“Microbial Production of Hydrogen and Methane for Clean Energy and Better Tomorrow”

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Photo credit to: Dr. Dhanajay Bodas

Ministry of External Affairs
Government of India

India, Japan to collaborate on EVs, battery storage, hydrogen

A India-Japan Clean Energy Partnership statement was issued, detailing areas of cooperation, after Japanese Prime Minister Fumio Kishida met India Prime Minister Narendra Modi

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India and Japan on Saturday agreed to extend clean energy partnership to cover EVs, battery storages and green hydrogen as the two Asian economic powerhouse pivot net zero carbon emission pathways.

GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENCE & TECHNOLOGY
INDIA-JAPAN COOPERATIVE SCIENCE PROGRAMME (IJCSP)
CALL FOR PROPOSALS-2022

The Department of Science and Technology (DST), Ministry of Science & Technology, Government of India, New Delhi and the Japan Society for the Promotion of Science (JSPS) conduct the India-Japan Cooperative Science Programme (IJCSP) to promote bilateral scientific collaboration between Indian and Japanese scientists. Applications are invited from eligible Indian researchers /scientists to submit proposals for **Joint Research Projects** and **Joint Workshops/Seminars** under IJCSP.

Biomass Resources from Rice Industry

The cultivation of rice results in two major types of biomass wastes - Straw and Husk

~8×10^{11} kg straw (Domínguez-Escribá and Porcar, 2010) and ~1.5×10^{11} kg husk (Singh, 2018).

-having attractive potential in terms of biomass energy. Although the technology for rice husk utilization is well-proven in industrialized countries of Europe and North America, such technologies are yet to be introduced in the developing world on commercial scale.

The importance of Rice Husk and Rice Straw as an attractive source of energy can be gauged from the following statistics:

