Report of the on-farm (household level) evaluation trials for 5 PolyBiogas digesters in Ruiru, Kenya

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I also want to thank Mr. Derrick Correa, the Managing Director, Polytanks Ltd for the unwavering support for this initiative, especially the spirit to continue innovating. I cannot forget Cypro technicians – Timothy, Eric, and Charles who had to work overtime without full compensation, all in the spirit of making the technology take its place. Mr. Stanley Njoroge too deserves commendation for having the faith in the process, recruiting the farmers and personally engaging in delivery of the digester and co-supervising the filling process. I also want to salute all the five farmers who, without supervision, did a good job of data entry on a daily basis.

May God bless you all.

Richard Karani.

Acknowledgements

Contents

Background

The design for PolyBiogas digesters was proposed during the Nairobi International Trade Faire in October 2012 when the management of Equity Bank Ltd approached the technical director of Cypro East Africa, Mr. Richard Karani to assist develop a digester that the Bank could promote to smallholder livestock keepers who kept less than 5 cows on zero grazing. At the time, Cypro East Africa promoted concrete digesters for livestock farmers who kept 10 or more livestock on zero grazing. During April 2012 Cypro East Africa had entered into a formal collaboration with Equity Bank Ltd through the signing of a memorandum of an understanding on biogas.

After the end of the trade faire Cypro East Africa approached Polytanks Ltd, a manufacturer of polyethylene HDPE products, to establish the potential to develop a biogas digester. Coincidentally, Polytanks Ltd had already done trials with a micro digester three years before which provided a basis to improve on the work done and initiate testing of the product. The first prototype was tested at Cypro Court in November 2012 with very encouraging results.

The first digester at Cypro Court in November 2012	Installed PolyBiogas digester at Cypro Court
	

The trials at Cypro Court attracted the attention of the International Fund for Agricultural Development (IFAD) who sponsored testing and evaluation of the digesters at 5 farmer sites from January 2013. As we set up the IFAD trials, a number of adjustments were made to the PolyBiogas digesters. This report is generated 12 months after the setting up of the IFAD evaluation trials in Ruiru, Kenya.

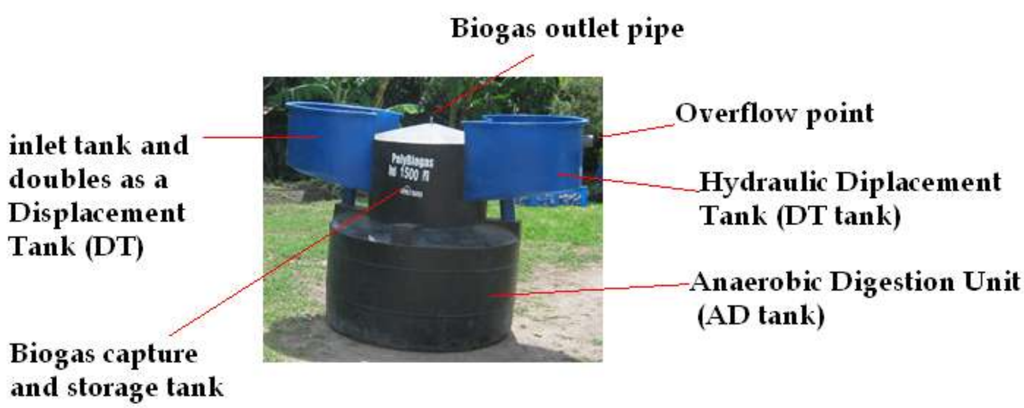
Many lessons have been learnt since we set up the evaluation trials site. A number of adjustments have also been made to improve the PolyBiogas digesters. For example, while we started with a model PTB1000, we adjusted the model to PTB1500 as soon as we had installed the first digesters. The data generated from the trials is therefore for the PTB1500 which is a 1.5 cubic metre digester system. The picture below is the first design (PTB1000) that was changed within a week after the first digesters were manufactured. We changed the size and strength of the AD digester tank, increasing it to 1000 litre capacity from the previous 550 litres.

The tank was also reinforced to serve as an underground tank. The gas holding tank remained 350 litres. Each of the displacement tanks is 180 litres.

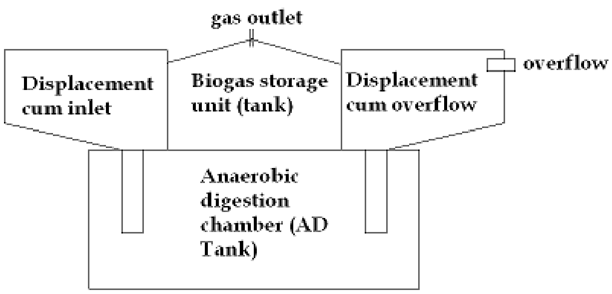
Design features of the PolyBiogas PTB1500 model

During the design of the PolyBiogas digester consideration was made to all the fundamentals of biogas science. First, the decomposing materials must be held in an environment that is free of oxygen so that the process can be populated by methanogenic bacteria. The Anaerobic Digestion (AD) tank therefore offers a suitable environment for anaerobic digestion.

Second, since the anaerobic process would result in biogas generation, there was need to allow for a biogas capture and storage tank. This tank is seamlessly connected to the AD tank. The tank is designed to be proportional to the AD tank. A calculation[1] was carried out to estimate the amount of biogas that can be generated from the AD tank, offering a guideline for the size of the biogas capture and storage tank.



