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THE BIOGAS PROGRAMME IN DOMINICA : DISSEMINATION OF BIOGAS TECHNOLOGY IN A SMALL EASTERRN CARIBBEAN STATE

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ABSTRACT

The «Biogas Programme» started in Dominica in February of 1986. Over the past two and a half years fifteen biogas units have been built and are all functioning efficiently. This document demonstrates how biogas technology was successfully introduced, evaluated, integrated and disseminated throughout the various systems in Dominica.

RESUME

BIOGAS

Le programme Biogas a démarré en Dominique au mois de Février 1986. Depuis cette date, 15 unités de biogas ont été construites et toutes fonctionnent avec efficacité. Cette note démontre comment cette technologie a été introduite avec succès, puis évaluée et diffusée après intégration dans les différentes parties de la Dominique.

INTRODUCTION

The Biogas Programme in Dominica started in February, 1986. Before introducing the programme to Dominica, the German Appropriate Technology Exchange (GATE), through the Technical Energy Unit (TEU) of the Caribbean Development Bank (CDB) conducted a feasibility study in the use of biogas technology on farms in Dominica.

Based on the outcome, it was decided that the introduction of biogas to Dominica was feasible. The most significant reasons were :

- Livestock rearing is common, and although the kind of livestock management in many cases is not suitable for the implementation of the biogas technology, programmes are being carried out by CARDI and the Ministry of Agriculture to improve livestock management.

-Organic backyard gardening is common in certain areas. The use of slurry (bio-fertilizer) therefore exists.

-Often, only part of the fresh manure produced is used for fertilizing backyard gardens and crops close to the site of manure production ; the remainder, especially in the case of pig manure, creates an unhygienic environment on the farm.

-All material for the construction of a floating-dome digester is available locally.

-Some rural areas in Dominica have no central water supply. Rain water usually is collected in drums. In the dry season water shortages occasionally occur. The installation of the biogas technology will make it necessary to construct additional water storage facilities. The use of slurry will also provide additional moisture for vegetable production.

-Although Biogas technology is new to the country, a few persons had experimented with «drum» digesters. Institutions, individuals and some farmers showed interest in the implementation of a biogas programme.

During the survey the CDB/GATE team was particularly interested in the work done by CARDI in Improved Livestock Management Systems. As a result CARDI was asked to coordinate the biogas programme with the main objective of integrating the biogas units with the Improved Livestock Management Systems. Since then the programme has gone from strength to strength. Fifteen biogas units have been constructed and all are fully functional. The number of requests by farmers for biogas digesters is also increasing.

This paper gives a detailed review of how the dissemination of biogas technology took place in Dominica over the past two and a half years.

METHODOLOGY

A five step methodology was used to introduce, evaluate and disseminate the biogas technology to farmers :

STEP 1 - The Reconnaissance Survey

A structured questionnaire provided by the CDB/GATE Team was used to train Extension Officers of the MOA in survey techniques by CARDI and MOA personnel. Three districts were targetted for the survey because these areas have farming systems conductive to the biogas technology and secondly CARDI's «Improved Livestock Management System» was being evaluated in the respective sub-districts. Sixty questionnaires were used to collect information on the following :

1.Farm household characteristics

2.Livestock production systems

3.Crop production systems, size of holdings and proximity to the household

4.Energy demand

5.Source of income

6.Fertilizer practices

STEP 2 - Demonstration Unit

Two demonstration units were constructed to demonstrate the technical feasibility of the biogas technology to all organisations affiliated with agriculture, manufacturers and farmers.

STEP 3 - Workshop

A one-week Workshop was conducted. The first day was an open session aimed at sensitising the public to all aspects of the biogas technology. A number of presentations were made and the day ended with field visits to two biogas demonstration units. The remainder of the sessions were held specifically for farmers, masons and engineers.

STEP 4 - Evaluation

On completion of the five demonstration units, farmers were familiarised with their functioning and management. Four of the units were evaluated for overall management (i.e. regularity of feeding, quality of organic matter and water fed into the digester). Gas meters were installed to measure gas consumption and production.

Economic analyses were conducted using biogas consumption data. In an attempt to quantify the biogas slurry, several experiments comparing slurry with pen manure and commercial fertilizers were conducted on four farms.

