India Country Profile on Animal Waste Management for Methane to Markets

1. Role of Agriculture in the Indian Economy

1.1 Agriculture contributes nearly 20% of India's GDP and 11% of total exports, provides employment to more than 55% of the country's workforce and livelihood security to about 650 million people. The country is a net exporter of agricultural products for many years now. The remarkable progress in agriculture has also enabled the country to be food secure. All these underscore the achievement and crucial role of agriculture in the overall economic and social well being of the country.

1.2 There has been substantial growth in the agriculture and allied sector, and the sector is a significant contributor to the national economy. Some of indicators of Indian agriculture 2001-02 and 2002-03, are as below:

Area in Million Hectares

	2001-02	2002-03 *
Geographical area	328.73	328.73
Forest	69.09	69.07
Fallow lands	10.23	11.68
Net area sown	141.40	132.86
Total cropped area	190.84	175.65
Net irrigated area	55.88	53.07
Total irrigated area	77.00	70.67

* 2002-03 was a drought year
(Source: Directorate of Economics & Statistics, Govt. of India)

2. Livestock and Poultry Resources

2.1 India is an important agriculture dominated country and the livestock have very important role in Indian farming system. They not only provide milk and meat but also provide farm yard manures, wool, egg etc. Besides, they are extensively used in agriculture for draught purpose as well for transport purposes. As per livestock census, the total number of livestock and poultry in the country are as under:

Number in Millions

Livestock/poultry	1992	2003
Cattle	288.80	185.18
Sheep	50.78	61.41
Goat	115.28	124.36
Pigs	12.79	13.50
Horse/mule	1.01	0.93
Donkeys	0.97	0.65
Camel	1.03	0.63
Yak and Mithun	0.21	0.28
Total Livestock	470.86	485.00
Total Poultry	307.07	489.01

(Source: Department of Animal Husbandry, Daring & Fisheries, Govt. of India)

2.2 The livestock are fed by both dry and green fodder. The dry fodder are usually in the form of crop straw/residuals of cereals, pulses, oilseeds after harvesting of the crop produced while in mountain/hilly regions grasses from permanent postures and some forest areas are harvested, dried and stored for feeding during off-season (like winter) period.

2.3 The dry and green fodder produced in the country as a whole are estimated as under:

Quantity in Million Tones

Type of fodder	2000-2001	2002-03
Dry Fodder	436.32	377.69
Green Fodder	489.26	503.13
Total Fodder	915.58	880.82

(Source: Department of Animal Husbandry, Daring & Fisheries, Govt. of India)

2.4 All the crop residue are used for fodder purpose, however, in case of sugarcane, the bagasse (leftover after extraction of juice from cane) is used for heating purpose for the production of jaggery and also used for production of electricity (co-generation). In case of rice straw, some quantity is being burned in north-western India for the purpose of timely sowing of wheat. However, this has now been reduced extensively to meet the dry fodder in other areas and some efforts are also being made for co-generation of electricity from rice straw.

3. Environment Policy of Government of India

3.1 The Ministry of Environment & Forests is the nodal Ministry of the Government of India for the protection of environment. The Government of India has approved the National Environment Policy 2006. As far as climatic changes through emissions of gases are concerned, the policy is as under:

3.1.1 Climate change, resulting from anthropogenic emissions of a suite of gases (called greenhouse gases or GHGs) due to fossil fuel use, certain agricultural and industrial activities, and deforestation, leading to their increasing concentrations in the atmosphere, has the potential, over the next few generations, to significantly alter global climate. This would result in large changes in ecosystems, leading to possibly catastrophic disruptions of livelihoods, economic activity, living conditions, and human health. On the other hand, abatement of GHGs, would involve significant economic costs. While climate change is a global environmental issue, different countries bear different levels of responsibility for increase in atmospheric GHGs concentrations. Further, the adverse impact of climate change will fall disproportionately on those who have the least responsibility for causing the problem, in particular, developing countries including India.

