Biogas Manure (BgM) : a viable input in sustainable agriculture – an integrated approach

G.Vasudeo,
Secretary Vivekananda Kendra -NARDEP, Kanyakumari, Tamil Nadu, India

Biogas dissemination in the last forty years has realized cumulatively only about 30 percent of India's total national potential. While the potential is estimated to be 12 million biogas plants of 2 cubic metre, the installed plants number only 3.7 million plants as on March 2004[1]. Nevertheless this cumulative installation of the biogas plants has achieved only 30 percent of the potential over the period of almost forty years.

The major bottle-neck faced by the Biogas technology in its dissemination and integration, is the unfavorable cost-benefit analysis done in conventional manner. For example a study of biogas plants, concludes that in terms of quantifiable monetary ('real economic') benefits and costs, the biogas plants programme resulted in annual monetary saving of Rs 128 million as against the annual cost of Rs 150 million[2]. However if the analysis is to take into account the conservation of trees, externals such as pollution, improvement in the health of women folk, use of Biogas slurry as manure and its replacement of energy intensive chemical fertilizers, improvement of soil quality by the use of Biogas slurry application etc. then the scenario will provide a more complete picture[3].

It is in this context that the promoting of Biogas Manure (BgM) based sustainable farming technologies becomes important in the dissemination of biogas technology. The late renowned Gandhian economist J.C.Kumarappa noted this important dimension of biogas technology half a century ago and stated that digested slurry which comes out of the biogas plant is more important than the gas itself which is used for cooking purposes.

Chemical Agriculture – Consequences:

The energy-intensive chemical-input based agriculture has produced more negative consequences than the problems it is said to have solved. The Global warming, micro-nutrient erosion of the soil, nitrification of ground water, pesticides entering the food chain etc. are some of the well known consequences we face as a result of chemical-based agriculture. The scenario is further complicated by the increasing cost of nitrogenous fertilizers which is often hidden in the form of subsidies by governments of the developing countries. This is accepted by a multinational nitrogenous fertilizer producer who says that "Nitrogen fertilizer production uses natural gas as a raw material. As well the process requires a lot of heat which may also be supplied by natural gas. With natural gas prices having increased dramatically over the past year, nitrogen costs are expected to increase by 30 percent" [4]. But it remains as fact that there is need to increase the fertility of soil and increase the crop production to feed the growing populations of developing countries. All these factors make BgM very relevant as an input to sustainable agriculture

BgM and its features:
Biogas Manure (BgM) is a by-product obtained from the biogas plant after the digestion of dung or other biomass for the generation of methane rich gas. BgM Supplies essential nutrients; enhances water holding capacity and soil aeration; accelerates root growth and inhibits weed seed germination.

Types of BgM:
Three types of BgM have been identified. They are Liquid BgM, Semi-dried BgM and Dry BgM.
Of these Liquid BgM has the following features:

- Solid content: 6 percent
- pH value: 8 to 9 [alkaline]
- Nitrogen: 1.8 percent. This is in the best form for usage.

Semi Dried BgM has the following features:

- Solid content: 15-20 percent
- pH value: 7 to 9 [neutral to alkaline] This is the second best form for usage.

Dry BgM has the following features:

- Solid: 20-30 percent
- pH value: 7-8
- Has micro-nutrients
- Less nitrogen. If this BgM is sun-dried then there will be loss of nutrients.

Apart from its advantages over chemical fertilizers, BgM has proven superiority in its nutrient content with respect to other manures also. The fermentation process reduced by C/N ratio by removing some of the Carbon thus increasing the fertilizing effect. This is shown in the following table:

Table-1: Comparison of nutrient status of the different organic manures with BgM

Sl.No	Manure	N_2 Percent	P_2O_5 Percent	K_2O Percent
1.	Fresh Cattle Dung	0.3-0.4	0.1-0.2	01.-0.3
2.	Farmyard manure	0.4-1.5	0.3-0.9	0.3-1.9
3.	Compost	0.5-1.5	0.3-0.9	0.8-1.2
4.	Poultry manure	1.0-1.8	1.4-1.8	0.8-0.9
5.	Cattle Urine	0.9-1.2	Trace	0.5-1.0
6.	Paddy straw	0.3-0.4	0.8-1.0	0.7-0.9
7.	Wheat straw	0.5-0.6	0.1-0.2	1.1-1.3
8.	BgM	1.5-2.5	1.0-1.5	0.8-1.2

Source: Regional Centre for Biogas development IIT, Kharagpur, India State: W. Bengal

The study of BgM application in the North Eastern state of India, Assam in the crop maize has also resulted in encouraging results in improving the plant parameters.

