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LIST OF ACTIVITIES

I. FROM THE CLASSROOM TO THE FIELD (2022 – 2023)

1. TNAU: Farm Enterprises - Vermicomposting Unit
2. KovaiBSF: "The Mighty Maggots: Utilizing Black Soldier Fly Larvae for Efficient Food Waste Management"
3. TNAU: Biogas production through integrated farming system
4. New Tirupur Area Development Corporation Limited (NTADCL)

II. AWARNESS POSTERS FOR WORLD SOIL DAY (5TH DEC 2022)

- Includes 12 communication materials to help create a buzz about World Soil Day

III. RESEARCH INSIGHTS (2022 – 2023)

1. Optimizing anaerobic digestion of food waste: analysis of key parameters and strategies for enhancing fertilizer utilization
2. Valorization of food waste through black soldier fly: analysis of frass and larvae parameters for developing a sustainable business model
3. Vermicomposting of organic waste: production and analysis of vermicompost for comparative evaluation with anaerobic digestate and insect frass

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FROM THE CLASSROOM TO THE FIELD

ACTION LEARNING

FROM THE CLASSROOM TO THE FIELD

Site Visited: New Tirupur Area Development Corporation Limited (NTADCL)

Date of Vist: 06/06/2022

Time of Visit: 9.00 AM to 6.00 PM

Batch: MBA WM&SE

Faculty: Dr. Prabhu Thangadurai

DESCRIPTION OF THE COMPANY (NTADCL)

First water supply project in the Public Private Partnership framework

New Tirupur Area Development Corporation Limited (NTADCL) has been established as a special purpose vehicle for development and implementation of the Tirupur Water Supply and Sewerage Project. NTADCL is promoted by Tamilnadu Water Investment Company Limited (TWIC), Infrastructure Leasing and Financial Services Limited and Tirupur Exporters Association to implement the first Water Supply and Sewage project under the public-private partnership in the country. It is the first water supply project in India financed commercially on a limited recourse basis. A Concession Agreement has been signed in 2000 between Govt of Tamilnadu, NTADCL and Tirupur Municipality (TM)

The Project foundation was laid on 20th June 2002 by Honorable Chief Minister of Tamilnadu. The Project was inaugurated on February 2006. Under the project, facilities have been constructed to abstract, treat and supply 185 MLD (million litres of water per day) from the confluence of river Cauvery and Bhavani. The water is being supplied to the dyeing, bleaching and other industries and domestic consumers in and around Tirupur. The domestic consumers are of Tirupur Municipality (TM), three Town Panchayats and fifteen Village Panchayats to cater around 11 Lakh beneficiaries. This provides umbrella coverage for the entire water supply requirements of Tirupur Planning area spread over 225 Sq Km.

In addition, water supply is being provided to enroute habitations in five wayside unions through Tamilnadu Water Supply and Drainage Board. The water supply project has been completed within stipulated time frame and budgeted cost as per prescribed standard.

NTADCL has commenced water supply to all consumers (industrial and domestic) since 2005 on continuous basis. The Project also includes about 120 KM length of sewer collection system with Four Sewage Pumping Stations and a 15 MLD Sewage Treatment Plant (STP) expandable to 30 MLD. The sewage system has been commissioned in the year 2008.

Salient Features

Water Quantity to be supplied	185 million litres per day
Concession Period	30 years
Cost of the Project	Rs. 10230 million
Debt	Rs. 6138 million
Equity	Rs. 3227 million
Sub-Debt	Rs. 865 million

Unique Aspects / Details of the Project

- Tirupur Water Supply and Sewage Project (TWSSP) is the 1st project in the country implemented by Public-Private Partnership.
- It is the largest private investment in the Urban Infrastructure sector.
- State Leverage support by 19 times (Rs.550 million of state financing helps raise over Rs.10000 million for the project).
- Provides a viable model for implementing other projects in the sector.
- Tamilnadu is the first State in the country to set up a Public-Private Partnership based institution in the sector, namely Tamilnadu Water Investment Company Limited.

Beneficiaries of the Project

1. Rural households (water supply through TWAD Board / Direct)
    - 8 Village Panchayats.
    - 600 Rural Habitation covered under 5 Panchayat Union.
    - Concession Quantity: 18 MLD.

Additionally, 461 habitations under 68 Village Panchayats in Tirupur & Erode Districts

- Additional Quantity: around 8 MLD.

2. Urban households (water supply through Tirupur Corporation)
    - Population - 8 lakhs

- Concession Quantity: 39 MLD and Additional quantity: 54 MLD.

3. Sewerage network covering over 60 per cent population of Tirupur - currently around 15246 sewer connections.
4. Low-cost sanitation facilities for slum areas - 31 sanitary complexes have been implemented
5. Providing quality water to the processing industries of Tirupur

Impact of the Project

- Tamilnadu emerged as the premier location for textile (Knitwear export) industry.
- Industrial growth by assured quality water supply.
- Improve health & hygiene conditions for households.
- Dignity of life, particularly for women through private in-house sanitation.
- Create enhanced opportunities for employment and poverty reduction.
- Exploitation of groundwater was protected.
- Free-up ground water for agricultural growth, productivity and development.

Photos of the Visit












HIGH NOISE AREA

ACTION LEARNING

FROM THE CLASSROOM TO THE FIELD

Site Visited: TNAU: Vermicomposting Unit

Date of Visit: 20/01/2023

Time of Visit: 12.00 PM to 6.00 PM

Batch: MBA WM&SE

Faculty: Dr. Prabhu Thangadurai

INTRODUCTION

There is a growing realisation that vermi-composting provides the nutrients and growth enhancing hormones necessary for plant growth. The fruits, flowers and vegetables and other plant products grown using vermi-compost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production of compost utilising earthworm activity. Some of them ventured into commercial production as well. As the cost of production of this compost works out to about Rs.1.5 per kg, it is quite profitable to sell the compost even at Rs.2.50 per kg. Other organic manures like neem cake, groundnut cake, etc., are sold around this price.

The process of composting crop residues using earthworms comprise spreading the agricultural wastes and cow dung in layers as 1.5 m wide and 0.9 m high beds of required length. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume. The beds are maintained at about 40 - 50% moisture content and a temperature of 20 - 30o C by sprinkling water over the beds. The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or vermi-castings. The vermi-casting containing nutrients is rich manure for the plants.

When the commercial scale production is aimed at in addition to the cost of production, considerable amount has to be invested initially on capital items. The capital cost may work out to about Rs.1500 to Rs.2500 for every tonne of compost produced annually. The high variability in the unit capital cost is due to the fact that large units require considerable expenditure on machinery and transport particularly when the source of raw materials is away from the site of production facility and the finished product has to be transported to far off places before being marketed. However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of vermi-compost.

ABOUT THE WORMS

Of about 350 species of earth worms in India with various food and burrowing habits, Eisenia fetida, Eudrilus eugeniae, Perionyx excavatius are some of the species for rearing to convert organic wastes into manure. The worms feed on any biodegradable matter ranging from coir waste to kitchen garbage and vermicomposting units are ideally suited to locations / units with generation of considerable quantities of organic wastes. One earthworm reaching reproductive age of about six weeks lays one egg capsule (containing 7 embryoes) every 7 - 10 days. Three to seven worms emerge out of each capsule. Thus, the multiplication of worms under optimum growth conditions is very fast. The worms live for about 2 years. Fully grown worms could be separated and dried in a oven to make 'worm meal' which is a rich source of protein (70%) for use in animal feed.

LOCATION

Suburbs of cities and villages around urban centres can be ideal locations for practice of vermicomposting on a large scale, from the view point of availability of raw material and marketing of the produce. As use of the compost is said to have ameliorative effect on product from fruit, flower and vegetable crops, vermicomposting units may be located in areas with concentration of fruit and vegetable growers and floriculture units.

USE

As the wastes are pulverised as they pass through the worm, the surface area of the material increases which in turn helps as base for nutrients. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Chemical fertilizer in moderate doses can go along with vermicomposting.

COMPONENTS OF A COMMERCIAL UNIT

Sheds

For a vermi-composting unit, whether small or big, this is an essential item and is required for having the vermi beds. They could be of thatched roof supported by bamboo rafters and purlins, wooden trusses and stone pillars. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room has to be left around the beds for easy movement of the labour attending to the filling and harvesting the beds.

Vermi-beds

Normally the beds are 75 cm - 90 cm thick depending on the provision of filter for drainage of excess water. The entire bed area could be above the ground. Care should be taken to make the bed with uniform height over the entire width to the extent possible to avoid low production owing to low bed volumes. The bed width should not be more that 1.5 m to allow easy access to the centre of the bed.

Land

About 0.5-1 acre of land will be needed to set up a vermiculture production cum extension centre. The centre will have at least 8-10 sheds each of about 180-200 sq.ft. It should also have a bore well, and pump set or watering arrangement and other equipments as described in the scheme economics. The land can be taken on lease of at least 10-15 years. Even sub marginal land also will serve the purpose.

Buildings

When the activity is taken up on a large scale on commercial lines, considerable amount may have to be spent on buildings to house the office, store the raw material and finished product, provide minimum accommodation to the Manager and workers. The cost of the buildings along with the electrification of these buildings and the vermi-sheds may be included under this item.

Seed Stock

This is an important item requiring considerable investment. Though the worms multiply fast to give the required numbers over a period of 6 months to a year, it may not be wise to wait till such a time having invested on the infrastructure heavily. Thus, worms @ 350 worms per m3 of bed space should be adequate to start with and to build up the required population in about two cycles or three without unduly affecting the estimated production.