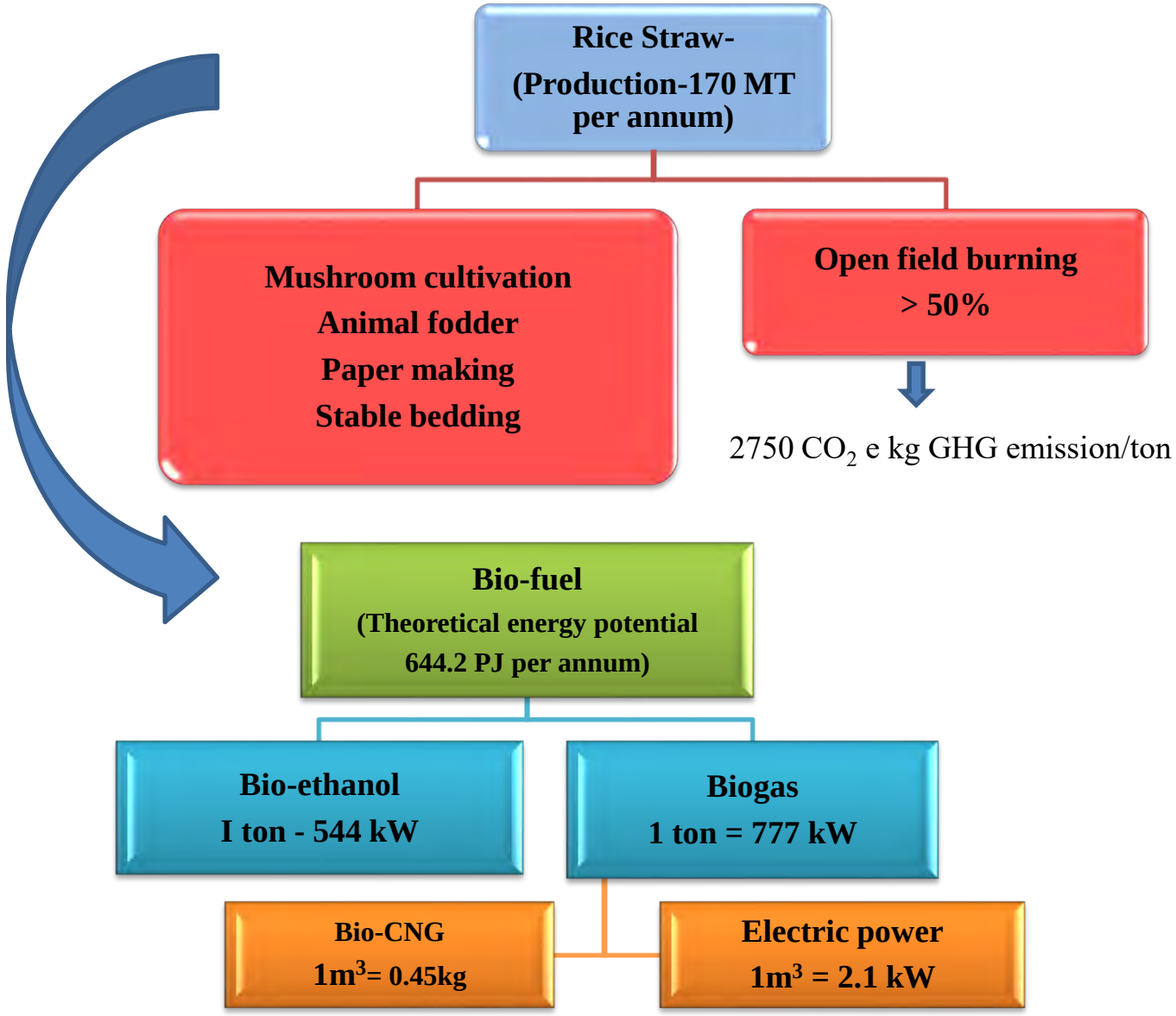
Rice Straw

- 1 ton of Rice paddy produces 290 kg Rice Straw
- 290 kg Rice Straw can produce 100 kWh of power
- Calorific value = 2400 kcal/kg

Rice Husk

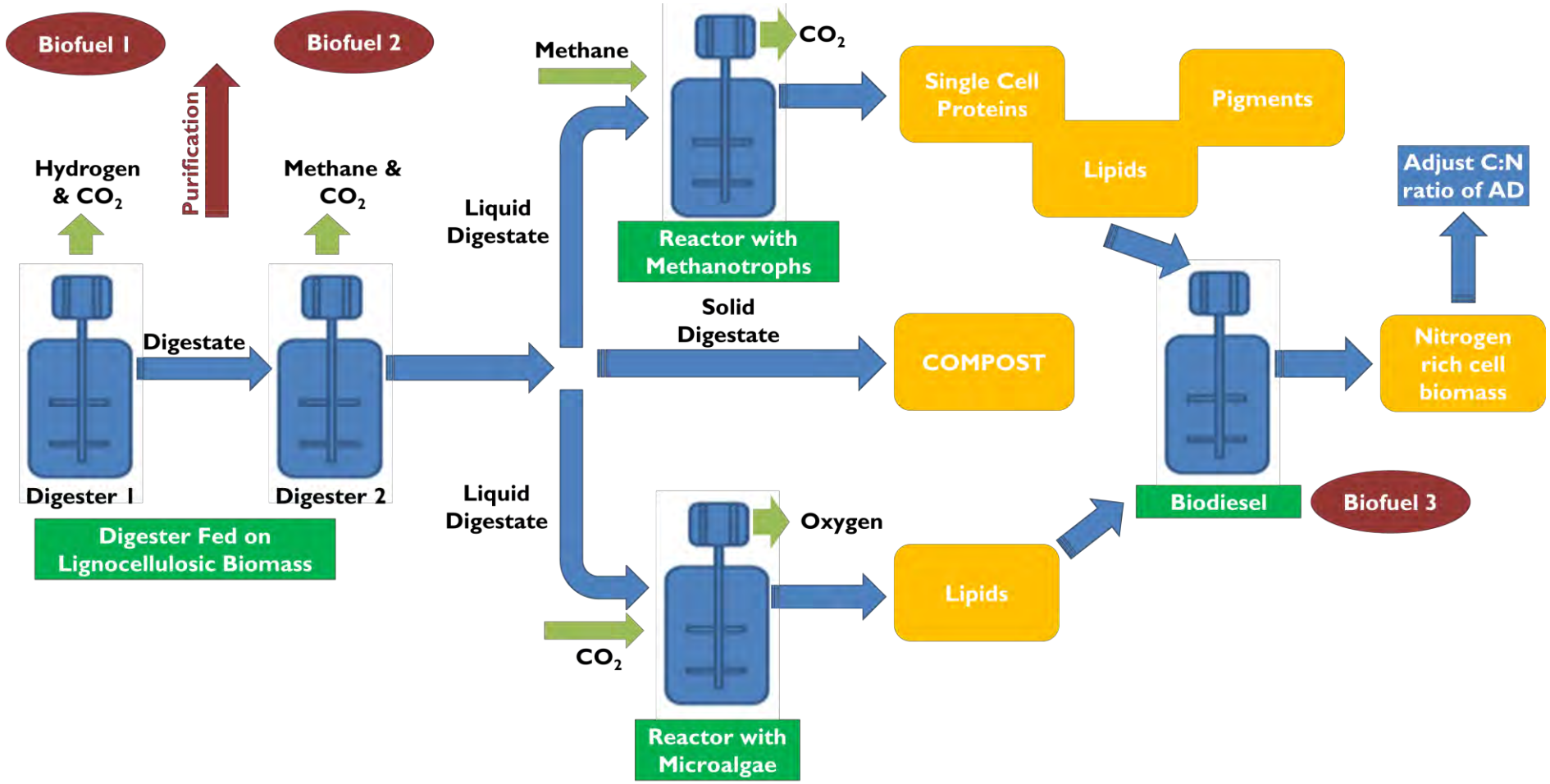
- 1 ton of Rice paddy produces 220 kg Rice Husk
- 1 ton Rice Husk is equivalent to 410- 570 kWh electricity
- Calorific value = 3000 kcal/kg
- Moisture content = 5 - 12%