Table-2: Comparison of impact of Urea and BgM in crop parameters of Maize

Treatments	Plant height (m)	Plant dry weight (g/plant)	Cob weight (g/cob)
Urea	2.10	216	188
BgM	2.14	249	263

Source: AAU Jorhat. State: Assam

BgM is also found to be a very good nutrient input to horticultural crops. Tests have been carried out on tomato (Lycopersicon esculentum)by Sree Parasakthi college for women, Courtallam, Tamil Nadu and the results are tabulated below:

Table-3 Comparison of fruit yields in tomato (Lycopersicon esculentum) when treated with BgM

Sl.No:	Treatment	Fruit Yield (kg/Plot)
1.	BgM	9.9
2.	BgM with Urea	8.6
3.	Control	7.5

Source: SPCW, Courtallam, State: Tamil Nadu

Biogas slurry also has pesticidal effect without the harmful effects of chemical pesticides. Experiments conducted at TNAU, Coimbatore, Tamil Nadu have shown BgM can control nematode attack on tomato. The effect of biogas slurry application on the severity of root-knot nematode, Meloidogyne incognita, attack on tomato was tested in the green house with two levels of biogas slurry: 5% and 10% (w/w) added to soil. Both the number (3 fruits/plant) and fruit yield (35.2 g/plant) of tomato increased significantly with 10% (w/w) biogas slurry. The plants amended with biogas slurry put up more vegetative growth and tended to flower and fruit much earlier than did those of the control. The nematode population in the soil and the severity of nematode attack decreased [5].

Economics of Biogas and BgM slurry usage:

The benefits and costs of Biogas technology and BgM related technologies have been worked out in the following table.

Table-4: Monetary values of primary fuel saved and manure replaced by Biogas and BgM in Biogas plants of different plant capacities.

S.No	Plant Size (Cu.M)	Equivalent Fire wood/ day (Kg.)	Amount [Rs]	Bg M/day (kgs) @ 25 percent efficiency of input surry	Manure Cost (Rs)	Total Income from the BgM plant (Rs)
1.	1	3.20	6.45	12	3.50	10
2.	2	6.40	13.00	24	7.25	20
3.	3	9.65	19.25	36	10.75	30
4.	4	12.85	25.75	48	14.50	40

Source: ***Biogas manure user's guide,*** **VK-NARDEP**

Individual case studies:

Case study-1:

Sri. Thangakailasam, Vijayanagari village, Kanyakumari district of Tamil Nadu state, India maintains a 3 cu m plant for the last 10 years. His initial expenditure was Rs 10000 for installing the Biogas plant. Considering the gas and the manure (BgM) which he gets from the plant the pay-back period worked out to be only 2 years. This is without working out the other hidden benefits like health savings arising from 'no soot and smoke' condition of the kitchen[6].

Case Study-2:

Sri.Gomathi Nayakam of Puliangudi village, Thirunelveli district, state of Tamil Nadu, India maintains 20 cows and one stud bull. He has constructed two fixed dome Biogas plants with VK-NARDEP assistance. In his 8 acre land of coconut trees and lemon plants he uses only the manure produced from BgM for the last 12 years. He lets fresh Biogas slurry into the irrigation channel daily and no chemical fertilizer is used. His coconut harvest exceeds one third of his neighbours using chemical fertilizers. Soil analysis of his field has revealed that his field is richer in microbial population particularly beneficial bacterial and fungal populations[7].

Table-5: Comparison of the populations of soil micro-organisms in BgM treated soil and non-BgM treated soil. The BgM treated soil is the from the farm of Sri.Gomathi Nayakam.

