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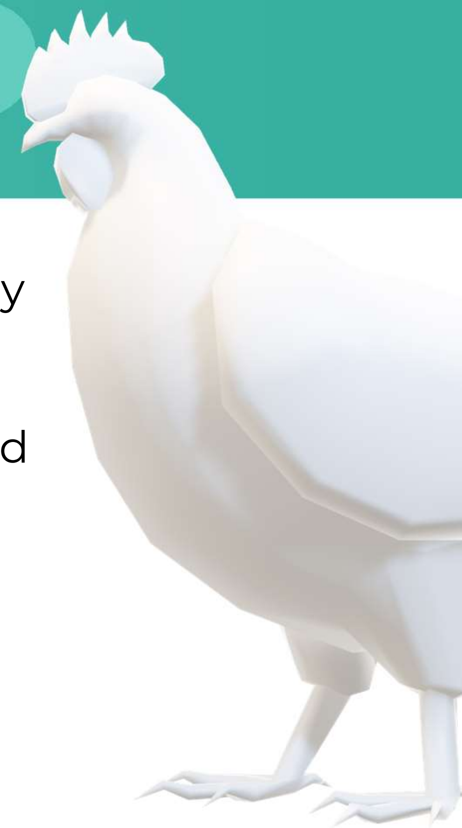
BIOGAS

Jagbir Singh Dhull

Layer Farming

1. India is the **3rd biggest egg producer** globally.
2. In 2022-23, the total egg production reached **122.78 billion.**
3. The per capita availability was **88 eggs/ annum**
4. The overall laying hen count is approximately **32.8 crores**.
5. Around 3 crore hens are country chicken, so total laying hen count is 35.8 crore

Associated problems with egg production



A farmer produce eggs which fulfil malnutrition and protein deficiency of our people.

But himself found in problem , complains from the society for flies and odor.

It is due to volatile solid which start decomposition.

Smell generate in this process and also very good media for flies.

If the waste manage properly, these complain can be rectified

Emission due to poultry

- Total green house emission from agriculture contributes 19.6%
- Livestock production contributes 63% means 12.3%
- Cattle contribute 2/3 of live stock 8.25%
- other then cattle sheep, goats,pigs & poultry 2.72%
- Total emission contribute by poultry is less then 1%
- 78% comes from litter & 22% farm management such as cooling,

Heating feed making ,transportation etc .

- Pollution from poultry is not significant but always on public radar expect

Impact poultry litter on the climate

- Methane, a potent greenhouse gas 22 times stronger than CO_2.
- Nitrous oxide has a global warming potential 310 times that of CO_2.
- These gases Co2, Methane and Nitrous oxide reach to environment when litter decomposed in open.
- Anaerobic digestion in biogas plants reduces Co2,methane and nitrous oxide emissions Also produces valuable biogas.

Gas yield from different biomasses

Biomass	Typical gas yields		Methane %	VS % of TS
	m^3 biogas/ kg DM	m^3 methane/ kg VS		
Pig slurry	0.37	0.32	65	75
Cattle slurry	0.24	0.21	65	75
Mink slurry	0.40	0.35	65	75
Deep bedding	0.24 – 0.37	0.21 – 0.32	65	75
Chicken manure	0.40	0.35	65	75
Flotation sludge from sewage treatment plant	0.41 – 0.86	0.36 – 0.75	70	80
Offal	0.49 – 0.57	0.40 – 0.46	65	80
Primary sludge	0.38	0.33	65	75
Biological sludge	0.11 – 0.23	0.10 – 0.20	65	75
Source-separated household waste	0.43	0.35	65	80
Maize	0.61	0.37	55	90
Grass	0.57	0.35	55	90

DM is the dry-matter weight of the biomass; VS is the organic biomass (volatile solids).

Biogas and methane yield

at a complete digestion of carbohydrate (cellulose), protein and fat.

Organic substance	Process	Gas yield, STP [1]		CH_4
		ml biogas/g	ml CH_4/g	%
Cellulose	$(C_6H_{10}O_5)n + nH_2O \rightarrow 3nCH_4 + 3nCO_2$	830	415	50.0
Protein	$2C_5H_7NO_2 + 8H_2O \rightarrow 5CH_4 + 3CO_2 + 2(NH_4)(HCO_3)$	793	504	63.6
Fat [2]	$C_{57}H_{104}O_6 + 28H_2O \rightarrow 40CH_4 + 17CO_2$	1,444	1,014	70.2

The composition of biomass, specifically the ratios of carbohydrates, proteins, and fats, influences the amount of methane it contains, affecting its calorific value. Biogas from animal manure has around 65% methane, while landfill gas can be as low as 50%. The biogas yield is well-defined: 1 kg of COD (organic matter consuming 1 kg O2) results in precisely 0.35 m3 of methane at normal conditions.

Solution

Addressing the root cause, waste management is the key solution.

1. Drying
2. Decomposition
3. Biogas

After testing all the solution we came to the conclusion that biogas emerges as the most effective choice.

What is BIOGAS

It is a renewable energy resource that is produced by the anaerobic digestion of organic waste.
This process produces a gaseous mixture of methane, carbon dioxide, H2S and other trace gases, which can be used as a fuel source for heating, cooking, or generating electricity.

Biogas Benefits

24/7 power generation throughout flock Cumulative Power Generation of 60- 100 kw/hr for 1lakh bird

The solid waste left over from the biogas production process can be used as a fertilizer, reducing the need for chemical fertilizers

Reduction in green house gasses emission

Control on flies, odour and improves hygiene at farm

95% reduction in Pollution produced by poultry litter

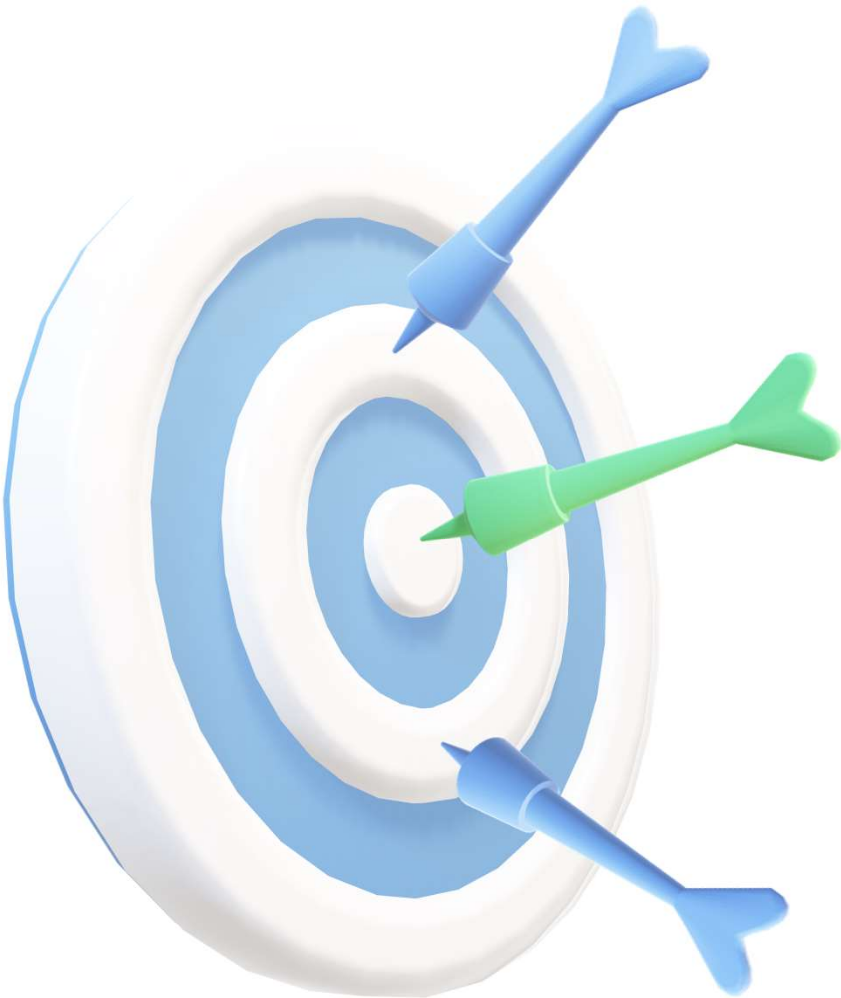
Cost effective investment considering return on investment.