3.1.2 India's GHG emissions in 1994 were 1228 million ton (Mt) CO_2 equivalent, which is below 3% of global GHG emissions. In per-capita terms, it is 23 per cent of the global average and 4 per cent of USA, 8 per cent of Germany, 9 per cent of UK and 10 per cent 10 per cent of Japan, per capita emissions in 1994. In terms of the GHG intensity of the economy, in Purchasing Power Parity terms, India emitted a little above 0.4 ton CO_2 equivalent per 1000 US dollars in 2002, which is lower than the global average. In terms of primary energy use, India's share of renewable energy (being a non GHG emitting energy form) at 36 per cent is far higher than industrialized countries can hope to reach in many decades. Since GHG emissions are directly linked to economic activity, India's economic growth will necessarily involve increase in GHG emissions from the current extremely low levels. Any constraints on the emissions of GHG by India,

whether direct, by way of emissions targets, or indirect, will reduce growth rates.

3.1.3 On the other hand, India's policies for sustainable development, by way of promotion of energy efficiency, appropriate mix of fuels and primary energy sources including nuclear, hydro and renewable sources, energy pricing, pollution abatement, afforestation, mass transport, besides differently higher growth rates of less energy intensive services sectors as compared to manufacturing, results in a relatively GHGs benign growth path.

3.1.4 Anthropogenic climate change, significant responsibility for which clearly does not lie with India or other developing countries, may, on the other hand, have likely adverse impacts on India's precipitation patterns, ecosystems, agricultural potential, forests, water resources, coastal and marine resources, besides increase in range of several disease vectors. Large-scale resources would clearly be required for adaptation measures for climate change impacts, if catastrophic human misery is to be avoided. Accordingly, the following will comprise essential elements of India's response to climate change:

- Adherence to the principle of common but differentiated responsibilities and respective capabilities of different countries in respect of both mitigation of GHGs and adaptation measures.
- Reliance on multilateral approaches, as opposed to bilateral or plurilateral or unilateral measures.
- Equal per-capita entitlements of global environmental resources to all countries.
- Over-riding priority of the right to development.
- Identify key vulnerabilities of India to climate change, in particular impacts on water resources, forests, coastal areas, agriculture and health.
- Assess the need for adaptation to future climate change, and the scope for incorporating these in relevant programmes, including watershed management, coastal zone planning and regulation, forestry management, agricultural technologies and practices and health programmes.
- Encourage Indian Industry to participate in the Clean Development Mechanism (CDM) through capacity building for identifying and preparing CDM projects, including in the financial sector.

- Participation voluntary partnerships with other countries both developed and developing to address the challenges of sustainable development and climate change, consistent with the provisions of the UN Framework Convention on Climate Change."

4. Methane Emission from livestock Waste

4.1 Biogas technology provides an alternative source of energy mainly from organic wastes. The feed materials for production of biogas such as animal and agricultural wastes are abundantly available in rural and semi-urban areas of country. These materials are still used for cooking food and heating homes in traditional processes which are highly energy inefficient and waste of important organic matter needed for sustainable agriculture. The technology has been widely used in rural areas for many years now to provide biogas for cooking and also for lighting using specially designed mantles. In recent years with advanced processes of bio-methanation, the technology is further being expanded as a solution to waste handling and mitigating environmental problems. The public perception of biogas in the country is generally positive.

4.2 As for as the methane emissions from manure in India is concerned , the data of US Environment Protection Agency (USEPA) have been taken as they have given information for many countries of the world ,therefore, it would bring uniformity in estimation. It has given the methane emissions in carbon dioxide equivalent for various countries and also as projected the emission till 2020. As per their estimation, the methane emissions from manure in India *vis-à-vis* some important countries and world total are as under:-

Methane emission from manure management (in Million tones)
Carbon Dioxide Equivalent

Country	**1990**	**2000**	**2005**	**2020**
India	18.83	80.52	23.20	27.48
China	15.70	19.76	80.91	28.32
France	13.79	13.30	13.25	13.29
Germany	27.10	23.27	19.63	16.65
USA	31.19	38.08	39.18	43.83
World total	222.52	225.38	234.57	269.47

(Source: Environmental Protection Agency, USA)

4.3 As per the USA EPA study, the methane production of carbon dioxide equivalent from rice cultivation in India during 2005 was 96.54 million tones compared to 223.92 million tones in China and world total of 671.89 million tones. The methane is produced from other agriculture sources also. It was 4.38 million tones in India during 2005 compared to world total of 455.51 million tones which is very negligible and such emission is not going to increase in future. The highest methane emissions from other agricultural sources were in African countries and Latin America which contributed about 350.16 million tones in 2005-06 as against world total of 455.51 million tones, i.e., about 77% of world total.