[1] Since the AD tank is 1000 litres, and assuming an Hydraulic Retention Time of 50 days, the daily feeding rate is therefore 20 litres. This is constituted of 10 kg of livestock dung and 10 litres of water. The two are mixed to form a mixture that is fed into the digester through the inlet chamber. A 10 kg feed rate is expected to generate approximately 0.5 cubic metres of biogas per day. The gas storage tank therefore is sized at 0.35 cbm. It assumed that the household has to use the stored gas in the morning to create space for more gas storage that is generated during the course of the day.

<table>
<tr>
<td>A sketch of the PolyBiogas Digester System

</td>
<td>At the factory before fitting the hoppers (displacement chambers)
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</tr>
<tr>
<td>Completely assembled unit already transported to a client site for installation

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<td>A fully installed unit at the home of one of the IFAD clients Mama Wangari, Ruiru, Kenya
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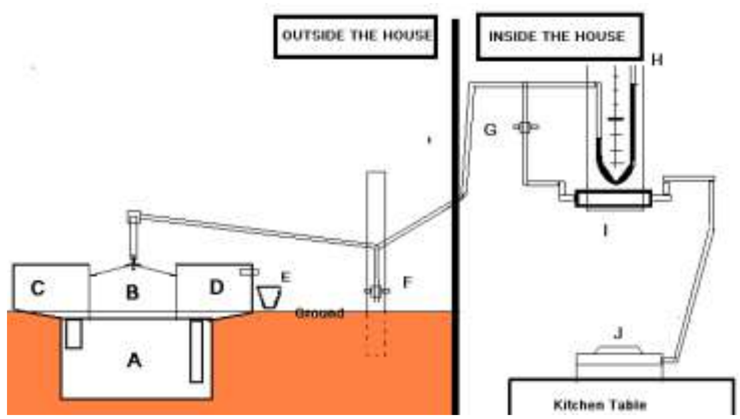
Displacement tanks



The displacement tanks are important because they allow the displacement of biogas to user points without causing unnecessary overflow of the slurry from the digester system. The second importance of the displacement tanks is to allow a continuous mixing of the slurry within the digester system, a function that is important to allow for maximum generation of biogas. The mixing happens as the slurry moves forward and backward between the AD tank and the DT tanks. A schematic is presented in the figure.

Installation of PolyBiogas digesters

While the digester is manufactured at factory level we still need to purchase various components from companies that manufacture pipes, fittings and biogas accessories. We therefore had a checklist prepared for all that items that we needed.

Installation checklist

- Installation manual
- 1 digester system
- Excavation measurements
- 3 length PPR pipes
- 1 thread seal
- 1 PPR female adaptor
- 2 PPR Tee
- 5 PPR sockets
- 5 PPR elbows
- 3 PPR ball corks
- 2 PPR male adaptor
- 2 PPR female gas nozzles
- 3 metres transparent hose pipe
- 5ft wood-plank (for manometer)
- 10 clips for manometer
- 1 short post (3 feet) to fix the water trap
- 1 biogas stove
- 3 inch 8mm transparent hose pipe
- Travel expenses
- Accommodation & food
- Excavation labour
- supervisory labour

Why PPR Piping ?

We chose the PPR pipes and fittings since these are readily available at almost all local shopping centres in rural Kenya.

Second, PPR pipes and fittings are long lasting and will normally last over 10 years if they are not tampered with.

Third, they are more resistant to abrasion compared to PVC pipes.

PPR technology has also diffused rapidly within Kenya and has become a dominant piping technology in all parts of the country.

the main fittings that we used for the piping system are shown below.


Female Adaptor


Tee


Nozzle


Manometer


Male Adaptor


Elbow


Elbow Male Adaptor


Ball Cork


Socket


Biogas Stove

Biogas Stove
We used a cast iron stove since the conventional biogas stoves available in the market were overpriced. The cast iron model was meant for LPG but we adjusted to use biogas. in 2014 prices of biogas stoves have declined since more importers have engage.

Setting up the evaluation trials (methodology)

After the concept of the evaluation trials was agreed between Cypro EA and IFAD office in Rome, Cypro EA was mandated to identify the farmers willing to enter into contract on the evaluation trials. Cypro EA had proposed Ruiru area for the evaluation trials since the company had engaged with farmers in the area. Cypro EA further engaged a local resident Mr. Stanley Njoroge of Lestan Dairy and Poultry Farm, and mandated him to identify potential farmers for the evaluation trials. Cypro EA furnished Mr. Njoroge with the requirements as follows;

a. Only those with one cow or maximum of 5 pigs were eligible
b. Beneficiary must be willing to assist in filling questionnaires to monitor the performance of the digesters, therefore a committed farmer, preferably not working outside the farm

Mr. Njoroge contacted five farmers and invited us to visit the farmers and discuss the way forward.

Identification of farmers for the IFAD evaluation trials	
Meeting with Damaris 	Meeting with Lucy Mwangi 
Meeting with Agnes Wambui 	All the farmers were selected separately and we visited the farmers with the M/E officer Mr. Haron Kebirah. Photos of the other two selected farmers were not available.

Once the agreements were made with the farmers, the process was ready to commence.

Installation process for the evaluation trials

Delivery – the digesters were delivered to installation sites by a trunk.

Excavation of digester hole

We hired local workers to excavate the digester

We had livestock dung transported by a truck belonging to Mr. Njoroge

I personally got involved in preparing the filler material. This was necessary to ensure that a consistent and uniform quality was used in all the digesters. We mixed the slurry and water in the ratio 1:1. We had proposed earlier to mix in a ration of 1:2 (1 dung and 2 water) but this changed on the material day due to the work load involved. Installation of all the digesters was done on one day January 19, 2013.