Types of Biogas

Fixed-dome plants

Floating-drum plants

Balloon plants

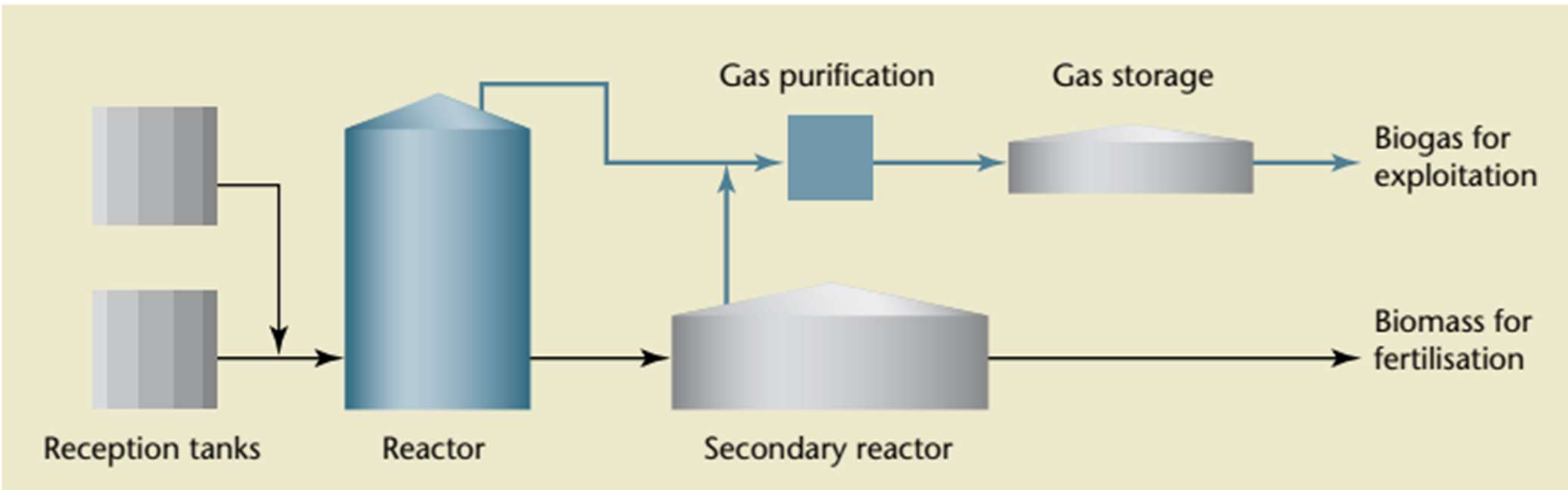


Factors in Gas Production

1. Technology
2. Volume of digestor
3. Quality of waste
4. Temperature
5. Agitation (Stirration

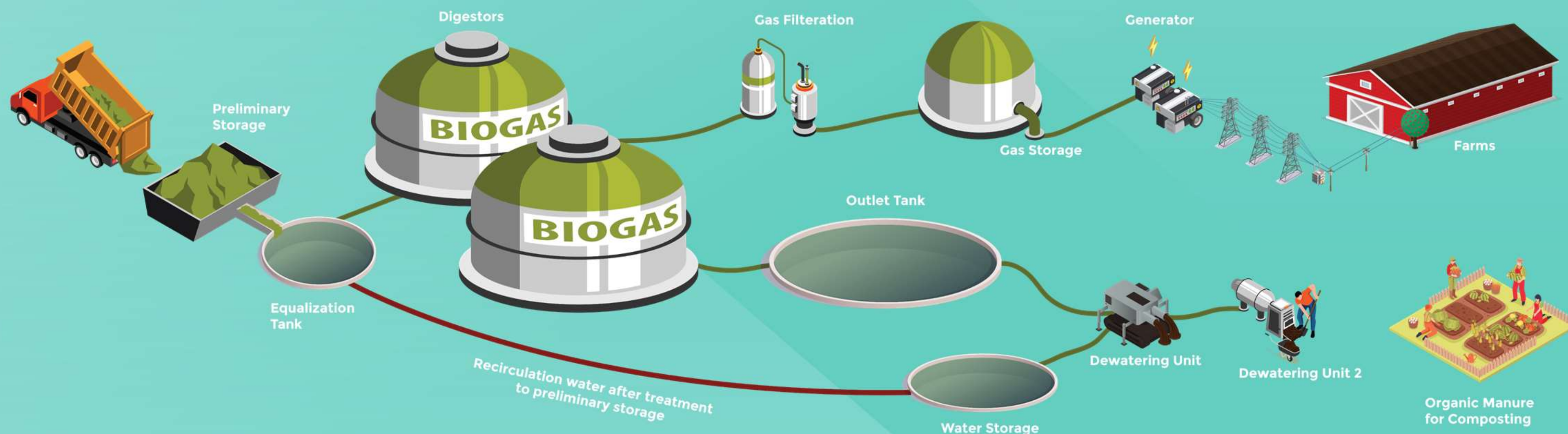
Biogas plant

The animal manure enters the system in the reception tanks. It is then pumped to the reactor where the digestion and biogas production take place



Biogas plant design

Schematic diagram of a communal biogas plant. The animal manure enters the system in the reception tanks. It is then pumped to the reactor where the digestion and biogas production take place



1.Preparation of biomass

•Poultry litter (raw material of biogas) should be as fresh as possible, Storage should be avoided

•Maintain the solid and water ratio (1:9)

•Cleaning and removal of inorganic matter like grit, feather

•Removal of fine silt through settling

•Keep it in Pre digestor tank with stirration and aeration

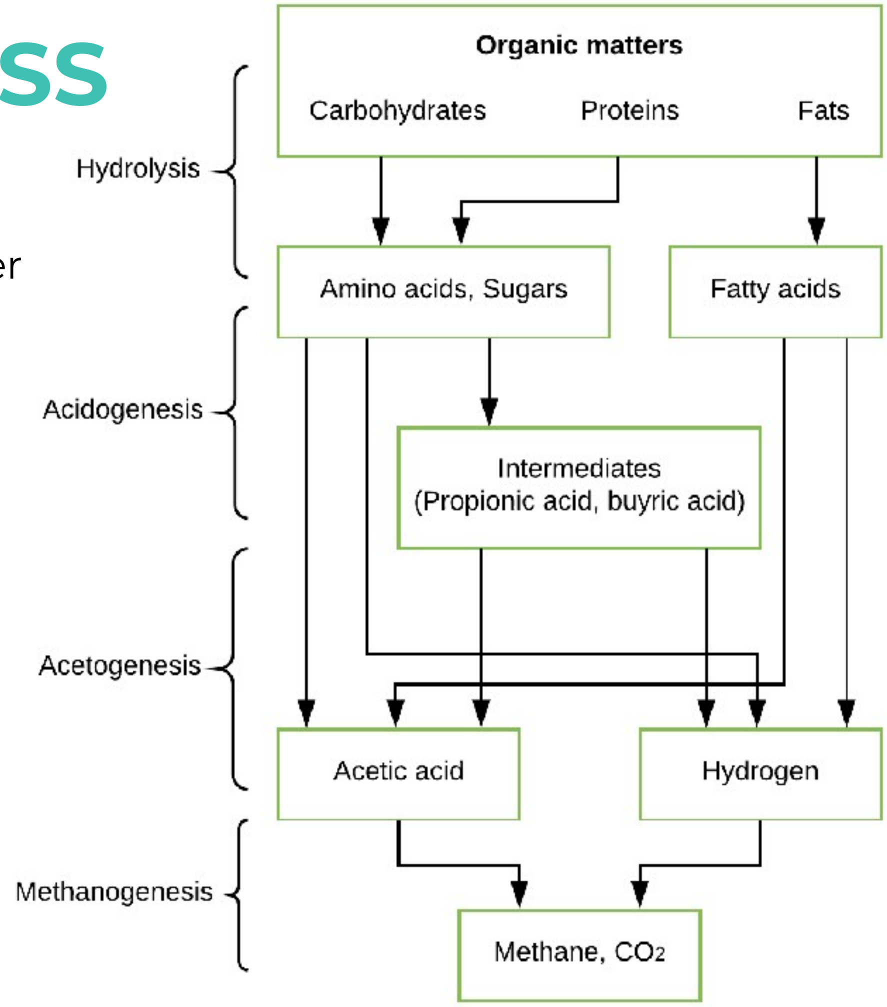
•After pre digestion, pump it into main digestors for fermentation.

THE BIOGAS PROCESS

The anaerobic decomposition of organic matter consists of three main phases:

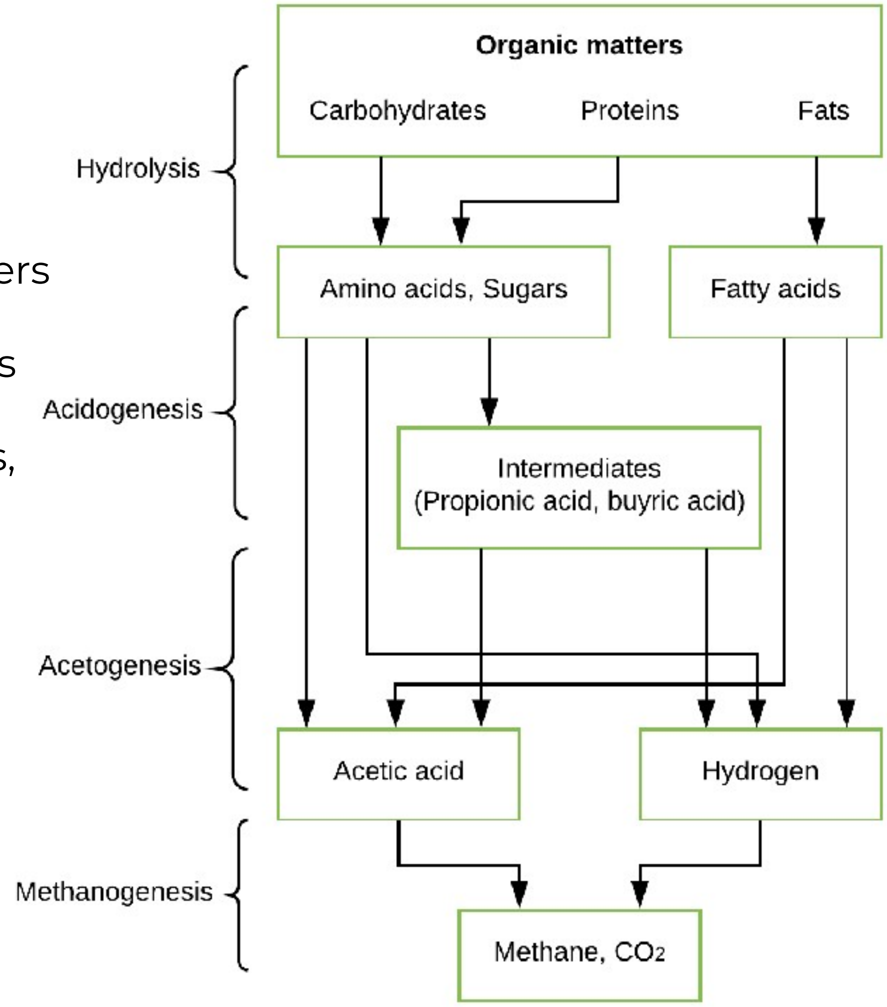
- A. Hydrolysis
- B. Acidogenesis, also called fermentation
- C. Acetogenesis
- D. Methanogenesis

