

INTRODUCTION TO HOME-MADE FUELS

- Access to reliable and sufficient energy is limited in less developed parts of the world
- Personal home generators can run on home-made biofuels
- Methane gas can be generated in sufficient quantities to provide energy for rural Guatemalan households, using homemade biodigesters and adequate amounts of food waste and animal waste.

PURPOSE AND HYPOTHESIS

- Purpose: We want to increase the efficiency of methane production in rural Guatemalan households, so that we can maximize the gas production per square feet of the biodigester used.
- Hypothesis: If we use a combination of household food wastes and animal wastes with the biodigester, we will get a better methane production than those with a single type of the waste

MATERIALS

- One-gallon plastic container (similar to big soda bottles)
- Hot glue
- 50cms plastic hose
- Funnel
- Tape
- Waste, according to each mixture
- Rubber balloon



Fig. 1 hot glued hose, photo by Edward Fujiwara



Fig. 2 Assembled biogas digester, photo by Edward Fujiwara

PROCEDURES

- Build 3 methane gas generation systems with easily accessible parts, with 1-gallon capacity each.
- On biodigester 1: Fill with clean water and $\frac{1}{2}$ pound of food waste. After at least 3 weeks measure amount of methane gas generated. Measure amount of gas twice a week.
- On biodigester 2, add water and a mixture of animal (chicken) waste and food waste totaling $\frac{1}{2}$ pound.
- On biodigester 3, add $\frac{1}{2}$ pound of animal (chicken) waste.



Fig. 3 Filled biodigester, photo by Edward Fujiwara



Fig. 4 compost gas captured by balloon, photo by Edward Fujiwara

FOOD WASTE ONLY (BIODIGESTER 1)

Food waste from a household				
Week	Dates	Circumference	Radius (cm)	Volume
1	1/7/2022	6.5	1.03450713	4.637565854
	1/10/2022	7.1	1.130000096	6.044008493
2	1/14/2022	7.4	1.177746579	6.842978555
	1/17/2022	7.7	1.225493062	7.709428683
3	1/21/2022	8.3	1.320986028	9.655711851
	1/24/2022	8.8	1.400563499	11.50795185
4	1/28/2022	9.1	1.448309982	12.7254807
	1/31/2022	9.5	1.511971959	14.47840883
5	2/4/2022	9.6	1.527887454	14.94045139
	2/7/2022	10.1	1.607464925	17.39859349
6	2/11/2022	10.2	1.62338042	17.92051701
	2/14/2022	10.5	1.671126902	19.54870158

Table 1, 6 weeks of compost gas produced from food wastes only, made by Edward Fujiwara

