# Rural and Urban Biodegradable Waste – Challenges, Opportunities & Strategies for Resource Recovery


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# Rural Sanitation (ODF)

# State of Art

- **ODF under SBM (Gramin)**
- **Vacating of the septic tank**
- **Collection and Transportation of Septage / Faecal Sludge**
- **Composting**
- **Application**

## Microbial organism and pathogen in Faecal Sludge

| Microbial Species | Population load (approx.) |
|---|---|
| *E.coli* | $1.3 \times 10^6$- $4.7 \times 10^7$CFU/100 ml |
| Helminths | 1- 20 eggs/100 ml |
| Salmonella sp. | $1.5*10^6$ CFU/100 ml |
| Hookworm | 1-15 eggs/100 ml |
| *Ascaris* | 1-12 eggs/100 ml |
| *S. haematobium* | 1- 6 eggs/100 ml |
| Faecal coliform | $1.5\times 10^6$ - $4.6 \times 10^7$CFU/100 ml |
| *S. mansoni* | 1-10 eggs/100 ml |

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# Dumping field

# BIOMASS

**Biomass is a contemporary plant matter which is continually being replenished by the photosynthetic conversion of $CO_2$ and water by the solar energy (Ragauskas *et al.*, 2010).**

## Biomass Materials

- Grains, fruits, Vegetables
- Agricultural crop residues
- Fuel wood & forestry wastes
- Agro-Industrial wastes
- Biodegradable municipal waste
- Animal dung and Poultry droppings

## Biomass Characteristics

| | |
|---|---|
| Carbon | 40-50 % |
| Hydrogen | 5-6 % |
| Oxygen | 40-50 % |
| Cellulose | 30-45 % |
| Hemi-cellulose | 20-35% |
| Lignin | 25-40% |
| Heating Value | |
| lower | 14-18 MJ/kg |
| Higher | 15-20 MJ/kg |

# Rice Straw Burning

**Farmers' fields stubble burning**

# Current Science

- emission of trace gases like $CH_4$, CO, $N_2O$, $NO_X$, $SO_2$, hydrocarbons and particles of organic and inorganic sp.

- 1 tonne of straw burning releases 3 kg particulate matter, 60 kg CO, 1460 kg $CO_2$, 199 kg Ash, 2 kg $SO_2$ (Jenkins and Bhatnagar, 2003)

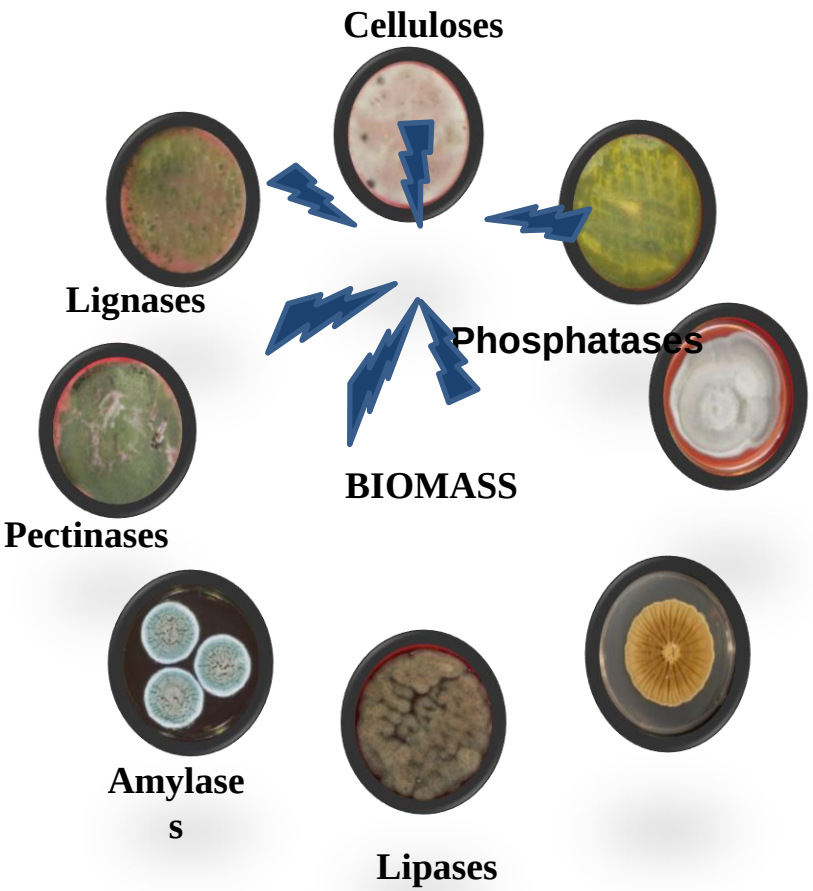
- Adverse impact on health of human beings (eyes, asthma, respiratory diseases, cough and cold)