STEP 5 - Disseminating the technology

From the onset, it was envisaged that the dissemination of the biogas technology would need a well executed, collaborative effort between researchers, engineers, extension officers and farmers. This collaboration manifested itself in the form of the «Biogas Committee», whose role is to provide supervision, technical assistance, monitoring and evaluating activities. The Committee's role was further expanded by the establishment of a revolving fund which is administered by SPAT ; the fund was supplied by GATE. The fund provides interest-free loans for small farmers with limited financial potential to procure material for constructing biogas units. Repayments to the fund are made monthly at rates reflective of the energy consumption patterns of the farmer before the establishment of the unit. Additional activites, such as exhibitions, radio interviews, field days and articles in the weekly newspaper and agricultural newsletters have been used as aids to promote biogas technology in the country.

RESULTS AND DISCUSSION

STEP 1 - Reconnaissance Survey

This survey was executed in three districts where CARDI has improved Livestock Management Systems Programmes.

Results of the reconnaissance survey indicate that farmers had sufficient cattle and pigs to supply manure to a biogas unit. Other farmers could do so if they combined different types of livestock. Alternatively, the farmer would have to purchase additional animals.

STEP 2 - Demonstration of Biogas Units

(a) Technical aspects

Initially a standardised BORDA design biogas unit (Fig. 1) was introduced to Dominica.

The size of digesters varied between 12 and 15m3 with a gas holder capacity of 2m3.

For the cylindrical part of the digester a wooden mould was made for faster and easier construction. The wooden moulds could only be used twice, therefore a more expensive but longer lasting steel mould was constructed. To date, nine biogas units have been constructed using the steel cylindrical mould. The mould has also been used for constructing water tanks which supply the biogas unit.

Recently a cylindrical biogas digester has been constructed in Dominica. This type is targeted for farmers with larger numbers of livestock and with the need for more gas.

As steel for gasholders is relatively expensive in Dominica, a larger gasholder suitable for this type of digester would be expensive. Therefore a ferrocement gasholder was constructed.

The introduction of the cylindrical type biogas unit coincided with two ferrocement watertank workshops, which were executed by the CDB/GATE Team in the framework of «measurements in the project environment» - (Massnahmen im Projektumfeld). This same technology will be used for the production of gasholders for the cylindrical type biogas units and may in future replace the metal gasholders in general.

(b) Cost of a biogas unit

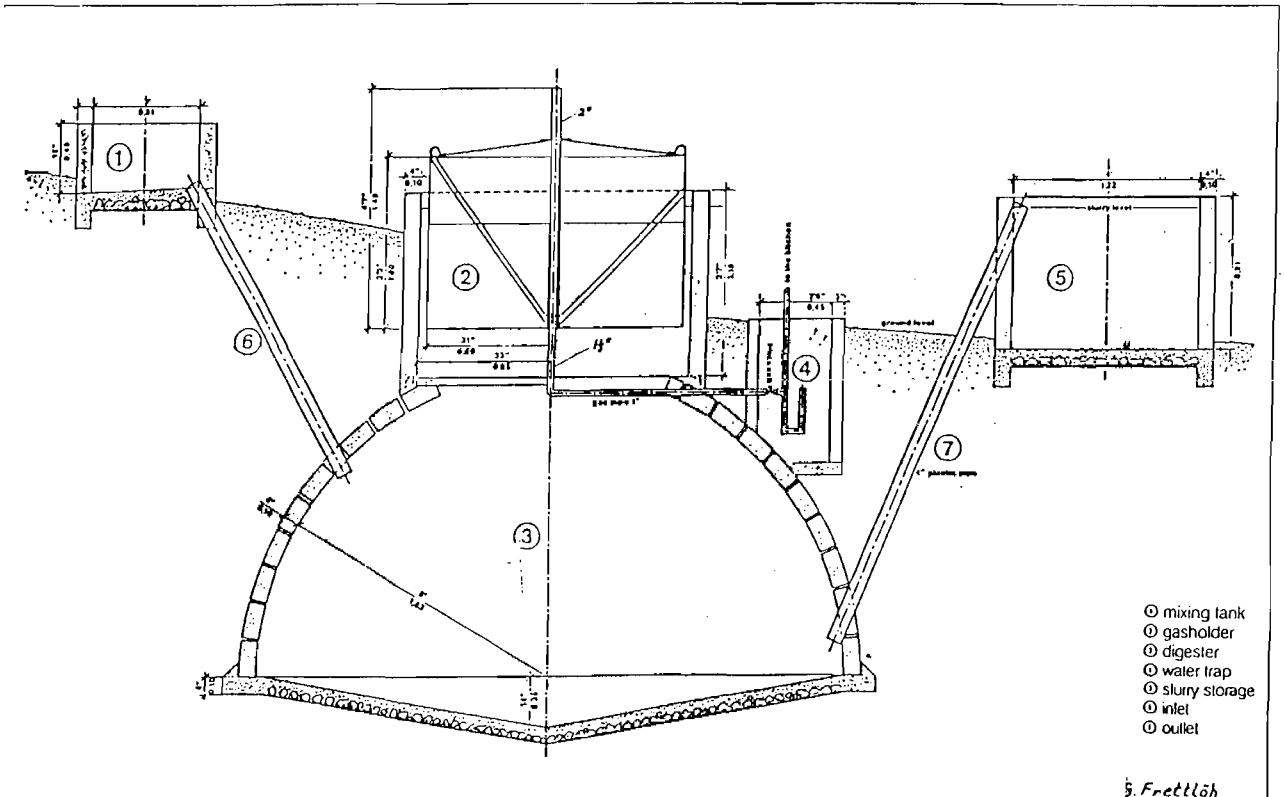
On average, the cost of building a biogas unit was as indicated in Table (1).

