## **Bezabih Yimer**

# Biogas Production using Geomembrane Plastic Digesters as Alternative Rural Energy Source and Soil Fertility Management

Biogas Production using Geomembrane Plastic Digesters

**Master's Thesis** 



# YOUR KNOWLEDGE HAS VALUE



- We will publish your bachelor's and master's thesis, essays and papers
- Your own eBook and book sold worldwide in all relevant shops
- Earn money with each sale

## Upload your text at www.GRIN.com and publish for free



## Bibliographic information published by the German National Library:

The German National Library lists this publication in the National Bibliography; detailed bibliographic data are available on the Internet at http://dnb.dnb.de .

This book is copyright material and must not be copied, reproduced, transferred, distributed, leased, licensed or publicly performed or used in any way except as specifically permitted in writing by the publishers, as allowed under the terms and conditions under which it was purchased or as strictly permitted by applicable copyright law. Any unauthorized distribution or use of this text may be a direct infringement of the author s and publisher s rights and those responsible may be liable in law accordingly.

### **Imprint:**

Copyright © 2008 GRIN Verlag ISBN: 9783656395416

### This book at GRIN:

https://www.grin.com/document/211838

### **Bezabih Yimer**

## Biogas Production using Geomembrane Plastic Digesters as Alternative Rural Energy Source and Soil Fertility Management

**Biogas Production using Geomembrane Plastic Digesters** 

## **GRIN - Your knowledge has value**

Since its foundation in 1998, GRIN has specialized in publishing academic texts by students, college teachers and other academics as e-book and printed book. The website www.grin.com is an ideal platform for presenting term papers, final papers, scientific essays, dissertations and specialist books.

### Visit us on the internet:

http://www.grin.com/ http://www.facebook.com/grincom http://www.twitter.com/grin\_com



Mekelle University



The School of Graduate Studies

Faculty of Dry Land Agriculture and Natural Resources

## **Biogas Production using Geomembrane Plastic Digesters as Alternative Rural**

**Energy Source and Soil Fertility Management** 

By

**Bezabih Yimer Abate** 

A Thesis

Submitted in Partial Fulfillment of the Requirements for the

**Master of Science Degree** 

In

**Tropical Land Resources Management** 

February, 2008

## Declaration

This is to certify that this thesis entitled "Biogas Production using Geomembrane Plastic as Alternative Rural Energy Source and Soil Fertility Management" submitted in partial fulfillment of the requirements for the award of the degree of MSc., in Tropical Land Resources Management to the School of Graduate Studies, Mekelle University, through the department of Land Resources Management and Environmental Protection, done by me. I further declare that this thesis is my original work and has not been submitted to any other university or institution for the award of any degree or diploma, and that all sources of material will have used from this thesis have been acknowledged.

Feburary, 2008

Bezabih Yimer

## Acknowledgements

I would like to express my sincere and deepest gratitude to my thesis advisors Nigussie Haregeweyn (PhD), Mitiku Haile (PhD) and Mulu Bayrey (PhD) for their intellectual advice, guidance, encouragement and constructive comments for the completion of the manuscript. I am particularly indebted to the CED fund of Mekelle University for sponsoring all the laboratory works of the study. I am sincerely grateful to the main office of Ambasel Trading Company in providing me geomembrane plastic welding machine without which, the whole study would not have been possible. Credit is given to Ministry of Agriculture and Rural development, and Mersa ATVET College in providing me chance for the MSc. Study, the services and facilities so necessary in such undertaking.

My special gratitude is due to my beloved wife Mrs.Serkalem Moges and entire families for their unlimited pray, encouragement and technical supports. Above all, my special thanks I want to direct to the Almighty God, in offering me all the patience and endurance during my study.

