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Capacity Building for Efficient Utilization of Biomass for Bioenergy & Food Security in the GMS [TA7833-REG]

Feasibility Study for a Pilot Investment Project to Scale-Up Efficient Bioslurry Management Practices within the Viet Nam National Biogas Program

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Landell Mills
DEVELOPMENT CONSULTANTS

nexus
Carbon For Development

KEY DATA

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CONTENTS

ABBREVIATIONS & ACRONYMS

ADB	Asian Development Bank
BTC	Biogas Technology Centre
BPs	Biogas Programs
CC	Climate Change
CDM	Clean Development Mechanisms
CF	Consulting Firm
CR	Carbon Revenues
DARD	Department of Agriculture and Rural Development
FR	Final Report
EIA	Environment impact assessment
FAO	Food Agricultute Organization
FS	Feasibility Study
GAP	Good Agricultural Practices
GHG	Greenhouse gas emission
HRT	Hydraulic retention time
IEE	Initial Environmental Examination
IPDP	Indigenous Peoples Development Plan
LCASP	Low Carbon Agricultural Support Project
LML	Landell Mills Limited
LPG	Liquefied Petroleum Gas
MARD	Ministry of Agriculture and Rural Development
MOU	Memorandum of understand
MPI	Planning and Investment
NBP	The Netherlands Biogas Program
NFP	National Focal Point
PMU	Project Management Unit
PTF	Poverty Task Force
QSEAP BPD	Quality and Safety Enhancement of Agricultural Products and Biogas Development Project
SPRSS	Summary Poverty Reduction and Social Strategy
SPSS	Statistical Package for Social Sciences
VGGS	The Vietnam's Green Growth Strategy

PREFACE

This Feasibility Study for a Pilot Investment Project to Scale-Up Efficient Bioslurry Management Practices within the Viet Nam National Biogas Program is one of activity under framework of ADB/Landell Mills Limited project on "Capacity Building for Efficient Utilization of Biomass for Bioenergy and Food Security in the GMS (TA7833-REG)' project" and carried out by Biogas Technology Center (BTC). The assignment commenced 10th July 2013. The location of the implementation of the feasibility study (FS) is Tam Xa commune, Dong Anh district, Hanoi, Vietnam, approved by National Focal Point and Technical Focal Point before conducting the survey.

The final report (FR) aims to (i) provide the evaluation of biogas plant management, bioslurry management, biogas utilization of 100 biogas households in Tam Xa commune, Dong Anh district, Ha Noi, Viet Nam and, (ii) propose the construction of a pilot of 25 biogas households to make use of bioslurry as organic fertilizer for their cultivation in order to improve the bioslurry management while contributing to environmental improvement.

The FR comprises of 7 chapters:

- Chapter 1: Project Summary
- Chapter 2: Biomass and feedstock availability and flows
- Chapter 3: Project Description
- Chapter 4: Total investment, capital structure and financial plan
- Chapter 5: Summary Poverty Reduction and Social Strategy (SPRSS) and Indigenous Peoples Development Plan (IPDP)
- Chapter 6: Initial Environmental Examination
- Chapter 7: Risks, assumptions and uncertainties

The expert team of BTC was responsible for conducting the FS and preparing this FR. The team comprises of:

- Mr. Nguyen Gia Luong –Biogas expert - Team leader
- Mrs. Le Thi Xuan Thu – Agronomist - Deputy team leader
- Mrs. Trinh Thi Quang – Social expert
- Mr. Nguyen Tung Lam – Environment expert
- Mrs. Tran Hai Anh – Financial expert
- Mr. Dang Viet Khoa - Enumerator
- Mrs. Vu Thu Ha – Enumerator

ABSTRACT

The FR aims to provide (i) evaluation on the biogas plant, the bioslurry use and biomass flow of Tam Xa commune, Dong Anh district, Hanoi and, (ii) design of a demonstration pilot investment to scale up bioslurry management in the commune.

To gain the information and data for evaluating the status of biogas plant management, bioslurry use and biomass flow, 100 biogas households, 3 non biogas households, 2 commune officers, two biogas mason and businesses have been interviewed with a designed questionnaire. Out of 100 households, only one household have a fishpond. 100% have field for crop cultivation.

Under the framework of the demonstration pilot, a number of main works will be conducted, constructed and purchased including: (i) 25 bioslurry pits having 3 m3 at 25 biogas households; (ii) mobile devices include 75 barrels (100 litre/barrel) for households; 3 barrels (200 litre/barrel) for woman/farmer union, 26 improved carts (25 for households and 1 for woman/farmer union); 30 aerosols (25 for selected households and 5 for woman/farmer union); (iii) 26 household water pumps to take bioslurry to barrel for transporting; (iv) 2 bioslurry pits of 40m3 for storing bioslurry at the field (one to be used for crops and one for composting); (v) 10 m2 of house for composting; (vi) 1000 bags to contain composting organic fertilizer for selling to the market and other households; (vii) Fish breed preparation.

Implementation time of the demonstration pilot is tentatively 8 months.