where different groups of bacteria are each responsible for each step



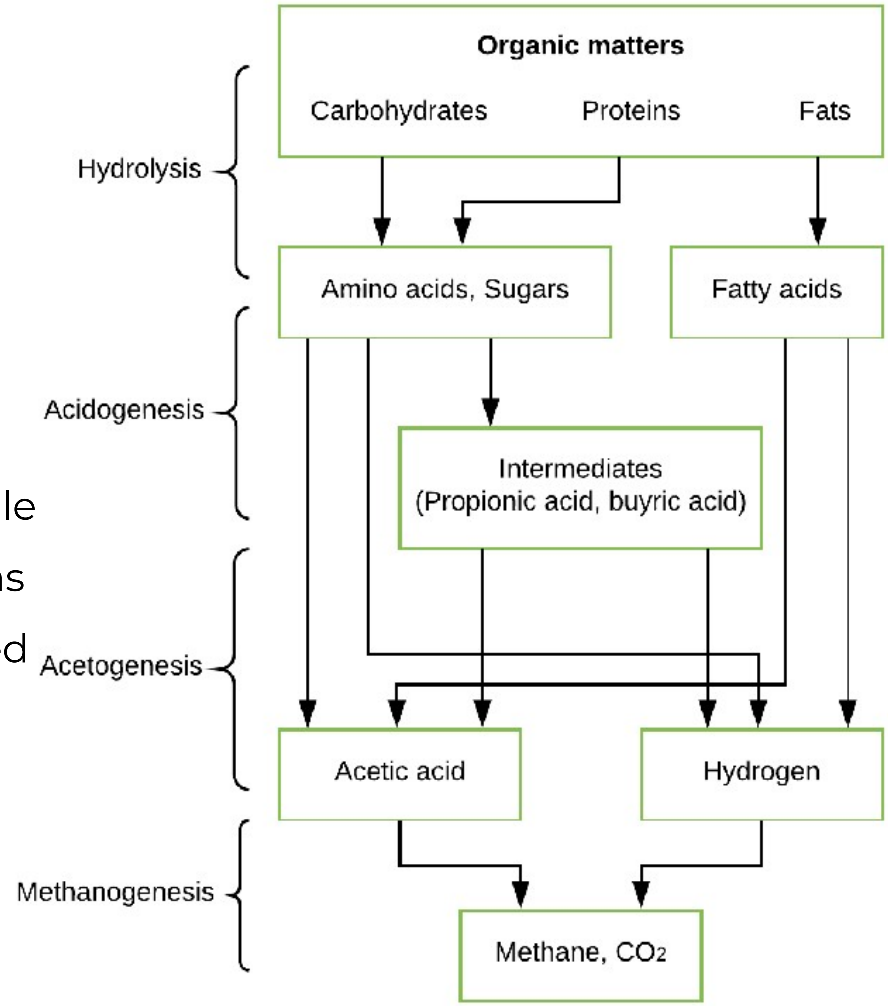
Hydrolysis

1. Biomass is made up of large organic polymers
2. Complex polymers hydrolysed to monomers
3. Complex organic molecules → simple sugars, amino acids, and fatty acids.
4. Done by hydrolytic fermentative bacteria



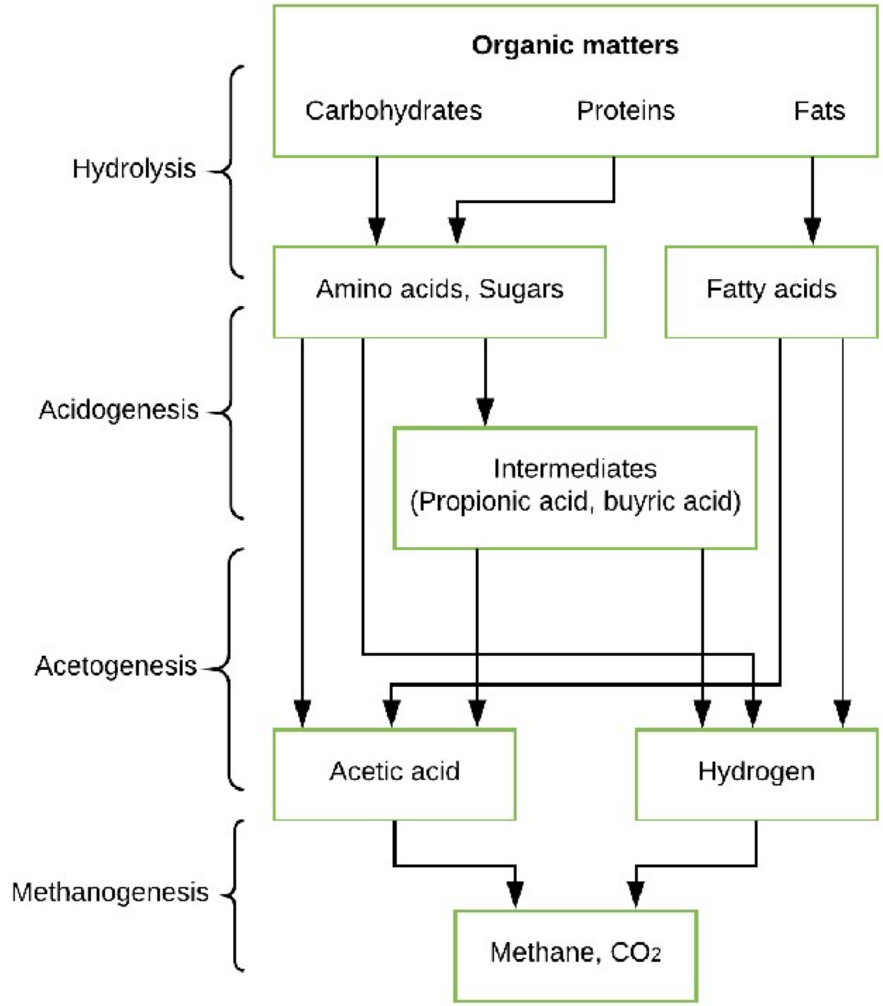
Acidogenesis

1. Results in further breakdown of the remaining components by acidogenic bacteria.
2. Ammonia, H2, CO2, H2S, shorter chain volatile fatty acids, carbonic acids, alcohols, as well as trace amounts of other byproducts produced
3. Intermediate consist of propionic acid, butyrate acid, Lactate and ethanol



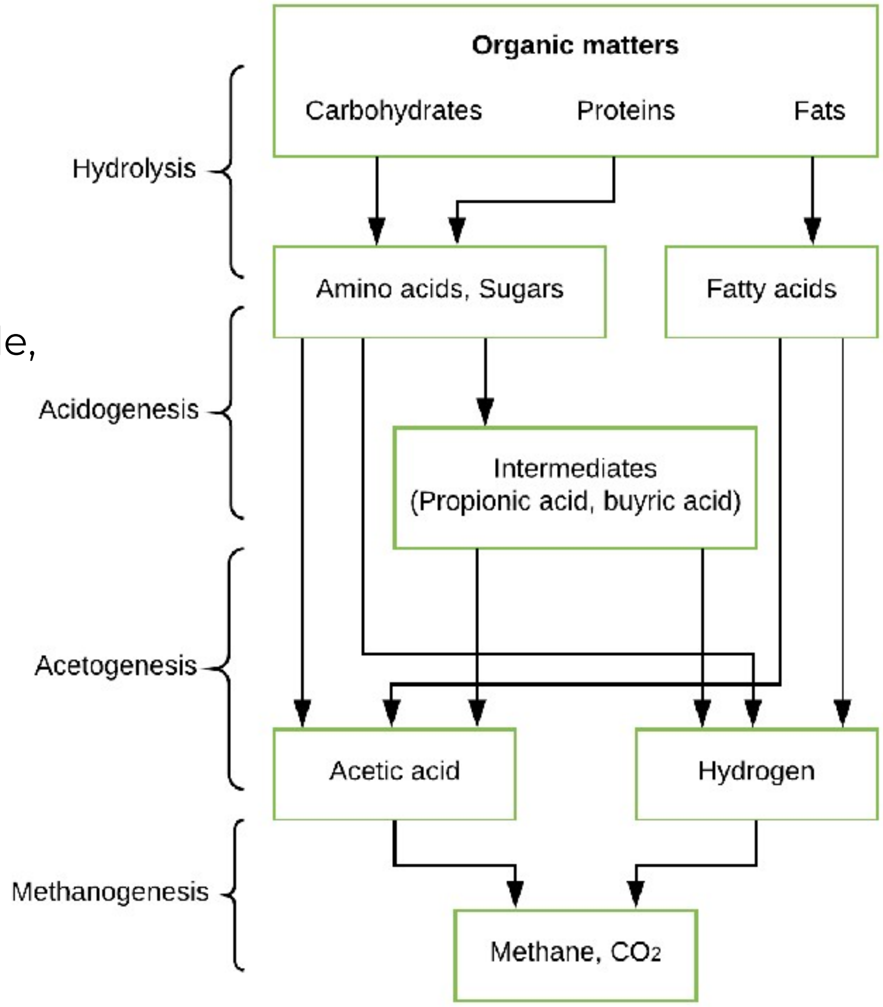
Acidogenesis

Simple molecules created through the acidogenesis phase further digested to acetic acid, carbon dioxide and hydrogen.