Fencing and Roads/Paths

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and the finished products to and from the vermi-sheds. The entire area has to be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

Water Supply System

As the beds have always to be kept moist with about 50% moisture content, there is need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply/application system requiring considerable initial investment, however, reduces the operational costs on hand watering and prove economical in the long run. The cost of these items depend on the capacity of the unit and the type of water supply chosen.

Machinery

Farm machinery and implements are required for cutting (shredding) the raw material in small pieces, conveying shredded raw material to the vermi-sheds, loading, unloading, collection of compost, loosening of beds for aeration, shifting of the compost before packing and for air drying of the compost, automatic packing and stitching for efficient running of the unit. Costs of providing necessary implements and the machinery have to be included in the project cost.

Transport

For any vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a 3-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the vermi-compost sheds could also be included in the project cost.

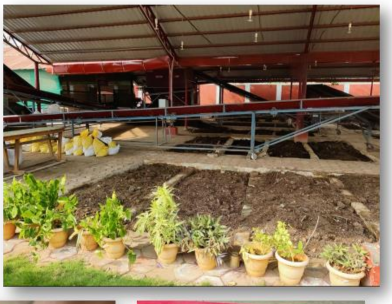
Furniture

A reasonable amount could also be considered for furnishing the office-cum-stores including the storage racks and other office equipment. These enhance the efficiency of operations.

Operational Costs

In order to operate the unit, expenditure on some items have to be incurred on a recurring basis. These items include salaries of the staff, wages to the labourers, cost of raw material, fuel cost on transport of raw materials and finished goods, packing material cost, repairs and maintenance, power, insurance, etc. The number of office personnel and labourers have to be decided breaking each activity into a number of sub-activities and for each sub-activity estimating the work involved and the capacity of the labour to finish the work in a given time. The number of persons should be so chosen to keep them engaged throughout by providing enough persons at various work points like stores, vermi-beds and equipping them with adequate number of implements to avoid undue waiting.

<u>Photos of the Visit</u>



ACTION LEARNING

FROM THE CLASSROOM TO THE FIELD

Site Visited: TNAU: Biogas production through integrated farming system

Date of Visit: 17/02/2023

Time of Visit: 12.00 PM to 6.00 PM

Batch: MBA WM&SE

Faculty: Dr. Prabhu Thangadurai

INTRODUCTION

Currently farmers working hard to improve their income in crop production and overcome shortage of labourers. It was developed with a focus such that is integrated farming system. Crop production, animal husbandry, fishery, and agro-forestry such agri-related professionals play a major role in agro-economics. In addition to improving the income of the peasant farmers has boosted employment. The interdependency of the two or more jobs at the same place on the same farm, combined with the activity in integrated farming project will probably be integrated farming system.

Bio-gas: In farm waste such as dung is mixed with straw, grass, leaves and kitchen waste were kept in anaerobic environment produced gas is called as bio-gas.The carbon dioxide, nitrogen, methane and hydrogen sulfide gases combinations, methane is inflammable. This is 55 per cent.

Uses and features:

- Accumulation of moist dung in heap will produce various pathogens and this will be avoided by biogas production.
- Because of smoke free it can be used for cooking. Speedy in cooking time. In the cooking protect the utensils from carbon sedimentation. It can be used to generate electricity and to run the engine. Saves 70-80% diesel requirement.

Well digested and odourless dung liquid is called as slurry. It's used for land reclamation and enrichment.

- If weeds and seeds by fermentation reduced capacity and in field production of weeds reduced.
- Used wastes as food to fish and pig.
- Used to make compost.

Parts of Biogas utensil

1. Fermentation tank
2. Gas tank
3. Pipe Systems
4. Mixing tank
5. Gas stove
6. Waste mixing exiting tank

Place and capacity

- Construct bio gas tank nearer to farm, levelled, elevated land, open to sunlight source.
- Land water level not within 7-8 feet deep and drinking water wells should not be close to 15 meters.
- Sufficient water must be available.

Vessel Size: One Cubic meter of container is required to set up at least 3 cows.

- 6 cubic meters - 15 cows
- 10 cubic meters - 25-30 cows
- 25 cubic meters - 60-65 cows

Setting method of vessel:

Fermenters

- The circular shape beneath of the earth with bricks and cement to be constructed. Upper part to be exposed to above the earth.

- The semi-circular shaped fermentors to be separated into two 2/3 heights. In that level, build the inner walls tolerant to gas vessel.
- Place a guide map in the middle of the wall. It helps to keep a level of gas vessel while going up and down. Protection walls constructed only when the capacity exceeds 3m3.
- Pipe which is from the mixed vessel between the two rooms should be organize 2-3 feet from the ground level.
- Mixed vessel's height just than exiting waste vessel is better.

Gas tank

- It is a circular-shaped iron box. Above ledger fit in reverse. The mouth should be immersed in the mixture.
- Fit tube in not outlet gas at top.

Method of usage

- Preserve it with two to three weeks by pouring water and then pour cow dung slurry. Initially full capacity of the tank should be filled with slurry, so collect cow dung when starting the construction of tank. Dung and water to be mixed in the proportion of 1: 1 ratio to fill the tank.
- Once the Biogas begun to come pour the cow dung slurry continuously then only it will supply gas continuously.
- Every time when pouring cow dung mixture slurry also come out from the tank. Tank gas pressure is sufficient to remove the slurry. Gas come out from the tank will be transferred to gas stove through adopter.

Measures to be considered

- In coastal area due to salinity the gas tank should be line with plastic.
- The gas production was higher in the summer, less in winter to prevent this, dissolve cow dung in medium warm water.
- Sometimes fermenter walls burst due to poor quality cement.
- In some cases, mixture in the vessel likely to sediment and it will be avoided by

- frequent stirring.
- Formation of water in the pipeline cause blocking. To prevent this place a valve
- to discharge the water.

Fermentation capacity: High fermentation occurs at a temperature of 30-35 ° C. At least 50 litres per day of gas produced per kg of dung.

Bio-gas production in integrated farming

- Family - 5 persons
- Productivity - 2 cubic meters / day
- Cow dung - 60 kg / day
- Needed cattle's - 3
- Biogas production - 730 cubic meters / year
- The value of biogas – Rs. 5000 / - / cubic meters / year
- Biogas Waste - 57 kg / day

Government has approved the various designs of bio-gas plants

Currently, the central government recommended the four types of biogas models approved to receive a subsidy.

1. Rural job Commission steel drum gas gallon.

2. The Commission KVIC fibre drum gas cylinder.

3. Concrete wall of the drum cylinder (Perro cement shape)

4. Standard ball-shaped roof cylinder (Dheena-bandhu model).

To set up the plant lot of trained trainers are available in the villages. The form of the building of the gas burner can be easily complete. The standard drum buy at the village level should be checked.

Khadi Rural job Commission and the fiber of the steel drum, fibre drum gas System (Biogas is large enough for a digester).

- Cow dung, urine and remaining in cattle feed or vegetables are cut into small pieces and put into tank and it will be fermented.

- This digester barrel above the gas vessel is shut off it. The standard of the gas coming through fermentation will be collected. The correct pressure for the gas and pass through gas pipe.
- Gas usages places like gas stove, cobra gas and gas engines receive gas through gas pipe without reduction in pressure. For Cobra gas stove, light and engines apparatus were specially designed.

Photos of the Visit

ACTION LEARNING

FROM THE CLASSROOM TO THE FIELD

Site Visited: KovaiBSF

Date of Visit: 03/02/2023

Time of Visit: 12.00 PM to 6.00 PM

Batch: MBA WM&SE

Faculty: Dr. Prabhu Thangadurai

INTRODUCTION

What is Black Soldier Fly?

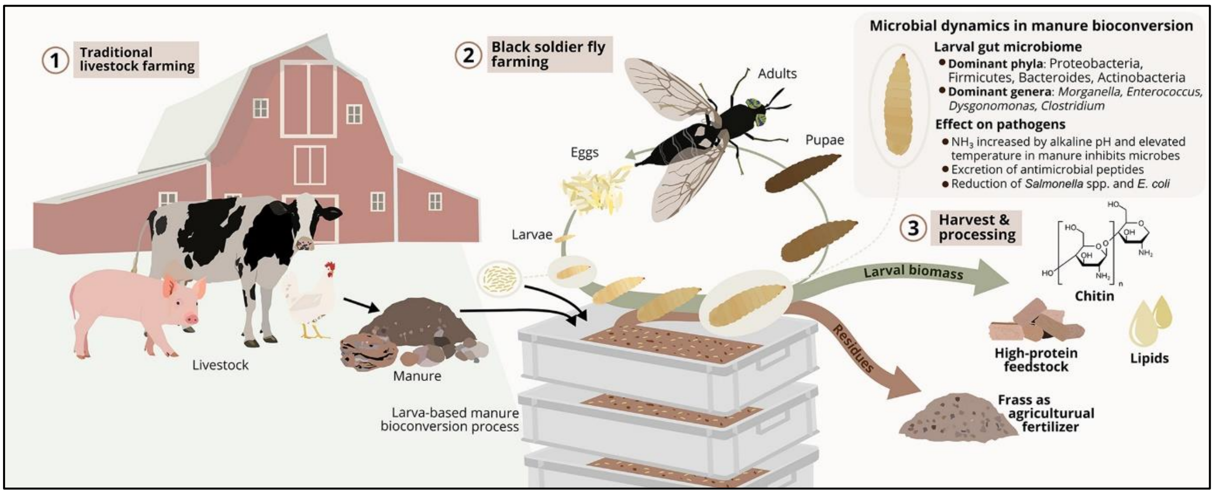
The black soldier fly (BSF), Scientific name: Hermetia illucens, is a valuable insect species whose larvae have high nutritional value. They are excellent source for Protein, fatty acids, amino acids among other vitamins and minerals. They are good for converting organic waste into compost, which is a good source of organic fertilizer for Terrace gardening.