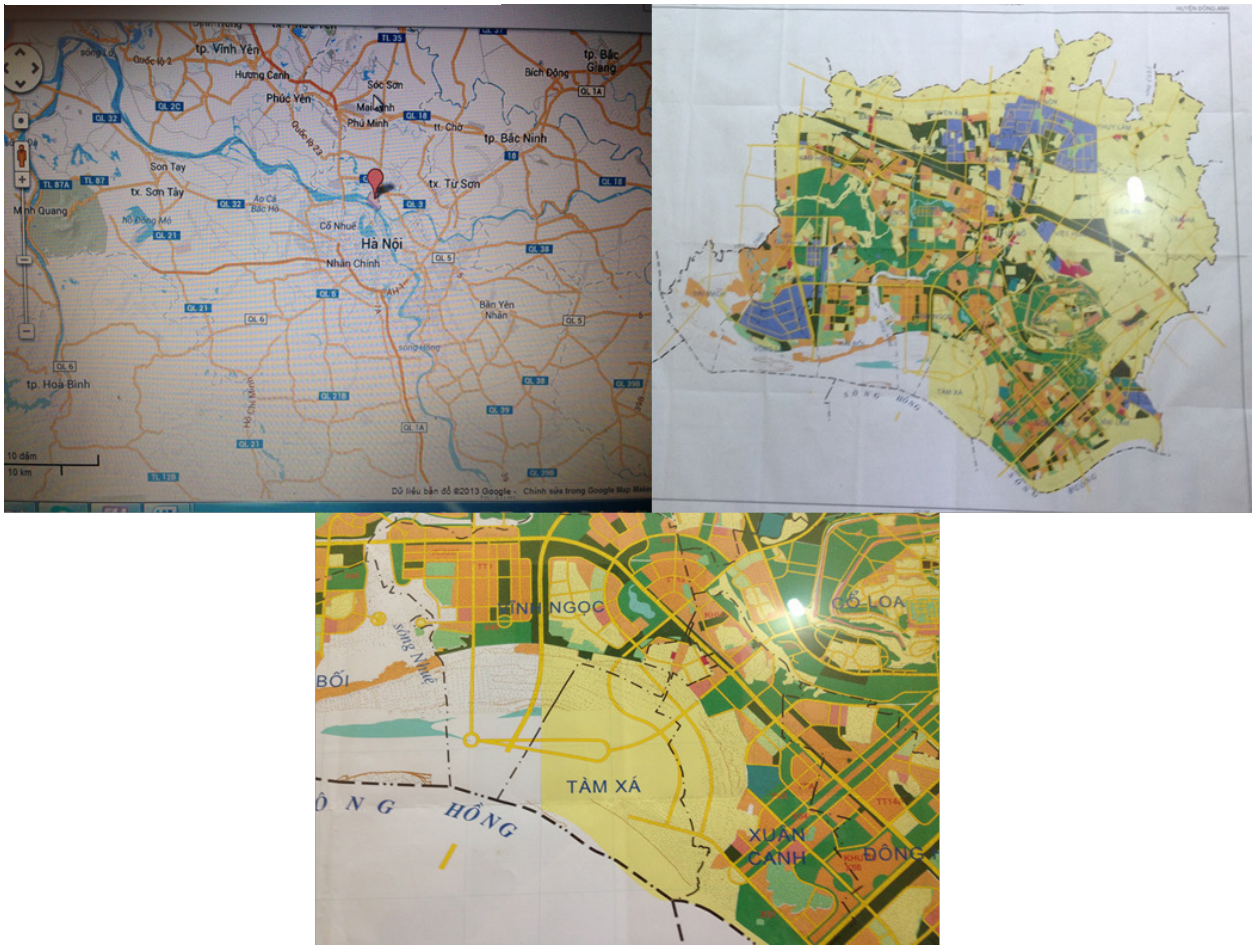
Total cost for the demonstration pilot is estimated at USD 77, 302.

1. PROJECT SUMMARY

1.1. PROJECT PILOT LOCATION[1]

Tam Xa is a commune in the district of Dong Anh in Hanoi, Vietnam. The commune naturally has 247.05 hectares of land, 218.05 of which is agricultural, mainly used for crop production such as maize (176.4ha), vegetable (20.5ha), fruit trees (23.29ha) and ornamental trees (7.63ha). The population of the commune, in 2012, was 4,200 people. Figure 1 is map of Tam Xa commune.

Figure 1: Map of Tam Xa Commune



Economic development: The economy of the commune developed well in the first six months of 2013. Revenue from economic industries increased by 32%, in comparison to the same period of 2012, reaching 61.9 billion Viet Nam Dong (VND) (equivalent to 29.5 million US dollars (USD). Agricultural production makes up 61.1% of the economy, in which crop production occupies 26.1% and animal production occupies 35%.

Crop production: The main crops that are cultivated in the commune are maize, vegetable, fruit and ornamental trees. Statistics of spring-summer season have showed the average revenue from crop production, i.e. maize reaches 194.6 million VND (equivalent to 9,266 USD) per hectare; vegetable reaches 166 million VND (equivalent to 7,900 USD) per hectare and ornamental tree reaches 1.7 billion VND (equivalent to 81,000 USD) per hectare. The data is easily understandable

[1] *Data and information is extracted and cited from the Report on implementation of eco-social mission, security and defense for the duration of first six months of 2013; and the focusing mission of the commune for the period of last six months of 2013.*

and significantly comparable when compared with the target of 50 million VND (2,381 USD) field of the Ministry of Agriculture and Rural Development (MARD) several years ago.

Animal production: Several years ago, Tam Xa was a well-known commune for dairy cows with 70% of households raising one to ten dairy cows in their stable. The situation has changed as the farmers did not find the market for their products – milk. Nowadays, Tam Xa raises mainly pigs and cows. Poultry is raised in some households with a number of several chickens, mainly for improve family meals and produce eggs. The number of main animals that currently raised in Tam Xa is presented in the below Table 1.

Table 1: Main raised animals in Tam Xa commune[2]

No.	Animal	Quantity
1	Pig	10,000
2	Cow	2,000
3	Chicken	14,000

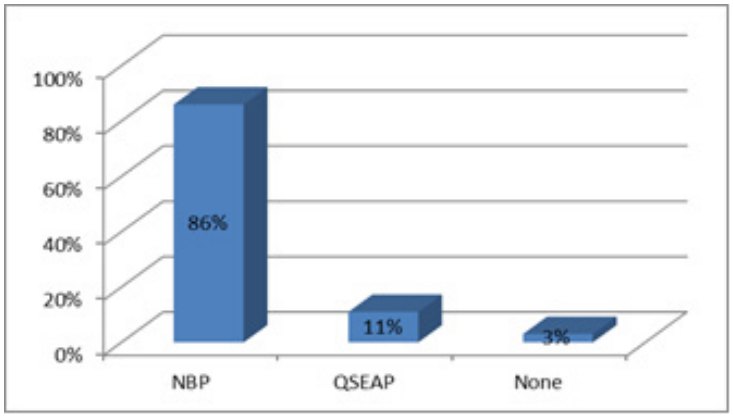
1.2. DESCRIPTION OF STAKEHOLDERS

A set of questionnaires have been developed for the Feasibility Study (FS) for biogas households. In addition, during the survey, non-biogas households, mason and biogas businesses, commune officers were also met for deep interviews. The surveys were mainly conducted at noon or end of the day, when people have come home after doing cultivation in the field.