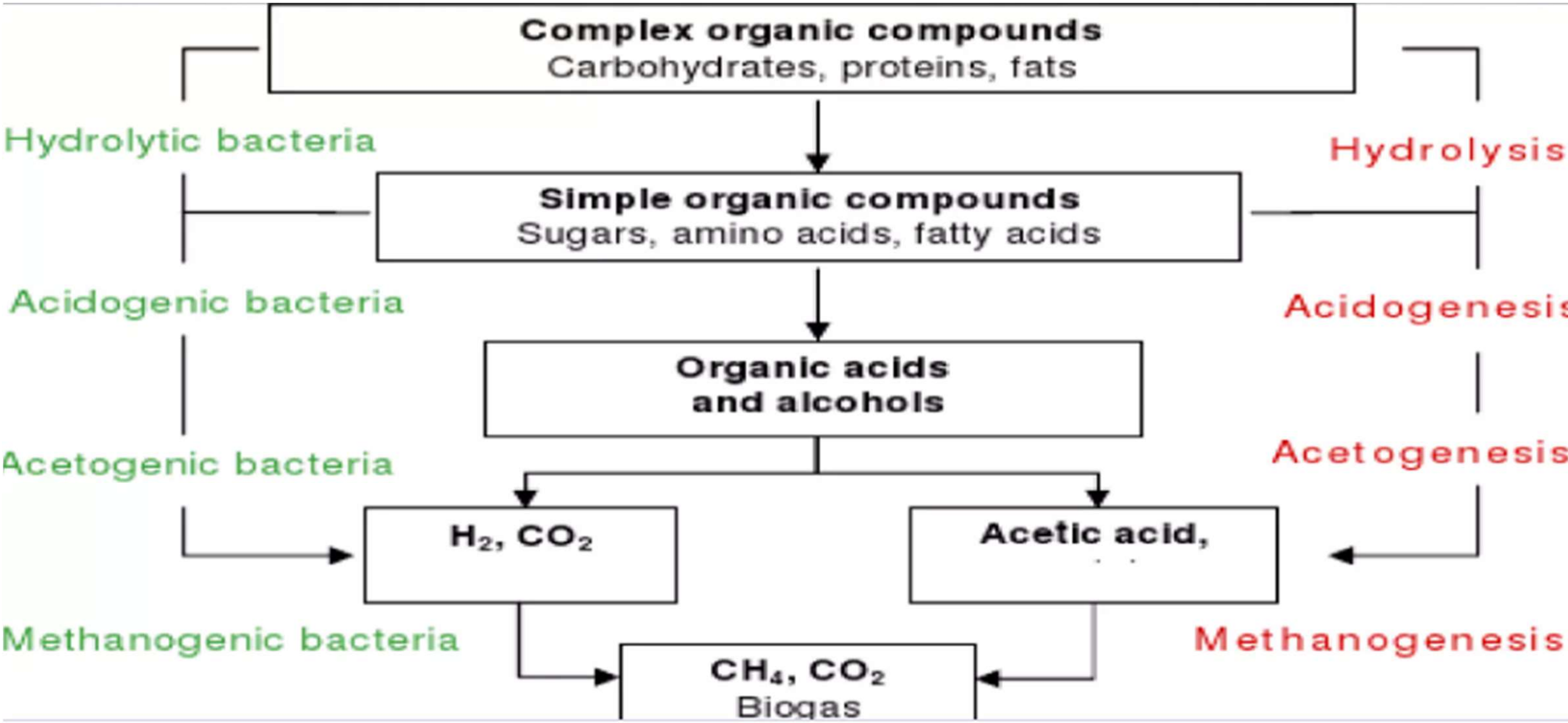


Methanogenesis

1. Intermediate products of the preceding stages converted to methane, carbon dioxide, and water.
2. These components make up the majority of the biogas emitted from the system.



Biogas process



PROCESS PARAMETERS FOR A BIOGAS PLANT

1. **Anaerobic Environment** To make biogas effectively, the environment must lack oxygen. Methanogens, crucial bacteria in this process, require an airtight reactor. Any oxygen present is swiftly consumed by aerobic or facultative anaerobic bacteria.

2. **Temperature Control** Biochemical processes speed up with higher temperatures. As a rule of thumb, the rate is doubled for every 10-degree rise in temperature. In this situation there are, however, several types or strains of bacteria involved:

    1. Psychrophiles **0 – 20°C**
    2. Mesophiles **15 – 45°C**
    3. Thermophiles **40 – 65°C**

    Maintaining temperature stability is critical, mesophilic bacteria have tolerating fluctuations is ±2°C and thermophilic have ±0.5°C.

PROCESS PARAMETERS FOR A BIOGAS PLANT

3. **Acidity (pH)** Methanogens, while using organic acids for food, can't thrive in acidic conditions. Optimal pH for effective biogas production is between 6.5 and 8, with 7.2 being preferred. Sometime pH value increases dure to higher concentration of ammonia. The system is stable when the reactor acidity is within this range due to its large buffer capacity.

4. **Substrate (Feedstock)** Almost all organic matter can be decomposed, enhancing decomposition methods. However, lignin remains indigestible.

5. **Dry matter content** is crucial for bacterial breakdown. In biogas plants, keep it at 8-10%

6. **Carbon/nitrogen (C/N)** ratio For methanogens to grow, they need nutrients like nitrogen, phosphorus, and potassium. The C/N ratio, comparing carbon to nitrogen, should be near to 25:1 to ensure enough nitrogen for growth, avoiding excess that may hinder the process.

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C/N ratio poultry litter

Nutrient	Caged system manure	Deep litter system manure
Nitrogen (%)	2.08	2.13
Phosphorous (%)	2.61	2.40
Potassium (%)	2.94	2.03
C:N ratio	**13:1**	**14:1**

Biogas Composition

Biogas is a mix of gases, mainly methane (CH4) and carbon dioxide (CO2), created by bacteria breaking down organic matter without oxygen. The gas composition varies based on the material decomposed. Carbohydrates yield less methane, while high-fat content increases methane production. Methane, the combustible part of biogas, is colorless, odorless, and forms the main part of natural gas. It burns with a blue flame and becomes explosive if mixed with 10-20% air.

Gas	%
Methane (CH_4)	55 – 70
Carbon dioxide (CO_2)	30 – 45
Hydrogen sulphide (H_2S)	1 – 2
Hydrogen (H_2)	1 – 2
Ammonia (NH_3)	1 – 2
Carbon monoxide (CO)	trace
Nitrogen (N_2)	trace
Oxygen (O_2)	trace

3. Gas Filtration

•Generated gas contains a mix of gases like Methane, CO_2, H_2S

•Gas filtration is necessary, particularly for removing H_2S to prevent corrosion of Generators.

•If supplying to government or using it as CNG, filtration of carbon dioxide is essential for improving methane quality.