Rice straw- a promising source of renewable energy

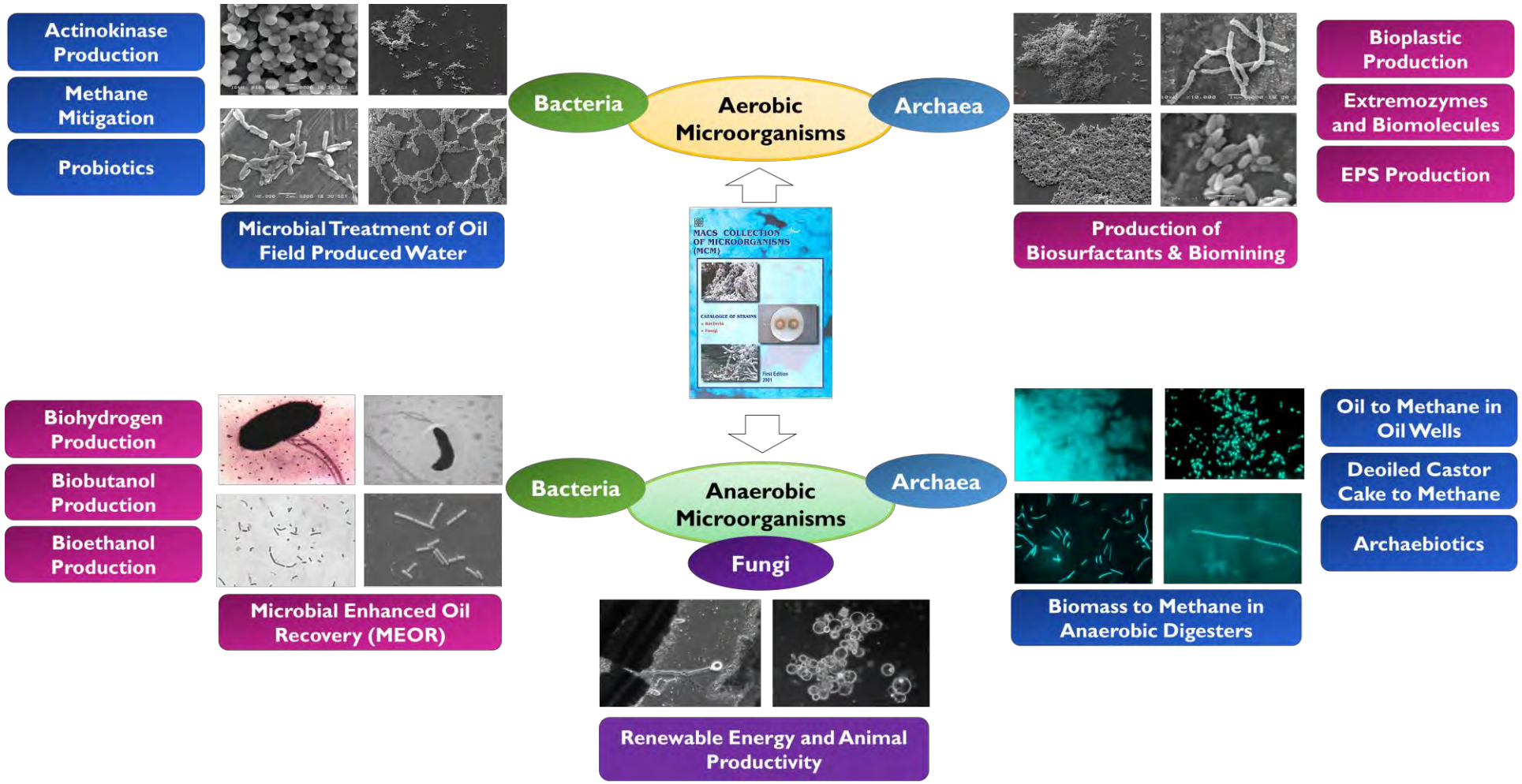


Conversion of rice straw to biogas provides a valuable source of affordable, sustainable, and renewable bio-energy while also taking care of safe disposal of large quantity of agricultural wastes generated