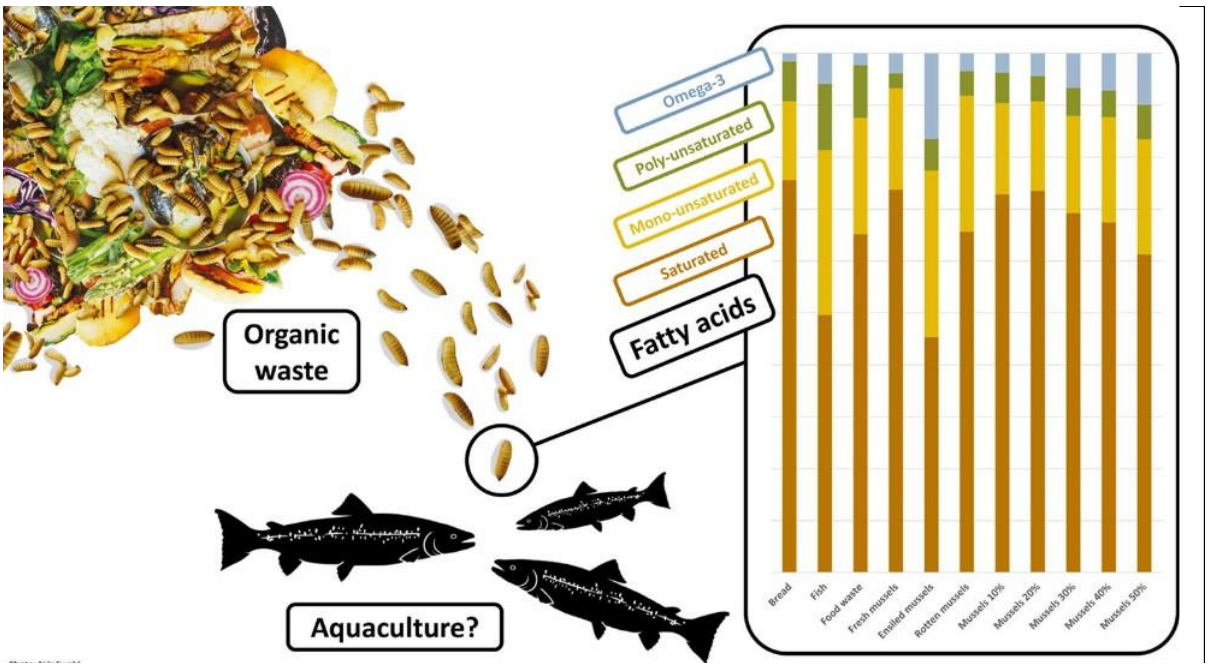
Why is Black Soldier Fly?

Black soldier fly are useful and non disease transmitting. They grow on resource that we consider as waste, hence unlike other feed they don't compete with resources available for human consumption. World is looking into sustainable sourcing of feed for animal husbandry and found BSF as best alternative for feed stocks. They can be cultivated in huge quantity as per need and help to keep our earth clean. Above all, being a natural diet for most of the animals, they are highly nutritious, improving the general health and immunity of the animals.

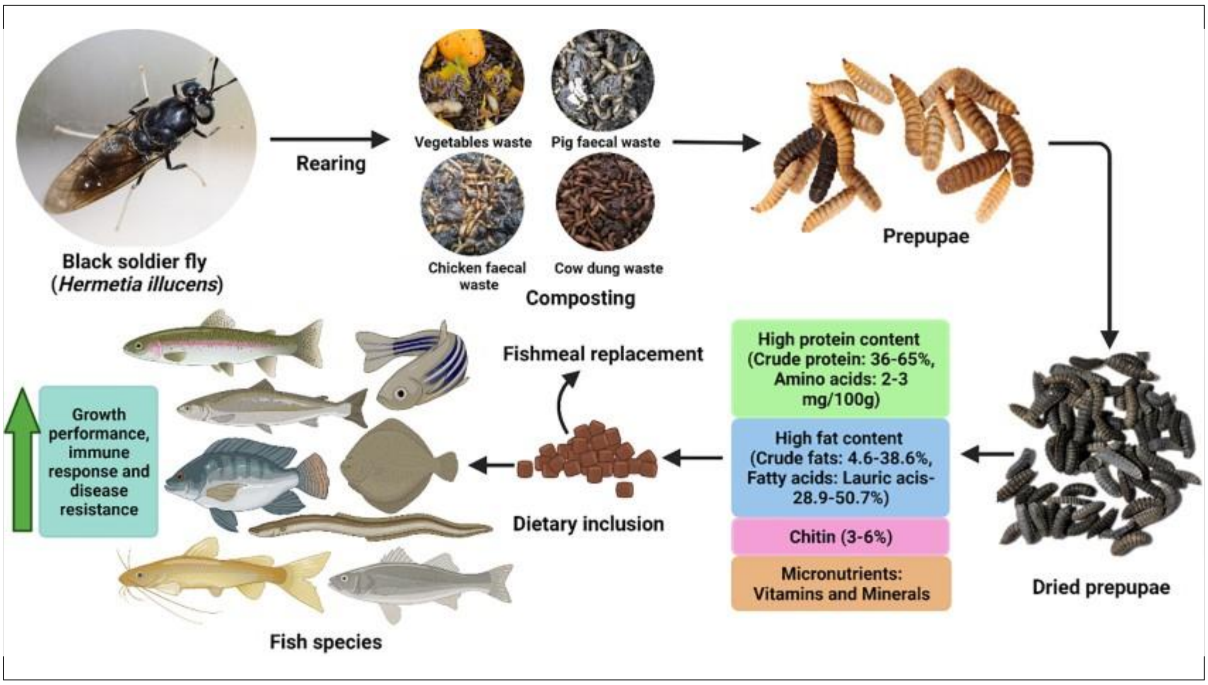
How Black Soldier Fly help a livestock farmer?

For poultry and aquaculture farmers BSF larvae is a great addition to their animal feed. BSF larvae can be given as a supplement for the animals to take care of overall health of the animals, thanks to the wide spectrum of amino and fatty acids they contain. Being a pure natural source of food, it 100% safe for your animals. Quantity requirement varies for each animal and have to be tailored by the farmer according to other feed the animals have. BSF larvae can be given to enhance the growth of the animals, thanks to the high protein and good fat content of these larvae. Animal growth have been reported to be double, that is the table size of the livestock is reached in half the time period.

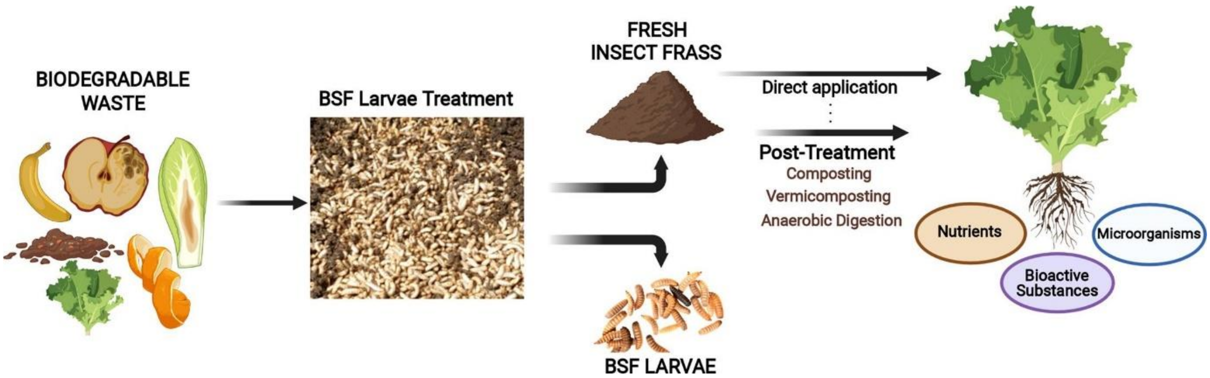




Black solider fly (BSF)
Black solider fly larvae (BSFL)
Organic waste degradation using BSFL
BSF prepupae
Dried BSF prepupae
Acid catalyst (H2SO4)
Estrification
Trans-estrification
Alkaline catalyst (NaOH or KOH)
Biodiesel
Fat extraction from BSF prepupae
Chemical extraction



Black soldier fly (Hermetia illucens)
Rearing
Vegetables waste
Pig faecal waste
Chicken faecal waste
Cow dung waste
Composting
Prepupae
Fishmeal replacement
High protein content (Crude protein: 36-65%, Amino acids: 2-3 mg/100g)
High fat content (Crude fats: 4.6-38.6%, Fatty acids: Lauric acis-28.9-50.7%)
Chitin (3-6%)
Micronutrients: Vitamins and Minerals
Growth performance, immune response and disease resistance
Dietary inclusion
Dried prepupae
Fish species



BIODEGRADABLE WASTE
BSF Larvae Treatment
FRESH INSECT FRASS
Direct application
Post-Treatment
Composting
Vermicomposting
Anaerobic Digestion
Nutrients
Microorganisms
Bioactive Substances
BSF LARVAE

Photos of the Visit (Set-up of BSF Biopod unit)