Methane production from food waste only

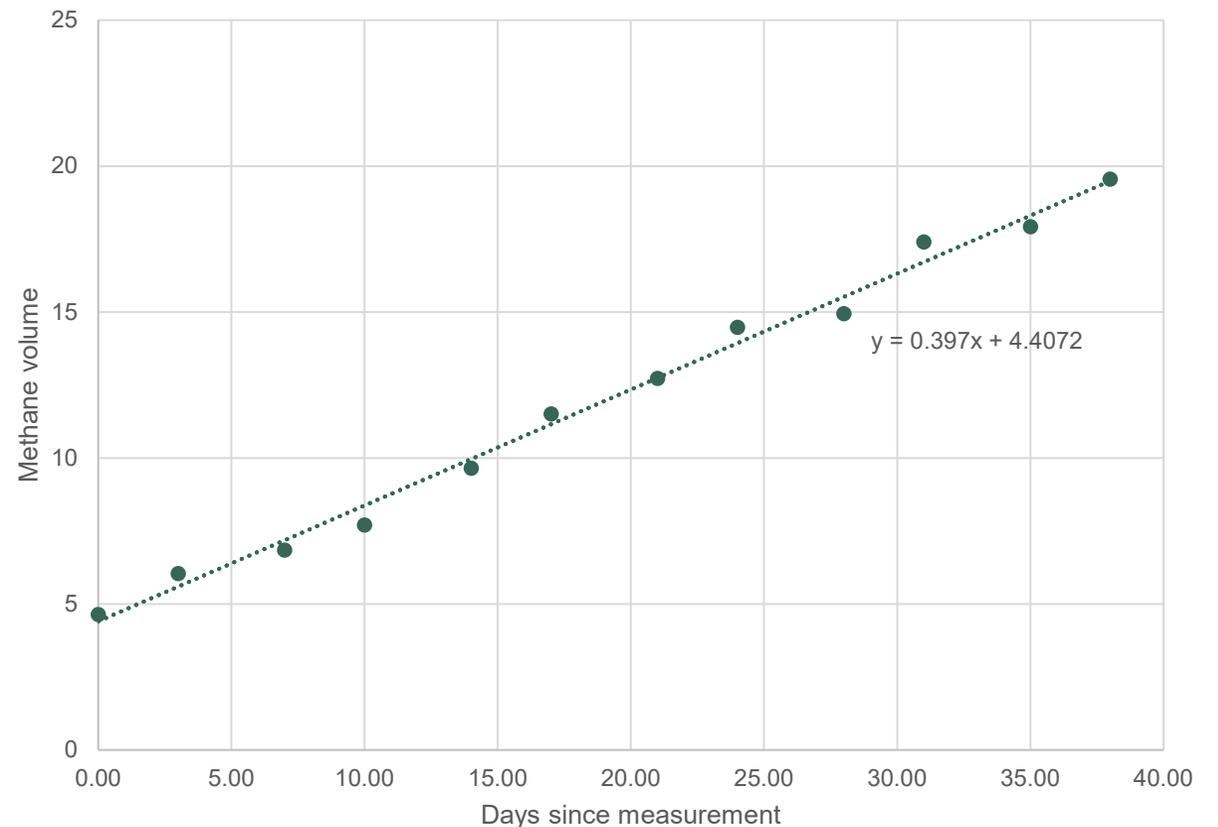


Fig 5, Gas produced from food wastes only (linear fit), made by Edward Fujiwara

FOOD WASTE AND ANIMAL WASTE (BIODIGESTER 2)

Food waste from a household and animal waste (chicken waste)				
Week	Dates	Circumference	Radius (cm)	Volume
1	1/7/2022	6.7	1.06633563	5.078920106
	1/10/2022	7.2	1.14591291	6.302958714
2	1/14/2022	7.8	1.24140565	8.013657578
	1/17/2022	8.1	1.28915202	8.974329888
3	1/21/2022	8.6	1.36872931	10.7409409
	1/24/2022	9.3	1.48013751	13.58300369
4	1/28/2022	9.7	1.54379934	15.41211269
	1/31/2022	10.2	1.62337662	17.9203913
5	2/4/2022	10.6	1.68703845	20.11243108
	2/7/2022	11.4	1.81436211	25.01851494
6	2/11/2022	11.9	1.89393939	28.45691766
	2/14/2022	12.5	1.98943214	32.98200188

Table 2, 6 weeks of compost gas produced from food wastes and animal wastes, made by Edward Fujiwara