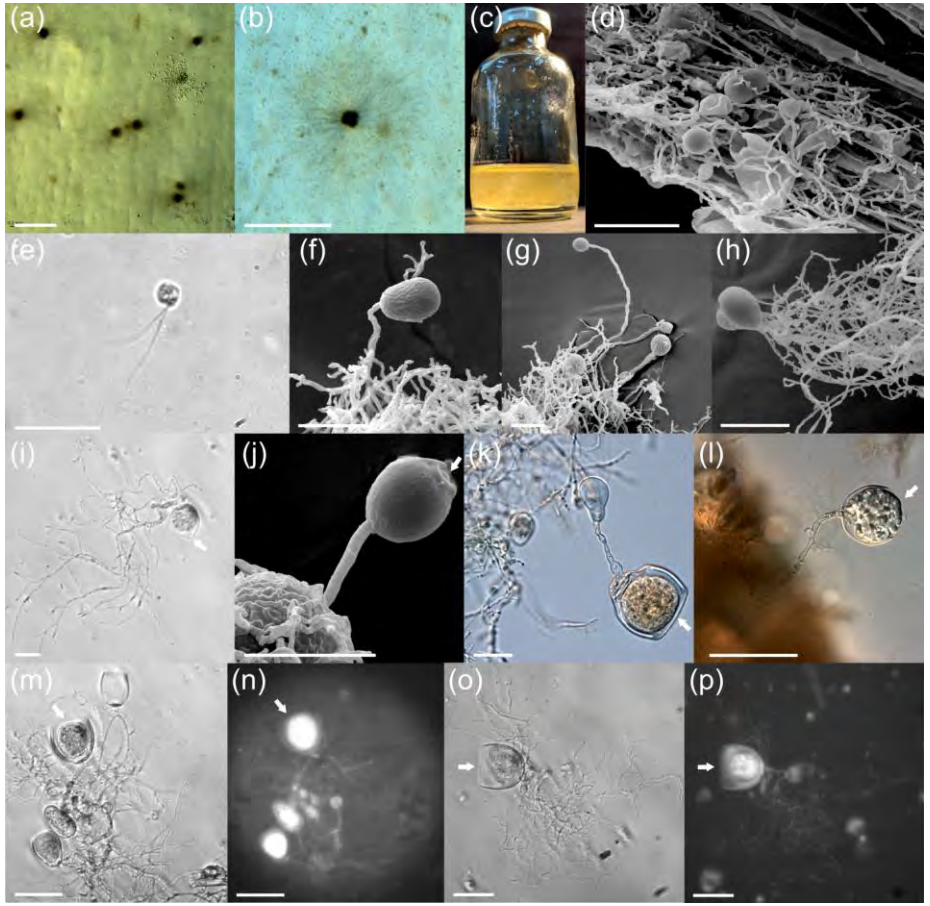
A BIO-REFINERY APPROACH FOR EFFICIENT UTILIZATION OF LIGNOCELLULOSIC BIOMASS



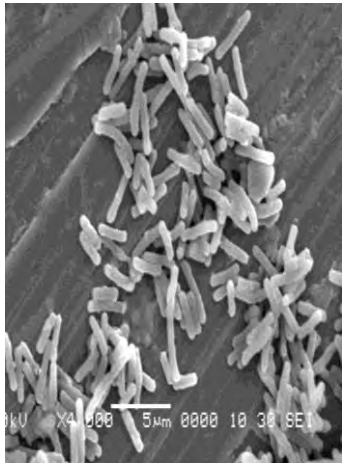
MICROBIAL CULTURE COLLECTION

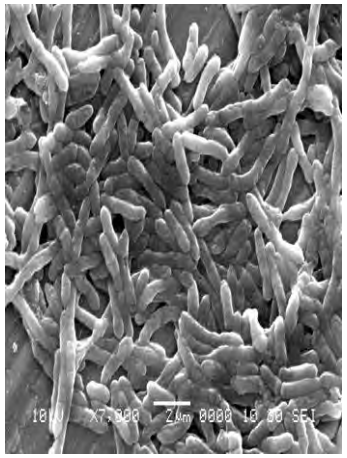


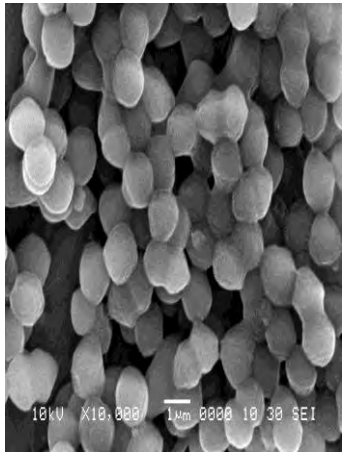
ANAEROBIC FUNGI

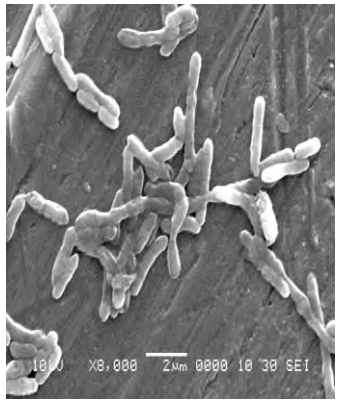


ANAEROBIC BACTERIA

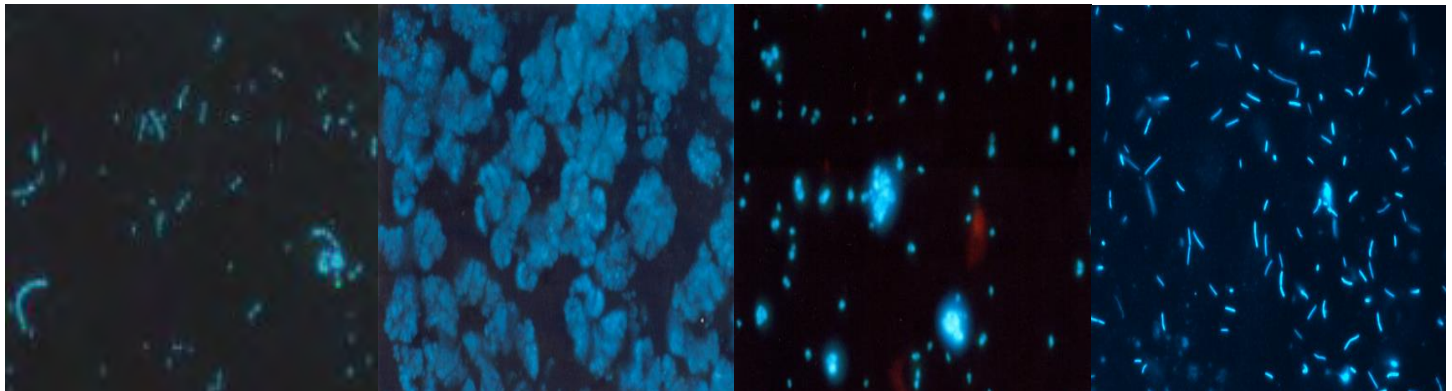




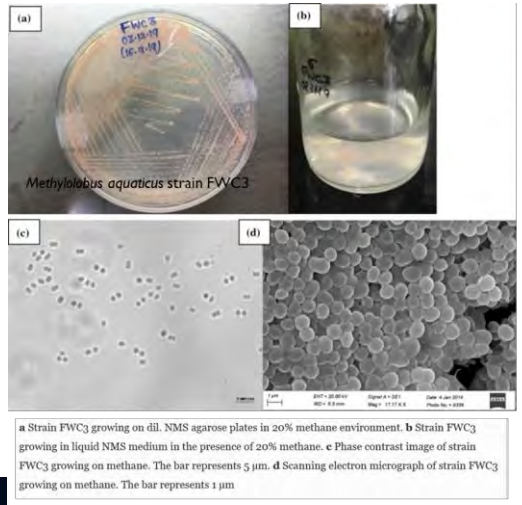




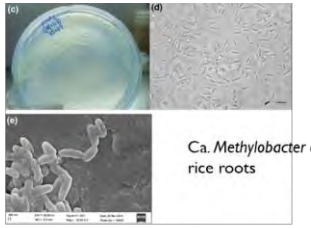
METHANOGENS

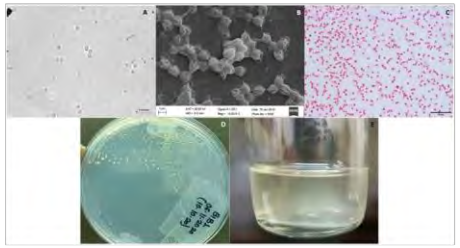


METHANOTROPHS



a Strain FWC3 growing on dil. NMS agarose plates in 20% methane environment. **b** Strain FWC3 growing in liquid NMS medium in the presence of 20% methane. **c** Phase contrast image of strain FWC3 growing on methane. The bar represents 5 µm. **d** Scanning electron micrograph of strain FWC3 growing on methane. The bar represents 1 µm

