Biogas – A Boon for India

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Mankind learned to use biogas long time ago. Biogas – is gas produced by means of anaerobic fermentation of biomass. The mathematics of fertilizer makes a bio gas plant a self sustainable module. The bio gas plants in the agriculture sector hold the key to Energy Security of India. They have the capacity to reduce the demand of electric power, reduce the consumption of chemical fertilizer and also reduce global warming.

Mankind learned to use biogas long time ago. In 1-2 millennium B.C. some primitive biogas plants already existed in the territory of contemporary Germany. Alemans that inhabited wetlands of Elbe basin seemed to see Dragons in the marshes. They thought that fire gas that accumulated in marsh pits was bed smelling Dragon's breathe. In order to please the Dragon they threw offerings and food remnants to the marsh. People thought that Dragon comes in the night and pits were filled with his breath. Alemans came to the idea to cover the pits with leather blankets and made leather pipes that transported the gas to their homes for cooking. This is obvious as dry wood was difficult to find and gas (biogas) solved that problem perfectly.

Biogas – is gas produced by means of anaerobic fermentation of biomass. Biomass decomposition is made by methanogenic bacterium. Gas composition is methane 50%-65%, 25%-45% CO2, and some admixtures. Microorganisms metabolizing carbon from organic substrates in oxygen free conditions (anaerobically). This process is called rotten or oxygen free fermentation. Biogas is also known as sewage gas, mine gas, marsh gas, and methane or gobar gas in India.

Green House Gases (GHG) under the Kyoto Protocol

There are many gases that contribute to the green house effect. The Kyoto Protocol deals with six of them as mentioned in the below table.

Global Warming Potential

Green house gases affect global warming with varying intensities. This intensity is measured by the "global warming potential" of the gas. The global warming potential (GWP) of HFC-23 for example is 11,700. The GWP of carbon dioxide is one. One tonne of HFC-23 has 11,700 times more the green house effect that Carbon dioxide does.

Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140-11,700
Perfluorocarbons (PFCs)	7,000-9,200
Sulphur hexafluoride (SF_6)	23,900

Source : IPCC Third Assessment Report. 2001 Climate Change : The Scientific Basis. Intergovernmental Panel on Climate Change

Bio Gas Plant would serve many purposes such as: Environment friendly converting waste to energy, which is the need of hour. Generation of fairly good amount of fuel gas, which will reduce dependence on the dwindling energy resources. Generation of high quality manure, which is an excellent soil conditioner. This is very important for replenishing fast decreasing resources of productive soils. Biogas is a color less, odour less and inflammable gas. The gas generated in this plant can also be used as a source of natural gas. The production is about 0.25 to 0.35 cubic meters per kg of cake.

Production Plant of Bio-Gas – World capacity 2008

According to the United Nations' Food and Agricultural Organization (FAO), the world population of animals is 1.3 billion cattle, 1 billion sheep, 1 billion pigs, 800 million goats and 17 billion chickens

The waste the animals produce has 55 percent to 65 percent methane, which if released into the atmosphere is bad news for us (it traps heat at 21 times the rate that carbon dioxide does) but when burned is another matter entirely. It gives us energy.

62.5 liters of bio gas can be produced from one kilogram of cow manure (heated at around 28 degrees Celsius or 82.4 degrees Fahrenheit).

Indian Scene

India's human population is 120 crores. Majority lives in villages. Rural population - directly or indirectly - is associated with agriculture.

The agriculture economy as such has been dependent on animal power for its energy needs. A family owns 4 to 6 animals. Animals have been a part of family assets which provided all the energy needs of the family- milk for protein & fats, animal dung for cooking & fertilizer for agriculture and horses for transport and bullocks for farm power etc. This is how all the civilizations in the world have evolved over the ages. Industrial revolution is a part of present history.

In the new world also the basic need of the family remain unchanged- energy for food and agriculture. People initially used wood/ agriculture waste as a source of energy. When wood became scarce, emphasis shifted to coal. People in Europe started using coal for home heating and industry found it convenient to use. Coal is a fossil fuel. Industrial revolution brought steel, cement, power stations etc to lime light. Coal was the cheapest fossil fuel, so it found wide acceptance. The importance of sustainable future was lost.

The main point of reference is sustainable future – Energy Security. Fossil fuels for India are - coal, oil, gas. These have limited availability. India needs alternative source of energy which should be renewable, dependable and sustainable.

All civilizations – Rome, Egypt, Mohinjodaro- have depended on domestic animal power. Even the wars were fought on the might of animals- elephant, horse, camel etc. On energy front – for cooking of food – cake made out of animal dung was the source of energy in addition to agricultural waste.

The times have moved forward.

In India, the mechanization of agriculture started in sixties through farm machineries, water pumps sets and chemical fertilizers in a big way. With the onset of machines, the concept of agriculture changed. Initially Indian economy was agriculture based through manual labor. All activities of agriculture – ploughing the field, water pumping, harvesting the crop, thrashing the produce and even transporting the produce to market for selling- derived energy from animal's power. The writer is a witness of all these activities and has participated in all these activities. There used to be a kind of joy to see the final produce in the home. The farmer used to grow food for the family The surplus was sold to the market to generate cash. There was hardly any input cost except labor.