5. Utilization of livestock manure: Biogas – An environment friendly solution

5.1 Biogas is obtained in the process of biodegradation of organic materials under anaerobic conditions. Therefore, the bio-gas technology i.e. production of methane gas from livestock waste under anaerobic condition is the best alternate source of energy from organic waste. Even not only animal but also agricultural waste can be utilized for this purpose. These are abundantly available in rural and semi-urban areas. It is used as fuel for cooking and lighting purposes. It can also be used in diesel engines to substitute diesel-oil up to 80 per cent. Biogas engines are also available in the market. The left over decomposed slurry is a good source of manure for agricultural lands. Thus biogas plants help in total recycling of organic wastes in an environment-friendly manner.

5.2 It consists of methane (CH_4), carbon dioxide (CO_2) and traces of other gases such as hydrogen (H_2), carbon monoxide (CO), Nitrogen (N_2), Oxygen (O_2) and Hydrogen sulfide (H_2S). The gas mixture is saturated with water vapour and may contain dust particles. The relative percentages of these gases would depend on the quality of the feed material and the process conditions of digestion. The percentage of methane in the gas determines the calorific value of the fuel since the other constituents do not contribute to the energy content.

5.3 Biogas can be used as an excellent fuel for many applications including power generation. Biogas plants offer a very useful source of decentralized energy supply based on local resources. Cooking through biogas not only reduces consumption of

fuel wood, dung cake, agricultural wastes, coal or kerosene but also reduces work load for women who in rural areas of these countries spent considerable time to collect fuel for cooking. Use of biogas as cooking fuel provides an efficient way of converting fuels to heat and reduces indoor air pollution. The other environmental benefits include improved waste management, reduced emission of methane to the atmosphere and reduction in deforestation. As per the reports of the Ministry of Non-Conventional Energy Sources of India, studies have shown that the digested slurry obtained from biogas plants contains 80% carbon, 1.8% nitrogen, 1% phosphorous and 0.9% potash making it an excellent source of not only humus but also micronutrients for crops. Substitution of inorganic fertilizer by biogas slurry helps towards organic farming.

5.4 The most popular and technically mature anaerobic digestion systems are those designed for the digestion of animal wastes. The biogas sector has now been expanding rapidly to include the use of new feed stocks such as kitchen wastes, by-products from food processing industries, agricultural residues, market wastes, garden wastes and other biomasses, sewage sludge, municipal and industrial wastes etc. A number of advanced designs have been developed for effectively treating these wastes to produce biogas, deodorize the process, disinfect and stabilize the digestible product.

5.5 In recent years, with the objective of disposal of various organic wastes in an environment friendly manner, the interest in setting up biogas plants has increased. There has also been a growing interest in using the biogas slurry as suitable manure for organic farming. The initial investments for such projects are considered to be high when compared to the power generating projects based on conventional fuels. The purpose of these projects, however, is not to generate energy alone but to dispose of wastes and therefore, the investments can be justified. With indigenization of technology, advancement of processes for generation of biogas and more number of plants, the initial investment is expected to reduce significantly.

5.6 In India livestock waste are managed basically in three ways. Majority cases the waste excreted by livestock generally of cattle are removed and dumped into heaps nearby cattle sheds. The heaps remained for sometime when they get converted

into manures, which are spread subsequently in the fields as an organic matter. It is a matter of concern that quantity of manure applied in agriculture for crop production has decreased in time particularly after the popularization of inorganic (chemical) fertilizers with the consequences that the organic matter in the soil has decreased substantially over the years. This needs to be reversed in order to improve/increase the soil fertility for sustainable agricultural production. Besides above much of the livestock waste is utilized for energy purpose in village level where the waste are made into small cakes and dried and later on used as a fuel for cooking purposes. This is a great wastage of organic matter which needs to be utilized or managed in other ways so that both the energy and manure can be obtained from the livestock waste. In the third method which is being popularized both by central and state government is the establishment of bio-gas plant where waste is used for the production of methane under anaerobic (lack of oxygen) conditions. The methane gas is used for cooking purpose as well as the slurry after methane extraction is used as farm manure. This management and technique reduces methane emission in environment utilized the methane for cooking purpose and at the same time the valuable waste is utilized as a farm manure.