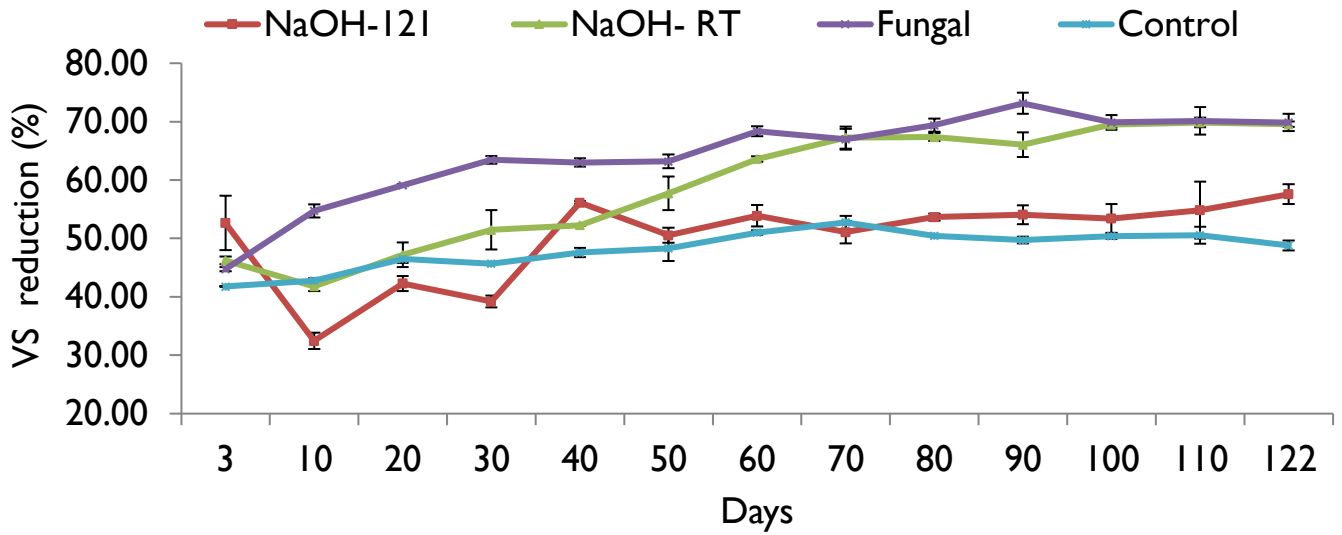


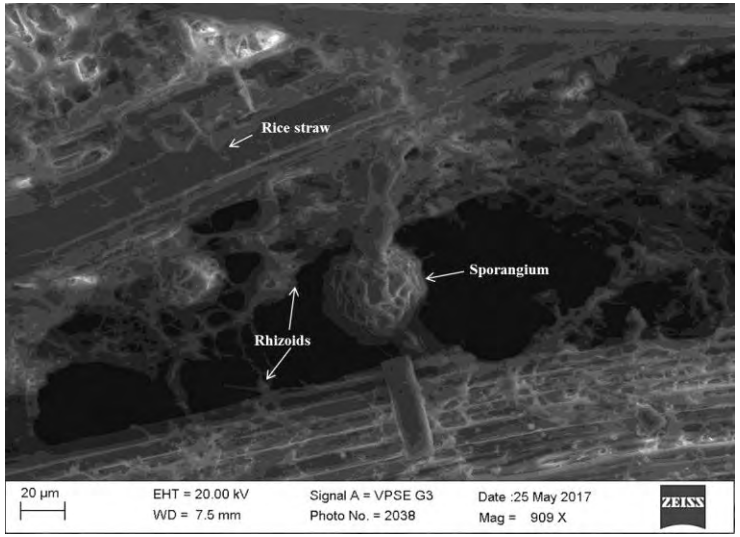


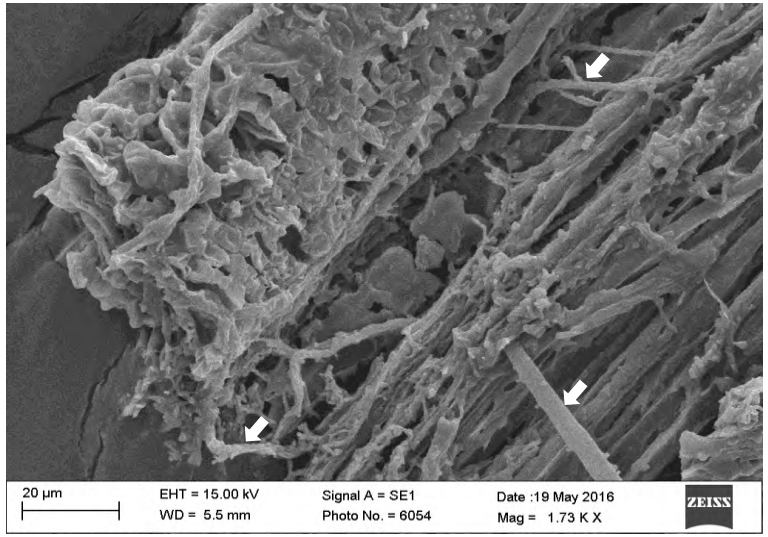
Ca. Methylobacter coli from blackbuck feces