Training of the farmers on the evaluation process

A training was held on January 20, 2013 to train the farmers on the evaluation process , including data capture, and also to elaborate the design and purpose of the evaluation trials. Before this training, an enumerator was engaged to carryout a baseline survey of the farmers engaged in the evaluation trials. The data from the baseline survey is presented in Annex I below.

The farmers participating in the evaluation trial are seen in this picture during the training meeting.

Livestock dung recommended for feeding the digester

Despite the variety of livestock dung available, we recommended to four farmers that they use cow dung to feed the digester. This is with the exception of farmer 3 to whom we recommended the use of pig dung instead.

Recommended feeding rate

For all the digesters we recommended a feeding rate of 10 kg of dung per day, mixed with 10 litres of water.

Feeding time

Since fresh livestock dung was available every day, we recommended feeding the digester on a daily basis . However, some variation occurred with one farmer (see observations below).

Primary data capture

Pre-prepared questionnaires were used to capture data on cooking time on daily basis. The farmers filled the data sheets to show the actual time used for cooking with PolyBiogas and other fuels. The data capture process started effectively for all farmers on March 25, 2013. This was the time Cypro East Africa was satisfied with the installation process and optimization of the PolyBiogas plants. The design was such that all the farmes commence data capture on the same day. The primary data captured during the first run with the questionnaires is presented in Annex II below. This is a series for 65 days from March 25th to May 29th. The duration of capture is considered ample time for the digesters to completely populate with methane producing bacteria and therefore operate optimally.

Observations during data capture

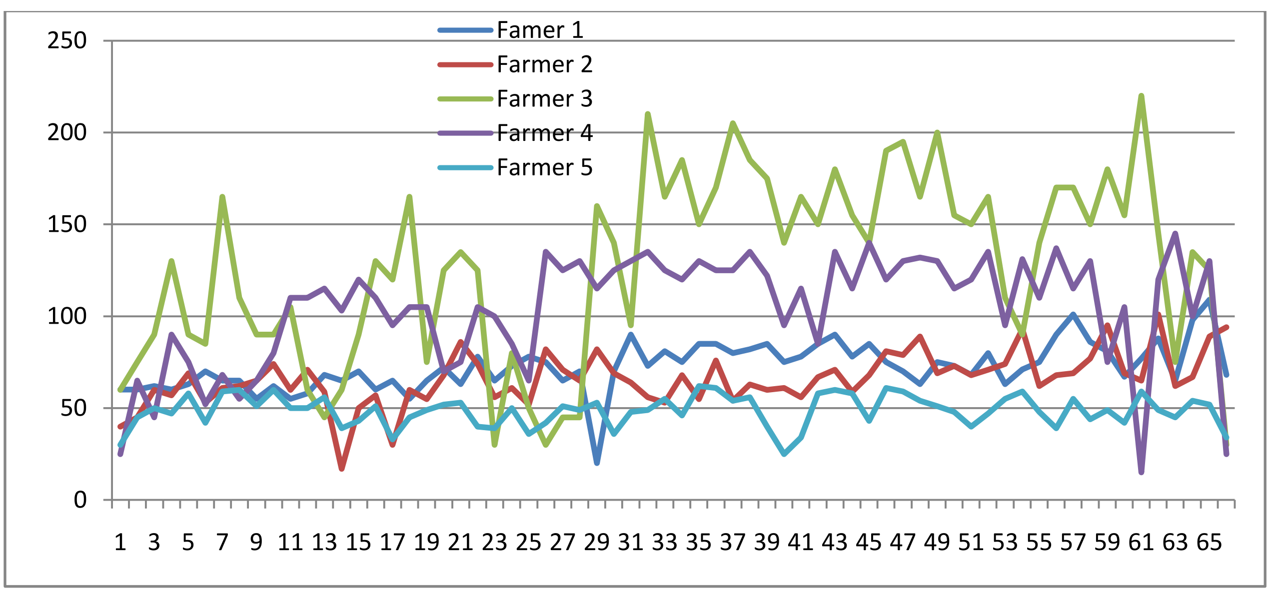
A number of things were observed during the data capature process

- (i) Two digesters leaked at the nipple (gas outlet pipe) but these were sealed using an adhesive
- (ii) One farmer could not feed the digester on a daily basis but was able to feed every second day, and with the total amount for two days.
- (iii) Cypro EA had to change the pressure monitoring unit (manometer) for farmer 3 since the pressure exceeded the expected levels and spilt out the water in the manometer.
- (iv) One farmer (farmer 3) has changed the cooking stove and is now using a double burner stove since she has adequate biogas for two burners cooking simultaneously
- (v) In order to make maximum use of the PolyBiogas digester, farmer 3 has adopted soaking of grains before cooking the following day. This softens the grains and makes cooking easier. This way farmer 3 has been able to cook tradition 'githeri' (maize and beans) within 2 hours using PolyBiogas. Without soaking the grains the cooking time would stretch beyond 3 hours.

Results from the evaluation trials

Cooking time with PolyBiogas for the 5 farmers

The digester for farmer 5 shows an average cooking time of 50 minutes per day, while farmer 1 and 2 registered between 50 and 100 minutes per day. Farmer 4 registered well above 100 minutes cooking time per day but below 150 minutes, while farmer 3 using pig dung registered above 150 minutes daily for the better part of the evaluation. A graphical presentation is presented below.