Biogas households

The biogar household interviewees were mainly farmers, with only 6 of them having other occupations; such as teachers or workers. Out of 100 biogas households, 86% participated in the Netherlands Biogas Program (NBP)[3], 11% participated in the Quality and Safety Enhancement of Agricultural Products and Biogas Development Project (QSEAP)[4], only 3% have built their biogas plant from their own resources. 100% biogas plants seem to be in good operation. The project participation is presented in Figure 2.

Figure 2: Project Participation



According to income per person households were mainly ranked as moderate, with 85 households, 2 households were ranked as poor, 4 households near poor and 9 households well off[5]. The household classification is presented in Figure 3.

[2] *Data and information is extracted and cited from the report on implementation of eco-social mission, security and defence for the duration of first six months 2013; and the focusing mission of the commune for the period of last six months of 2013. In the commune, there is a chicken farm raising about 10,000 chickens.*

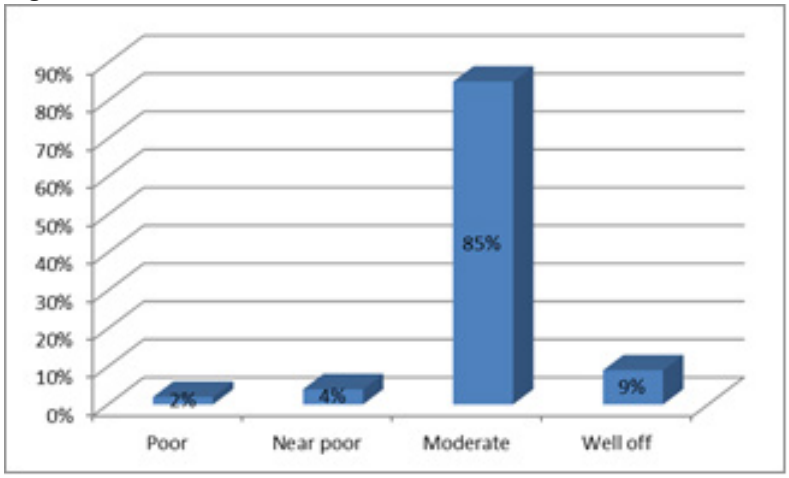
[3] *Under NBP, only fix domed biogas plants having models of KT1 and KT2 are introduced to the farmers. Main construction materials are brick, cement, grave etc. … are used for the construction. The sectoral standards for the household biogas plants KT1 and KT2 No. 10 TCN 102 – 2006 is applied.*

[4] *.Under QSEAP, the fixed domed biogas plants KT1, KT2 and composite plants are introduced to the farmers. The sectoral standards for the household biogas plants KT1 and KT2 No. 10 TCN 102 – 2006 is applied. For composite plants, they have been certified by MARD for the Science, Technology and Enviroment.*

[5] *Ranking household by income per person – Institute of sociology*

Answering the question "what reason(s) made you decide to invest in a biogas plant, 100% households chose (i) clean and convenient cooking and (ii) save cooking expenses, while 96% said (iii) saving time for house work (cooking, finding energy, cleaning etc.); only 60% communicated (iv) reduce pollution at ranch/home as 40% communicated (v) have bioslurry to replace inorganic fertilizer.

Figure 3: Household Classification



Non biogas households: The non-biogas households that were interviewed demonstrated the same conditions, with the biggest groups of biogas households being of moderate income. They now use liquefied petroleum gas (LPG) and electricity for cooking. A household with 5 – 6 members have to buy 12kg LPG and average 200 KWh per month. There were multiple reason the households not being ready to invest a biogas plant, as they (i) have no money, (ii) have no animals, (iii) it is possible to use gas from neighbor.

Masons: There is only one mason team in the area. The masons were trained by NBP. They provide construction and installation services to farmers. The competitiveness is less, as they are under the same group. In addition, to increase income, particularly in the rainy season, masons are foremen at house-building, or utilities service work, with stable and high incomes or they provide biogas equipment trading such as cook stoves, lamps, meters and spare parts as well as maiternance biogas plant for the households.

Commune officers: The 2 commune officers that were interviewed are vice president of the commune and head of the cooperative. Through talking to the commune officers, information and data on the general and specific issues of Tam Xa commune were defined.

1.3. WORK UNDERTAKEN DURING FEASIBILITY

During the FS, the consultant team did the following work and assignment:
Desk study and secondary information: Documents were compiled during the desk study phase including (i) Manual on biogas technology for technicians and masons by NBP; (ii) Q&A handbook on biogas technology by Agricultural Publishing House 2009; (iii) Biogas User Survey of 2006, 2007, 2008, 2009 by NBP; (iv) Manual on biogas technology by QSEAP; (v) Manual on composite biodigester by QSEAP.

Develop questionnaires: A set of questionnaires for biogas households were developed by the consultant team, comprising of question on 7 aspects (i) General information, (ii) Biodigester management, (iii) Biogas management, (iv) Biogas appliances, (v) Social assessment, (vi) Building capacity need and, (vii) Environmental assessment. The draft questionnaire was commented by LML and tested in field. Besides, questionnaires for non-biogas households, masons, businesses and commune officers were also developed for deep-interview.

Test questionnaire: The questionnaire was tested for the suitability for the interviewees and getting the interviewers familiar with it.

Conduct interview: The survey was conducted on 100 biogas households, 5 non-biogas households, 2 masons, 1 business and 2 commune officers. In reality, the interview was only carried out at noon or end of the day when farmers are at home. It took about 2 – 3 hours for a questionnaire because of the volume of questions, sometimes it was necessary for the interviewer

to explain the questions to the farmers. In addition, the interview implementation was conducted during harvest time so the percentage of farmers at home was low; therefore, it took a number of extra working days to complete.

