UNDERSTANDING FOOD WASTE MANAGEMENT TECHNOLOGY

Site visit at Dinshaw's Nagpur, a project executed bySun Enviro Technologies Pvt Ltd

ABSTRACT

Globally, food waste has become an increasingly recognised environmental issue over the last decade. Not only has the issue of wasted food become an ethical one in a world where approximately 800 million people suffer from hunger, but the environmental impacts of producing food that is then discarded can no longer be overlooked. As population and urbanisation grows, more food is being produced and more food is being wasted. This report studies global food management, defining food waste management and the ill impacts or it being poorly done. The report looks into food waste management in India and field visit to waste management site of Dinshaw's Nagpur

By: Khushi Dave

Student of Class 12, R N Podar, Mumbai

Introduction:

The lifecycle of the food we eat begins in the farms where it is grown and harvested or the sea, rivers, and lakes it is fished from. It continues through handling and storage stages and, often, processing prior to distribution and consumption. Throughout the food cycle, losses and wastage occurs, at farms, processing plants, distribution centres, storage houses, supermarkets, restaurants, and households. The magnitude of the problem and lost opportunity is highlighted by the following three facts:

- A third of the food produced for human consumption globally, about 1.6 billion tonnes per year, is lost or wasted
- The cost of food waste globally is estimated at around USD 2.6 trillion – of which USD 1 trillion is incurred from greenhouse gas (GHG) emissions, water scarcity, biodiversity loss, increased conflicts, and loss of livelihood due to issues such as soil erosion, nutrient loss, reduced yields, wind erosion and pesticide exposure
- Food waste accounts for 4.4 giga-tonnes (Gt) of CO2 eq. per year, which represents 8% of global anthropogenic GHG emissions in comparison, the overall emissions from China, USA and India are 12.45, 6.34 and 3.00 Gt of CO2 eq. per year

(Source: Global Food Water Management)

Definition of Food Waste:

The terms food, inedible food, food loss and food waste need to be contextualised both geographically and within the food chain. For this report, 'food' is defined as any substance, whether processed, semi processed or raw, that is intended for human consumption as well as the 'inedible parts' associated with food that are not intended to be consumed by humans 6. For example, pineapple is a food; its skin is inedible

Food loss refers to food that unintentionally undergoes deterioration in quality or quantity because of food spills, spoils, bruising, wilting or other such damage as a result of infrastructure limitations at the production, storage, processing and distribution stages of the food lifecycle.

Food waste means any food and inedible parts of food, removed from the food supply chain that can be recovered or disposed. This includes food waste that is to be composted, spread to land, treated through anaerobic digestion, combusted for bio-energy production, incinerated, disposed to sewer, sent to landfill, dumped in open dumps, or discarded to sea.

The rationale behind this choice of food waste definition is that from a resource efficiency perspective, any parts of food that are not consumed are still rich in carbon, water, and nutrients. By collecting and recycling this food waste, nutrients and water can be recovered and recirculated, and renewable energy from the carbon harvested to substitute fossil fuels.

Figure 1: Food waste Vs Loss

In addition to the squandering of resources (including energy, carbon, water, and nutrients) needed to produce food that is not consumed, poorly managed food waste has following adverse impacts:

- **GHG emissions and climate change**: Carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) are greenhouse gases that contribute to global warming and climate change and are emitted at all stages of the food life cycle.
- **Adverse impact on Water footprint**: Wastage of food results in the waste of water extracted from the ground or surface water bodies for irrigation. Use and

subsequent runoff of fertilisers and pesticides has an adverse impact on the water quality of ground and surface water bodies.

- **Nutrient loss:** Plants are primarily made of carbon and water, and need nitrogen (N), phosphorus (P) and potassium (K), amongst other nutrients, for their growth. Plants photosynthesize carbon from the atmosphere while the NPK are obtained from soil, and from organic and inorganic fertilisers applied by farmers. Decades of unsustainable agricultural practices have resulted in depletion of these nutrients, as well as of organic matter in the soil.
- **Sanitation:** Globally, about 50% of waste is sent to landfills while 13 to 33% of waste is still being openly dumped in lower and middle-income countries 23. The food and other organic waste in the landfills and dump sites can lead to parasitic and gastrointestinal diseases in the populations living and working near the site
- **Ecological impacts:** Increased food production to support the growing global population has resulted in widespread ecological damage due to Change of land use from forests, prairies, peat, marshes, etc., to agriculture; Loss of biodiversity of species, including mammals, birds, fish, and amphibians; and Over exploitation of marine life
- **Economic impacts:** The total annual economic, environmental and social costs of food waste to the global economy are in the order of USD 2.6 trillion 26, the figures attributed to each of these aspects are shown in the table below:

TABLE 1 : GLOBAL COSTS OF FOOD WASTE

ASPECT	COST (US DOLLARS)
Economic	1 trillion
Environmental	700 billion
Social	900 billion
Total	2.6 trillion

Source: FAO (2014) Food wastage footprint (2014)

Major areas and reasons for food wastage:

Manufacturing:

- Over-production resulting from pressure to meet contractual requirements,
- Appearance quality standard for produce,
- Damaged products,
- Cheap disposal alternatives,
- Inedible parts of produce.

Wholesale and retail:

- Temperature changes leading to spoilage,
- Aesthetic standards expected by the consumers and retailers,
- Packaging defects making produce not fit for sale,
- Over supply due to consumer choices,
- Overstocking due to poor planning and excess surplus.

Food services:

- Lack of flexibility in portion sizes,
- Insufficient planning in forecasting and ordering ingredients,
- Consumer attitudes towards taking leftovers home,
- Refused food due not meeting customer preferences.

Households:

- Buying too much due to poor planning,
- Bad storage resulting from lack of awareness,
- Confusion over freshness and safety labels,
- Discarding edible parts of produce like bread crusts or apple peals,
- Discarding leftovers,
- Large portion sizes.

Food Waste Management in India:

In a CSR Journal report, it stated that "Indians waste as much food as the whole of United Kingdom consumes. " With over 1.3 billion people in a nation like India, millions are still sleeping hungry. In the Global Hungry Index - 2017, India ranks 100 among the 119 countries.

Food wastage not only represent hunger, climate change or pollution, but also various glitches in the nation's economy, like inflation. Our traditions and culture play one of the major role in these situations where the policies of the government aren't responsible for such wastages. Most of the food is wasted in weddings, canteens, hotels, social and family functions, and households. It is estimated that the number of individuals who sleep hungry in Indian are now more than 65 million, which is statistically higher than the population of few countries in the world.

In India, the larger the marriage, the larger the party, and also the additional stupendous the waste. No doubt weddings and banquets are an enormous supply of food wastage, however, restaurants and hotels conjointly contribute to food wastage, although the awareness around this has grown full-grown within the last 5 years.

- On Average, 40% of food produced were being disposed of. This means that 7.5 tons of food are discarded daily.
- Approximately 21 million tonnes of wheat is wasted every year
- According to Ministry of Agriculture, Rs 50,00 trillion worth of food is wasted every year

Food Waste Management:

The diagram of the hierarchy shown below was produced by the United Nations Environment Programme (UNEP) and the FAO and shows an inverted pyramid with prevention of food and drink waste as the preferred action