## Table of contents

Contents	Pages
Acknowledgements	iii
Table of Contents	iv
List of Tables	viii
List of Figures	ix
Acronyms	x
Abstract	xi
1Introduction	1
1.1 Background	1
1.2 Problem Statement	3
1.3 Purpose of Study	4
1.4 Hypothesis	5
1.5 Objective of study	6
1.5.1 General objective	6
1.5.2 Specific objective	6
2 Literature Review	7
2.1 Fuel Consumption in Ethiopia	7
2.2 Biomass and Biogas Energy Technologies in Ethiopia	8
2.3 Theory of Biogas Technology	10
2.4 Benefits of low-cost Plastic Biodigester Technology	10
2.4.1 Environmental Benefites of Biogas Technology	12
2.4.2 Social Benefits of Biogas technology	13
2.4.3 Economic Advantages of Plastic Biogas Technology	13
2.4.4 Beneficiaries of Biogas Production	14
2.5 Input materials of Bio-Gas production	14
2.6 Biogas Production Process	16
2.7 Theory of Biogas Burner	16
2.8 The Slurry after Digestion	17
2.9 Measurement of Biogas Production	17
	iv

	2.10	Design	ning of Digester	18
	2.11	Worki	ng of Fixed-Dome Biogas plant	18
	2.12	Selecti	on and Layout of Pipeline and Biogas Accessories	19
	2.13	Transf	er of the plastic film Bio-digester Technology	20
	2.14	Promo	tion of Fixed and Floating Dome Biogas Plant	20
	2.15	Econor	mic Evaluations of Biogas Plants	21
	2.16	LDPE	Geo-membrane Plastic	21
	2.17	Theory	of Environmental Impact Assessment (EIA)	23
3	Materials	and Met	thods	25
	3.1 De	escriptio	n of the Study area	25
		3.1.1	Location	25
		3.1.2	Socio-economic activity	26
		3.1.3	Climate	26
		3.1.4	Land Use	26
		3.1.5	Livestock population	27
	3.2 Ex	perimer	ntal Design and Layout	27
	3.3 Geo-membrane plastic construction and methodology			
	3.4 Da	ta colle	ction procedures	
		3.4.1	Input to the digester	31
		3.4.2	Measurement of gas production	32
		3.4.3	Temperature of the air and Slurry	33
		3.4.4	Total-Solids(DM) content	33
		3.4.5	The organic dry matter(ODM)	33
		3.4.6	pH of the fresh Cow Dung and Digested	
			Slurry	33
		3.4.7	Quality of output Slurry	
		3.4.8	The efficiency of Bio-digester	34
		3.4.9	Social aspect of biomass and biogas technologies	35
		3.4.10	The economic Visibility of a plastic and fixed Dome biogas plant	35
		3.4.11	The Environmental Impact of the plastic biogas plant	35
	3.5 Sta	atistical	Analysis	37
4	Result and	l Discus	sion	.37

	4.1 O	peration of Plastic Bio-digester	37			
	4.2 Biogas production					
	4.3 Temperature of the Air and Slurry					
	4.4 Characteristics of Bio-digested Slurry (Effluent) and the Influent					
	4.5 Cl	46				
	4.6 Cl	48				
	4.7 Cl	4.7 Characteristics of pH of Fermented Slurry				
	4.8 Ef	fficiency of the Bio-digester	49			
	4.9 Ec	conomic Evaluation				
		4.9.1 Market price of inputs	51			
		4.9.2 Market price of inputs	53			
		4.9.3 Cost-Benefit analysis of Biogas Plants				
	4.10	Social aspect of biogas technology	58			
		4.10.1 Income generation through increased crop production				
		4.10.2 Income generation through Cost saving				
		4.10.3 Perceptions of Habru Woreda People regarding the use of Biomas	s & Biogas			
		Technology				
	4.11	Technological aspect of geo-membrane plastic bio-digester	60			
		4.11.1 Sustainability	60			
		4.11.2 Simple technology	60			
		4.11.3 Replicability	61			
		4.11.4 Demand driven	61			
	4.12	Technical problems with the geo-membrane plastic digester	62			
	4.13	Environmental Impact Assessment of the Plastic Bio-digester	63			
		4.13.1 Reduction of green house gas emissions	63			
		4.13.2 Reduction of rate of deforestation	66			
5	Conclusio	ons and Recommendation				
	5.1 Co	onclusions	68			
	5.2 Re	ecommendation	71			
Re	eferences					
Aj	ppendix		81			
	Apper	ndix 1				
			VI			

Appendix 2	
Appendix 3	87
Appendix 4	90
Appendix 5	91
Appendix 6	92
Appendix 7	94
Appendix 8	96
Appendix 9	97
Appendix 10	98
Appendix 11	99