STEP 3 - Workshop

The Workshop was very successful and accomplished the following :

1.Sensitive the public to biogas technology and its uses ;

2.Twenty-one persons (engineers, researchers, farmers and tradesmen) were trained in both theoretical and practical aspects of constructing and



Construction drawing for 15m^3 digester

Table 1 : Cost of constructing a BORDA biogas unit about the middle of 1986 in Dominica

Component	Cost (EC$)	
Digester and cylinder	1 228	
Inlet and Outlet	366	
Gas holder	548	
Gas pipe	464	
Sub-total		2 606
Labour		
Excavation	144	
Skilled labour	360	
Other	140	
Sub-total		648
Total cost		$ 3 254

Source : CARDI - Dominica

operating the BORDA biogas unit ;

3.Initiation of a revolving fund to assist farmers with limited financial potential in the establishment of biogas units ;
4.Establishment of a core of trained persons to supervise construction of additional biogas units ; and

5.The formation of a «Biogas Committee».

With the above elements in place, the stage was set for the construction of units island wide.

STEP 4 - Evaluation of the Biogas Units

(a) The first units

The evaluation of the biogas units highlighted some major factors which were originally overlooked. The first observation made by farmers and researchers indicated that not anything biodegradable should be fed into the digester. Our experience showed that when manure mixed with (fibrous) elephant grass was fed into these digesters, scum sometimes developed and this reduced gas production. Farmers were therefore advised to only feed the digesters with manure and water. If coarse material was used, it was finely chopped ; this practice aided fermentation.

(b) Modification

Additionally, technical modifications on the gasholders were done by the CDB/GATE Team. On two farms, gasholders were modified to find out the best design to prevent scum formation. A viewing hold was installed on three gasholders.

c) Gas Consumption/Production

Table 2 shows that each farm(er) had different management techniques and organic materials with which to feed their digester. These differences were the major factors which determined the quantity of gas produced. In the case of Farm(er) 3, the digester was smaller, (4,5m3) than those on Farms 1 and 2 which were 12m3.

It is important to note that what was actually measured, was consumption and not production. Where farmers did not produce sufficient gas for their daily use, consumption was equated to production, as in the case of Farmer Gas consumption on Farm 3 was close to that of production, but on Farm 1

the farmer was hardly able to consume all the gas produced on any one day.

On Farm 3, fifteen buckets of chicken manure produced on average 12.25 kg of gas monthly whereas on Farm 1 approximately 25 buckets of pig manure produced 14.97 kg of gas monthly. The lowest was obtained from farm 2 where the farmer used pig and cow manure. Cow manure formed about 60-70% of the combination. In this case 30 buckets of manure produced an average 6.49 kg of gas monthly. One should note however, that the unit on Farm 2 experienced difficulties such as scum formation and leakages.

(d) Livestock Activities

Introduction of biogas has increased livestock production and improved livestock husbandry on all farms (Table 3).