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AWARNESS POSTERS

5TH DECEMBER 2022

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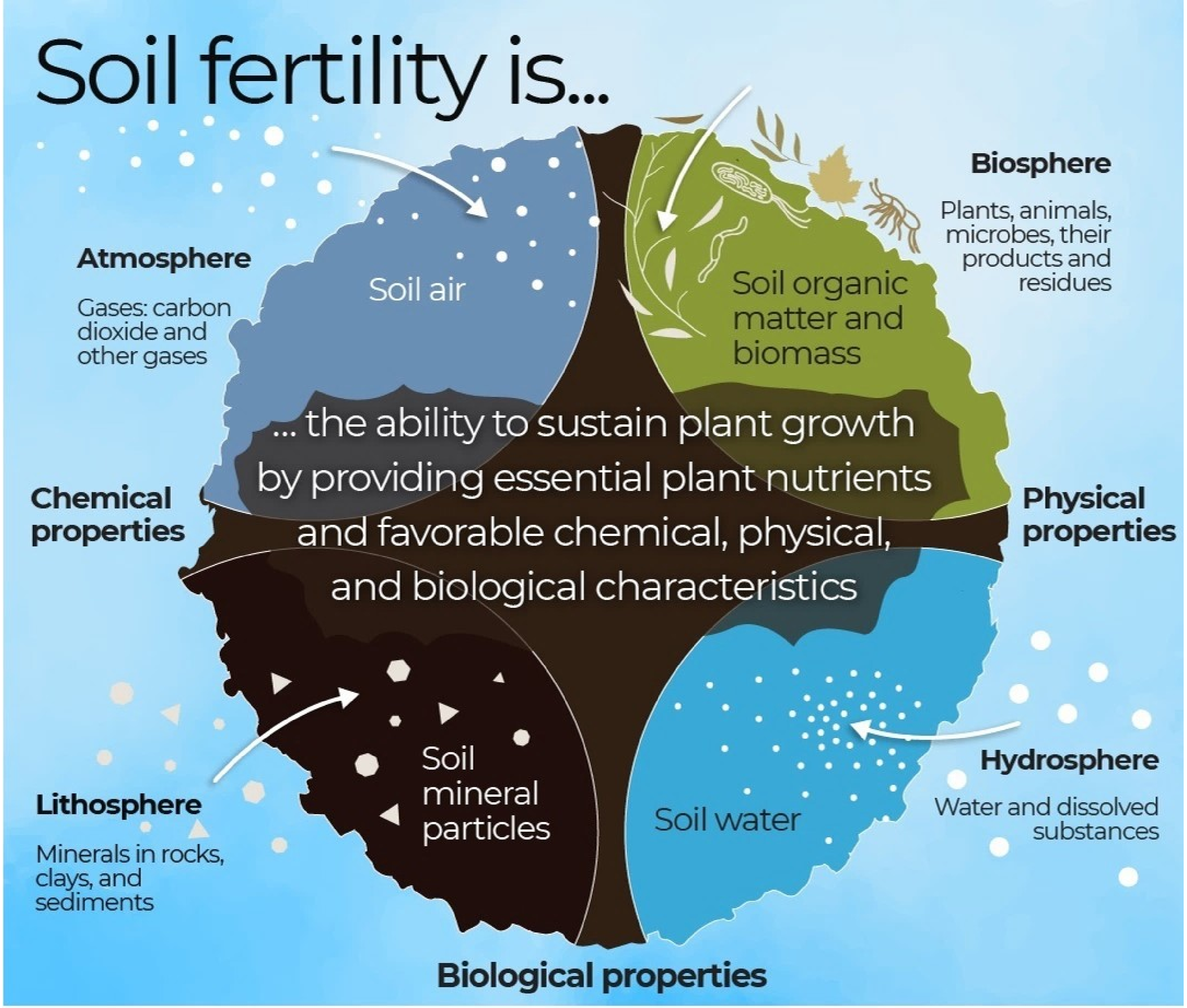

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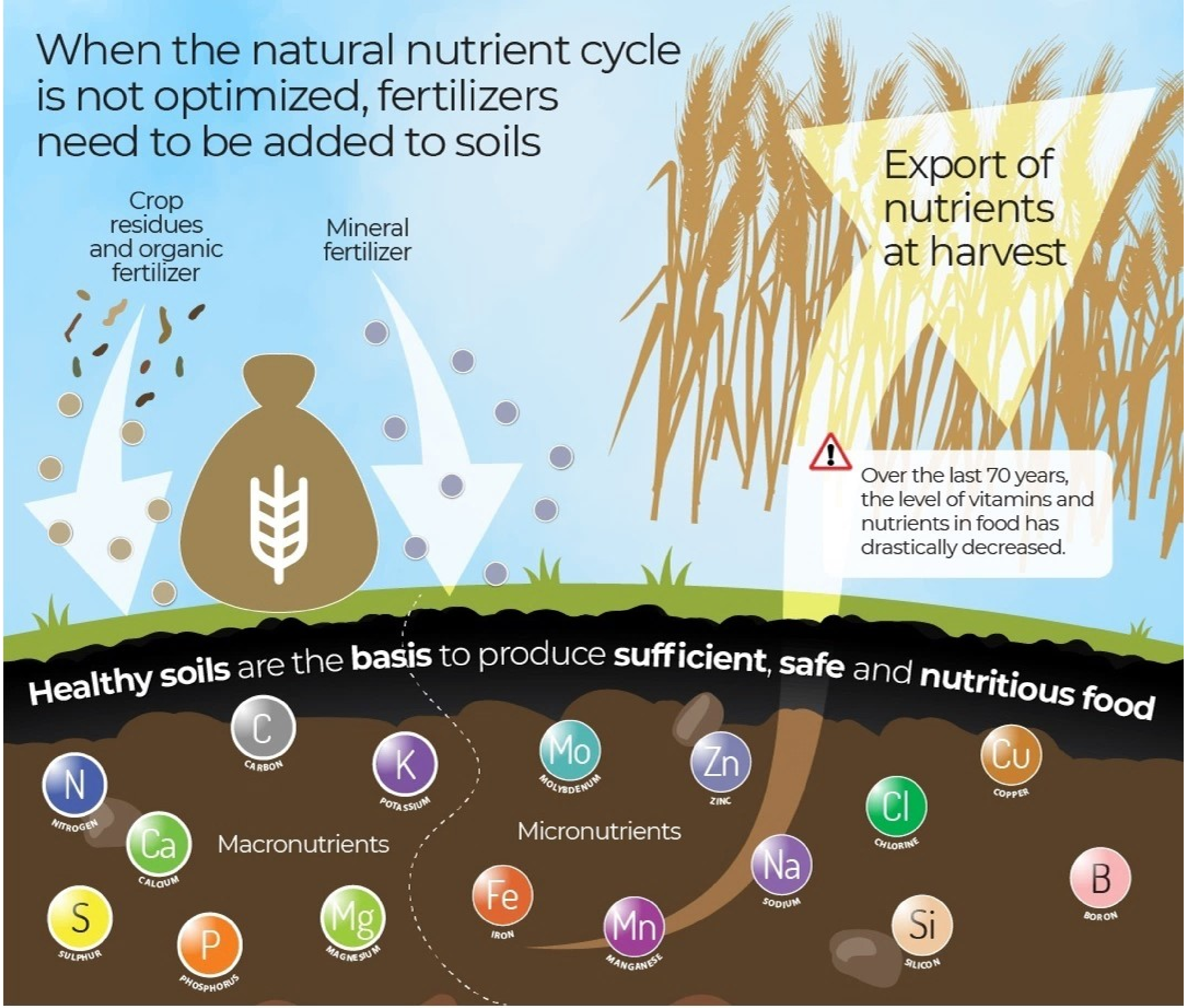