Gas Filtration System

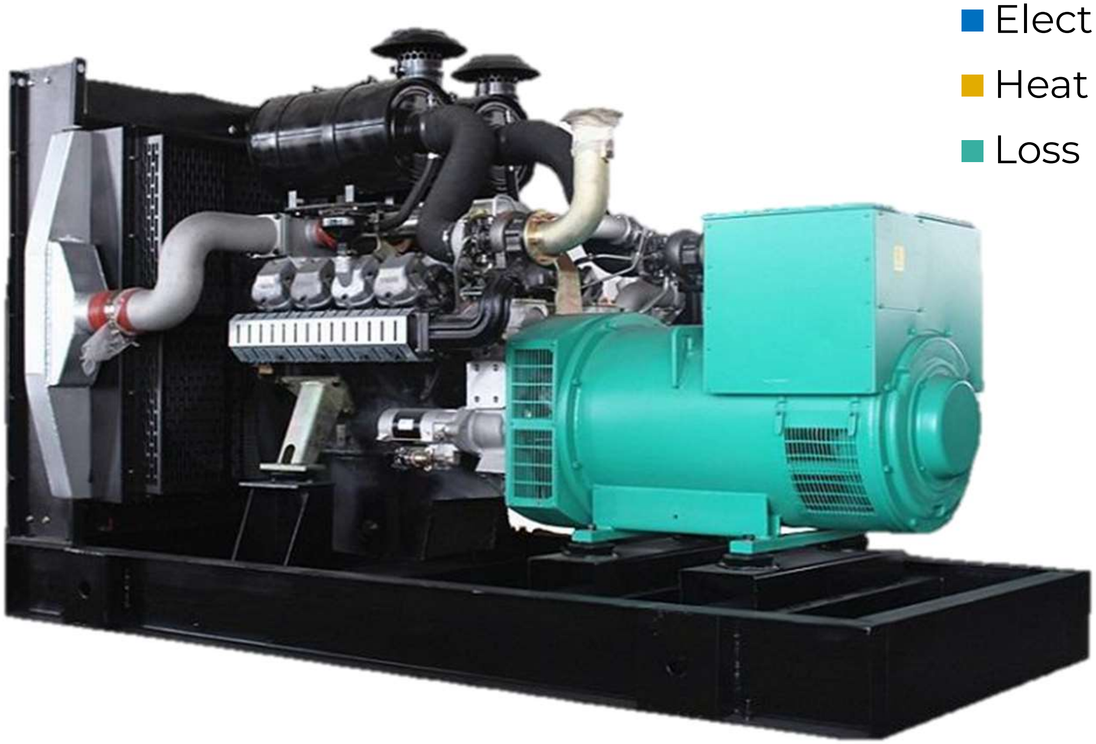
Calorific Value of Biogas

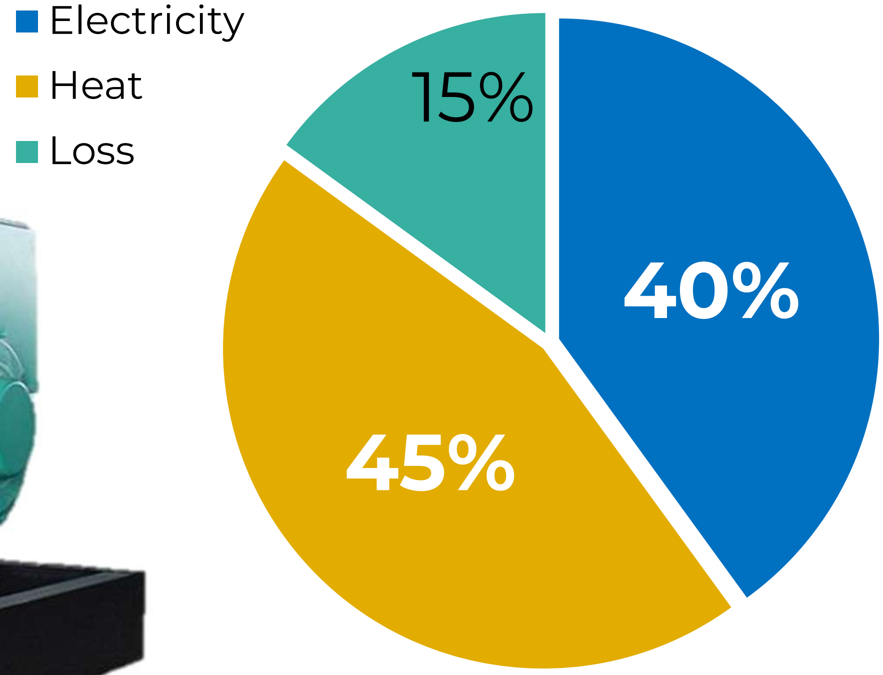
70% CH_4 + 28% CO_2 + 2% (H_2 + H_2S + N_2)

Serial Number	Fuel	Calorific Value in MJ/Kg
1	Fire Wood (Dry)	16 MJ/Kg
2	Biogas	30 MJ/Kg
3	Hard Black Coal (IEA Definition)	>23.9 MJ/Kg
4	Diesel	42-46 MJ/Kg
5	LPG	46-51 MJ/Kg
6	Methane (CH_4)	50-55 MJ/Kg
7	Hydrogen (H_2)	120-142 MJ/Kg

Efficiency

Gas yield from different biomasses. DM is the dry-matter weight of the biomass; VS is the organic biomass (volatile solids)





Slurry after digestion

•Slurry may be applied as organic manure direct to the field.

•If the direct use of slurry in the field is not feasible around the year then Solid and liquid separation is require.

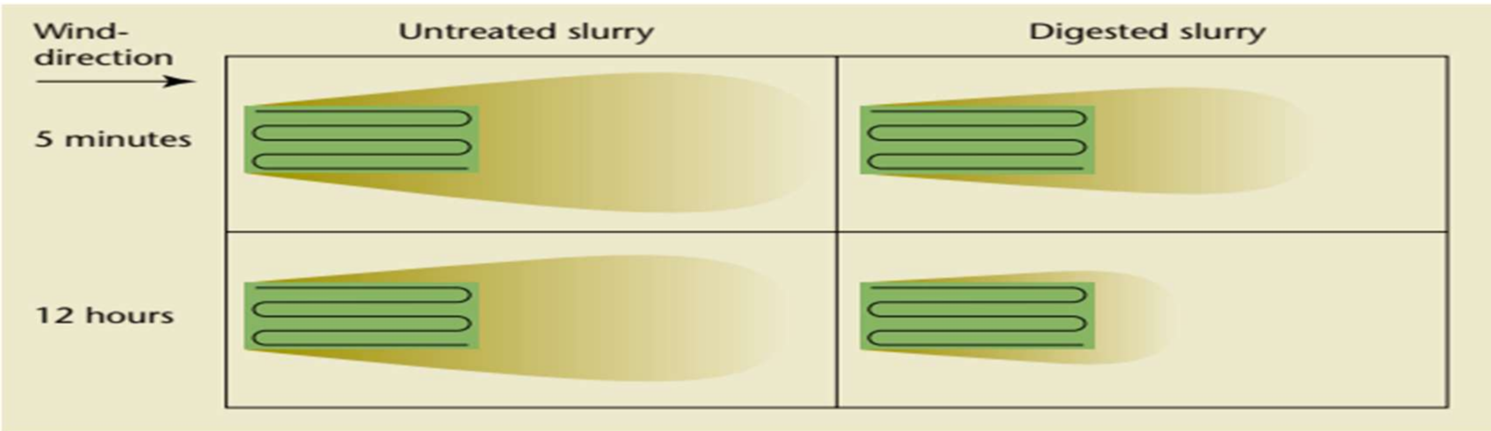
• The water recycling is possible after proper treatment, making it a **zero waste management**.

Solid Sepration Primary

Solid Sepration Secondary

Decontamination of slurry

1. Raw slurry may contain millions of pathogenic organism which are reduced post fermentation after biogas upto 0.
2. Additionally, weed seeds lose their ability to grow, reducing weed pressure in fields and minimizing herbicide use.
3. The odour is not as strong and pungent from digested slurry as from raw slurry



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Biogas Economics

Establishing a Biogas Unit for 100000 Birds

Capacity of Digestor Required: **1500 m3**

Yearly Generation from Bio Gas

1. Biogas production estimated per year :- **273750 Cum**
2. Electricity production estimated per year :- **388800 Unit**
3. Solid organic bio fertilizer per year :- **2160 ton**
4. Heat generation per year :- **465375 kw,** which can be used as a heat source for incubators, or for the farm use

Setup Cost

1.5 Crore

For 1 Lakh Birds

Electricity: 388800 Unit

Organic Manure: 2160 ton

After establishing the biogas farm, your initial investment expenses will be recouped within 3.3 years.

The details are calculated based on 75% efficiency

ROI

Electricity: 388800 -20% (For running the plant) = 311040 unit *9 Rs/unit

Organic Manure: 2160000*2 Rs/kg

Total: 2799360 + 4320000 = 7119360 - 2580000(Running Expense)

=Rs 4539360/ Year

SF0 32000/Month (3 Labour)
SKYLARK FEEDS, 2024-01-31T10:59:22.400

SF0 0 384000/year (Worker Cost)
SKYLARK FEEDS, 2024-01-31T10:59:50.138

CLIMATE CHANGE

Maximum CO2 replacement if biogas is used instead of coal for electricity and heat production.1)Surplus after own consumption of heat and electricity

Maximum CO_2 replacement Biogas heat and power cogeneration	g CO_2 per. m^3 biogas, 65% methane
Electricity production[1)], 2.5 kWh/m^3	1,600
Heat production[1)], 1.5 kWh/m^3	400
Total	**2,000**

Figures from the Danish Energy Agency show a significant environmental impact: for every kWh of electricity from biomass and wind, 640g of CO2 emissions are reduced, with additional savings in slag and ashes. **Each m3 of biogas, producing 2.5 kWh electricity, leads to a CO2 reduction of 1,600g.** Beyond electricity, the engine generates usable heat, from both the cooling system (70-80°C) and cooling the flue gases (150-200°C), allowing extraction of 45-50% of the biogas energy as heat.