Biogas units have encouraged farmers to build pens with concrete floors which make manure collection easier.

(e) Economic Analyses

Biogas utilisation on Farms 1 and 3 were monitored over a period of 7 and 4 months respectively. The average monthly and daily amounts of biogas utilised and the equivalent to bottled LPG is presented in Table 4.

Exante analysis done last year indicated the average monthly amount of LPG gas equivalent which has to be utilised to break even with the cost of establishing the biogas digester unit was 1.5 cylinders (12Kg) per month or approximately 18 kg.

This equivalent amount of biogas would satisfy cooking purposes only. Thus, it would not be economical to establish biogas units on farms when the only product which is utilised is biogas for replacing cooking fuel.

(f) Fertility experiments

Another product of biogas digester which will improve their economic feasibility is the slurry. This product is a good source of fertiliser (Table5).

STEP 5 - Disseminating the Technology

Biogas units were first disseminated in the Giraudel area primarily because the farming systems indicated in Fig. 1(a) were prevalent. Also Giraudel was one of CARDI's target areas for implementing the Improved Livestock

Table 2 : Biogas Production on three farms in Dominica

Farmer no. and location	Month	Type of materials) fed (Faeces	Regularity of feeding (days)	Quantity (buckets) 11 litres	Gas consumed monthly (kg)
No. 1					
D. St. Rose	March	Pig	Every 2-3 days	3 manure	16,43
Giraudel				3 water	
	April		" Every 3 days	2 manure	16,7
				2-3 water	
	May		" Every 4-5 days	3 manure	14,54
				3 slurry	
	June		" Every 2-3 days	5 manure	16,92
				2 slurry	
	July		" Every 5 days	5 manure	12,92
				3 slurry	
	August	"	Daily	1 manure	13,75
				4 slurry	
				5 Water	
	September	"	-	-	13,3
No. 2					
A. Royer	June	Pig & Cow	Daily	1 manure	5,42
Giraudel				2 Water	
	July	"	"	2 manure	5,48
				3 Water	
	August	"	"	1 manure	6,71
				3 Water	
	September	"	"	1 manure	8,33
				2 Water	
No. 3					
O. Daniel	June	Chicken	Daily	0,5 manure	10,65
Mahaut				0,5 Water	
	July	"	"	"	13,39
	August	"	"	"	12,62
	September	"	"	"	12,33

Source : CARDI - Dominica

Table 3 : Changes in number of pigs on four farms

Number of pigs			
	Before establishment of biogas units	After establishment of biogas units	
Farm No.		1986/1987	1987/1988
1	1	3 adults	5 adults
		8 piglets	7 piglets
2	2	3 adults	2 adults
		4 piglets	5 piglets
3	1	3 adults	5 adults
4	-	3 adults	3 adults
5	8	-	21 adults
6	3	-	6 adults

Source : CARDI - Dominica

Table 4 : Average monthly and annual biogas utilisation (m3) and LPG equivalent (kg) on two farms

	average monthly biogas utilisation (m3) *	Estimated annual biogas utilisation (m3)
Farm No.		
1	32,9	394,8
2	26,9	322,8

* 7m3 Biogas is equivalent to 0,45kg LPG with respect to heating value

Table 5 : total weight of lettuce (G) on low farms
Treatment*

Farm	Control	Slurry low	Slurry high	Pen manure	Inorganic fertiliser	S.E.D.
1	501,5	656,3	631,5	912,2	580,5	169,15
2	436,3	479,8	571,8	500,5	565,8	101,52
3	499,5	508,5	565,3	589,5	376,3	183,04
4	546	709,8	835,8	852,2	601,8	208,17

Management Systems.

(a) System of Dissemination

Since its formation, the Biogas Committee meets on a regular basis in order to discuss the problems and possible solutions for the programme. CDB/GATE and CARDI have a coordinating role in the biogas dissemination programme.

CARDI also evaluates the biogas units and does research and PR activities in cooperation with the CDB/GATE Team. As the programme becomes fully established, it is expected that a gradual withdrawal of the CDB/GATE Team will take place.

The Small Projects Assistance Team (SPAT) is administering the Revolving Fund. The Biogas Technician and an Engineer from MOA supervise the construction of the biogas units.