DIVERSE MICROBES IN BIOENERGY

Effect of Anaerobic Fungal Supplementation on Digestion of Rice Straw- Semi continuous Mode

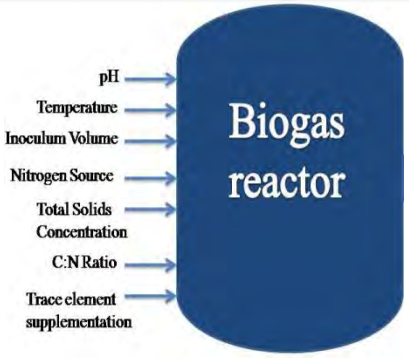






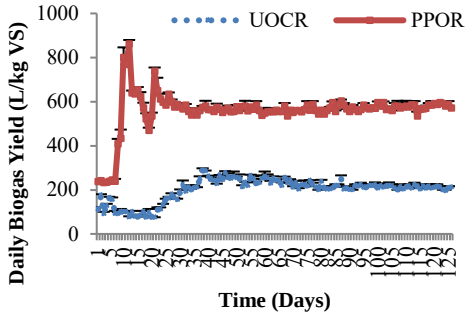
Biomethanation of rice straw

Rice straw



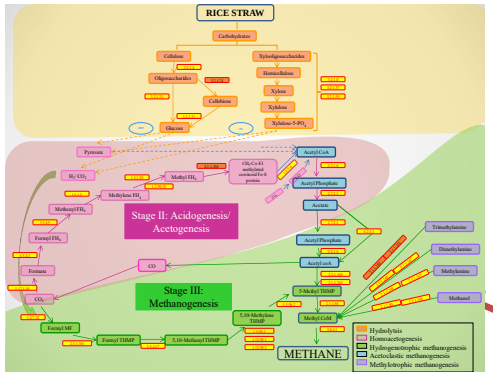
Optimization of process and nutritional parameters

Enhanced Methane Yield of 272L/kg VS achieved (~83% of theoretical value)

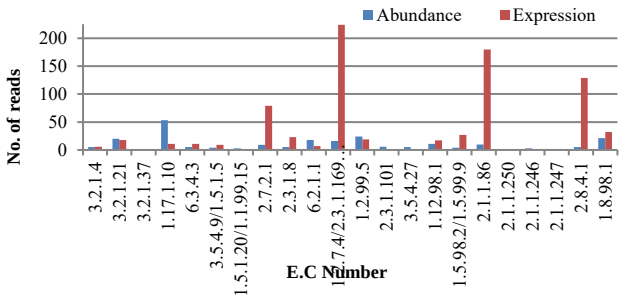


Steady state lab scale biogas reactor2

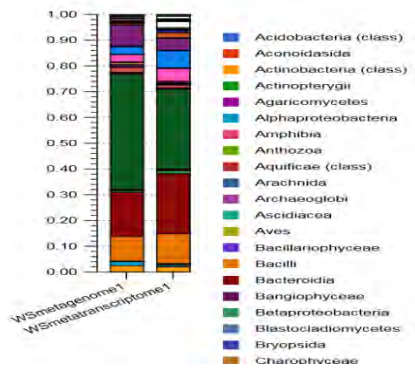
The process of biomethanation of rice straw reported here is an energy efficient, cost-effective and environmentally benign method for efficient extraction of energy from agricultural waste bypassing the need of any polluting pretreatments



Pathway for conversion of rice straw to methane was constructed



Abundance and expression of key enzymes in the entire process was revelaled



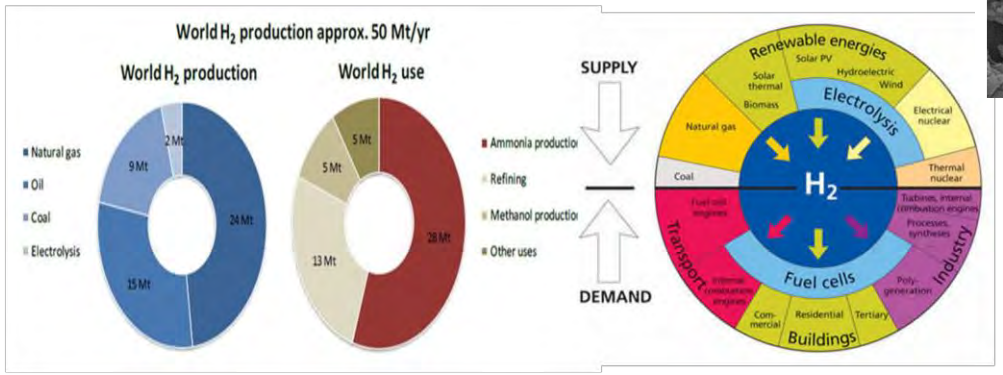
Insights into the microbial community and metabolism revealed dominance of *Clostridium*, *Bacteroides* and *Ruminococcus* amongst bacteria and *Methanosarcina* and *Methanothermobacter* amongst archaea