# The Opportunity …Why Compost

**Great potential to blend organic wastes and compost them collectively, thereby producing a beneficial product**

- **Compost contains agriculturally important nutrients**
- **Could result in potential cost savings in handling high moisture or high volume materials that are generated 365 days per year**
- **Provides means for IARI to reduce it's environmental footprint by recycling**

# Role of Fungi For Rapid Degradation of Substrates




**In-situ decomposition of Paddy straw using Pusa Decomposer:**




**Ex-situ Composting variants**




# Biogas storability in Balloon

Analytical facts of the Biogas from the admixture of cattle dung and biomass

| Property | $CH_4$ | $CO_2$ | $H_2S$ | $H_2$ | Biogas |
|---|---|---|---|---|---|
| % by volume | 54-80 | 20-45 | 1/10 | 0.0-10 | 100 |
| Energy value (kcal $L^{-1}$) | 9.0 | □ | □ | 2.9 | 5.4 |
| Density (g $L^{-1}$) 25$^0$C 760 mm | 0.72 | 1.98 | 1.54 | 0.99 | 1.22 |
| Specific gravity (relative to air) | 0.55 | 1.5 | 1.2 | 0.07 | 0.93 |
| Critical temperature ($^0$C) | 82.5 | +31.1 | +100.4 | 239.9 | |
| Critical pressure (Atm.) | 45.8 | 73.0 | 88.9 | 12.8 | |
| Odour | None | None | Rotten egg | None | |

# Bioslurry utilization in agricultural & ornamental crops

# Cost-Benefit analysis of the 1 $m^3$ biogas plant

**There are two products of the biogas plant**

**(1) Biogas and (2) Biogas slurry**

- **Biogas yield: 0.92 $m^3$ methane content (55% of 0.92) = 0.506 $m^3$ $d^{-1}$**

  **(Equivalent to 1.2 cylinder (LPG cylinder size=14.5 Kg isobutane) per month)**

  **the cost-INR 750/- per cylinder (1.2 x 750 x12) = INR 10800 pa**

- **Biogas slurry (wet) : 15 L per day per m3 biogas plant (15 x 365 days) = 5475 L**

# CBG production potential

- **Total CBG Potential: 62 MMT**
- **Bio-manure/FOM Production potential: 370 MMT**
- **FOM productivity/ quality/ composition depends on feedstock**

| Sl.No | Parameters | FOM |
|---|---|---|
| 1 | Moisture % by weight, maximum | 30-40% |
| 2 | NPK Nutrients-<br>Total N, $P_2O_5$ and K2O nutrient should not be less than | 1.2% |
| 3 | Total Organic Carbon(minimum) | 14% |
| 4 | C:N Ratio | <20 |
| 5 | Practical Size | Minimum 90% material should pass through 4.0 mm IS Sieve |
| 6 | pH | 6.5-8.0 |
| 7 | Pathogens | NIL |
| 8 | Conductivity (as $dSm^{-1}$) not more than | 4 |
| 9 | Heavy metal content, (as mg/kg),maximum | |
| 10 | Arsenic as ($As_2O_3$) | 10.0 |
| 11 | Cadmium (as Cd) | 5.0 |
| 12 | Copper (as Cu) | 50.0 |
| 13 | Chromium (as Cr) | 300.0 |
| 14 | Mercury (as Hg) | 0.15 |
| 15 | Nickel (as Ni) | 50.0 |
| 16 | Lead (as Pb) | 100.0 |
| 17 | Zinc (as Zn) | 1000.0 |