Harnessing Renewable Energy

47 Digestors

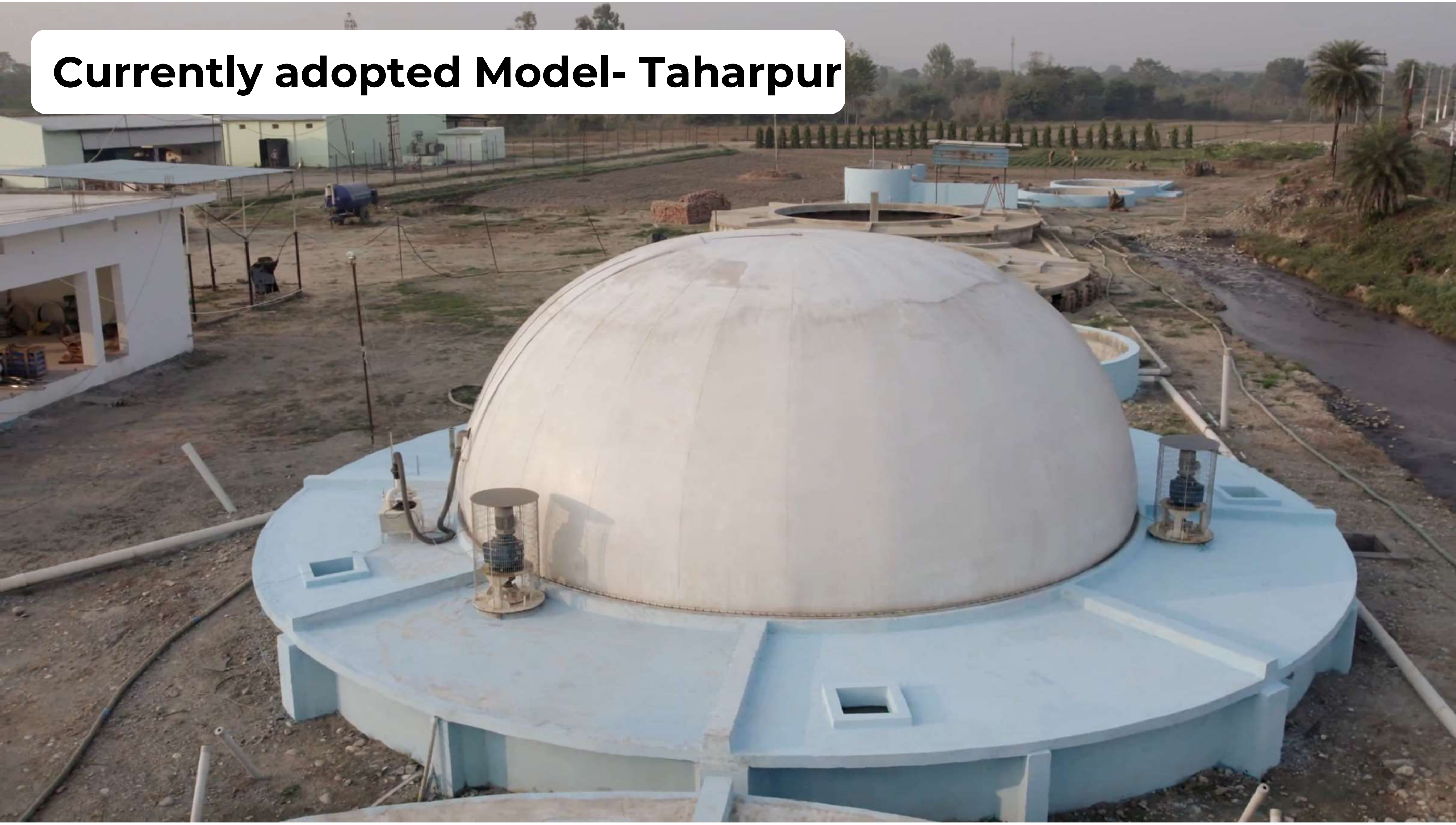
30000 m^3 Capacity

13 Sites

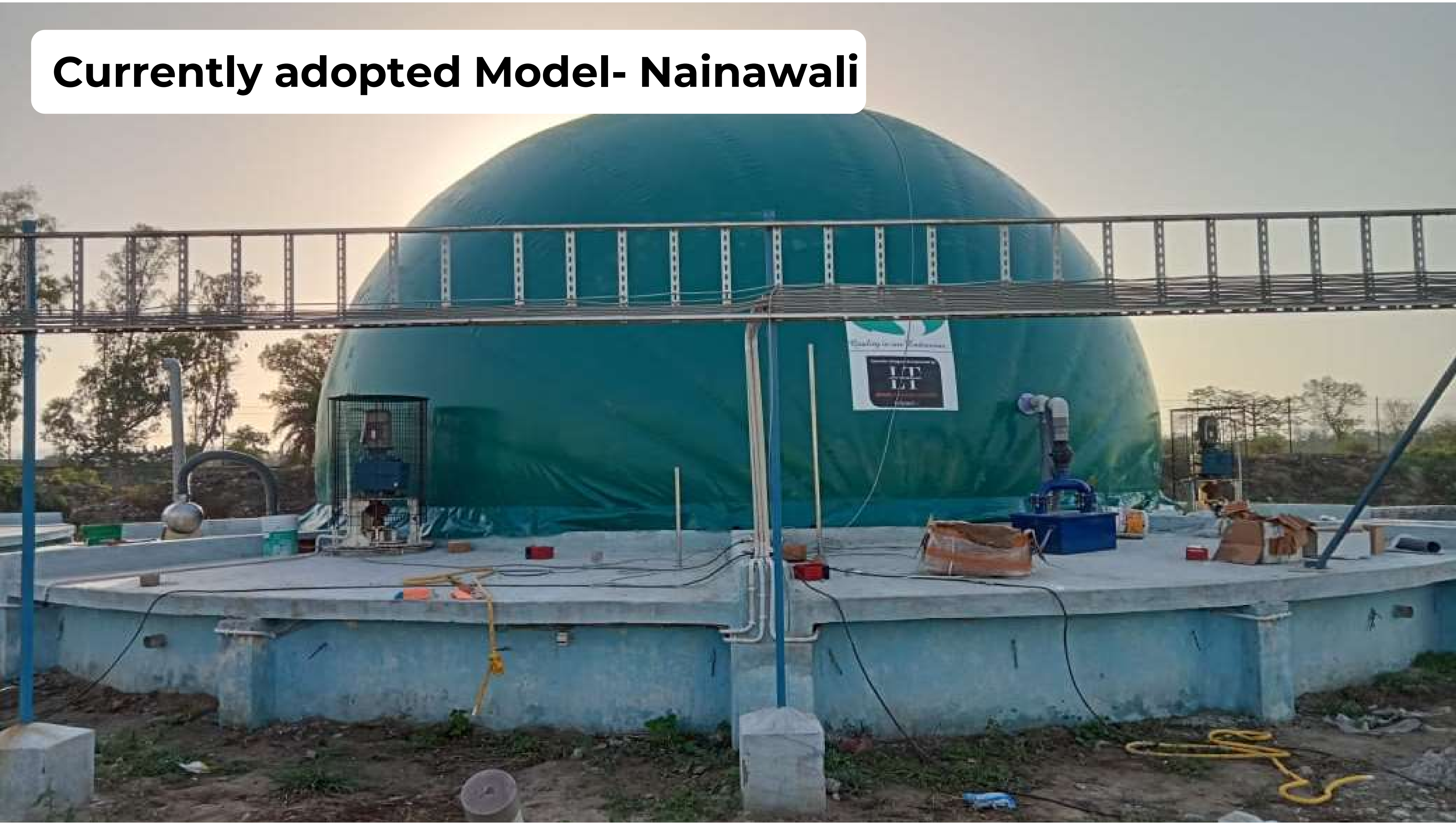
815 KW/hr Energy

Skylark is making a positive contribution to the environment by developing biogas to process poultry waste. Through these biogas we are able to reduce the amount of methane, carbon dioxide, and hydrogen sulphide emitted into the atmosphere. We have installed **47 digestors** across **13 sites**, producing **815KW/hr** of clean energy annually and repurposing thousands of tons of waste which otherwise polluted the environment

Currently adopted Model- Taharpur



Currently adopted Model- Nainawali



Currently adopted Model- Nainawali

Generator System

OLD MODEL- MS sheet Dome

OLD MODEL- Urlana


OLD MODEL- Pilani

OLD MODEL- Anta

Current Project- Surholi, Raipur

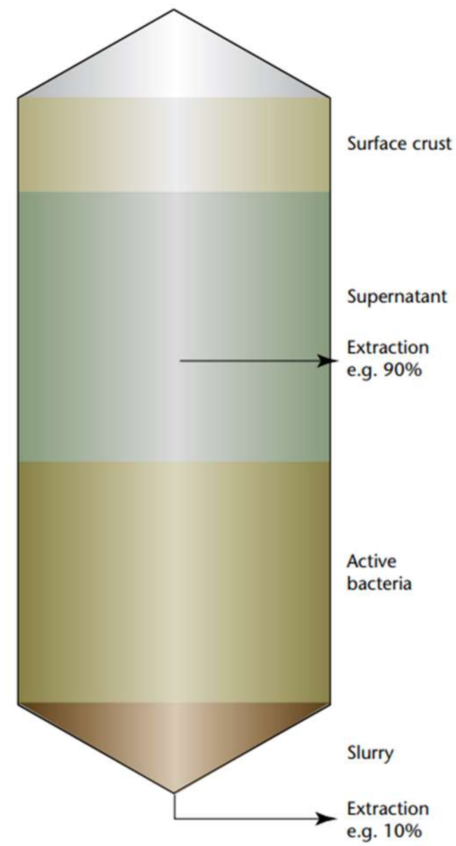
4 Digestors- 18 meter each for 5 Lakh bird

Current Project- Budakhera

Setling of solids in reactor during a mixer stop

A unique method for improving biogas production involves a special pumping approach based on hydraulic relationships in the reactor. When mixing stops, the biomass naturally separates into four layers: a surface crust, Supernatant- a water layer, an active bacteria layer, and a slurry layer with heavier particles.

By selectively pumping from the water layer, the surface crust can be retained longer, increasing gas yield per unit of organic biomass. However, this method is challenging to control, requiring periodic slurry removal to prevent sand buildup and careful monitoring to avoid thickening of the surface crust, which could jeopardize the process. Only a few plants are designed using this approach due to its complexities.



Conclusion

1. Biogas helps to make zero-waste discharge farming.
2. It ensures a hygienic environment, free from flies and odors, making it friendly to society
3. Furthermore, it promotes organic agriculture, minimal emissions, and generating green energy.
4. Biogas helps to reduce ammonia and pathogens which improves the hygiene at farm eventually improve the health of poultry birds.
5. As an economically viable sustainable solution, resulting in revenue generation.