From discussions with farmers, and also evidenced on the graphical presentations below it is evident that;

(a) PolyBiogas is now the dominant cooking fuel for all the households on the evaluation trials. The following table shows the expenditures on fuels after installing the PolyBiogas. This was reported during interviews with the farmers on January 21, 2014.

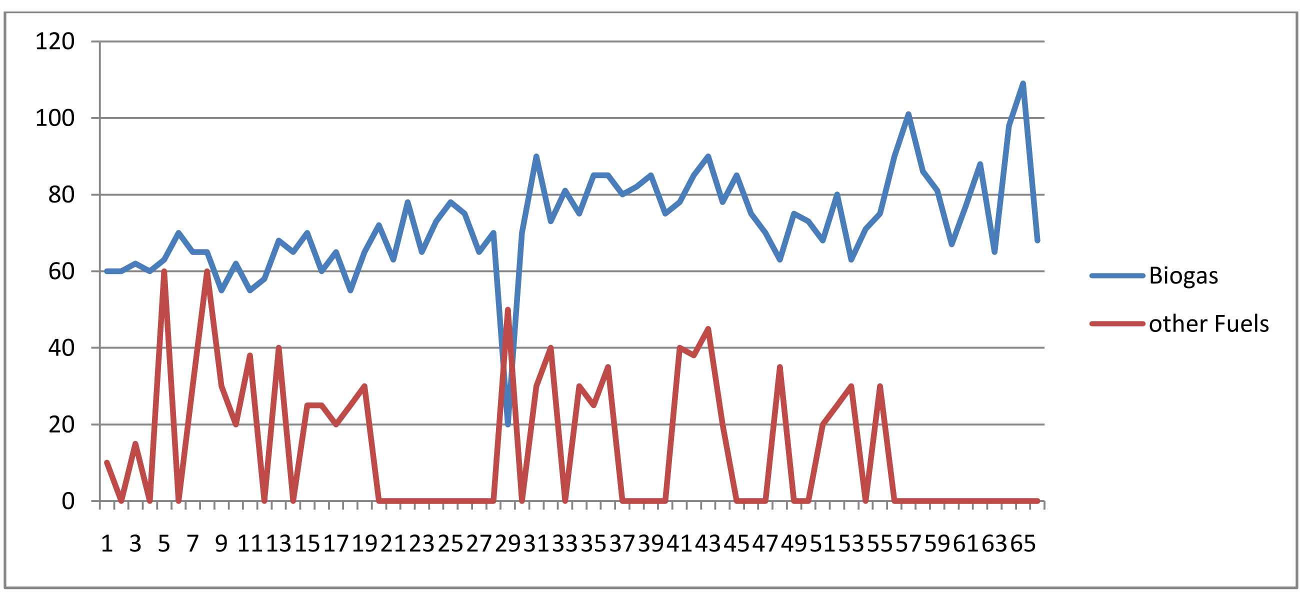
	Wood fuel	Charcoal	Kerosene	LPG	With PolyBiogas	Baseline	Reduction	Percentage reduction
FARMER 1	670	400	150	-	1220	2600	1380	53%
FARMER 3	0	0	0	0	0	1500	1500	100%
FARMER 4	0	600	0	-	600	4900	4300	88%
FARMER 5	0	-	-	270	270	1575	1305	83%

We were not able to get feedback from farmer 2 since he was travelling on the day we made the visit.

(b) Farmer 3 has completely replaced all the other fuels used before,
(c) Farmer 4 has replaced firewood and kerosene 100%, although her use of charcoal has declined by 50%. Overall, her household fuel expenditure has fallen by 88%.
(d) Farmer 5 on the other hand has replaced all her firewood and the LPG spreads over a period of 4 months which implies a reduction by approximaley 50% since she previously used the same amount within 2 months
(e) Farmer 1 reduction is estimated at 53% per cent, although some clarity is needed about the practice on feeding. There is suspicion that data capture here was not very accurate as with other farmers.

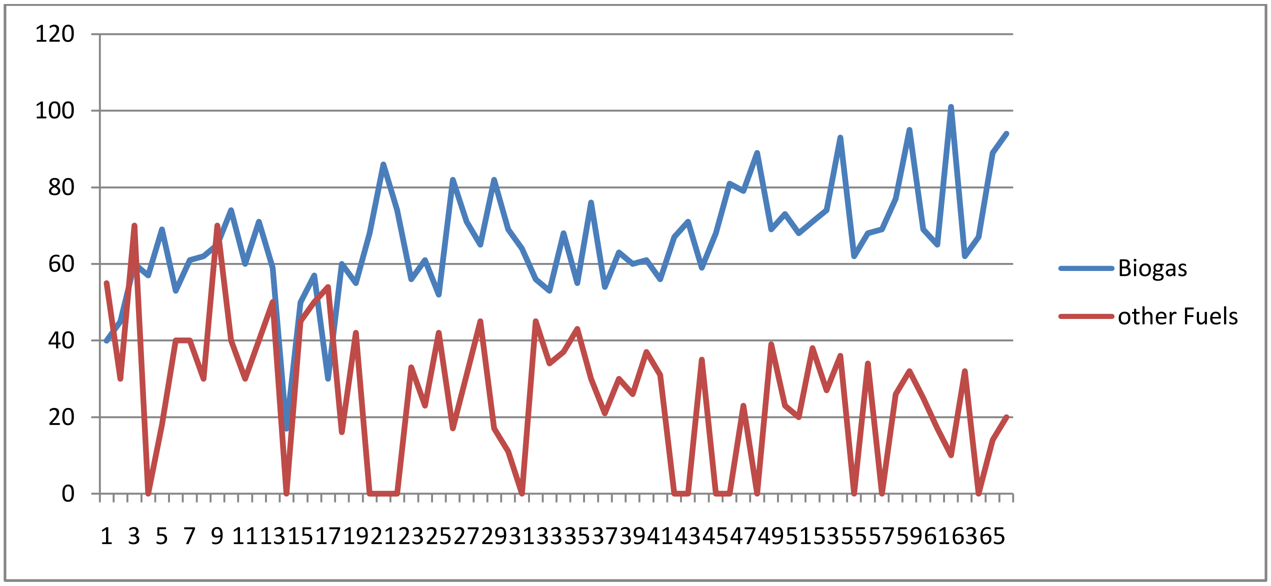
<u>Farmer 1 use of PolyBiogas compared to other fuels</u>