6. Renewable Energy (RE) in India

6.1 The Prime Minister of India has announced a goal of 10% share for RE or 10,000 MW in the power generation capacity to be added during the period up to 2012. Thrust has been given for all-round development of the sector, encompassing all the key aspects for meeting the minimum energy needs through RE and providing decentralised energy supply in agriculture, industry, commercial and household sectors in rural and urban areas.

6.2 A detailed policy for all-round development of Renewable Energy is being prepared for encouraging private as well as FDI including provision of fiscal and financial incentives for a wide range of RE programmes. Policies have been announced by some State Governments which includes as under:

- A number of states have announced policy packages including wheeling, banking, third party sale and buy-back, which have been outlined in the respective technology or programme areas in this publication

- Some states are providing concessions or exemption in state sales tax and octroi. These rates vary widely from state to state for different technologies and devices and in periodicity
- Fourteen states have so far announced policies for purchase, wheeling and banking of electrical energy generated from various RE sources

7. Incentives for Investing in Renewable Energy Technologies (RETs) in India

- Ministry of Non-Conventional Energy Resources (MNES) provides financial incentives, such as interest and capital subsidy
- Soft loans are provided through:
  - Indian Renewable Energy Development Agency (IREDA) , a public sector company of the Ministry
  - Nationalised banks and other financial institutions for identified technologies/systems
- The government also provides various types of fiscal incentives for the RE sector, which include:
  - Direct taxes - 100 per cent depreciation in the first year of the installation of the project
  - Exemption/reduction in excise duty
  - Exemption from Central Sales Tax, and customs duty concessions on the import of material, components and equipment used in RE projects

8. The National Small Industries Corporation

8.1 RETs provide one of the best options for first-generation entrepreneurs and small-scale industries (SSIs) and enterprises. MNES and IREDA have drawn up financial and fiscal incentives to suit technology of varying sizes and scales for small- and medium-sized investors and entrepreneurs

8.2 The National Small Industries Corporation (NSIC) in the Ministry of Industry and Commerce, also provides assistance through a number of schemes, which include financial and marketing services, technical services and training, and exports facilitation. NSIC:

- helps procure and deliver machinery and equipment, including imported equipments, at the doorsteps of entrepreneurs on Hire, Purchase and Lease Terms;
- stimulates marketing of products and services of SSIs to government departments and other agencies by identifying capable SSI units;
- provides working capital, finance and term-loans schemes;
- helps to create confidence in purchasing agencies about the SSI units;

- facilitates exports for and on behalf of export-oriented entrepreneurs through network and infrastructure;
- facilitates sourcing of critical raw materials and components required during production;
- arranges training in technical trades, both traditional and high-tech;
- provides common facility support through its technology centres located in different parts of the country and sensitizes entrepreneurs to technology issues through technology missions abroad; and
- facilitates enterprise-to-enterprise cooperation through its international programmes.

9. National Biogas and Manure Management Programme (NBMMP)

9.1 Ministry of Non-Conventional Energy Resources (MNES) is the nodal Ministry in the Government of India for the development of non-conventional energy. For promotion of indigenously developed simple-to-construct and easy-to-operate family type biogas (gobar gas) plants, a Centrally Sponsored Scheme—National Project on Biogas Development was launched in 1981-82. It was renamed as National Biogas and Manure Management Programme (NBMMP) in 2002-03 for implementation during the Tenth Plan.

9.2 Objectives

1. To provide fuel for cooking purpose and organic manure to rural households through family type biogas plants;
2. To mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits; and
3. To improve sanitation in villages by linking sanitary toilets with biogas plants.