Field visit: This included the whole area for the future pilot site. The field is 3 – 4 km from the digesters. There is a household in the other commune which has a fishpond of 1,000 m2. The owner showed willingness to participate in the pilot.

Data analysis: Statistical Package for Social Sciences software (SPSS) was used to analyze the questionnaires. Before entering the data into the software, the questionnaires are cleaned and cross checked. The missing information was re-checked with the households (mostly households have mobilephone numbers).

Report preparation: The final report (FR) was developed with the participation of all members of the consultant team. The FR contains 7 chapters including (i) Project summary, (ii) Biomass and feedstock availability and flows, (iii) Project description, (iv) Total investment, capital structure and financial plan, (v) Summary poverty reduction and social strategy and indigenous peoples development plan, (vi) Initial environmental examination and, (vii) Risks, assumptions and uncertainties.

2. BIOMASS AND FEEDSTOCK AVAILBILITY AND FLOWS

Development of biogas technology in Vietnam: The biogas technology (BT) has been introduced and developed in Vietnam since 1960. After the country's reunification in 1975, it was a top priority of the state research program on new and renewable energy until 1990. Within the framework of this program, there were many research projects focusing on biogas technology. Besides research work, a budget was also applied to develop work. The institutions engaged with the program were: Institute of Energy, Technology University of Hanoi, Technology University of Ho Chi Minh city, Technology University of Da Nang, Can Tho University, provincial departments of Science, Technology and Environment. Since 1991, although this program has not existed, the R & D activities on BT have continued. Since 1992, within framework of the projects of the Ministry of Agriculture and Rural Development (MARD) supported by FAO, SAREC, SIDA, the National Institute of Animal Husbandry (NIAH), College of Agriculture and Forestry in Ho Chi Minhcity have developed plastic bag digesters. Owing to low cost and simplicity of installation, this technology has been rapidly adopted and disseminated by the network of Agricultural and Forestry Extension, Association of Vietnam Gardeners (VACVINA) and some local private actors. Recently, under the National Program on Clean Water Supply and Environmental Sanitation, the Rural Development Assistance Centre (RDAC) has developed a fixed-dome model with the hemispherical dome made of composite and ferro-cement. The Biogas Program for the Animal Husbandry Sector of Vietnam (NBP), is a joint project between the Government of Vietnam and the Netherlands Government. The NBP has supported farmers nationwide to build 18,000 biogas plants in phase I (2003 – 2005) in 12 provinces of 8 ecological regions; 27,000 plants by the end of 2006 and by the end of 2007, 16,000 plants were built. For phase II (2008 – 2011) BP plans to upscale and expand into more than 50 provinces out of 64 provinces and cities in the country, with construction of 140,000 biogas plants. There is an estimated 500,000 biogas plants country-wide, most of which are of are fixed-dome type and nylon bag type.

Table 2: General Information about Biogas[6]

	Unit	2005	2006	2007	2008	2009	2011
Size of digester	(m3)	8.2	8.83	10.81	9.91	11.22	11.3
Digester connect with latrine	(%)	40.00	62.5	58.62	39.62	46.00	65.3
Households use bio-slurry	(%)	41.00	60.00	61.72	40.56	21.3	39.0

Nutrient content of bio-slurry: Research results in Vietnam have shown bio-slurry contains rich nutrients. From 1988 to 1990 national research was carried out by IE, showing that: 1 cubic metre of bio-slurry contains 0.8 cubic metres of liquid slurry and 0.2 cubic metres of solid slurry. Levels of N, P, K differ according to feeding materials. On average, one cubic meter of bio-slurry contains 0.16 – 2.4 kg nitrogen, equivalent to 0.34 – 5.2 kg of urea (46% N); 0.5 – 2.7 kg P2O5, equivalent with 2.5 – 13.5 kg phosphate (20% P2O5); 0.9 – 4.0 kg K2O, equivalent to 1.8 – 8.0 kg potassium fertilizer (50% K20).

Table 3: N, P, K concentration in bio-slurry

Indicator	N total	NH4+	P2O5 total	K2O total	pH
Liquid slurry (mg/l)	170-2240	130-930	56-320	100-434	7.1-8.5
(%)	0.017-0.22	0.013-0.093	0.0056-0.032	0.01-0.043	
Solid slurry (m/l)	140-3800	30.8-261,7	246-620	434-3100	7.0-8.6
(%)	0.07-1,9	0.015-0.13	0.123-0.31	0.217-1.55	

Source: Institute of Energy (1990)

[6] *According to data base of BP and Biogas User Survey 2005, 2006, 2007, 1999 and 2010-2011 of BP*

The result is similar with the researche undertaken by national institute and university between 2004 and 2005, under NBP.

Table 4: Macro nutrient and micro nutrient availability in bio-slurry

Bio-slurry of different feeding material	Nutrient Concentration						
	N (g/l)	P2O5 (g/l)	K2O (g/l)	Ca (ppm)	Mg (ppm)	Zn (ppm)	Mn (ppm)
Research carried out by National Institute of Soils and Fertilizers (NISF) in 2005							
Pig liquid slurry	0.47	0.18	0.32	109.7	91.8	5.3	1.1
Cattle liquid slurry	0.80	0.31	0.56	239.6	125.6	3.3	5.7
Pig-cattle liquid slurry	0.37	0.17	0.32	71.2	81.3	1.4	0.6
Research carried out by National Institute of Animal Science (NIAH) in 2004							
Pig liquid slurry	0.79			77.5	51.7	0.74	0.25
Research carried out by Hanoi Agricultural University (HAU) in 2004 and 2005							
Pig liquid slurry	0.38	0.99	0.51	92	60.8	1.2	
Pig solid slurry	0.56	0.38	0.96	66	22.8	0.46	

The table shows that nutrient content in bio-slurry is largely depentant on feeding materials. In Vietnam, pig dung and cattle dung largely dominate. It also shows that, due to different conditions, the chemical composition of bio-slurry between the different research is not constant, making general conclusions on bio-slurry content difficult to make.