The mechanization of agriculture changed the scenario. The input cost of agriculture came into being. The farmer now needs to pay for the use of machines, diesel and electricity also which were missing earlier. They are now a part of input cost. Add to this cost of seeds, fertilizer and insecticides. Any increase in the cost of diesel and fertilizer puts a pressure on the input cost of agriculture. Now the farmer grows crops which can provide better returns (financial term of business) to meet increased input cost. The choice of crop is determined by the market and not by the farmer. Mechanization has created a situation when fodder – animal feed- has become scarce. Oxen are no longer required as they became redundant. Cows and buffalos – natural provider of milk, protein, calcium and carbohydrates- are no longer considered as family asset. This change of culture – from animal based agriculture to mechanized agriculture - should have reduced the total number of animals in India. Fortunately that has not been the case. Rather the numbers have still been growing upwards. Following graph is an indication of the same. There are 529.7 million animals in 2010[2] as compared to 300 million in 1950. These animals are in rural India only as urban population is not allowed to keep animals.

Villagers are keeping more domestic animals than before as is clear from the above graph. Tractors and trolleys are the automatic choice and the norm in rural urbanized villages. In 1961 the population of live stock was 335.4 million of which 51 million were buffaloes. The numbers went up to 510.2 million in 2007 of which 102.4 million were buffaloes. There is a 100% increase in the number of buffaloes in 46 years. The milk production went up by 100% from 51.4 million tons in 1989-90 to 112.5 million tons in 2009-10.

The cost of fertilizer, insecticides, electricity, machines etc. are major cost input of present day agriculture. They cost about 80% of the produce. The farmer is left with only 20% of his produce as his income on which he has to sustain his family.

Current Usage of animal dung

Currently the practice in rural area is to make cake out of animal waste. People dry it in the open and use it to cook food by burning.

A small joint family of a farmer which has four animals will get 40 Kg of animal waste daily. Add to this agriculture and kitchen waste. This mixture will provide 0.8 M3 of pure gas. This amount of gas will burn one burner for two hours. The quantity and quality of cooking gas is sufficient and meets his complete requirements.

The Mathematics of Fertilizer

A normal farmer has a land of about 5 hectares. He needs 135.3 Kilogram per hectare. The farmer shall consume not more than 676.5 kilograms of fertilizer in his fields. The rest (13.2 Tons) is available for sale which will bring him additional income. With these equations, agriculture turns into a profitable proposition.

Let us examine the issue from different perspective. As per the statistics of Government of India the total consumption of fertilizer in the country is as follows:

Nitrogen	15090.5 Metric Tons
Phosphorous	6506.2 Metric Tons
Potassium	3312.6 Metric Tons
Total	**24909.3 Metric Tons**

13.87 Tons per year is available from four animals which means 3.65 tons per year of fertilizer per animal. Hence we need 6824466 i.e. 6.8 million animals – which is 1.29% of the total population of animals in India- to generate the total desired quantity of fertilizer needed for Indian agriculture. It is already mentioned above that India has about 529.7 million animals. It is clear that if farmer in the village generate biogas for cooking and uses the home produced fertilizer, he does not need to buy fertilizer from the market. This reduces the input cost of agriculture. On the other hand he has surplus fertilizer for the market which brings him more cash. The easy availability of organic fertilizer at comparatively cheaper rates will discourage the usage of chemical fertilizer. This move will save huge amount of electricity used for manufacturing chemical fertilizer.

Bio gas is a boon for India

One meter cube bio gas plant costs about Rs.20000/-($ 444). This plant is sufficient for the animal waste from 4 animals and some kitchen waste. The farmer also gets 38 Kilogram of organic fertilizer per day i.e 13.87 metric tons per year. This fertilizer is at no cost. At Re.1/- Kg the cost of this fertilizer is Rs. 13870/-($308). This is the earning of the farmer which was earlier missing. The original investment is recoverable in less than 24 months. In addition there will be reduced usage of electricity for pumping and reduction in water usage.

If we consider output from waste of 529.7 million animals,

Direct benefits
Export of organic Fertilizer worth $436 billion at international price.
Saving of subsidy amount of $18 billion at current rates withdrawn.
Cost of bio gas produced is $286 billion at domestic prices.
Total benefit = $790 billion per year.

Note: India achieved exports of $300 billion in 2011 and targets $500 billion by 2015.
Bio Gas can accelerate exports.

Collateral Benefits
Agriculture becomes profitable venture.
80% of population rises above poverty line.
The economy grows at a faster pace and pushes many into middle class.
Biogas holds promise of sustainable future for India & humanity.

References

[1] Economic Survey 2010-11
[2] Agriculture Statistics at a Glance 2009, Publication Division, Directorate of Economies & Statistics
[3] Alexender H., in A Hollender, Trends in the biology of fermentation for fuels and chemicals, Ed Plenum Press, New York, Vol 18, p 126-127 and 155, 1981.