To date a total of 14 biogas units have been completed and two are under construction.

(b) Revolving Fund

As mentioned before the Revolving Fund is targetted to small farmers with limited financial resources.

The farmer who is chosen to get an interest-free loan signs a contract with the Administering Agency, SPAT. The loan covers the expenses for the material needed for the construction of a bio-digester.

When the biogas unit is in operation, the farmer has a grace period of three months before he starts repaying his loan. The monthly payback premium is reflective of the former monthly cooking fuel expenses of the recipient.

So far, the Revolving Fund has obtained EC$23,500 from CDB/GATE.

LETTUCE TRIAL

No significant difference (at $p < 0.05$ were found for the total weight of lettuce after the application of different fertilizers (Biogas-slurry, pen Manure, Inorganic Fertilizers) and a zero-control.

The lettuce responded better to organic fertilisation (biogas-slurry, Pen Manure) than to Inorganic Fertilizers.

* The treatments were based on Phosphorus :

100 % P = 60 kg P205/ha
Control = zero - treatment
Slurry low = 40 % P
Slurry high = 100 % P
Pen Manure = 100 % P
Inorganic = 100 % P
Fertilizers
(12-12-17)

CABBAGE TRIAL

The cabbage treated with Slurry showed significant higher weights of plants on three of the four test - farms (farm 1 at $p < 0.05$; farm 2 at $p < 0.01$; farm 3 at $p < 0.01$). Slurry and Inorganic Fertilizersbeing the most successful treatment on farm 4. The Pen Manure treatment was not as successful as expected.

CARROT TRIAL

Slurry high treated carrots had a significantly higher weight of tubers on Farm 2
(s.d. at $p < 0.0001$). All the organic fertilizers produced better yields than the Inorganic Fertilizer. Pen Manure and Slurry High were the most successful treatments. Farmers prefer Inorganic fertilizer to grow carrots.
A total of EC$11,000 has been disbursed to six farmers.

It is too early to indicate whether the Revolving Fund will be successful or not as only two farmers have started to repay immediately after the biogas unit started to operate without being approached. The remainder had either to be reminded by letter or their repayments are not yet due.

(c) P R Activities

In order to maintain continuous interest in «biogas technology», additional activities have been carried out . To date, the biogas technology has been exposed to the general public through five radio presentations, seven newspaper articles, five exhibitions and two CARDI Annual Reports, several field trips and a video film on CARDI's activities.

Constraints

Apart from the main constraint of cost, other constraints have affected the biogas programme in Dominica to a lesser extent. These are :

1. Continuous changing of personnel. For example, three ingineers from the Ministry of Agriculture after becoming involved in the programm have left over the past two years.

2. The dissemination of the technology is relatively slow due to the centralisation of the REAP Project in Barbados.

3. The speed with the technology is spread depends heavily on locally trained craftsmen. A solution to this problem is the employment of a Biogas Technician by the project.

CONCLUSIONS/RECOMMENDATIONS

Over the past two years, the «Biogas Programme» in Dominica has gained increased acceptance by farmers, the 14 units established over the period attests to this. However, the major constraint to a wider acceptance of the technology is the initial capital outlay which is about EC$3,000 - 3,500.

It is important to note that the cost of the gasholder (EC$1,400) was borne by the Project. This will no longer occur when the Project ends in December 1988. Therefore, the actual cost to the farmer for constructing a biogas unit will increase to EC$4,500 - 5,000.

Continued evaluation of the biogas unit is therefore necessary in order to quantify all products and by-products. This we hope will make the biogas technology financially more acceptable to farmers. Evaluation of all management practices should also be continued in order to enable more conclusive recommendations to be made to farmers.

The Biogas Programme, though run by a well organised Biogas Committee, could possibly have made more progress from the involment of other organisations and programmes. Recently the increased involment of the Livestock Division of the Ministry of Agriculture and the Dominica Pig Growers Association has assisted the project in gaining wider acceptance by farmers.
To ensure the continued success of the Biogas Programme, the following have been recommended :

- Involment of the Pig Growers Association and the Livestock Unit of MOA in the integration of the biogas technology on farms.

- Replenishing the Revolving Fund, in order to assist financially deprived farmers who have the required resources for a fully functional biogas unit.

- Linking the Biogas Committee to a recognised banking institution to increase the possibilities for additional financing.

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