Methane production from food waste and animal wastes

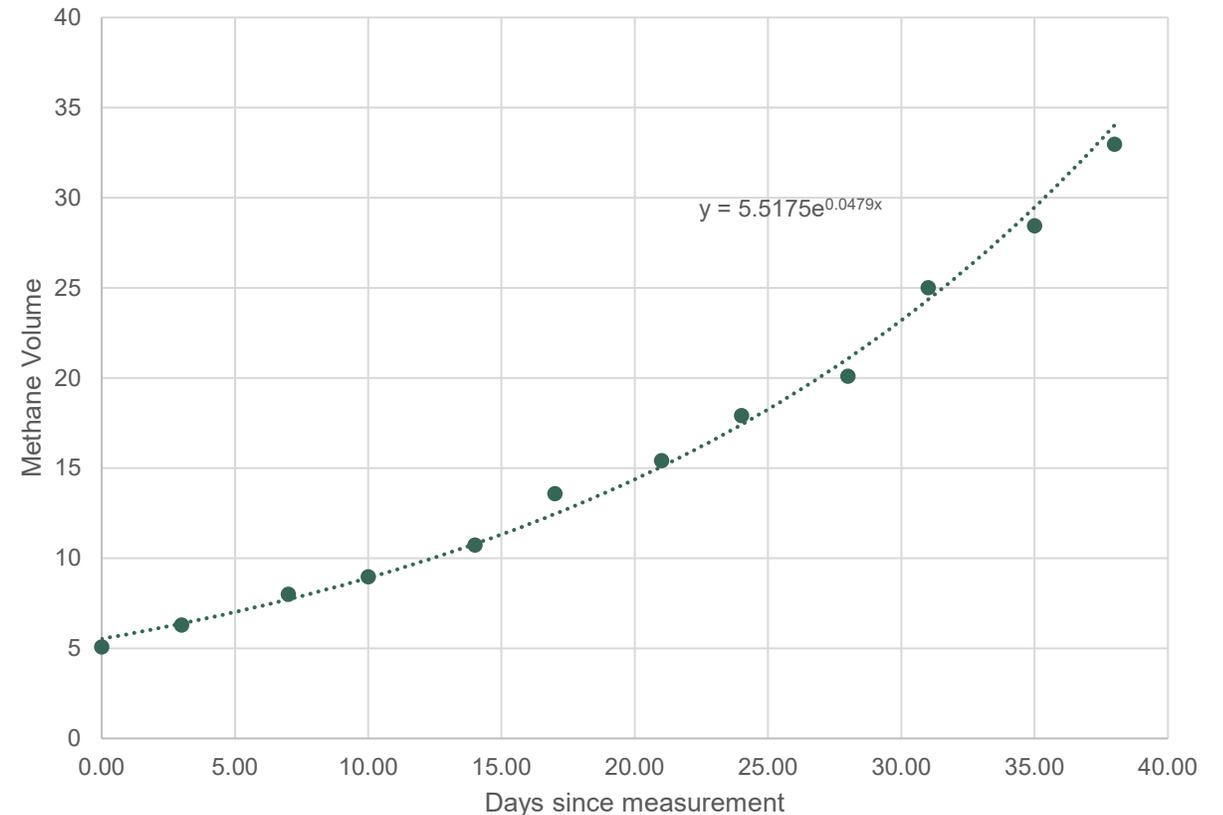


Fig 6, Gas produced from food waste and animal waste (exponential fit), made by Edward Fujiwara

ANIMAL WASTE ONLY (BIODIGESTER 3)

Food waste from animal waste (chicken waste) only				
Week	Dates	Circumference	Radius (cm)	Volume
1	1/7/2022	5.4	0.859434683	2.659060707
	1/10/2022	5.7	0.907181054	3.127314368
2	1/14/2022	6.1	0.970842883	3.832979338
	1/17/2022	6.3	1.002673797	4.22248992
3	1/21/2022	6.7	1.066335625	5.078920106
	1/24/2022	7	0.114081996	5.792167242
4	1/28/2022	7.05	1.122039725	5.917173779
	1/31/2022	7.1	1.129997454	6.043966093
5	2/4/2022	7.1	1.129997454	6.043966093
	2/7/2022	7.3	1.161828368	6.569246426
6	2/11/2022	7.5	1.193659282	7.124112406
	2/14/2022	7.9	1.25732111	8.325843571

Table 3, 6 weeks of compost gas produced from animal wastes only, made by Edward Fujiwara