Thankyou

धन्यवाद * तुहाडा धंनवाद * धन्यवाद * থেংকিউ * આભાર * शुक्रिया(شکریہ) *ಧನ್ಯವಾದಗಳು * നന്ദി * देव बरें करूं * ଧନ୍ୟବାଦ * ਤੁਹਾਡਾ ਧੰਨਵਾਦ * अनुगृहितास्मि * நன்றி * ధన్యవాదాలు * آپ کا
شکریہ

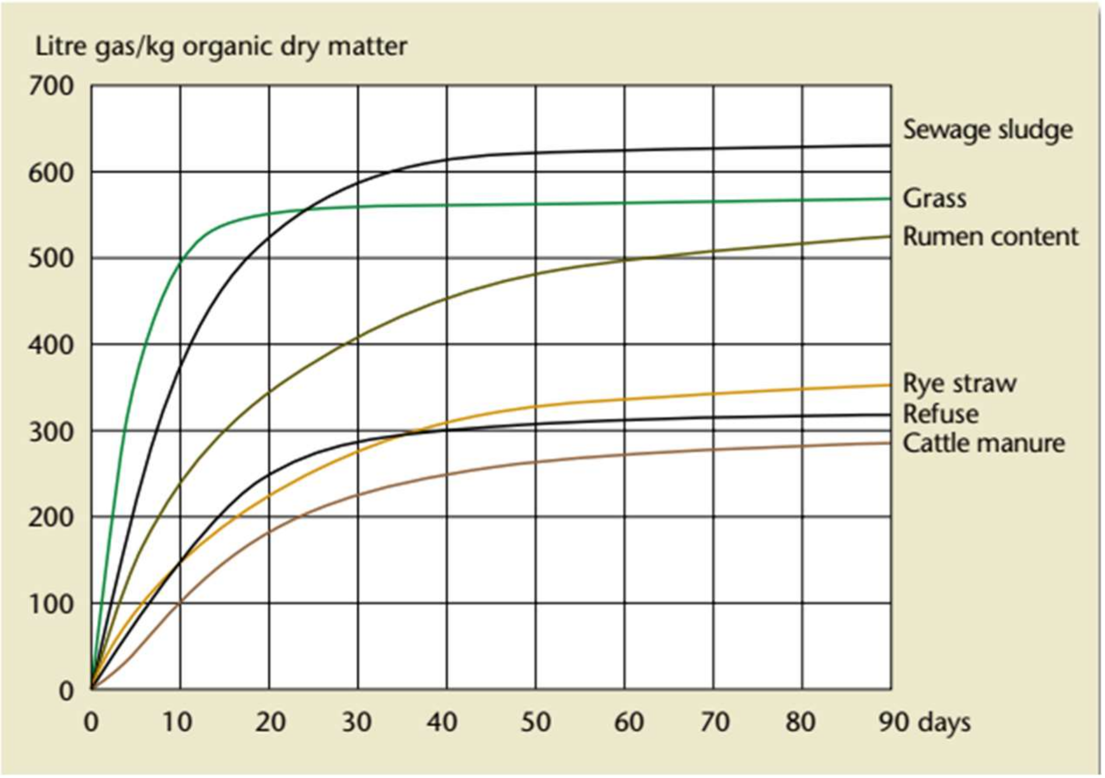
COD = Chemical Oxygen Demand. The amount of oxygen used to degrade organic matter in water. COD is an expression for how much oxygen is needed to degrade organic matter to CO_2 and H_2O. It is mostly used to measure the organic loading of an aquatic environment. It is usually given in mg O_2/litre water. In biogas plants, the COD is given in kg/m^3 = 1000 mg/L

Selected inhibitors with values at which they are inhibiting and toxic.

Chemical/formula	Inhibition level	Toxicity level
Ammonia, free, NH_3	50-100 mg N/l	100-200 mg N/l
Ammonia, total, NH_4^++NH_3	1,000-6,000 mg N/l	10,000 mg N/l (pH<7,5)
Chloride, Cl^-	< 8,000 mg/l	10,000 mg/l
Cyanide, CN^-	2-20 mg/l	30 mg/l
Formaldehyde, H_2CO	100-400 mg/l	500-1,000 mg/l
Phenol, C_5H_5OH	100-200 mg/l	
Chloroform, $CHCl_3$	>1 mg/l (single dose)	>50 mg/l (continuous feed)
Hydrogen, H_2	p(H_2) ca. 10^{-4} atm.	
Copper, Cu^{+++}	10-250 mg/l	
Chrome, Cr^{+++}	50-100 mg/l	200-400 mg/l
Nickel, Ni^{++}	100-200 mg/l	300-1,000 mg/l
Sodium, Na^+	3,000-10,000 mg/l	
Calcium, Ca^{++}	8,000 mg/l	
Magnesium, Mg^{++}	3,000 mg/l	
Zink, Zn^+	350-1,000 mg/l	
Sulphate, SO_4^{--}	500-4,000 mg/l	
Sulphide, (as sulphur)	200 mg/l	
Hydrogen sulphide, H_2S	250-1,000 mg/l	

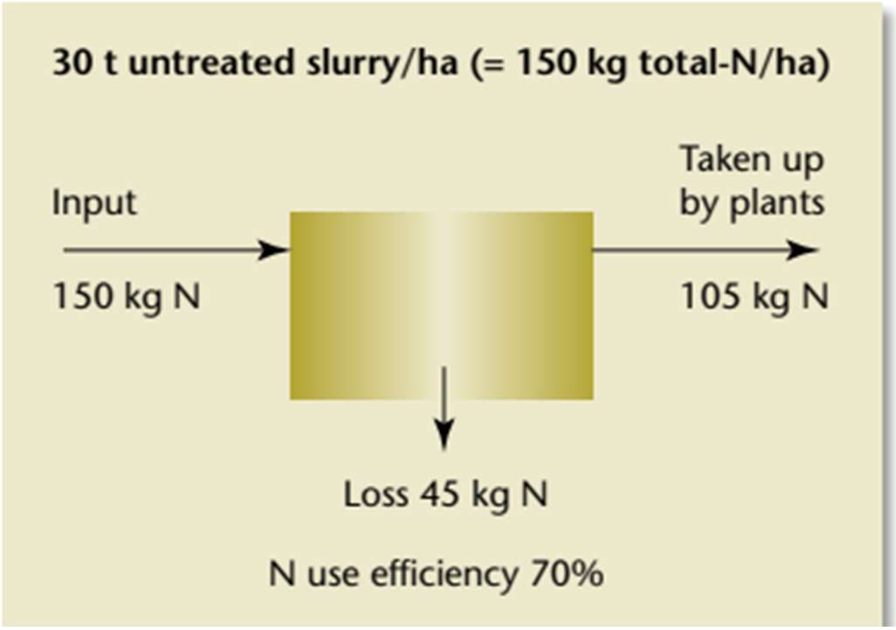
Biogas yield with batch digestion of different organic materials at 30°C.

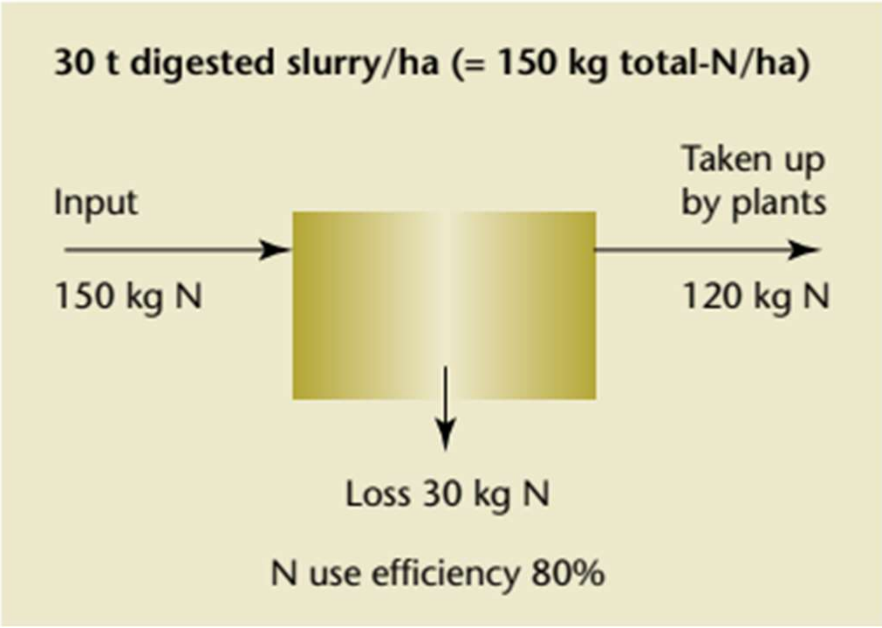
The chart reveals significant variations in biogas potential among different biomasses. Some, like grass, digest quickly, reaching close to 100% potential, while others take longer. Additionally, an initial adaptation period of a few days for bacteria is evident. Warmer temperatures lead to faster adaptation and quicker achievement of full potential.



Simplified nitrogen balance

when using untreated slurry (½ cattle, ½ pig) and digested slurry





Challenges in Biogas

Management of sludge by-product of biogas

Solution:

1. We have developed a system to reuse the Sludge, which is a mixture of liquid and solid waste
2. Separating the solid and liquid ,by solid liquid separator machines.
3. Further treated it to make able to recycled to dilute poultry litter in the biogas making .
4. Separated biogas Solid is further dried remove the excess water and can be used as an organic manure rich in nutrients.

Biogas Gallery

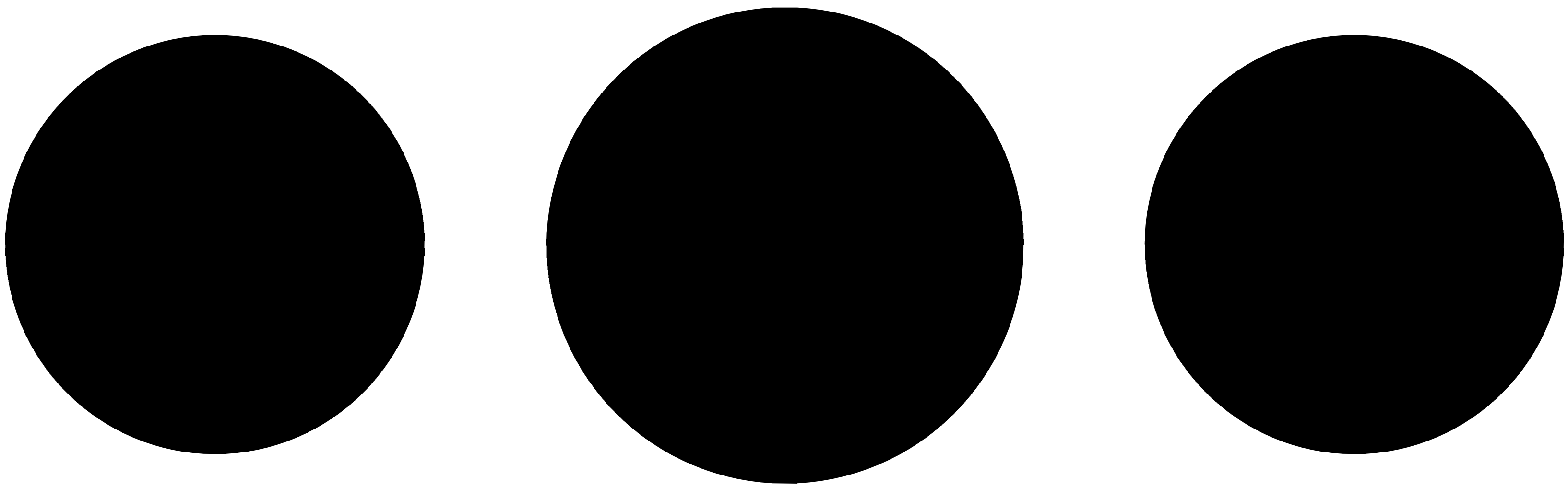
Organic Manure of Biogas

After the biogas generation from poultry waste, the leftover organic matter is processed and converted into a nutrient-rich organic manure.