As time progressed PolyBiogas increasingly became important as a cooking fuel for farmer1

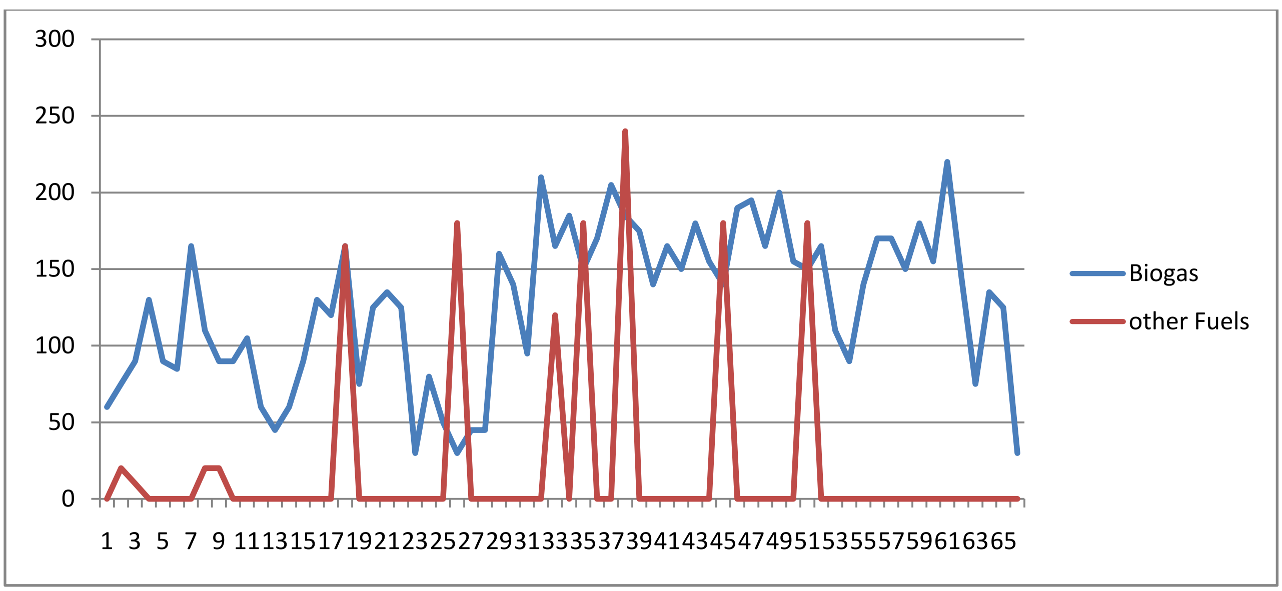


Farmer 2 use of PolyBiogas compared to other fuels

For farmer 2 both PolyBiogas and other fules were both significantly used for cooking during the first 65 days of trials. However, it is clear that a pattern was emerging with PolyBiogas use increasingly being more dominant while the other fuels were on the decline.



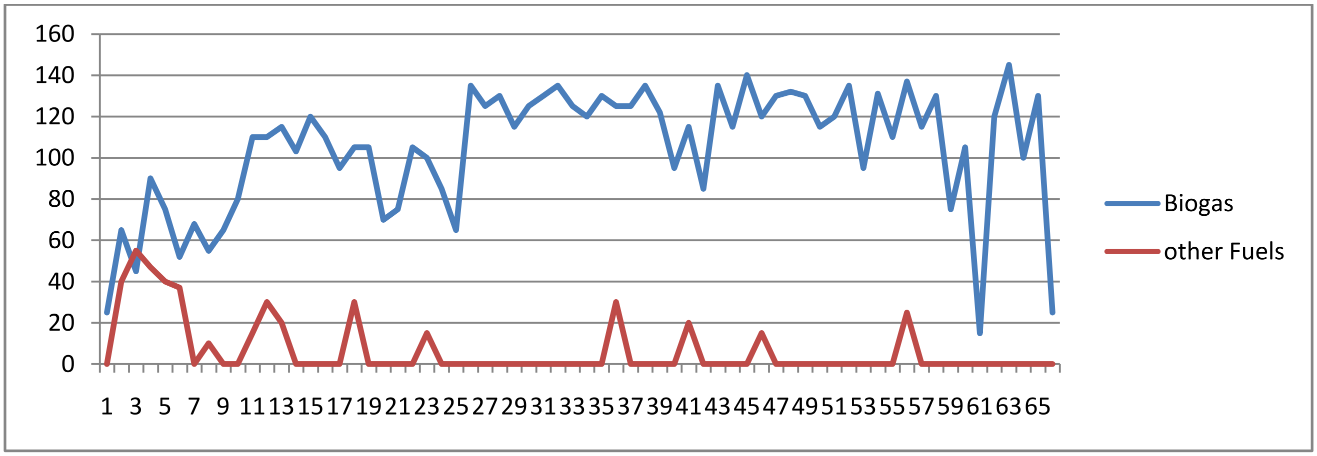
Farmer 3 use of PolyBiogas compared to other fuels