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On earth
there are 92 naturally occurring chemical elements
18 are essential to plants and 15 of them are supplied by soils
Macronutrients: needed in large amounts (>50 mg/kg)
Micronutrients: needed in small amounts (<1 mg/kg)
C CARBON
Ca CALCIUM
K POTASSIUM
N NITROGEN
S SULPHUR
P PHOSPHORUS
Mg MAGNESIUM
Mo MOLYBDENUM
Cl CHLORINE
Si SILICON
Cu COPPER
Na SODIUM
B BORON
Zn ZINC
Fe IRON
Mn MANGANESE
SOILS: WHERE FOOD BEGINS
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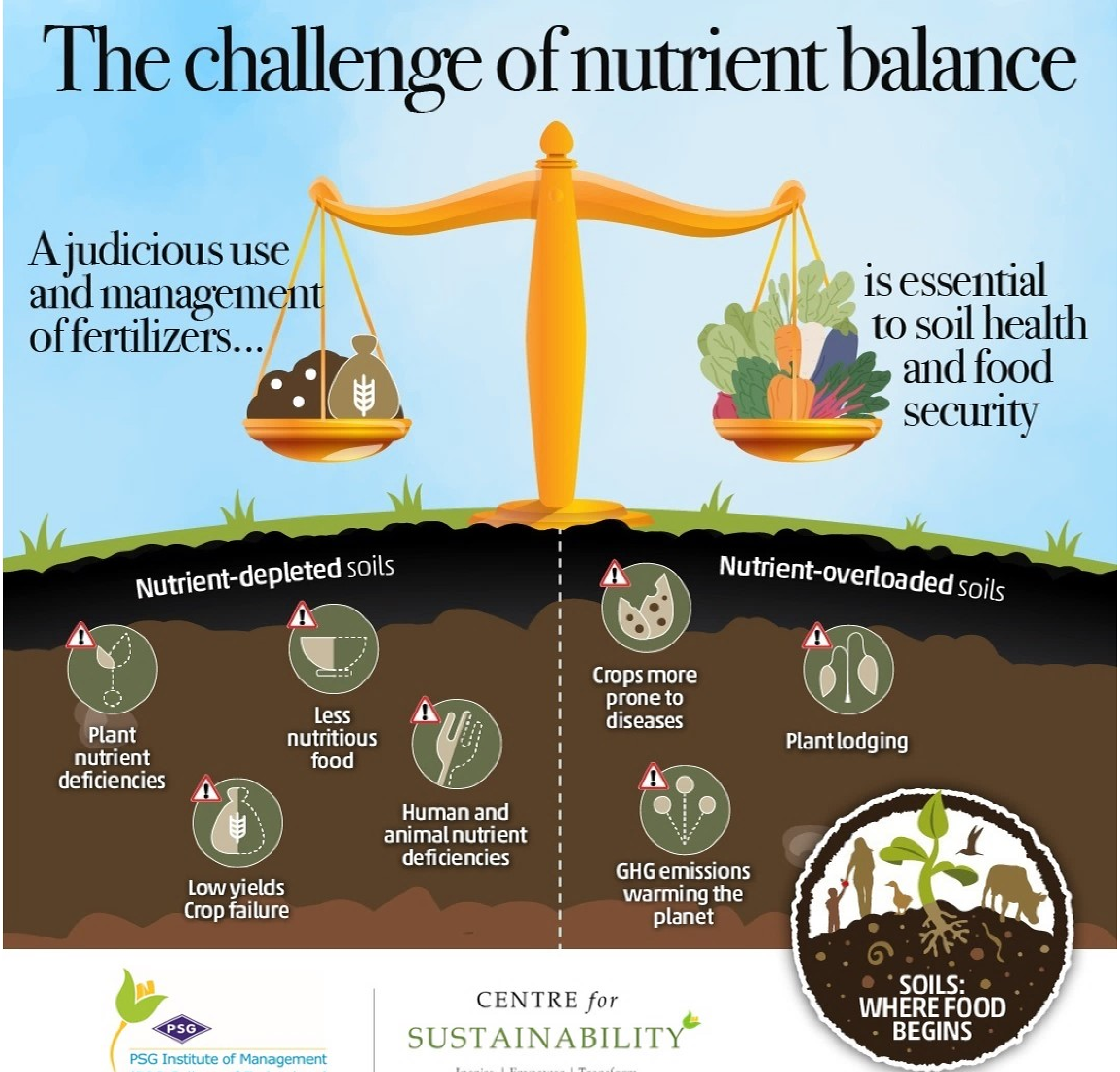

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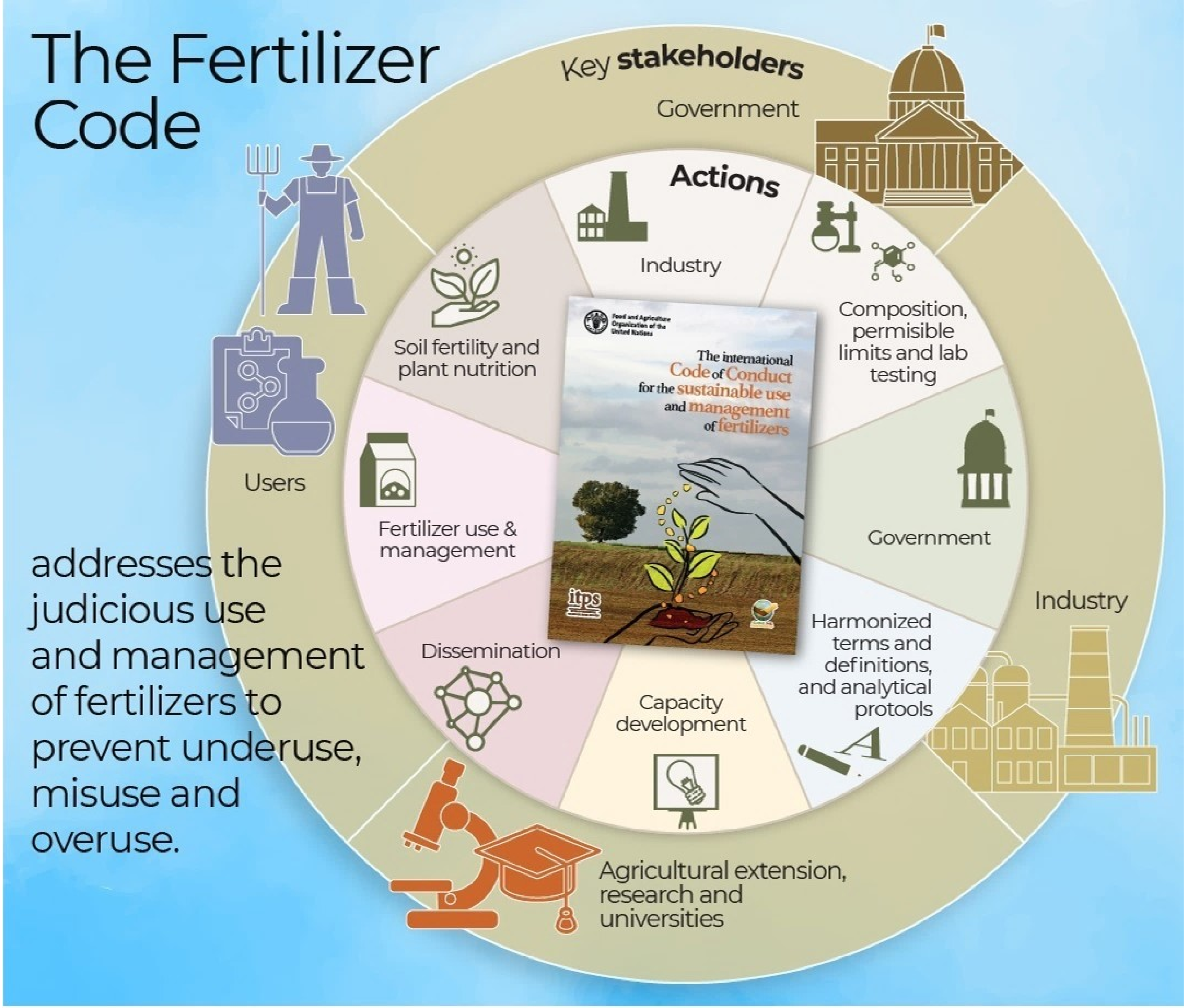

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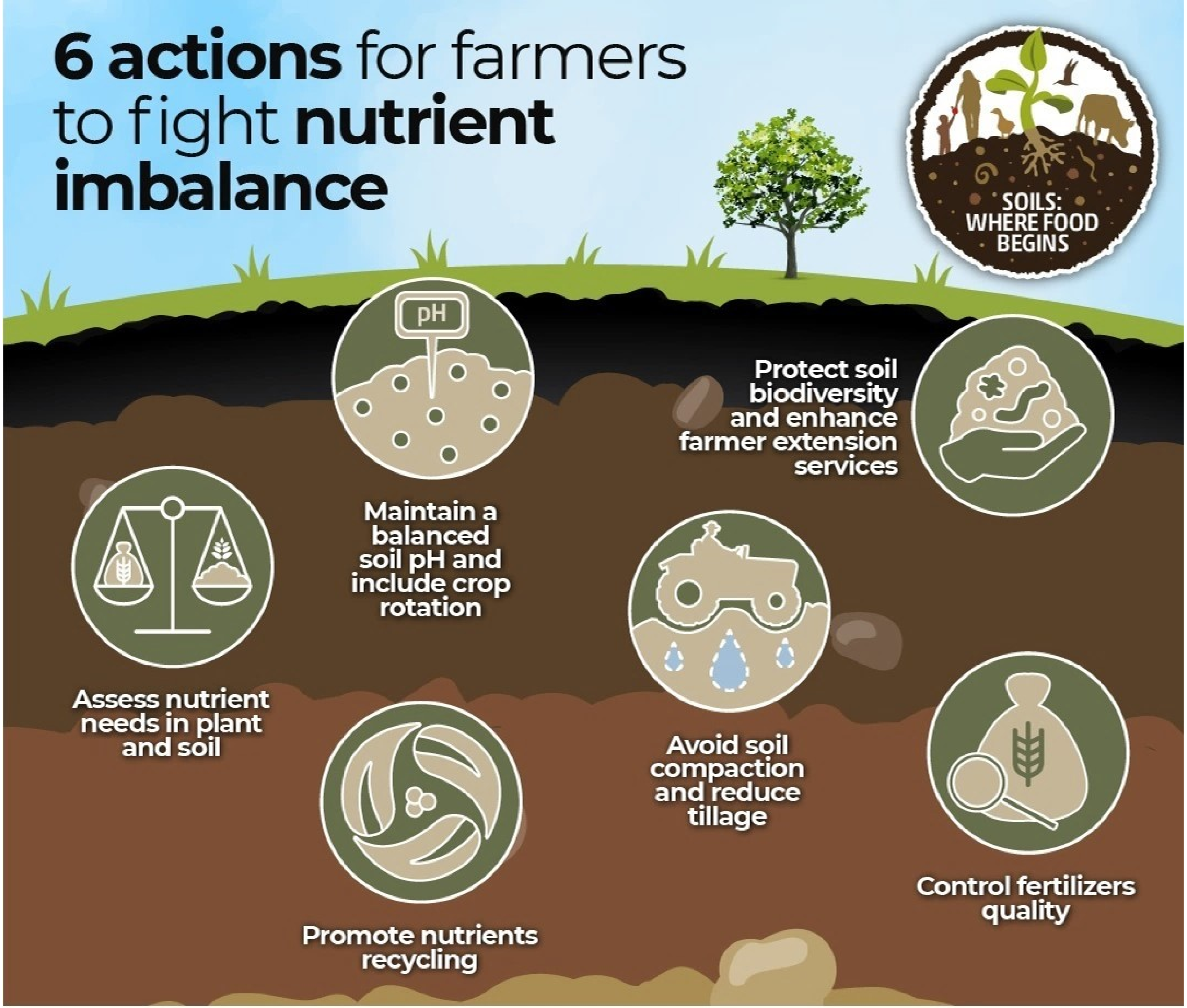