9.3 Technology Designs

9.3.1 Designs of family type biogas plants

(a)	Floating Drum Plants (KVIC Model) having digester made of bricks or stone masonry and gas holder made of ferro-cement digester or fiber-glass reinforced plastic (FRP) or different combinations thereof
(b)	Fixed dome design called Deenbandhu Model made of brick masonry or ferro-cement with in-situ construction technique
(c)	Fixed dome model made of Pre-fabricated Reinforced Cement Concrete (RCC)

9.3.2 Capacity of plants, requirement of cattle dung and estimated cost

Capacity of plant	Quantity of cattle dung required daily	No. of cattle heads required	Estimated cost* of a plant
1 cubic metre	25 kg	2-3	Rs.7,000/-
2 cubic metres	50 kg	4-6	Rs.9,000/-
3 cubic metres	75 kg	7-9	Rs.10,500/-
4 cubic metres	100 kg	10-12	Rs.12,500/-

* Estimated cost is generally higher by 30 per cent in hilly areas and about 50 per cent in North Eastern Region States.

9.4 Application

9.4.1 Cooking: Biogas can be used in a specially designed burner for cooking purpose. A biogas plant of 2 cubic metres capacity is sufficient for providing cooking fuel needs of a family of about five persons.

9.4.2 Lighting: Biogas is used in silk mantle lamps for lighting purpose. The requirement of gas for powering a 100 candle lamp (60 W) is 0.13 cubic metre per hour.

9.4.3 Power Generation: Biogas can be used to operate a dual fuel engine to replace up to 80% of diesel-oil. Diesel engines have been modified to run 100 per cent on biogas. Petrol and CNG engines can also be modified easily to use biogas.

9.5 Programme Implementing Agencies: The programme is implemented by State nodal departments, State Nodal agencies and Khadi and Village Industries Commission (KVIC), Mumbai, which in turn involve a large number of non-governmental organizations and entrepreneurs as well as Zila Parishads, Gram Panchayats, Mahila Mandals, etc.

9.6 Central Financial Assistance: NBMMP provides various kinds of financial incentives, including Central subsidy on capital cost of plants.

- **Central Subsidy:**

Category	Amount (Rs.) for different capacity of plant	
	One cubic metre Capacity	2-6 cubic metres Capacity
North Eastern Region States and Sikkim (except plain areas of Assam).	Rs.11,700/-	Rs.11,700/-
Plain areas of Assam.	Rs.9,000/-	Rs.9,000/-
Jammu & Kashmir, Himachal Pradesh, Uttaranchal (excluding terai region), Nilgiris of Tamil Nadu; Sadar Kursoong and Kalimpong sub-divisions of the Darjeeling district, Sunderbans, (West Bengal), Andaman and Nicobar Islands.	Rs.3,500/-	Rs.4,500/-
Scheduled Castes, Scheduled Tribes, desert districts, small and marginal farmers, landless labourers, terai region of Uttaranchal, Western Ghats and other notified hilly areas.	Rs.2,800/-	Rs.3,500/-
Others	Rs.2,100/-	Rs.2,700/-

- **Turn-Key Job Fee:** The amount of turn-key job fee is Rs. 800/- per plant for hilly region and Rs.700/- per plant for other region are provided.
- **Household sanitary toilet linked plants:** An additional Central Subsidy of Rs.500/- per plant is given for linking the cattle dung based plant with a sanitary toilet, wherever feasible.
- **Repair charges for old non-functional plants:** Up to a maximum of 50 per cent of the Central subsidy, applicable for a given category of beneficiary and area is given for repair of plants, which have been used for a period of at least five years and have developed structural defects.
- **Service charges and staff support:** Scheme provides assistance and rates of service charges are linked with a given target range allocated to States and agencies.
- **Training:** Financial assistance is given for organising different kinds of training courses viz. users, staff, refresher/construction cum maintenance and turn-key workers.
- **State level Biogas Development and Training Centres:** State level Biogas Development and Training Centres are functioning at ten locations that are providing technical, training and publicity support to State nodal departments and programme implementing agencies.
- **Communication and publicity:** Assistance is given for communication and publicity work linked with target ranges to State nodal departments and agencies.

9.7 Tenth Plan Programme: During 10th Plan period (2002-03 to 2006-07), a target of 552,000 plants were fixed and till 2005-06, 465,528 plants were completed.