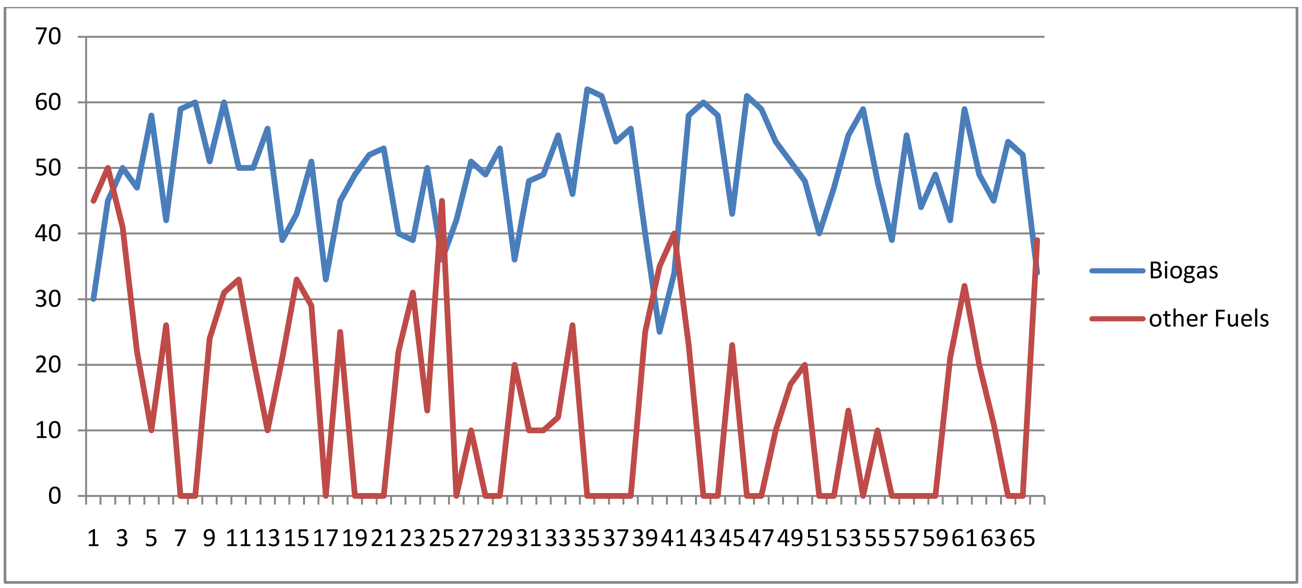
It is evident from the chart for farmer 3 that she only uses other fuels occasionally, but uses PolyBiogas for most of her cooking everyday.

Farmer 4 use of PolyBiogas compared to other fuels

The dominance of PolyBiogas in household fuels for the target farmers is demonstrated by this next chart for farmer 4. It is clear from the figure that farmer 4 only uses other fuels on specific days and most of the days she uses only PolyBiogas for all her cooking.



Farmer 5 use of PolyBiogas compared to other fuels



PolyBiogas is again predominant for farmer 5 although her frequency for the use of other fuels is higher than other clients.

Overall, only farmer 3 has PolyBiogas completely replace other fuels. Farmer 4 has attained 88% replacement of other fuels. Other farmers consider that a bigger digester would make it possible for them to completely replace other cooking fuels even using livestock dung from one cow. At the moment the farmer argue that the size of the ptb1500 does not allow the use of all the dung from one cow.

Cypro strategy for larger digesters

During 2013, Cypro EA has developed other larger digesters. These include the 3, 5 and 7 cubic metre digester systems. These have been piloted at client level and therefore avail the opportunity for clients with larger volumes of waste to generate more biogas to **completely substitute traditional household fuels.**

Installation of a 3 cubic metre polybiogas digester during May 2013

Features of the 3 cubic metre digester system

The capacity of the anerobic chamber is 3000 litres. Assuming a retention time of 50 days it is possible therefore to feed the digester with a total of 60 litres daily. At the recommended ratio 1:1 a client needs a maximum of 30 kg of cow dung daily. This can be obtained from 1-3 cows on zero grazing. The 3 cubic metre digester will generate approximately 1.5 cubic metres of biogas per day, assuming it is fed with cow dung. This amount of biogas is enough for cooking for at least 3 hours a day. We have established trials with 5 clients on loan basis through Mifugo Sacco Ltd. These include Rev. Waweru (Ngong), Mr. Wafula (Ngong), Mr. Haron Kebira (Kisii), Ms Emilly (Eldoret), and Mr. Michael (Kiambu).