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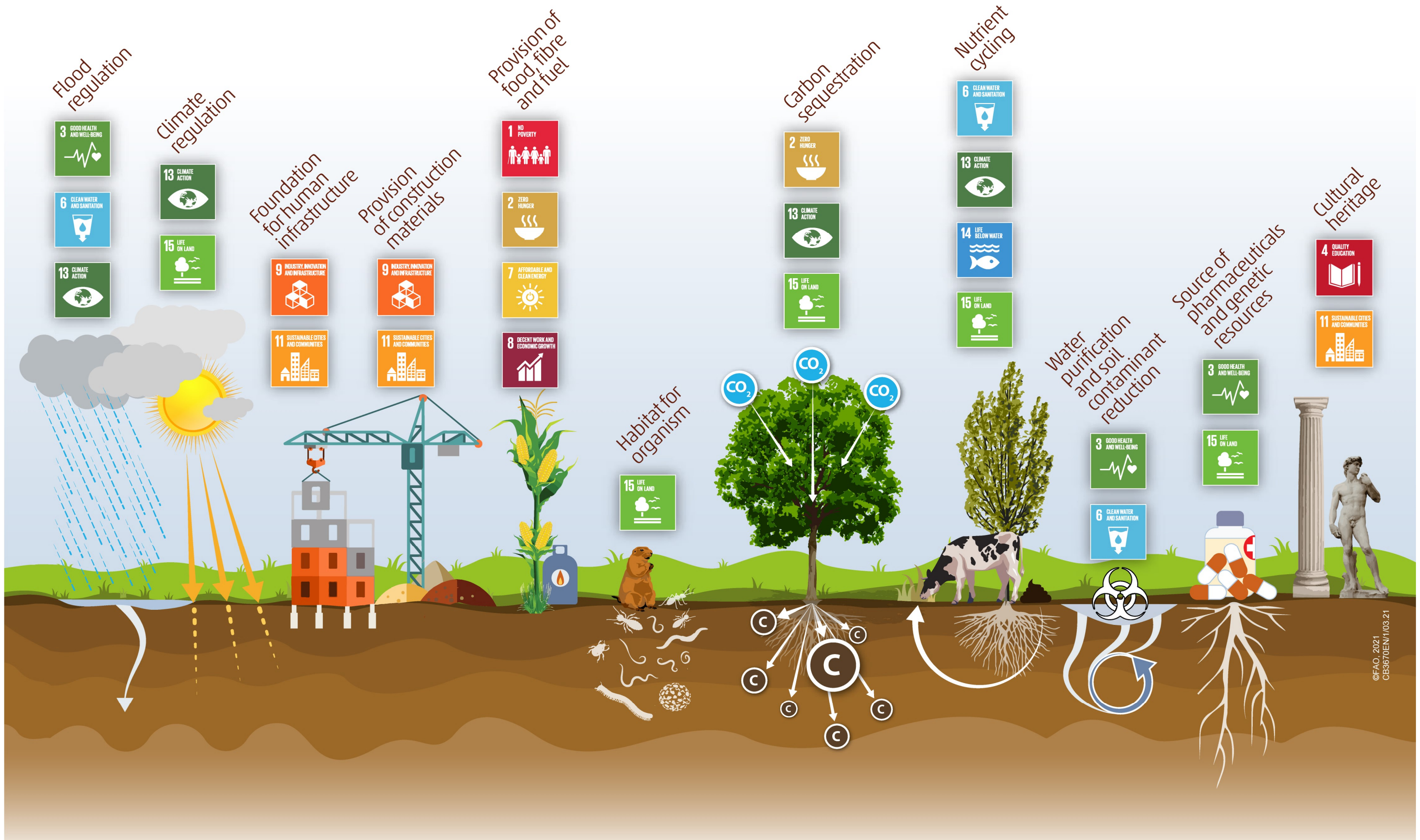
Healthy soils
a prerequisite to achieve the SDGs



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RESEARCH INSIGHTS

(STUDENT RESEARCH PAPERS)

A COMPREHENSIVE STUDY ON THE USAGE OF BLACK SOLDIER FLY IN TRANSFORMATION OF ORGANIC WASTE: ANALYSING THE PARAMETERS OF FRASS AND LARVAE

AISHWARYA, AJITH, ARUNKUMAR, HARIHARAN, PREETHA, PRISSILLA, RAKESH, SOUNDARYA, SWATHI

HIGHLIGHTS

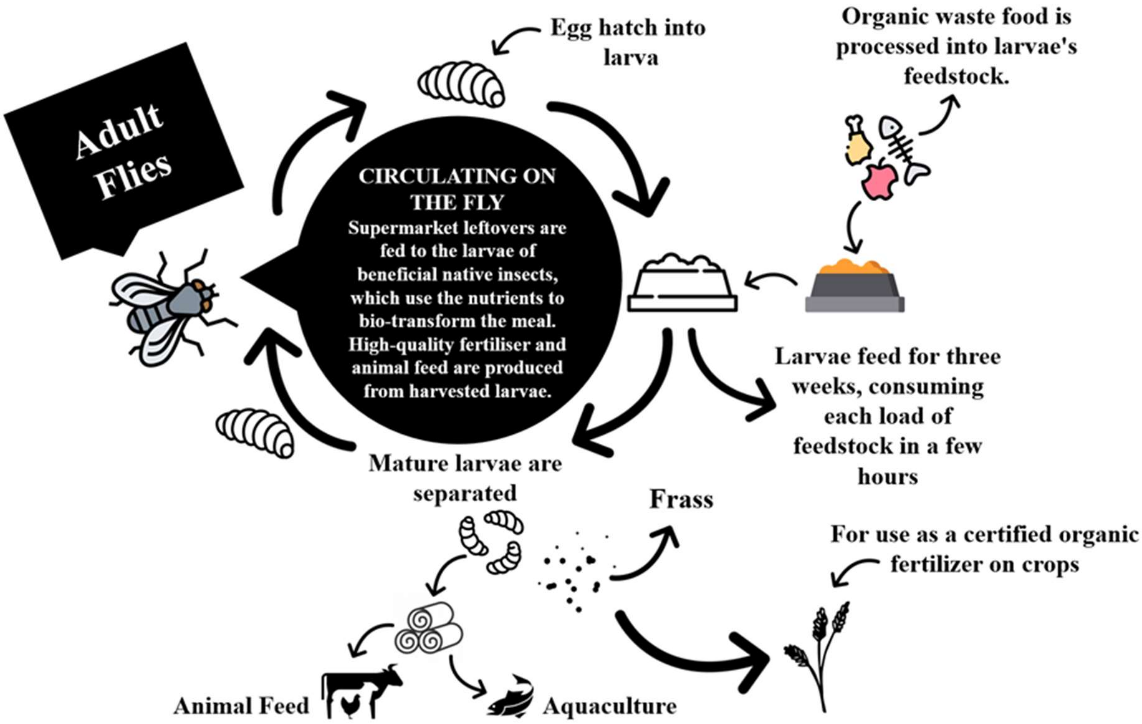
- **BSFL has the ability to turn organic material into fertilizer, biodiesel, and animal feed.**
- **BSF larvae is a good source of protein and lipid.**
- **Larvae are offered to broilers as an innovative enriching method.**

ABSTRACT

Hermetia illucens, a black soldier fly, has the ability to efficiently turn a variety of organic materials, including food waste and manure, into insect biomass. Its larvae have 29% fat and 42% crude protein, yet they have more saturated fats than most insects. They have a distinct advantage over other insects because they can convert organic waste into fertilizer or valuable resource, which lowers costs and pollution while adding value and closing nutrient loops. Black soldier fly frass develops as a considerable by-product in artificial rearing settings and has the ability to supplement or replace synthetic fertilizers. In a laboratory setting, fundamental parameters like pH, EC, total organic carbon, micronutrient content, NPK, lipid content, and amino acid content were tested on the frass and larvae. Several concentrations of frass (1:2:3:4:5) were combined with soil to test the germination of fenugreek and mustard seeds. The outcomes of vermicomposting and slurry from anaerobic digestion were compared.

Keywords: Black soldier fly larvae, Frass, Germination, Parameters, Organic waste.

GRAPHICAL REPRESENTATION



1. INTRODUCTION

A species of fly native to North America is the black soldier fly (Hermetia illucens), but because it is used in many different industries, it is now widespread around the world. The adult black soldier fly is a distinctive black color with a metallic sheen and measures between 16 and 20 millimeters in length. The larvae of the black soldier fly, however, are more well-known because of their versatility. The black soldier fly's larvae have a special capacity for rapidly and effectively decomposing and processing organic waste. In addition to being quite simple to raise and maintain, they are a well-liked option for waste management and sustainable farming methods.

Nitrogen, phosphorus, and other micronutrients are abundant in BSF frass' nutritional composition, making it a potentially beneficial fertilizer for farming. According to studies (Sánchez-Muros et al., 2014; Lalander et al., 2013), BSF frass can contain higher levels of nitrogen and phosphate than conventional fertilizers like compost or manure. Frass has the potential to provide environmental advantages by reducing greenhouse gas emissions from fertilizer manufacturing and the leaching of nutrients into waterways. BSF frass can also aid in the soil's ability to sequester carbon. Yet, due to its varied nutrient content and high moisture content, there may also be negative effects (Lalander et al., 2013).