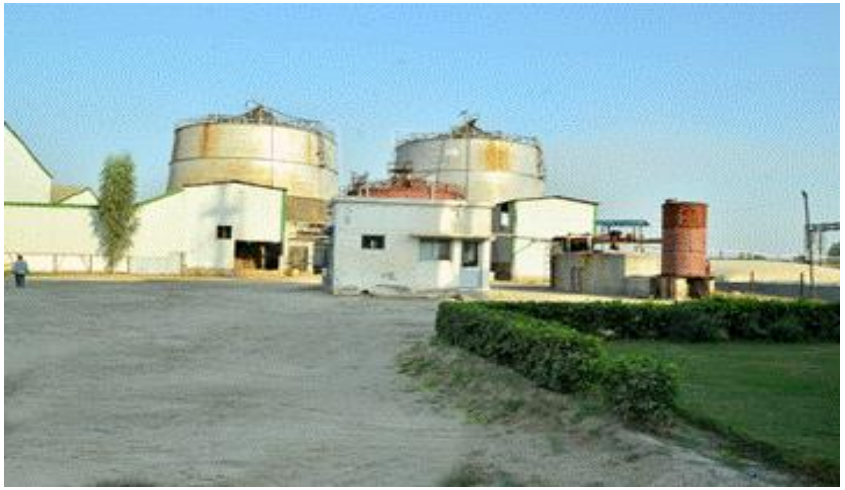
# FUTURE WITH BIOENERGY

- More than 1000MW of energy could be generated from 'waste' biomass in Punjab only using highly-efficient, modern bio energy systems.
- Sufficient for the energy needs of some 8 to 16 million people.
- It could prove to be a cost-effective option. Liquid and gaseous fuel production from renewable sources and usage in rural areas could be Rs. 20-30,000-crore/year industry and can bring substantial wealth to these areas.
- Positively impact "energy conservation, social hygiene, employment generation and women's health.
- Biomass can beat oil and coal.
- Energy self-sufficiency to villages.
- For plants to be introduced on large scale in villages it is necessary to set up a National mission on electricity production for rural areas.


**Banaskantha**

# CBG plants

Banas CBG-Gujrat



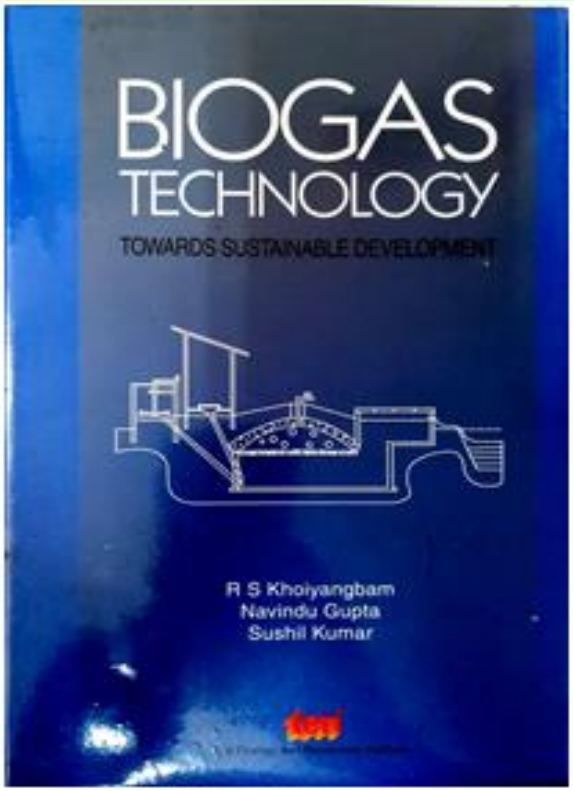
Fazlika-CBG-Punjab

Surat CBG-Gujrat

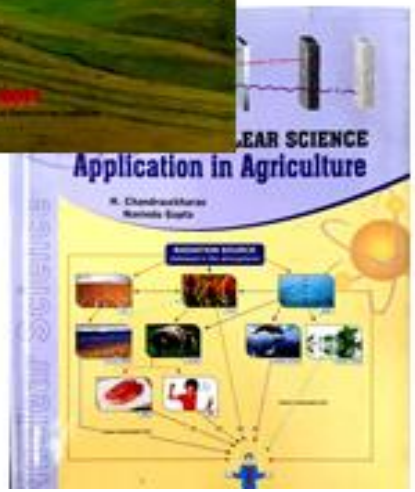
Lehragaga- CBG-Punjab


Namakkal CBG-Tamil Nadu

## Books Published








Thank You All