Cost of the 3 cubic metre digester system

The total cost of purchase, delivery, installation, fittings and accessories for the 3 cubic metre digester system is Ksh124,040

Annex I - Baseline survey

Farmer information

NO	FARMER'S NAME	GENDER	AGE	EDUCATION	LOCATION
1	LUCY WANGARI MWANGI Telephone 0726-673046	FEMALE	48	COLLEGE DIPLOMA	RUIRU
2	KAMUNYI MANJE Telephone 0722658410	MALE	61	MASTERS	RUIRU
3	WANJIRA GACHIRA Telephone 0720-137437	FEMALE	40	HIGH SCHOOL CERTIFICATE	RUIRU
4	DAMARIS NDUTA Telephone 0723-830904	FEMALE	37	PRIMARY LEVEL	RUIRU
5	AGNESS WANJIRU KIAMBUTHI Telephone 0725-599185	FEMALE	60	HIGH SCHOOL CERTIFICATE	RUIRU

In the discussion below we have used the number in the table to reference the farmer

Size of farm holding for selected farmers.

Three of the clients have half acre plots of land. One farmer has half an acre and the other farmer has three quarter acre plot of land. Based on recommendations by the Ministry of Livestock, Kenya, only one cow can **sustainably** be kept on a quarter acre plot.

	HOUSE OWNERSHIP	LAND/PARCEL SIZE	LAND USE	
			FOOD CROPS	PLANTED FODDER
FARMER 1	OWNED	½ ACRE	¼ ACRE	1/8 ACRE
FARMER 2	OWNED	¾ ACRE	¼ ACRE	¼ ACRE
FARMER 3	OWNED	¼ ACRE	1/8 ACRE	N/A
FARMER 4	OWNED	¼ ACRE	1/8 ACRE	N/A
FARMER 5	OWNED	¼ ACRE	1/8 ACRE	N/A

Cropping activities

All the farmers planted some form of crops. Farmer 1 and 2 grew fodder on part of the plot. Farmers 3, 4 and 5 grew some form of food crops, especially vegetables on an average of 1/8 of an acre. The cropping therefore offered an opportunity to carryout evaluation on the effects on bio-slurry.

Livestock kept

At the time we conducted the baseline survey farmer 1 had one exotic cow and 8 local chickens. Farmer two kept 4 exotic cows and 3 calves. He also kept 3 local sheep, 20 chicken, a donkey and 3 rabbits. Farmer 4 kept 1 exotic cow, a goat, 12 chicken, 2 rabbits and 11 piglets. Farmer 4 on the other hand kept 2 exotic cows, 2 calves, 1 exotic goat, and 30 local chickens. Finally, farmer 5 kept 1 cow, 1 bull, 6 goats, and 15 chickens.

	CATTLE	GOAT	SHEEP	POULTRY	DONKEY	RABBITS	PIGS
FARMER 1	1 Exotic cow			8 Local chicken			
FARMER 2	3 exotic cows 1 Heifer 3 Calves		3 Local sheep	20 Local Chicken	1 Donkey	3	
FARMER 3	1 Exotic cow	1 Exotic goat		12 Local Chicken		2	11 Exotic pigs
FARMER 4	1 Exotic cow 1 Heifer 2 calves	1 Exotic goat		30 Local chicken			
FARMER 5	1 Exotic cow 1 Bull	6 Exotic goats		15 Local Chicken			

Household fuel types

From the baseline survey, all the farmers used wood fuel, although in varying proportions. Four farmers used charcoal significantly. For farmer 1 the expenditure on charcoal was as much as 46% of total expenditure on household fuel.

	FUEL WOOD		**CHARCOAL**		**KEROSINE**		**ELECTRICITY**		**LPG**	
	QUANTITY	**PRICE**	**QUANTITY**	**PRICE**	**QUANTITY**	**PRICE**	**QUANTITY**	**PRICE**	**QUANTITY**	**PRICE**
FARMER 1	1 Sack	1000/=	90 Kgs	1200/=	5 Litres	400/=	½ kw		-	-
FARMER 2	½ Sack	500/=	45 Kgs	600/=	5 Litres	500/=	-	-	15 Kgs	2150/=
FARMER 3	1/8 Sack	100/=	30 Kgs	400/=	5 Litres	500/=	-	-	3.3 Kgs	500/=
FARMER 4	3 ½ Sack	3100/=	90 Kgs	1200/=	6 Litres	600/=	-	-	-	-
FARMER 5	½ Sack	500/=	-	-	-	-	-	-	7.5 Kgs	1075/=

Proportion of each fuel in total expenditure on household fuels

Wood fuel	Charcoal	Kerosene	LPG	Total	Charcoal	Kerosene	Wood fuel
1000	1200	400		2600	46%	15%	38%
500	600	500	2150	3750	16%	13%	13%
100	400	500	500	1500	27%	33%	7%
3100	1200	600		4900	24%	12%	63%
500			1075	1575	0%	0%	32%

Annex II

Primary data showing daily cooking time in minutes for the 5 farmers on evaluation trials