1. Organic manure generated from poultry waste after biogas generation is rich in all the nutrient content and can be used as a Bio manure to produce Organic Crops
2. It is also rich in Humus (solid bio-fertilizer) which plays an essential role in maintenance of ecological balance in soils.
3. It can help to reduce water pollution and improve fertility to increase organic carbon in soil
4. The manure is also rich in beneficial microorganisms that can help to promote the growth of healthy crops.
5. It help to restore soil structure, reduce soil compaction, and increase water and nutrient uptake by plants.
6. The Bio Manure is free from Weed and harmful organism .

Our Locations

1. Skylark Hatcheries, Anta, HR
2. Skylark Hatcheries, Urlana Kalan, HR
3. Skylark Hatcheries, Budakhera, HR
4. Skylark Hatcheries, Pilani, RJ
5. Skylark Hatcheries, Tajewala, HR
6. Skylark Hatcheries, Taharpur, HR
7. Skylark Hatcheries, Sipyawali, HR
8. Skylark Hatcheries, Nainawali, HR
9. Skylark Hatcheries, Kharra, CH
10. Sushant Poultry, CH
11. Jyoti Hatchery, Pilani, RJ
12. Star India, Karnal, RJ
13. Skylark Hatcheries, Raipur, CH



Price Validation of Biogas Manure

Type of fertilizer	N	P	K	Efficiency %	Price (INR)
Chemical Fertilizer					
Sardar (50 kg)	12	32	16	40%	
Utilize (1bag)	4.8	12.8	6.4		1250
Urea (1 bag)	46	0	0		270
Utilize	18.4	0	0		
Urea (2 bags)	27.6	0	0		405
Total utilization (1.6 urea+1 NPK)	**32.4**	**12.8**	**6.4**		**1655**
Biogas Fertilizer					
Skylark	1.9	0.8	0.65		
Skylark Biogas Fertilizer (1000 kg)	19	8	6.5	80%	828
Usable Fertilizer	15.2	6.4	5.2		
2000 kg	**30.4**	**12.8**	**10.4**		**1655**

The price validation is not less than 2 Rs kg. and organic manure also contain other nutrient like Humus and other micro

Poultry Farming

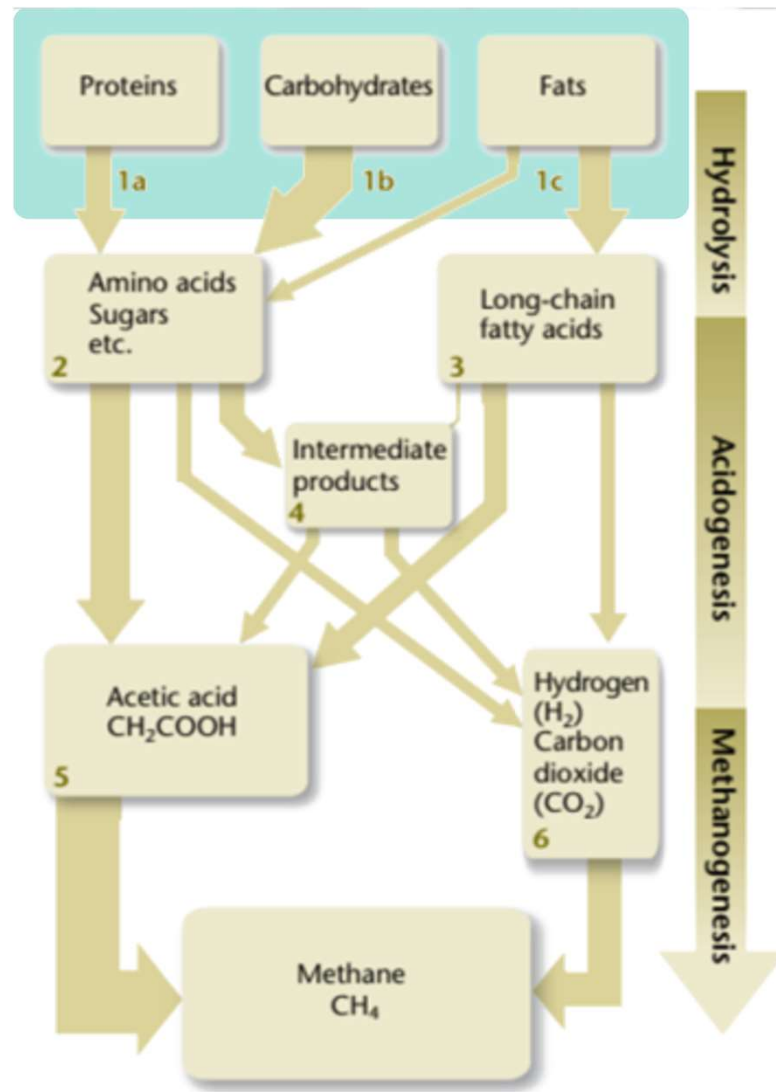
In India, despite being the **3rd-largest global egg producer**, the poultry industry faces challenges that impact both businesses and Society.

With poultry business there are other problems faced like **unhygienic condition**, **foul odors**, and the presence of **flies**.

This not only affects the overall hygiene of poultry farms but also creates a negative perception of the poultry industry.

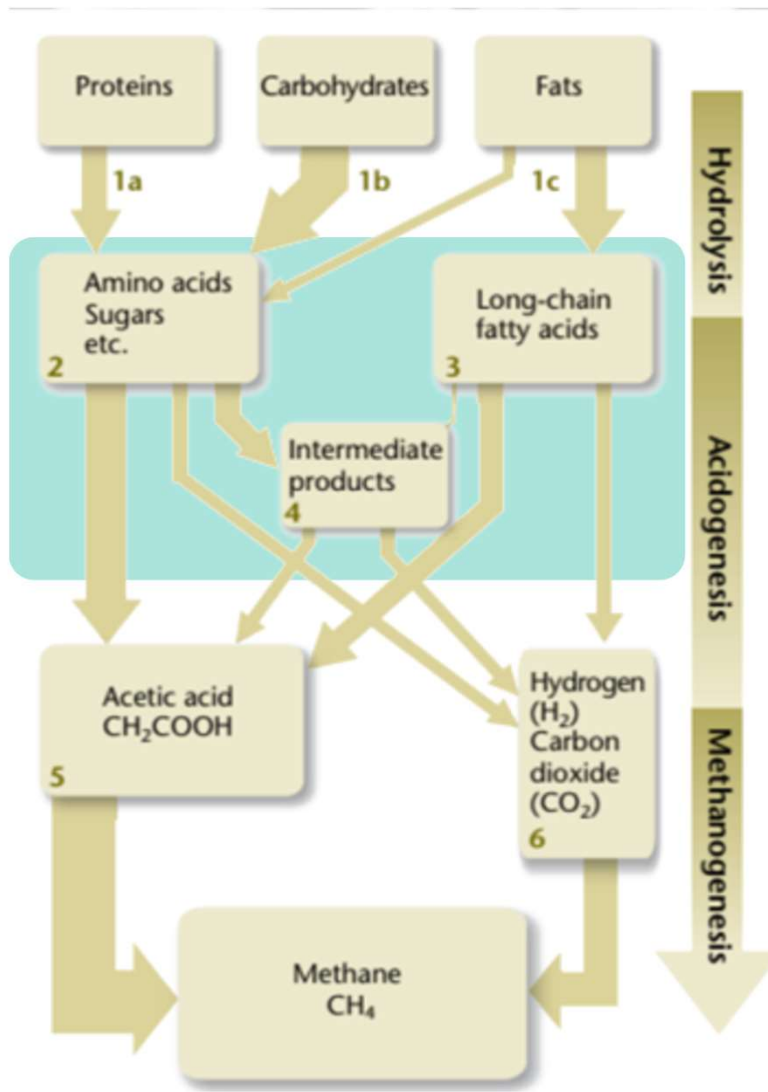
Hydrolysis

During hydrolysis long-chain molecules, such as protein, carbohydrate and fat polymers, are broken down to monomers (small molecules). Different specialised bacteria produce a number of specific enzymes that catalyse the decomposition, and the process is extracellular – i.e., it takes place outside the bacterial cell in the surrounding liquid.



Acidogenesis

During fermentation, about 50% of substances like glucose and amino acids are transformed into acetic acid. Another 20% becomes carbon dioxide and hydrogen, and the remaining 30% forms short-chain volatile fatty acids.



Methanogenesis

The last step in the production of methane is undertaken by the so-called methanogenic bacteria or methanogens.