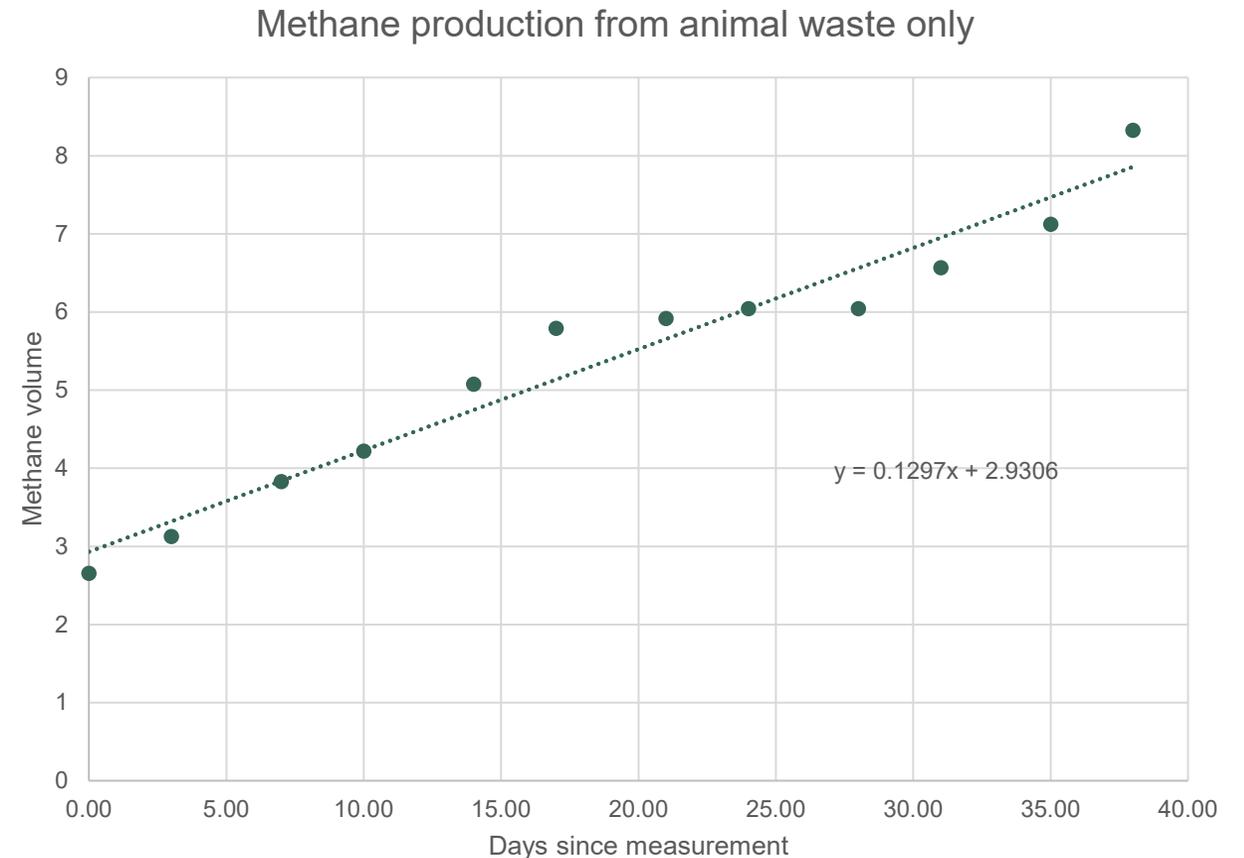


Fig 6, Gas produced from animal wastes only (linear fit), made by Edward Fujiwara

ANALYSIS

- By measuring circumference, we were able to calculate the radius of the balloon:

$$\frac{\textit{circumference}}{2\pi} = r$$

- Using the radius of the balloon, we estimated the volume of the balloon:

$$V = \frac{4}{3}\pi r^3$$

- The volume of balloon is used to infer the total methane produced by the composting

ANALYSIS

- Both biodigester 1 and 3 generated compost gas in a linear trend
 - Biodigester 1: 0.397 cubic centimeter per day
 - Biodigester 3: 0.1297 cubic centimeter per day
- When both wastes are combined to 1:1 ratio, the gas generation was in an exponential trend
 - Doubling time can be calculated by: $\frac{\ln(2)}{0.0479} = 14.47 \text{ days}$
 - Biodigester 2 (w/ exponential growth) will yield a greater volume of compost gas with sufficient compost time to double every 2 weeks

SUMMARY

- Our hypothesis were proven to be correct. We did get a result supporting the claim that a 1:1: ratio of food waste and animal waste generated more gas than food waste only or animal waste only

FUTURE WORK

- Usually a biological compost generate gases other than methane (e.g. carbon dioxide). It will be worthwhile to assess the methane content of the gas
 - This experiment will involve methane detector
 - The total methane content will be compared between each conditions
- Investigating the bacterial content of the compost will explain why we got more gas from the combination of food wastes and animal wastes.
- Different ratio of wastes can optimize methane generation