In comparison to conventional waste management methods, the use of black soldier fly larvae has a number of advantages, these advantages include more effective waste reduction, the production of high-quality compost, less greenhouse gas emissions, lower costs, and less energy use. According to studies, BSF larvae can cut the amount of organic waste by 50–70% in just a few days (Diener et al., 2009; Lalander et al., 2013). It has been demonstrated that the compost contains more nitrogen, phosphate, and other micronutrients than conventional compost (Lalander et al., 2013). The infrastructure and energy requirements for BSF larvae are lower than those of conventional waste management systems (Q, Li et al., 2011).

Although there may be number of advantages in using BSF larvae for waste management, it is crucial to carefully assess and minimize any negative environmental effects that may result from this system. BSF larvae break down organic waste into nutrient-rich frass (excreta), which can be utilized as fertilizers. If not properly controlled, this could result in nutrient runoff and eutrophication of nearby water bodies. Examples of mitigating strategies include using frass at controlled application rates and avoiding application close to water sources (Siddiqui et al., 2022). Energy inputs, like as power for lighting and temperature control, are necessary for the generation of BSF larvae. Using renewable energy sources and increasing energy efficiency are examples of mitigation tactics. Methane and carbon dioxide are two more greenhouse gases emitted during the formation of BSF larvae. Enhancing the effectiveness of larvae production and lowering emissions from larvae processing and transportation are two mitigation options (Liu et al., 2008).

Several factors can affect the growth and development of black soldier fly (BSF) larvae, including temperature, moisture, substrate quality, and crowding. Optimizing these factors can help to increase the efficiency of using BSF larvae for waste management purposes. A substrate with a balanced ratio of protein, fat, and carbohydrates is ideal for BSF larvae growth, and the addition of prebiotics and probiotics can enhance larval development and reduce mortality (Lievens, S et al., 2021).

The use of BSF larvae for waste management was shown to be highly scalable and has the potential to cut the quantity of organic waste sent to landfills by up to 80%, according to a study published in the Journal of Cleaner Production. The study also emphasized the potential financial gains associated with increasing the production of BSF larvae, including the creation of high-value goods like protein and fat for animal feed. Scaling up this kind of technology could provide some difficulties and restrictions, though. There may be regulatory and logistical constraints to the use of BSF larvae in some regions or industries, the

ASSESSING THE EFFICACY OF VERMICOMPOSTING: PREPARATION, ANALYSIS, AND COMPARATIVE EVALUATION WITH OTHER COMPOSTING METHODS FOR ORGANIC WASTE MANAGEMENT

Aravind Muthiah K, Deeksha J, Dhanush M, Gopinath V, Hamsavardhan S, Lavanya T, Lekshmi SR, Nandha Kishore SV, Siva Atchara K

HIGHLIGHTS

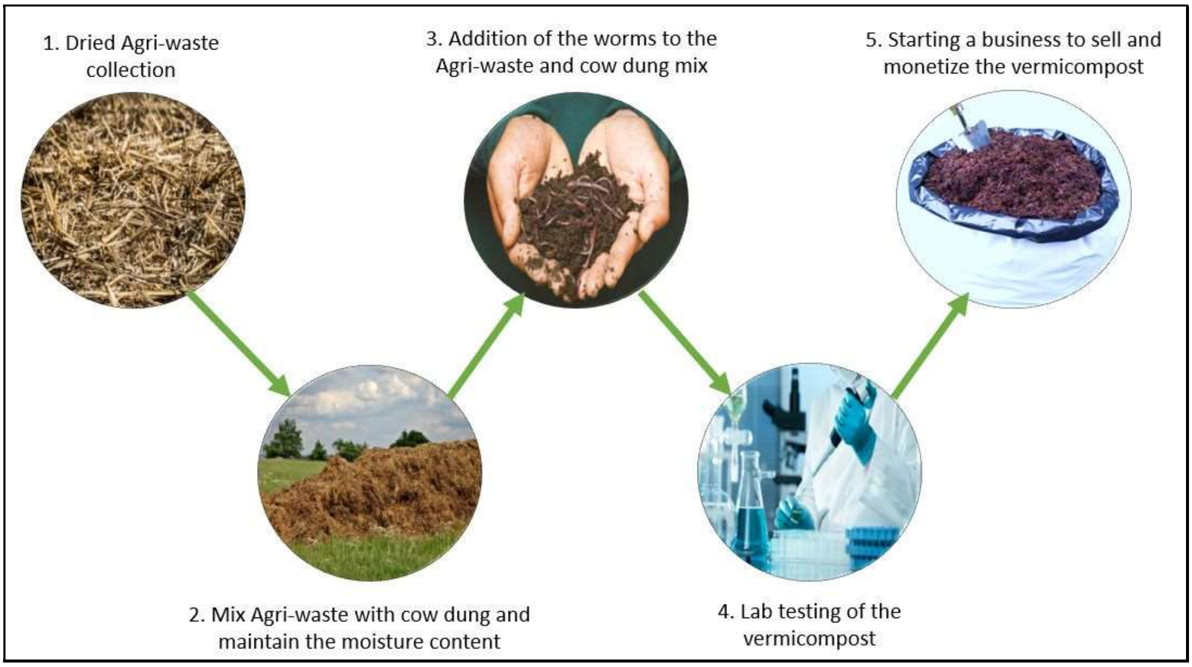
- Vermicomposting is an eco-friendly way to dispose of food scraps, yard waste, and other organic materials. It diverts waste from landfills and reduces greenhouse gas emissions.
- Red wiggler worms (*Eisenia fetida*) are the most commonly used worms for vermicomposting. They are efficient at breaking down organic material and produce a high-quality compost.
- Vermicompost is rich in nutrients and can be used as a soil amendment or fertiliser.
- It contains beneficial microorganisms that can help improve soil health and plant growth.

ABSTRACT

Composting and vermicomposting are two biological waste treatment processes that are typically recognised as a clean and sustainable way to manage organic waste. The study provides an overview of the Vermicompost process and benefits of vermiculture over other techniques that are carried out. The purpose of this review is to evaluate the potential of vermicomposting as methods of recovering nutrients from organic waste and reintroducing them into the ecosystem. The role of vermicomposting in waste management and soil improvement is vital as it reduces the amount of waste that ends up in landfills and produces a high-quality fertiliser that enhances soil health and plant growth reducing the production of greenhouse gas. The factors that influence the vermicomposting process, including temperature, moisture, and pH level, and provides guidelines on how to create and maintain an optimal environment for the worms to thrive. Overall, the study investigates the potential obstacles and limitations of vermicomposting and suggests solutions. The paper emphasises the many advantages and possibilities of vermicomposting as a sustainable and environmentally friendly waste management and soil enhancement approach.

Keywords: Vermicomposting, fertiliser, biological treatment process, soil health.

GRAPHICAL ABSTRACT



INTRODUCTION

A suitable ratio of "green" and "brown " organic elements is necessary for composting, or regulated decomposition. "Green" organic material includes lawn cuttings, food leftovers, and manure, which contain significant quantities of nitrogen. Dry leaves, wood fragments, and twigs are examples of "brown" organic elements because they are high in carbon but low in nitrogen. It takes time and research to find the ideal nutritional combination. It is a component of the science and craft of decomposition. It was found that vermicompost can be made from a variety of organic wastes, including kitchen refuse, cow manure, and a mixture of the two, agricultural wastes like straws, green stems, barks, leaves etc (Garg and Satya, 2006). Additionally, research showed that vermicomposting a combination of kitchen refuse and cow dung produced the greatest rate of waste decomposition and highest nutrient content in the finished compost. (Ahmad et al., 2021) study offers an overview of the positives of vermicomposting while preserving suitable health and hygienic environments for earthworms. The breakdown of organic refuse and creation of high-quality compost both depend heavily on earthworms. Maintaining ideal temperatures and moisture levels, offering a suitable substrate and food supply, preventing exposure to toxins and pathogens, and other variables play a role in the health of earthworms (Ana et al, 2021). In order to prevent illnesses and infections in earthworms, this research also emphasises the significance of good hygiene and sanitation practices. Regularly cleaning the vermicomposting bin, getting rid of refuse and excess moisture, and handling and storing the compost properly all contribute to keeping the worms' habitats healthy.