Heavy elements in bio-slurry: Residue of toxic elements in bio-slurry hampers the application of this product on crops and animals, because people afraid that it may have negative effects on human health. Research carried by NIAH in 2004 in suburban area of Hanoi prove that heavy metals in bio-slurry is minimal and within the national standards of Vietnam.

Table 5: Concentration of some heavy metals in bio-slurry

Heavy metals	Analyze of NIAH	Vietnam national standards	
		Fresh water quality for protection of aquatic life	Water quality for irrigation
Cd, ppm	0.0056	0.008-0.018	≤0.01
Pb, ppm	0.0331	0.002-0.007	≤0.1
As, ppm	0.0041	≤0.02	0.05-0.1
Hg, ppm	0.00093	≤0.10	≤0.001

Bacteria and pathogens in bio-slurry: One of the main concerns when applying bio-slurry to crops and animals is the safety of the product. The quality of bio-slurry, in terms of bacteria and pathogens, depends not only the suitable size of digester but also the right operation by biogas users. Suitable size of digester and correct operation of it guarantee the manure fed into digester is completely digested and fermented. The following table shows analyze results of bio-slurry from incorrect size of digester nor operation.

Table 6: Some bacteria and pathogens in bio-slurry

Analysing parameters	HH1	HH2	HH3	HH4	HH5	Average
Solid slurry (cell/ml)						
Anaerobic bacteria (x 106)	8.15	5.32	3.33	6.60	3.55	5.39
Molds (x 104)	5.33	0.67	4.33	3.33	2.67	3.27
Yeast (x 107)	5.12	2.45	3.57	2.91	1.53	3.12

Ammonification bacteria (x107)	0.97	2.83	3.60	1.57	0.17	1.83
Cellulose decomposing bacteria (x105)	7.18	1.13	4.12	1.23	1.67	3.07
E.coli (x 105)	0.35	0.61	0.35	0.36	0.83	0.50
Salmonella (x104)	0.56	1.40	0.62	3.67	1.12	1.47
Parasitic worm eggs (x105)	0.7	5.7	2.5	3.5	4.5	3.38
Liquid slurry (cell/ml)						
Anaerobic bacteria (x 106)	0.42	0.15	0.17	0.13	0.21	0.22
Molds (x 104)	2.31	2.15	1.00	3.67	2.32	2.29
Yeast (x 107)	1.25	0.37	0.33	0.42	0.57	0.59
Ammonification bacteria (x106)	0.86	0.26	0.26	1.52	1.23	0.83
Cellulose decomposing bacteria (x105)	1.17	0.85	0.85	0.83	0.72	0.88
E.coli (x 105)	0.17	0.30	0.30	0.15	0.66	0.32
Salmonella (x104)	2.33	4.31	4.31	1.67	2.53	3.03
Parasitic worm eggs (x105)	2.4	5.1	5.1	0.4	0.4	2.68

HH: Household

Bio-slurry contained more total N and P compared with animal manure, especially the content of available ones. Total N in bio-slurry is 0.56% (0.35% in manure); total P2O5 was 0.38% (0.22% in manure); available N, P2O5, K2O –respectively: 168.89; 146.85; 39.28 mg/l. In addition, bio-slurry contains a number of secondary nutrients including S, Ca, Mg, Zn, B. There is a large amount of cellulose decaying bacteria (3.07x105 cells/g), ammonification bacteria (1.83x107 cells/g), and yeast (3.12x107 cells/g) in bio-slurry which is very good for composting. Liquid slurry had base reaction. It contains significant content of total and available nutrients, especially N and K. N; P2O5 ; K2O reached 0.37; 0.01; 0.051% respectively; available N; P2O5 ; K2O reached 455.0; 66.38; 394.66 mg/l respectively. However, both liquid and solid slurry contain high pathogens, so necessary treatments are needed to avoid negative effects on humans and environments.

Benefits from using bio-slurry: Benefits of using bio-slurry as crop fertilizer have been proved by a number of researches. The below table is summary of experiments of bio-slurry application on different crops. The most positive effect is increased crop yield and reduction of chemical fertilizer consumption. Research of IE, in 1990, on the application of solid bio-slurry on potato crops showed that the yield of applied potatoes increased by 64.2% comparing to that of non-applied bio-slurry. Research carried out by Can Tho university, on using bio-slurry for soybean, shows that the application helps increase yield by 22%. When bio-slurry was applied to fishponds an increase of fish yield up to 10.6% was seen.

Table 7: Using bio-slurry result in increasing yield of crops and reducing chemical fertilizer consumption

Crops	Increased yield (%)	Saved fertilizers
Maize	25.8	
Korahbi	13.7	
Cabbage	24.0	4.6kg urea, 3.6kg phosphate and 3.6kg potassium per sao (360m2)
Buck wheat	8.2	
Peanut	8.5	21.7-43.4 kg urea; 3.8–7.6 kg phosphate and 5.6-11.2 kg potassium per hectare
Paddy rice		32.6-130.4 kg urea, 59.4-238.2 kg phosphate and 3.2-12.7 kg potassium per hectare

In 2004, NISF carried out research on applying liquid bio-slurry to cabbages with a ratio of slurry to water of 1:1 and 1:2. The results showed that: the use of 60 cubic metres of liquid bio-slurry to

cabbage, as additional fertilizer, helps increase yield by up to 24%. In addition, the following quantities of chemical fertilizers were saved: (per hectare) 28 kg urea, 10.8 kg phosphate fertilizer and 27 kg potassium fertilizers. Moreover, amount of pesticide needed to control leaf damage caused by insects reduced by 50%.