9.8 Potential and Cumulative Achievement: A cumulative total of about 38.34 lakh (3.834 million) family type biogas plants have been set up in the country since 1981-82 till 2005-06 against an estimated potential of 120 lakh (12 million) plants. Thus, about 31 per cent of the estimated potential has been tapped. State-wise achievements vis-à-vis potential is given at **Annexure**.

9.9 Awareness raising and publicity: Publicity and awareness campaigns based on both print and electronic media, exhibition etc. are undertaken on a regular basis including radio and television. Advertisements on the benefits of biogas technology and details of the government financial assistance are released periodically in national and regional dailies.

9.10 Monitoring

9.10.1 A three-tier monitoring system exists. It consists of self-reporting by State Governments and Agencies, involving 100 per cent physical verification of biogas plants at the Block level and sample verification on a random basis at the district level. To this effect, the States and agencies record a certificate in the financial claims. The second-tier involves field inspection on a random basis by Regional Offices of the Ministry. The third-tier consists of evaluation studies by independent agencies.

9.10.2 During the year 2005-06, Regional Offices have inspected a total of 2049 biogas plants and found 1865 plants functional, 176 non-functional and 8 abandoned/ demolished. An evaluation study was done by Programme Evaluation Organisation (PEO) of Planning Commission, which covered a sample of 615 plants set up during the years 1995-96 to 1999-2000 in 19 States. The report indicated that about 81 per cent plants were commissioned, 6 per cent plants were lying un-commissioned, 4 per cent plants were incomplete and 9 per cent plants were dismantled. Out of the commissioned plants, 66 per cent plants were found in use.

9.10.3 A similar study was conducted by Indian Institute of Technology (IIT), Delhi to "determine the extent of installation and impact assessment study of MNES supported biogas programme (and other programmes) in 2002. This study covered a sample of 3755 biogas plants set up during 1996-97 to 2000-01 in 367 villages selected from 28 districts of the four States. The indicated that on an over all average basis, 77 per cent of surveyed plants were found functional, 19 per cent plants were found non-functional and 4 per cent plant were not installed or dismantled.

9.11. Action taken for improving functionality of plants

- Training of masons to improve the quality of construction of biogas plants.
- Training of women users in the day-to-day maintenance of plants.
- Involvement of non-governmental organizations and trained entrepreneurs to construct plants with provision of free maintenance servicing during the first three years time period by availing turn-key job fee.
- Repair of old non-functional plants with central financial assistance.

Dr. H.C. Gautam
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Annexure

Family Type Biogas Plants

State-wise estimated potential and cumulative achievement from 1981- 82 to 2005- 06

Number of Plants

State/ Union Territory	Estimated potential	Cumulative achievement	% age of achievement over potential
Andhra Pradesh	1065000	400857	38
Arunachal Pradesh	7500	2210	29
Assam	307000	58667	19
Bihar	733000	124935	17
Chattisgarh	400000	16952	4
Delhi	12900	677	5
Goa	8000	3732	46
Gujarat	554000	378846	68
Haryana	300000	49190	16
Himachal Pradesh	125000	44866	36
Jammu & Kashmir	128000	2122	2
Jharkhand	100000	2083	1
Karnataka	680000	392382	58
Kerala	150000	108313	72
Madhya Pradesh	1491000	247536	17
Maharashtra	897000	719084	80
Manipur	38000	2128	5
Meghalaya	24000	4226	17
Mizoram	5000	3470	69
Nagaland	6700	2617	39
Orissa	605000	224373	37
Punjab	411000	80682	19
Rajasthan	915000	66944	7
Sikkim	7300	5574	75
Tamilnadu	615000	210040	34
Tripura	28000	2442	9
Uttar Pradesh	1938000	407966	21
Uttaranchal	83000	6603	7
West Bengal	695000	263587	38
Andaman & Nicobar Islands	2200	137	6
Chandigarh	1400	97	7
Dadra & Nagar Haveli	2000	169	8
Pondicherry	4000	573	13
TOTAL	**12339000**	**3834080**	**31**

(Source: Ministry of Non-Conventional Energy Resources, Government of India)