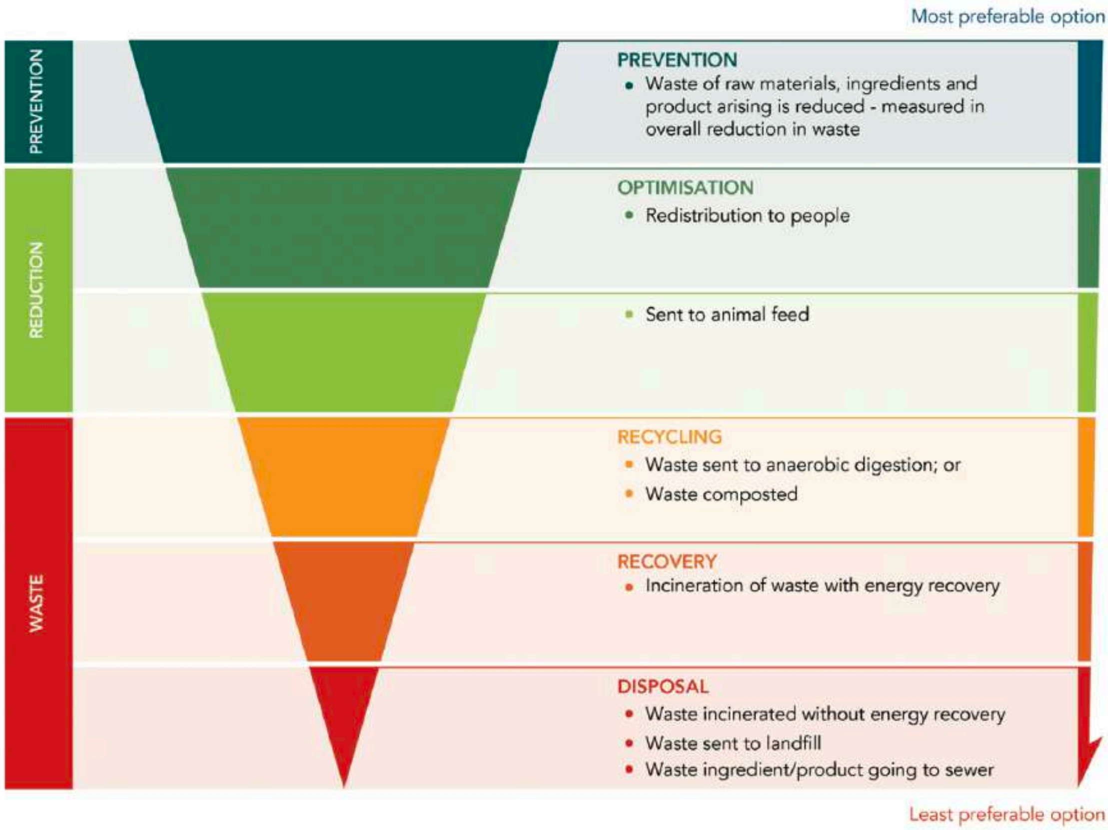

Figure 2: Food and Drink Material hierarchy

The food and drink material hierarchy sets out guidance on the preferred methods of dealing with food waste to minimise its impact on the environment and the society. On the top of the hierarchy is prevention of waste. While every effort should be made to prevent the generation of food waste, any that is still generated should be redistributed to people, if possible, if not then to animals. Once it has been deemed that the food cannot be consumed, then it should be treated through composting or anaerobic digestion (AD), as energy and nutrients can be recovered and available for reuse. Incineration with energy recovery is the least preferred recovery method for food waste. Methods of disposal by which all nutrients and energy is lost, including incineration without energy recovery, landfilling or disposal in sewers, are least preferred.

Food Waste Management Technologies:

Composting and digestion are two often-used methods of processing biodegradable materials, including organics discarded as wastes. Many think they are different methods, but both are processes that manage decomposition, carried out by biological organisms transforming the materials through chemical reactions. Each process has inputs, products, and by-products. The inputs are the materials being treated (feedstocks), which include sludges, manures, food scraps, etc. The outputs are those products with real or potential revenue value (compost, energy captured from composting piles or derived from biogas, and some digestates). The by-products are process outputs with real or perceived negative value (gases/odours, leachate, and some digestates).

The process of conversion of inputs to outputs differs between composting and digestion primarily due to the presence, or absence, of oxygen. Composting is an aerobic process, so oxygen is essential for its success. Digestion can be either aerobic or anaerobic but is more often configured as an anaerobic process for the purpose of producing and capturing methane-rich biogas (aerobic digestion is used in some sewage sludge treatment schemes for stabilization and pasteurization but is very energy-intensive).

Consider the biodegradation of simple sugar (glucose), both aerobically and anaerobically:

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ (aerobic)
$C_6H_{12}O_6 \longrightarrow 3CH_4 + 3CO_2$ (anaerobic)

In composting, glucose is converted to carbon dioxide and water; in digestion, that glucose is converted to carbon dioxide and methane. How are these simple sugars created in composting and in digestion? Essentially, different groups of microorganisms break down more complex molecules, so that the microbes can utilize the underlying carbon substrates as food for their life processes

Aerobic Digestion:

Aerobic digestion is the latest food waste disposal technology making its way onto the market. Aerobic digestion is the process of creating an oxygenated environment, which with the addition of microorganisms, naturally breaks down food waste over a short period of time into water that can be discharged via existing drainage systems. This technology manages food waste on a small scale and is commonly used to deal with waste arising from in-house commercial kitchens.

Composting is an aerobic process that decomposes organic material into a nutrient-rich soil conditioner. Types of composting include backyard or onsite composting, vermicomposting, aerated windrow composting, aerated static pile composting and in-vessel composting

Anaerobic Digestion

In contrast, anaerobic digestion (AD) is the process by which microorganisms break down biodegradable material in the absence of oxygen. This waste management method can be adopted for both industrial and domestic purposes and in addition to disposing of the waste, anaerobic digestion can produce renewable energy from the captured biogas (a mixture of Carbon Dioxide and Methane) and fertilizer from the nutrient rich digestate

AD is a series of biological processes in which micro-organisms digest plant and/or animal material in sealed containers, producing biogas, which is a mixture of methane, carbon dioxide and other gases. The organic material left over, known as digestate, is rich in organic matter and nutrients such as nitrogen, phosphate and potash. Biogas and digestate are therefore both important outputs of AD and their uses are explained below. The difference between AD and composting is that anaerobic digestion occurs within containers in absence of oxygen, whereas composting, or aerobic digestion, requires oxygen.