Research on using bio-slurry as additional pig feed: In 2004 research on the effect of different levels of liquid bio-digester effluent in diets on the growing rate, feed efficiency, meat quality and economic efficiency of F1 crossbred fattening pigs conducted by NIAH under research plan of BP. A total of 36 F2 crossbred fattening pigs (Mong cai local sow x Yorkshire boar) witn an average initial weight of 21 kg were allocated to a household which was using a biogas system. The pigs were divided into 12 pens (2 males and 1 female in each pen) consist of 4 treatments with 3 replications following a completely randomized design. There was no significant difference in breeds, age, sex and other conditions of the pigs in all pens. Pigs in 4 treatments were fed with 4 different diets. Pigs in treatment 1 were fed a basal diet consisting of maize meal, rice bran, soybean meal, cassava meal and fish meal which were formulated to meet requirements according to the recommendations of NIAH (2001) for crossbred fattening pigs from 15-50 kg of weight and 50 kg-slaughter. The samples of the feedstuff were analyzed for nutritive values (dry mater, crude protein, ask, fibre, NDF, calcium, phosphorus) before formulating the balanced diets. Pigs in treatment 2, 3 and 4 were fed the basal diet mixing with liquid bio-slurry at 3 different levels as 1, 2, 3 litre/kg of feed, respectively. The bio-slurry was taken out from a 10m3 biogas container after 2 months of fermentation, which was recharged by pig manure. The samples of bio-slurry were taken and analyzed every month for nutritive values, and some heavy elements. During the experimental period the pigs were fed semi ad-libitum twice per day, at 8.00h and 16.00h, which is the normal practice of the farmers in the village. The semi ad-libitum system is as follows: the amount of feed remaining about 4 hours after every feeding was recorded, then in the next meal, the amount of feed offered was adjusted by this amount, so that the feed refused after around 4 hours was consumed before the next feeding. Feed offered was weighed and recorded daily for calculation of feed intake. The pigs were weighed in the morning before feeding, at the beginning and at the end of each period (50 kg of weight and before slaughtering) to determine live weight gain and feed conversion ratio. At the end of the experimental period, samples of liver, kidney, heart, lung and intestine of 3 pigs, which were taken randomly from each treatment to analyze for parasites and disease symptoms, were taken. Samples of meat from these pigs were also taken to analyze their quality as smell, taste, dry mater and heavy elements. In the first period (20-50 kg), daily feed intake and nutrient intakes in the diets mixed with the effluence were significantly higher than the basal diet ($P<0.05$), especially in treat 2 and 3, in which they were lower in treat 4 compared to treat 2 and 3 ($P<0.05$) while there was no difference between the treat 1 and 2 ($P>0.05$) (1.49, 1.61, 1.62 and 1.58 kg of feed intake/day of treatments 1, 2, 3 and 4, respectively). However, in the second period (50 kg - slaughter), the feed and nutrients intake were not improved in treat 4 compared to the basal diet ($P>0.05$), while treat 2 and 3 had significantly higher feed and nutrient intakes compared to treat 1 and 4 ($P<0.05$) (3.14 and 3.21 kg of feed intake/day of treat 2 and 3 compared to 2.91 and 2.98 kg feed intake/day of treat 1 and 4). Overall the feed and nutrient intake had the same tendency with period 1 (2.61, 2.33, 2.37 and 2.24 kg of feed intake/day overall of treatments 1, 2, 3 and 4, respectively). All the pigs were healthy during the experimental period and the pigs between treatments did not have any differences. Before the slaughter, the samples of liver, kidney, heart, lung and intestine from 9 pigs of 4 treatments did not show any symptoms of the respiratory diseases and digestive diseases. Samples of lean meat from ham were taken to evaluate colour, smell and taste by a three-point scale. All of the samples of uncooked meat had a pink colour and there were no differences found between treatments. The heavy element residue levels of meat are presented in table 8. All 4 heavy elements (Cd, Pb, As and Hg) were similar in 4 treatments and under Vietnam standards for pig meat quality.

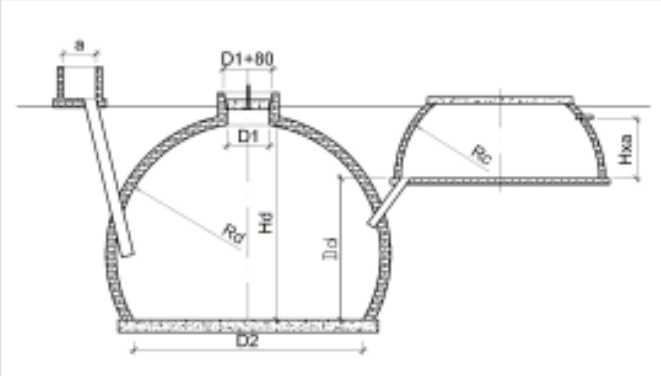
Table 8: Heavy metals residue in pig meat

Heavy metal	Liquid bio-slurry	Vietnam standards
d, ppm	0.0019	1.00
Pb, ppm	0.0046	2.00

As, ppm	0.0047	1.00
Hg, ppm	0.00009	0.05

Biogas plants that are surveyed: 100% of biogas plants are brick fixed domes, model KT1. They are constructed totally underground. The plant has a rather simple structure and applies a continuous feeding mechanism. Normally, the plant has 5 main parts: (i) mixing tank, (ii) inlet pipe, (iii) digester, (iv) outlet pipe and, (v) compensation tank. Sectoral standard No. 10 TCN 102 – 20067 is applied for this type of biogas plant. Figure 4 is diagram of KT1 biogas plant. Sizes of plants range from 6 cubic meters to 11 cubic meters. The average size is 9 cubic meters.

Figure 4: KT1 biogas plant



Livestock production status: Out of 100 households interviewed, 77 households have pigs, 59 have cows and 38 have both pigs and cows. On average, each household has nearly 10 pigs (variance is 45) and 2 cows (variance is 1.3). With this number of animals, the households are qualified to construct household biogas plants[8].