	Farmer 1		Farmer 2		Farmer 3		Farmer 4		Farmer 5	
	LUCY MWANGI		MIRIAM WAMBUI		WANJIRA GACHARIA		DAMARIS NDUTA		AGNES KIAMBUTI	
DATES	Biogas	other Fuels	Biogas	other Fuels	Biogas	other Fuels	Biogas	other Fuels	Biogas	other Fuels
25-Mar	60	10	40	55	60	0	25	0	30	45
26-Mar	60	0	45	30	75	20	65	40	45	50
27-Mar	62	15	60	70	90	10	45	55	50	41
28-Mar	60	0	57	0	130	0	90	47	47	22
29-Mar	63	60	69	18	90	0	75	40	58	10
30-Mar	70	0	53	40	85	0	52	37	42	26
31-Mar	65	30	61	40	165	0	68	0	59	0
1-Apr	65	60	62	30	110	20	55	10	60	0
2-Apr	55	30	65	70	90	20	65	0	51	24
3-Apr	62	20	74	40	90	0	80	0	60	31
4-Apr	55	38	60	30	105	0	110	15	50	33
5-Apr	58	0	71	40	60	0	110	30	50	21
6-Apr	68	40	59	50	45	0	115	20	56	10
7-Apr	65	0	17	0	60	0	103	0	39	21
8-Apr	70	25	50	45	90	0	120	0	43	33
9-Apr	60	25	57	50	130	0	110	0	51	29
10-Apr	65	20	30	54	120	0	95	0	33	0
11-Apr	55	25	60	16	165	165	105	30	45	25
12-Apr	65	30	55	42	75	0	105	0	49	0
13-Apr	72	0	68	0	125	0	70	0	52	0
14-Apr	63	0	86	0	135	0	75	0	53	0
15-Apr	78	0	74	0	125	0	105	0	40	22
16-Apr	65	0	56	33	30	0	100	15	39	31
17-Apr	73	0	61	23	80	0	85	0	50	13
18-Apr	78	0	52	42	50	0	65	0	36	45
19-Apr	75	0	82	17	30	180	135	0	42	0
20-Apr	65	0	71	31	45	0	125	0	51	10
21-Apr	70	0	65	45	45	0	130	0	49	0
22-Apr	20	50	82	17	160	0	115	0	53	0
23-Apr	70	0	69	11	140	0	125	0	36	20
24-Apr	90	30	64	0	95	0	130	0	48	10

25-Apr	73	40	56	45	210	0	135	0	49	10
26-Apr	81	0	53	34	165	120	125	0	55	12
27-Apr	75	30	68	37	185	0	120	0	46	26
28-Apr	85	25	55	43	150	180	130	0	62	0
29-Apr	85	35	76	30	170	0	125	30	61	0
30-Apr	80	0	54	21	205	0	125	0	54	0
1-May	82	0	63	30	185	240	135	0	56	0
2-May	85	0	60	26	175	0	122	0	40	25
3-May	75	0	61	37	140	0	95	0	25	35
4-May	78	40	56	31	165	0	115	20	34	40
5-May	85	38	67	0	150	0	85	0	58	23
6-May	90	45	71	0	180	0	135	0	60	0
7-May	78	20	59	35	155	0	115	0	58	0
8-May	85	0	68	0	140	180	140	0	43	23
9-May	75	0	81	0	190	0	120	15	61	0
10-May	70	0	79	23	195	0	130	0	59	0
11-May	63	35	89	0	165	0	132	0	54	10
12-May	75	0	69	39	200	0	130	0	51	17
13-May	73	0	73	23	155	0	115	0	48	20
14-May	68	20	68	20	150	180	120	0	40	0
15-May	80	25	71	38	165	0	135	0	47	0
16-May	63	30	74	27	110	0	95	0	55	13
17-May	71	0	93	36	90	0	131	0	59	0
18-May	75	30	62	0	140	0	110	0	48	10
19-May	90	0	68	34	170	0	137	25	39	0
20-May	101	0	69	0	170	0	115	0	55	0
21-May	86	0	77	26	150	0	130	0	44	0
22-May	81	0	95	32	180	0	75	0	49	0
23-May	67	0	69	25	155	0	105	0	42	21
24-May	77	0	65	17	220	0	15	0	59	32
25-May	88	0	101	10	145	0	120	0	49	20
26-May	65	0	62	32	75	0	145	0	45	11
27-May	98	0	67	0	135	0	100	0	54	0
28-May	109	0	89	14	125	0	130	0	52	0
29-May	68	0	94	20	30	0	25	0	34	39

Annex III

Concerns by IFAD Officer Mr. Karan Sehgal April 2013

Mr. Karan Sehgal visited the project on April 5, 2013. During the visit he raised a number of concerns. These included the following;

Covers for digesters

Mr. Karan was concerned that the displacement tanks were exposed and open, and therefore a need to introduce a cover for the displacement tanks.

Action: A cover was immediately introduced after Mr. Karan's

Capture more biogas to reduce emissions into the atmosphere

Mr. Karan was also interested in how we can capture more gas to avoid losses into the atmosphere.

Action: We have not actioned this due to technicalities of re-moulding.

How to manage scam in the digesters

Mr. Karan was concerned on how we manage scam in the digester

Action: We have now introduced a pressure testing unit so that we are able to introduce pressure into the digester to break scam. This method was tested by the EU GIZ Biogas Promotion initiative and is very effective in breaking scam.

How to integrate kitchen waste

Mr. Karan was interested in how we can integrate kitchen waste into the digesters to deliver maximum gain to the households:

Action: We have revisited a concept of processing kitchen food and vegetable waste so that this can be used in the digesters. A hand grinding system, fitted with a wheel to improve levelage has been developed. This was first tested before the concern was expressed but now has been revisited during 2014 with modifications. This hand grinding equipment is able to also grind green grass and leaves. This will increase the range of materials available for biogas generation.

Earlier in 2012, Cypro EA had developed a home made waste processing unit using a small mincer that was bought from a local supermarket, and used a old bicycle wheel to create levelage for the mincing. Although this broke, the idea has been revisited to offer an opportunity for processing kitchen vegetable waste. A prototype will be released in February 2014. The equipment is able to process green matter and food waste into a flowing paste that can be diluted and used for biogas generation, especially in urban areas where livestock keeping is not popular.

The home made kitchen waste mincer	Waste obtained after mincing
	

The total cost of the grinding unit completely assembled would be approximately Ksh7,500

END