Urban waste for AD may include:

- Lipid wastes, including fats, oils and greases;
- Simple carbohydrate wastes, including bakery waste, brewery waste and sugar based solutions;
- Complex carbohydrate wastes, such as fruit and vegetable waste and organic fraction of municipal solid waste (MSW);
- Protein waste, such as waste from abattoirs and dairy processing facilities; and
- Other waste from commercial and industrial facilities.

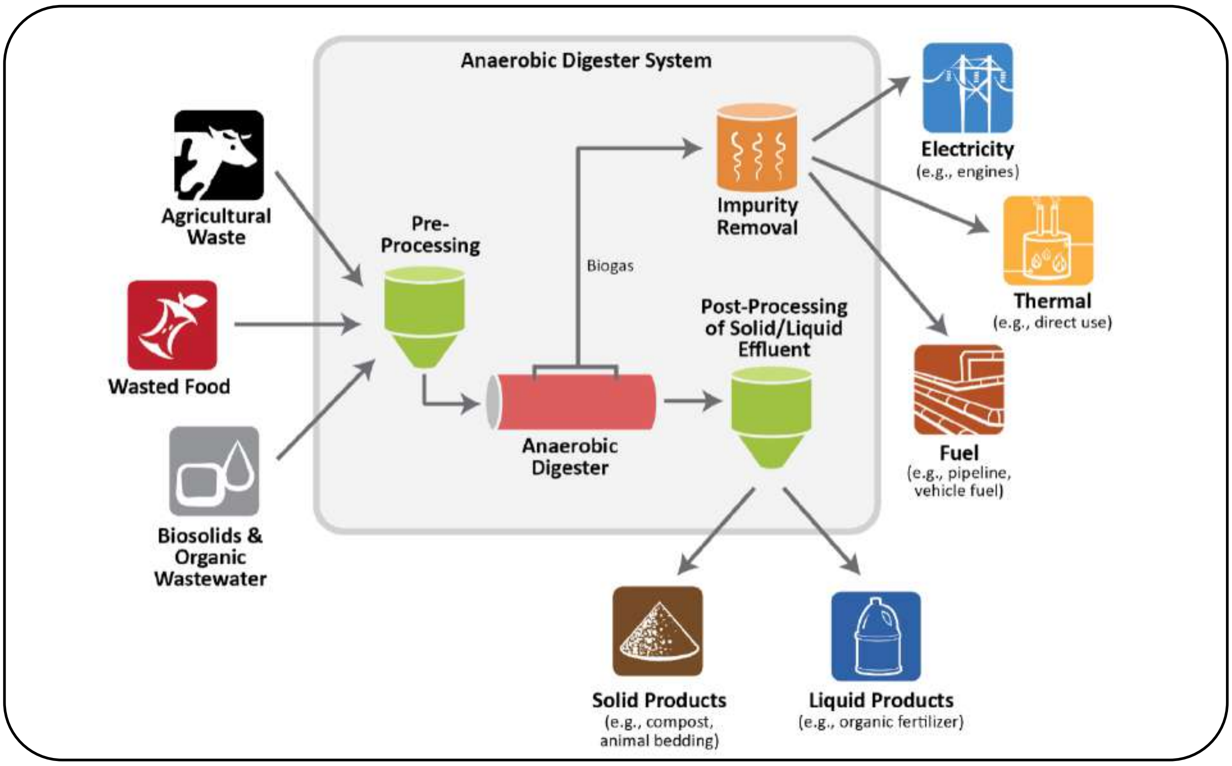

Figure 3: Anerobic Digester System

Understanding Digesters:

Many different types of anaerobic digesters are available. These vary in configuration, retention time, pre- and post-treatment requirements and operating temperature among other things, depending upon the principal feedstocks being treated. During AD, the breakdown of organic compounds is achieved by a combination of many types of bacteria and archaea (microbes). The biomass added to the digester is broken down into sugars, amino acids and fatty acids (hydrolysis), fermented to produce volatile fatty acids and alcohols (acidogenesis) followed by the conversion into hydrogen, carbon dioxide and ammonia and, finally methanogens produce biogas from acetic acid and hydrogen. These stages are shown in Figure below:

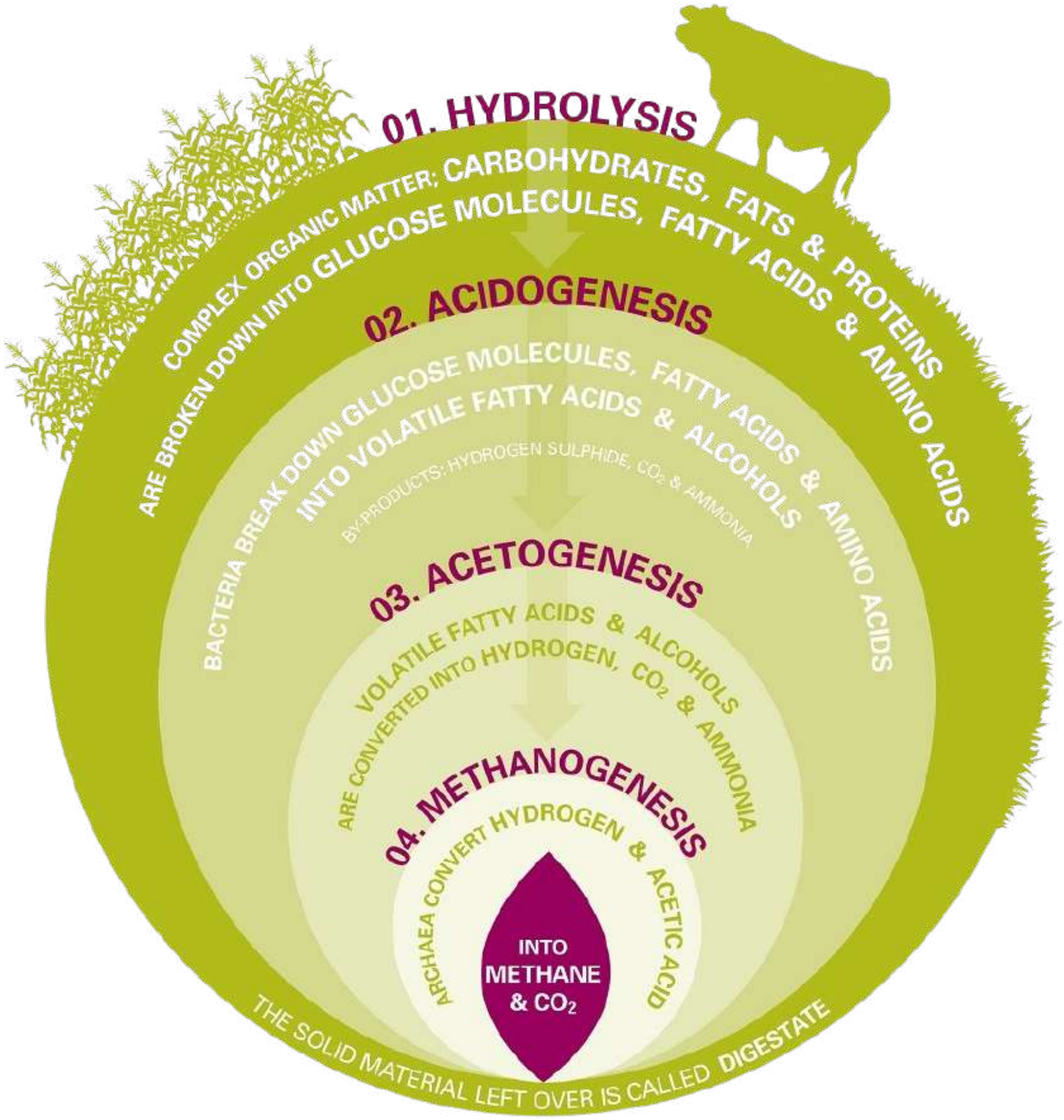

Figure 4a: Stages of Anaerobic digestion

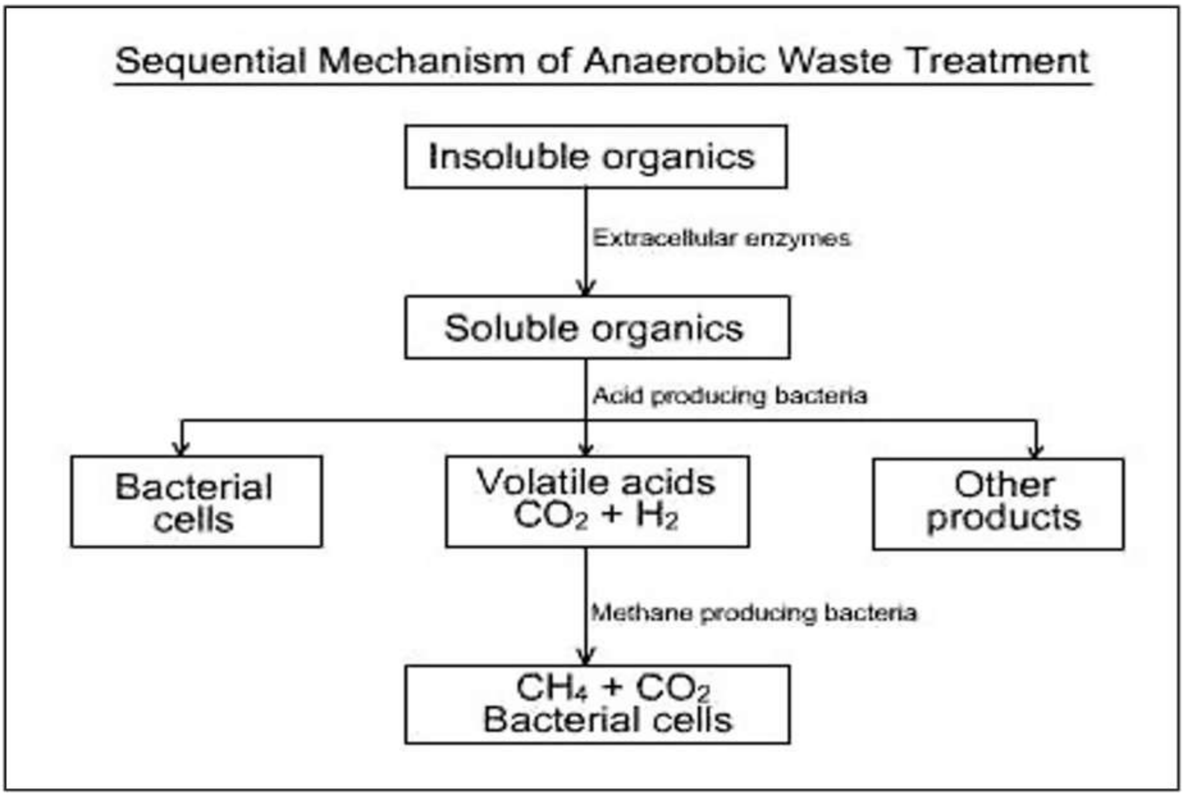

Figure 4b: Sequential mechanism of Anaerobic waste treatment

The anaerobic treatment of organic wastes resulting in the production of carbon dioxide and methane, involves two distinct stages. In the first stage, complex waste components, including fats, proteins, and polysaccharides are first hydrolysed by a heterogeneous group of facultative and anaerobic bacteria. These bacteria then subject the products of hydrolysis to fermentations, oxidations, and other metabolic processes leading to the formation of simple organic compounds, mainly short-chain (volatile) acids and alcohols.

The first stage is commonly referred to as "acid fermentation". However, in the second stage the end products of the first stage are converted to gases (mainly methane and carbon dioxide) by several different species of strictly anaerobic bacteria. This stage is generally referred to as "methane fermentation".

<u>Field Visit:</u> Anaerobic Sludge Digester used at Dinshaw's Dairy Food Products Pvt Ltd, Nagpur, installed by Sun Enviro Technologies Pvt Ltd, Nagpur

Sun Enviro is a multi-disciplinary consultancy and engineering organisation that offers complete solution for treating effluent or waste, water recycling and energy recovery and is based out of Nagpur, India.

Anaerobic Sludge Digester details:
Capacity: 40 M3/Day
Biogas generation : 800 – 900 m3/day

Actual site picture of Anaerobic Digester at Dinshaw's Nagpur

<u>In Conclusion:</u>

As a technology for food waste utilisation, AD is flexible, effective, and sustainable and contributes towards a circular global economy. Key advantages of Anaerobic technology are as follows:

- The energy input of the system is low as no energy is required for oxygenation
- Lower production of excess sludge (biological synthesis) per unit mass of substrate utilized
- Lower nutrient requirement due to lower biological synthesis
- Degradation leads to production of biogas which is a valuable source of energy