Vermicomposting is a biotechnological method that composts a wide variety of organic waste by including certain earthworm species that improve waste conversion into a very valuable high-quality end product known as vermicompost Vermicomposting involves bio-oxidative processes and the stabilisation of organic material; however, in vermicomposting, this includes interactions between earthworms and microbes. Microorganisms have a part in the biochemical degradation of organic waste by producing enzymes, whereas earthworms contribute to a bigger microbial population by fragmentation and absorption of fresh organic material. Earthworms interact with other species in the soil and can have an impact on diverse microflora and microfauna groups. (Gupta et al. 2019) discusses several factors that can affect the rate and quality of compost produced in vermicomposting. The content and quality of the feedstock (depending upon the nutrient content) can have a major influence on the reproduction rate and quality of compost production. For ideal vermicomposting, the optimal moisture content of the feedstock should be around 70-80%. The activity and reproduction of earthworms are influenced by temperature. 20-30°C is the ideal temperature range for vermicomposting with an optimal pH range of 6.5-8. The composting container should have adequate ventilation to ensure an appropriate supply of oxygen. Heavy metals and pesticides can build in vermicompost and degrade its quality. It is critical to prevent utilising polluted feedstock.

pH, electrical conductivity, moisture content, organic carbon content, and nutritional content are among the vermicompost's quality indicators. Vermicompost should have a pH of 6.5 to 7.5. This is because the supply of nutrients to plants can be impacted by pH, which is among the most crucial parameters. Additionally, moisture level should be between 50% and 60%, and electrical conductivity should be less than 2.5 mS/cm. A vermicompost's stability and nutrient composition are also indicated by the material's high organic carbon content. the significance of vermicompost's nutrient content, especially its nitrogen, phosphorus, and potassium contents, which are crucial to plant development. which has a minimum nitrogen content of 2%, a minimum phosphorus content of 1%, and a minimum potassium content of 1.5%. Now, we shall discuss the impact of vermicomposting on greenhouse gas emissions (Panda et al., 2022). Vermicomposting has the potential to reduce greenhouse gas emissions by diverting organic waste from landfills, reducing methane emissions, and producing a soil amendment that can reduce the need for synthetic fertilisers and also reduces carbon dioxide,

TOWARDS SUSTAINABLE FERTILIZER PRODUCTION: ANALYZING KEY PARAMETERS AND INNOVATIVE APPROACHES FOR SLURRY IMPROVEMENT IN ANAEROBIC DIGESTION OF FOOD WASTE

Abarnavahani, Akhilesh, Deepthi, Jeevika, Jeronia, Kaviarasan, Kaviya, Prabaharan, Sanjay

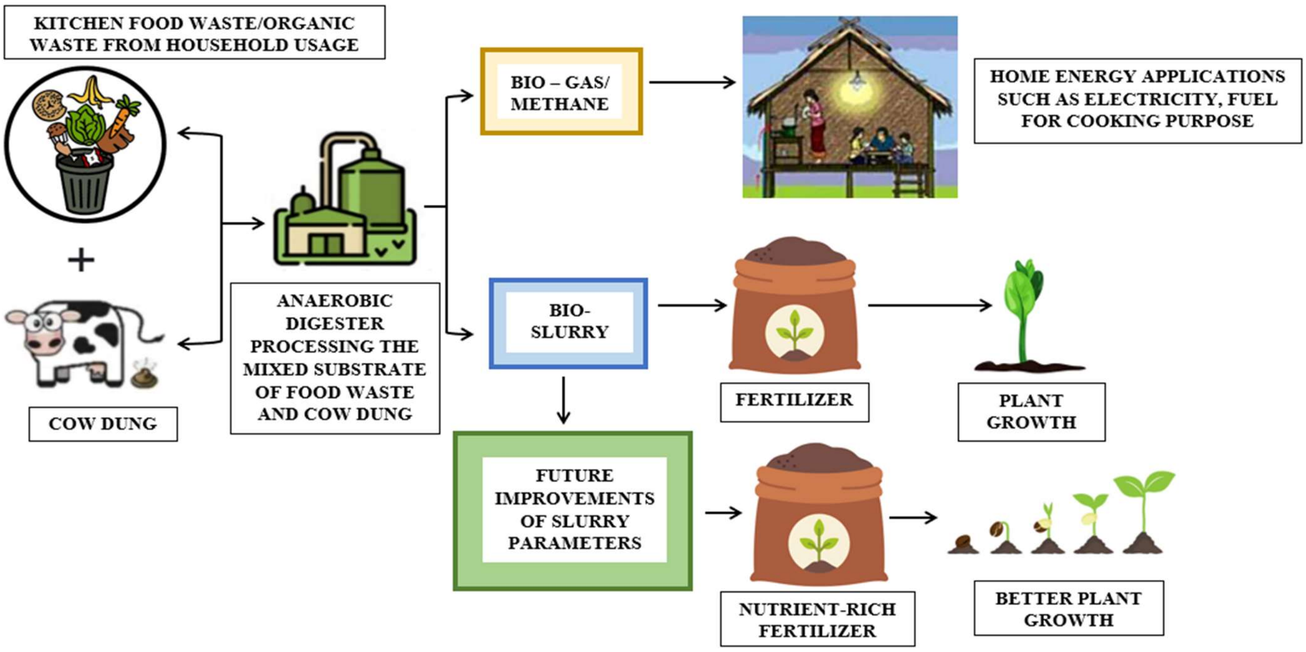
HIGHLIGHTS

- Anaerobic digestion of food waste produces biogas, which can be used as a renewable energy source.
- Reduces the potential for odors associated with food waste by breaking down the organic matter.
- Helps to reduce greenhouse gas emissions by diverting organic waste from landfills.
- The slurry (digestate) produced is a valuable fertilizer, used to improve soil quality and crop yields.
- Creates a sustainable circular economy by converting food waste into energy and fertilizer, thereby reducing waste and creating value from waste.

ABSTRACT

The treatment of food waste through anaerobic digestion has become increasingly popular in recent years as it provides an effective way to convert organic waste into renewable energy and nutrient-rich fertilizer. In this study, we investigate the process of anaerobic digestion from food waste, analyzing the parameters of the obtained slurry and improvising methods for fertilizer usage. We describe the anaerobic digestion process using a single digester where food waste mixed with cow dung is taken and the biogas and slurry is obtained. Analytical methods such as pH, moisture, and electrical conductivity were used to measure the slurry parameters. The slurry parameters were compared with vermicompost and black soldier fly (BSF) compost, and the germination test was conducted on the fertilizers to assess their effectiveness. Our results indicate that the anaerobic digestion process was successful in generating biogas from food waste. The methane concentration in the biogas ranged from 50% to 65%. The slurry parameters such as pH, moisture, and electrical conductivity were within the desired range for fertilizer usage. The germination test showed that the slurry fertilizer was effective in promoting plant growth, similar to vermicompost and BSF compost. Anaerobic digestion from food waste is a promising method for waste management and renewable energy generation. The obtained slurry is an effective fertilizer that can be used to promote plant growth. Our study suggests that slurry fertilizer can be a viable alternative to commercial fertilizers and can help reduce the environmental impact of food waste.

GRAPHICAL ABSTRACT



KEYWORDS

Anaerobic digestion, food waste, slurry, fertilizer, renewable energy

1. INTRODUCTION

A biogas plant is a facility that uses organic waste to generate biogas via anaerobic digestion. Anaerobic digestion is a biological process that breaks down organic matter in the absence of oxygen, resulting in the production of biogas as a byproduct. The biogas produced is primarily composed of methane, which can be used as a fuel for heating, cooking, and power generation. The collection and pre-treatment of organic waste is the first step in the biogas production process. The waste is then fed into an anaerobic digester, where it is broken down into biogas and digestate by a consortium of microorganisms. The digestate, which is high in nutrients, can be used as a soil amendment or animal feed. The majority of the biogas produced is methane, with the remainder being carbon dioxide, water vapour, and trace amounts of other gases.

The biogas is then purified to remove impurities like hydrogen sulphide, moisture, and carbon dioxide that can degrade the fuel's quality. Purified biogas can then be used for a variety of purposes, including generating electricity, heating, and transportation fuel.

1.1 FEEDSTOCKS

A biogas plant typically uses a variety of feedstocks, including agricultural waste, food waste, animal manure, and sewage sludge.Weiland (2010) explains that biogas plants typically use a variety of feedstocks, including agricultural waste, food waste, animal manure, and sewage sludge. Agricultural waste can include crop residues, such as corn stover and wheat straw, and livestock manure, such as cow and pig manure. Food waste can come from restaurants, supermarkets, and households, and can include food scraps and spoiled or expired food products. Animal manure can also be used as a feedstock, and is often readily available on farms. Sewage sludge is another feedstock that can be obtained from wastewater treatment plants.Barnert et al. (2014) discuss the processing of feedstocks in biogas plants, and explain that the feedstocks are typically first ground or shredded to increase their surface area and make them easier to digest by microorganisms. The feedstocks are then mixed with water and fed into an anaerobic digester, where microorganisms break down the organic matter and produce biogas. In the digester, microorganisms break down the feedstocks in an oxygen-free environment, producing biogas (primarily methane and carbon dioxide) and a nutrient-rich digestate.Deublein and Steinhauser (2011) provide an overview of the various methods used to process different types of feedstocks in biogas plants, processing of feedstocks can involve anaerobic digestion, co-digestion, and biowaste fermentation. Anaerobic digestion involves the use of microorganisms to break down organic matter in an oxygen-free environment and produce biogas. Co-digestion involves the use of multiple feedstocks in the same digester to improve biogas production. The biogas can then be used to generate electricity, heat, or transportation fuel, while the digestate can be used as a fertilizer for crops or as a byproduct of the process. The feedstocks chosen, their processing, and the mixing ratio can all have a significant impact on biogas yield and quality.

1.2 CAPACITY

According to Weiland (2010) the capacity and daily/weekly/monthly production of biogas from a biogas plant can vary depending on several factors, including plant size and type, feedstock type and quantity, and process conditions. The capacity of a biogas plant, according to the reviewed articles, can range from a few hundred cubic metres to several thousand cubic metres, with the largest plants used for commercial-scale energy production. The amount of biogas produced per day, week, or month can also differ significantly. Achinas et al. (2017), for example, reported that a biogas plant fed by food waste could produce 30-50 m3 of biogas per tonne of waste per day, whereas Divya et al. (2015) reported biogas production rates of 50-60 m3/ton of organic waste per day. However, the actual production rate is affected by a variety of factors such as feedstock type, temperature, retention time, and hydraulic loading rate. Overall, the capacity and production rate of a biogas plant are determined by the plant's specific design and operational parameters, which must be optimized in order to maximize biogas production while ensuring the plant's stable operation.