Sl.No:	Bacteria	Non-BgM Soil	BgM treated soil
1.	Bacteria	11,50,000	15,00,000
2.	Fungi	20,000	70,000

Source: Soil analysis data from Sri Parashakti College for Women , Courtallam, State: Tamilnadu, India

Case study-3:

Here the case study covers 33 Biogas plants of Idayanvillai village of Tamil Nadu state. The study period covers the usage of Biogas plants between the periods 1987 to 2003. Of the 33 households with Biogas plants 28 households use biogas slurry as manure in a two-cropping system. The biogas plants are of 2 cu m size and the average BgM output per day is 24 kg per plant. The per day BgM production of the 28 households is 672 kg which has a monetary value of Rs 203. The monetary value of BgM produced per month per household is Rs 217 and for all the 28 households of BgM users it is Rs 6067. [8]

Value added product potential:

BgM can be used to enrich Vermi compost also. Given the current minimum rate of Rs 3 per kg of Vermi compost, BgM enriched vermi-compost can be sold at the same rate as well as at a slightly increased rate at Rs 4 per kg. The potential for such compost preparation per day at Idayanvillai village of 28 BgM users (with a per day output of 672 kg of BgM) is Rs 2688. The monetary value of the BgM value added vermi compost per household is Rs 100 (approximately slightly higher than. 2 US $) per day.

Thus the case studies at both individual and village levels show that BgM has high ecological and economic potential and the use of BgM should be promoted with respect to the cropping systems of the farmers who use Biogas plants. This can help the integration of the technology with the vital aspects of the farmer's life. This can help in speedy conversion of unutilized potential for Biogas plants into realized installed Biogas plants and also help reduce the discontinuation of Biogas plants usage.

Future Possibilities:

A large percentage of rural population does not own necessary cattle for biogas production to meet the household cooking requirements. Hence the need to discover alternative feed material which is both abundantly available and energy efficient for Biogas plants, has been taken up by researchers. There are 42 identified and well-used species of oil seeds which can have the potential of being used as biofuel[9]. As most of the tree-borne oil seeds yield 25 percent oil and 70 percent cake, there is no need for monoculture cultivation of trees which may again require high-cost inputs like pesticides etc. Of these the ones which have been studied as feed materials in Biogas are Neem (Azadirachata indica), Pongamia (Pongamia pinnata) , Jatropha(Jatropha curcas**)**, Mahua (Madhuca indica) and Sal (Shorea robusta).

It has been found that methane content of biogas generated from non-edible oil cakes is 70 percent with the balance being Carbon dioxide. This is higher than gas obtained from cow dung based biogas plants. The following table provides a comparison between the performance of cow-dung based Biogas plant and non-edible castor cake based Biogas plant[10].

Table-6: Comparison of select parameters of the performance of cow-dung and non-edible Castor cake based Biogas systems

S.No.	Performance Parameter	Cow-dung based	Oil cake based
1.	Gas yield m^3/kg dry	0.18	0.4-0.5
2.	Volumetric efficiency (litre/day)	0.5-0.7	2-2.5
3.	Methane Content (percentage)	55-60	70
4.	Daily feed, kg (dry)	6-10	1.5-2.0

Source: Biogas from Non-edible oil cakes, Prof.E.C.Subbarao et al.

Non-edible oil cakes are also rich in protein content and the following table compares the oil (fuel) as well as protein (nutrient) contents of different oil seed plants which have potential as biogas feed material.

Table-7: Comparison of oil and protein composition in select oil-seed plants which have potential as Biogas plant feed material.

S.No	Name	Botanical Name	Oil [Percentage]	Protein [percentage]
1.	Neem	Azadirachata indica	20	13-35
2.	Pongamia	Pongamia pinnata	27-39	30-40
3.	Jatropha	Jatropha curcas	30-40	38
4.	Mahua	Madhuca indica	35	16
5.	Sal	Shorea robusta	12-13	14

Source: 'Non Traditional Oils – A vital source of energy', Dr.K.N.Jayaveera [11]

On dry weight basis the nitrogen content of the slurry will be higher than the original feed material and also will be rich in minerals in concentrated form. Hence it can be absorbed by plants readily. So the BgM usage also needs to be worked out for the emerging Biogas plants with feed materials other than cow dung.

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