Dilution ratio: In reality, all interviewed households use pumpers to clean animal stable from 1 to several times a day. Each time normally lasts for 15 – 20 minutes, resulting in a big volume of water being fed into the biogas plant, especially during the summer. According to sectoral standard 10TCN 97 – 102 – 2006, dillution ratio should be 1 to 3 for manure (only dung) and 3 to 6 for animal waste (dung and urine), it means 1 manure will be mixed with 1 to 3 water if only dung fed or 3 to 6 water if dung and urine is fed into the digester. NBP also recommends households to construct flow way for redundant water. However, in reality no household has the flow way for their biogas plant. The below figure 5 presents the dillution ratio of interviewed households.

Figure 5: Dillution ratio of biogas digester

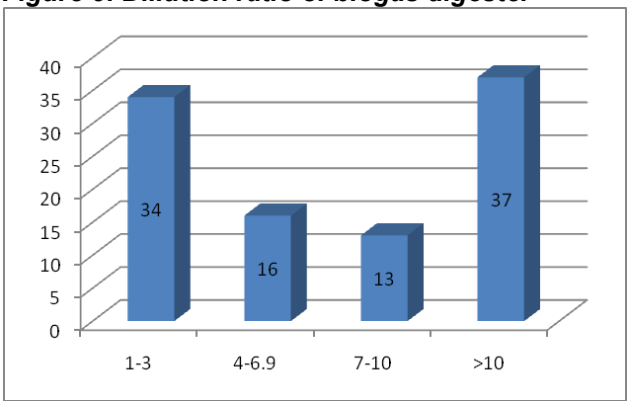


Figure 5 shows that only 34 households out of 100 interviewed households apply the recommended dillution ratio. 66 households apply dillution ratio of 4 and above, with 37 households applying a dillution ratio of more than 10. To date, no research has been done on this

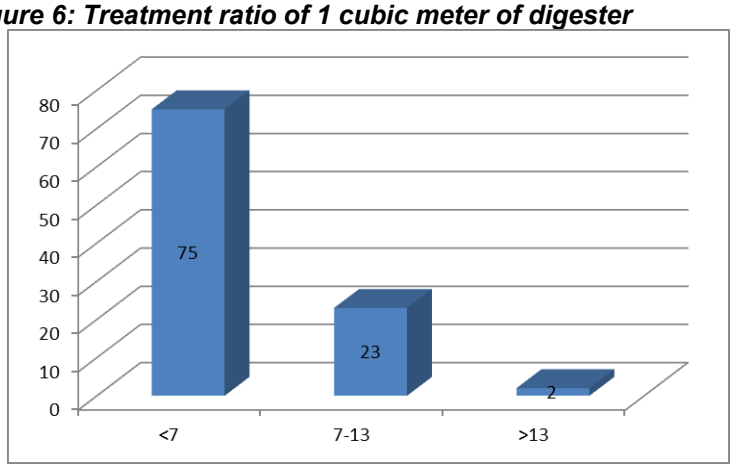
[7] *Sectoral Standard 10 TCN 102 -2006was revised and edited based on Standard 10 TCN 499-2002 by Ministry of Agriculture and Rural Development. In sectoral standard 10 TCN 499 – 2002 have six samples designs. In sectoral standard 10 TCN 102 – 2006, there are only 2 samples designs, are KT1 and KT2.*

[8] *According to selection criteria of NBP, a household having at least 6 pigs or 2 cow is qualified to built small scale biogas plant, eg biogas digester having digestion volume up to 40m^3.*

issue (applied dillution ratio and quality of bioslurry). In theory, if overfed with water there will be two key results:

i) Hydraulic Retention time (HRT)[9] of manure is reduced, leading to lower quality bioslurry. Taking an 8m3 biogas plant as an example, applying dillution ratio of 10. In cases where recommended manure is applied, e.g each cubic meter treats 7 kg of manure. An 8m3 biogas plant has the digestion volume of 6 cubic meters[10] and will treat 42 kg of manure. The volume of water is 420kg. Subsequently, the HRT = 6,000 kg/(420kg+42kg) = 13 days.

Figure 6: Treatment ratio of 1 cubic meter of digester



ii) As the manure undergoes the fermentation and digestion in a shorter time the designed gas productivity cannot be reached, meaning less gas for use by the households.

Treatment ratio for 1 cubic meter of biogas plant: As designed, one cubic meter of digester should treat 7 - 12 kg of manure, according to NBP guidelines. In reality, masons or biogas technicians often recommend households construct bigger biogas plants for the expansion of livestock production in the future. Below, figure 6 presents the treatment ratio of 1 cubic meter of biogas plants. Figure 6 shows that most households (75) have treatment ratio of less than 7, meaning that the bigger biogas plants are decided in comparison to animal production; the reason is given above. Another probable reason is the households decide the size of biogas digester, based not on livestock production, but instead the size of their neighbour's biogas digester. This phenomenon is very common in rural of Vietnam. After visiting a good performing biogas plants, the household often wants to copy exact the design, not taking the conditions of their house into account (eg. the number of animals)

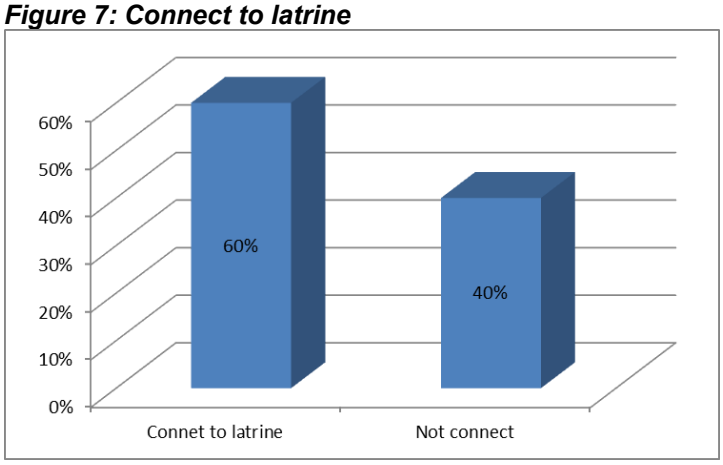
Biogas plant connected with latrine: 60% of biogas plants are connected with latrine, in which 90% of latrine use the chemical (HCl) for cleaning. The cleaning happens from once a month to once every couple of months. The volume of human excrete is not incorporated into the total volume of manure fed into the digester as the volume is rather small. According to NBP guidelines, each person can produce about 0.2kg – 0.5kg of excrete perday. The average number of people per household is 5.14 persons (variance is 3.3). The average total of excrete produced per day is only about 1 – 2.5kg. In theory, if the chemical is fed into biogas plant, it may inhibit the performance of