BIO-HYDROGEN

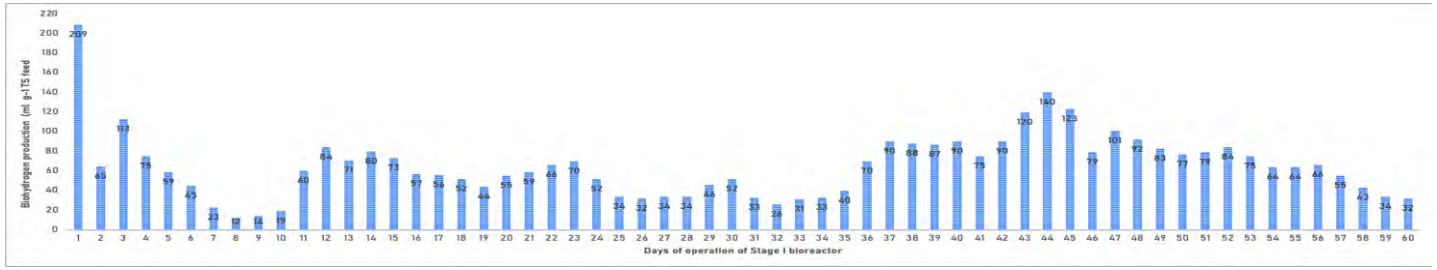
- Efficient : high energy content
- Approximately 2.6 times the energy per unit mass as gasoline
- Clean and environment friendly
- as water is the sole end product after combustion without carbon dioxide formation.

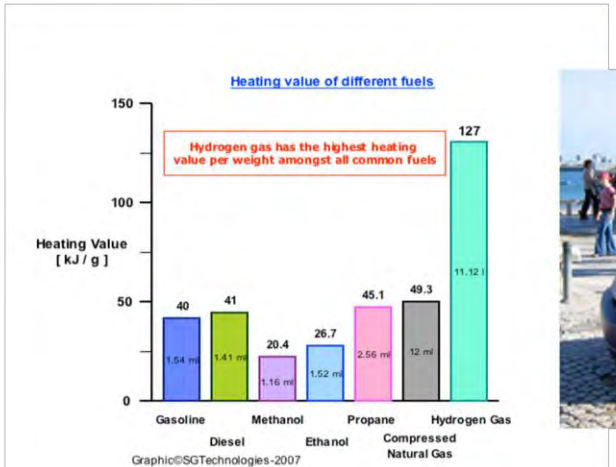
Microbial colonization of rice straw particles during biohydrogen production from rice straw

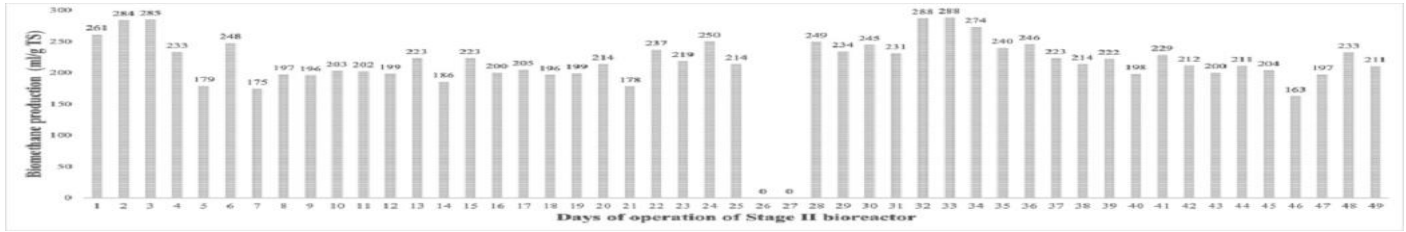
Development of anaerobic microbial consortia for biohydrogen and biomethane production



two-stage process to produce biohydrogen and biomethane in Stage I to II from rice straw







Scope for collaboration

- Scale-up studies
- Field Implementation
- Development of diagnostic/ reactor monitoring tools
- Development of microbial cultures for the start-up of biogas digesters or/ recovery of sour digesters

Thank You!