Converts agricultural waste and other organic residues into nutrient-rich products, closing nutrient loops and reducing environmental pollution from unmanaged waste.

Lower Risk of Runoff Pollution: Upgraded biofertilizers often contain stabilized nutrients, which are less prone to leaching or runoff into waterways, helping to prevent eutrophication.

Soil Health Improvement: Biofertilizers improve soil organic matter, biodiversity, and water retention compared to chemical alternatives, enhancing long-term sustainability.

Economic Benefits

Cost Efficiency for Farmers: Provides an affordable alternative to increasingly expensive synthetic fertilizers, potentially reducing input costs.

Marketable Products: Upgraded biofertilizers, such as pelletized or liquid formats, are easier to transport, store, and sell, creating additional revenue streams.

Value Addition to Waste: Upgrading waste into high-quality biofertilizers creates economic value from what would otherwise be disposal costs.

Increased Crop Yields: Enhanced nutrient formulations improve crop productivity, generating higher income for farmers.

Energy Savings: Many upgrading processes (e.g., biogas integration) recover energy, reducing energy costs associated with farm operations.

Example: Use of upgraded fertilizer for tomato production

An example in Norway is Den Magiske Fabrikken (The Magic Factory), which has the capacity to produce approximately 120 GWh of biogas. At the facility, food waste and livestock manure are transformed into biogas, bio-fertiliser, and vermicompost, and green CO2. The food waste comes from approximately 1.2 million residents in Eastern Norway, while the livestock manure is sourced from cattle and pig farms in Vestfold County.

A pilot bubble (BBBLS) greenhouse has been built adjacent to the biogas plant, utilising captured bio-CO2 and dewatered liquid digestate from the biogas plant, along with vermicompost derived from the digestate. The system is called digeponics. Digeponics is a method of agriculture which integrates the organic fertiliser products of anaerobic digestion, including CO2, with greenhouse cultivation of vegetables. This sustainable system produces climate-friendly tomatoes for local supermarkets. The bubble greenhouse technology alone offers an 80% energy saving, and when combined with bio-CO2 and bio-fertiliser use, the greenhouse achieves a remarkable 90% reduction in energy consumption compared to traditional greenhouses.

Tomato production at Den Magiske Fabrikken in Norway

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