[9] *According to The biogas technology in China, the hydraulic retention time (HRT), also known as hydraulic residence time or t (tau), is a measure of the average length of time that a soluble compound remains in a constructed bioreactor. Anaerobic digestion depends on the biological activity of relatively slowly reproducing methanogenic bacteria. These bacteria must be given sufficient time to reproduce, so that they can replace cells lost with the effluent sludge, and adjust their population size to follow fluctuations in organic loading. If the rate of bacteria lost from the digester with the effluent slurry exceeds the growth rate of the bacteria, the bacterial population in the digester will be "washed out" of the system. This washout is avoided by maintaining a sufficient retention time for solids ensuring that the bacterial cells remain in optimal concentration within the digester.*

[10] *According to NPB manual, for a KT1 biogas plant, 4/5 is digestion volume and 1/5 is for gas volume.*

biogas creating bacteria. However, in reality all biogas plants are in good operation, maybe due to the small volume of chemical being used sporadically.

Figure 7: Connect to latrine

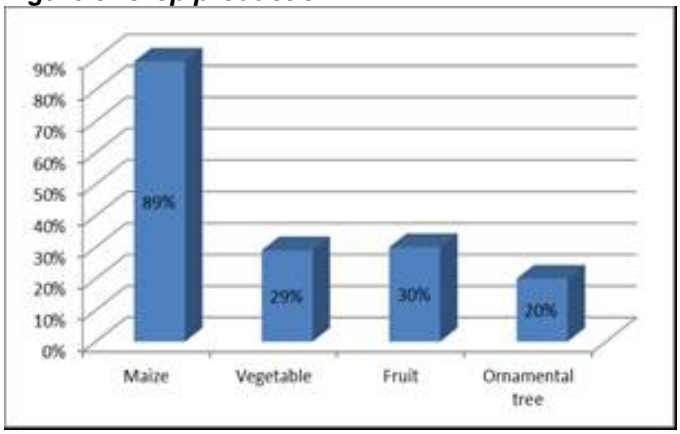


Bioslurry disposal: Non-used bioslurry (effluent) is discharged into the sewage system of the village. This sewage system connects with the canal then flows into a bigger canal of the district. The total volume of non-used bioslurry is 47 m3 per day for 100 households out of 49m3 bioslurry produced per day. The total number of biogas plants of Dong Anh district is about 1,000 (550 plants of NBP and 450 plants of QSEAP projects). The total volume of bioslurry discharged into the sewage system is estimated at 470m3 per day. Only 2 m3 bioslurry is used by 11 households per day for watering near by gardens. The households communicated that they take bioslurry directly from the compensation tank to water their gardens, in replacement of water. This practice does not replace inorganic fertilizer. The practice is not proper bioslurry management, it causes the decrease of gas pressure inside the digester, resulting in less gas availability for use.

Crop production[11]: Main crops planted in the commune are (i) maize, (ii) vegetable, (iii) fruit and (iv) ornamental tree. All agricultural residue is burnt or used as feedstuff for cattle (maize bulk). The average cultivation area is 3,466.6 m2 per household. Figure 8 presents the crop production status.

Maize: Maize is cultivated in 2 seasons per year. The area of maize occupies about 70% of the total area of 346,660m2, e.g. 242,662m2. For maize, both organic and inorganic fertilizer are used. Organic fertilizer – usually composting manure – is used when preparing soil. In organic fertilizer (NPK) is used for basal fertilizing and additional fertilizing. For 1 sao (360m2) in one season, 500kg manure and 40 NPK are used, costing about 86 US dollars. For 242,662m2 in two seasons, it needs nearly 674 tons of manure and 54 tons NPK, costing 116,000 US Dollars.

Figure 8: Crop production



[11] *Information and data is cited from interview of the head of cooperative.*

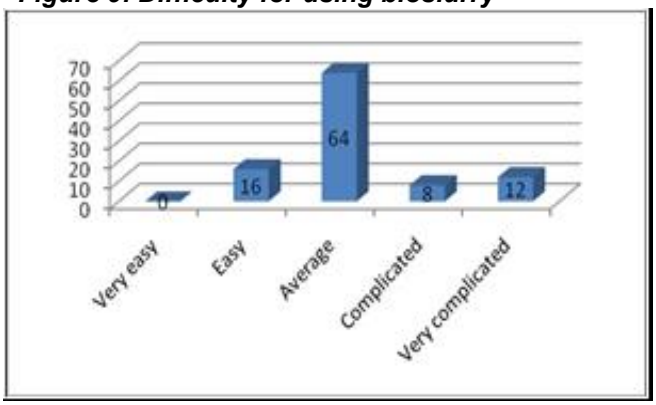
Vegetable: Vegetable crops occupy 15% of the area, i.e. 52,000 m2. The main types of vegetable are cabbage, green cabbage, bean etc. The vegtable season lasts from 15 to 30 days.

Fruit tree: Fruit tree crops occupy 10% of the area, i.e. 35,000 m2. Fruit trees are cultivated anually. The amount of organic and inorganic fertilizer used is dependant on the type of tree. The common fruits are papaya, water melon etc.

Cum quat: Cum quat occupies only 5% of the total area, i.e. 17,300 m2. Cum quat has one season per year, serving as a Tet tree for the people for the traditional lunar new year of Viet Nam.

Using bioslurry is difficult?: Most of farmers communicate that the application of bioslurry is not difficult but cost a lot in terms of labour and time in comparison to using NPK ferilizer. This is why farmers hesitate to use bioslurry, eventhough they consider it a good fertilizer. Figure 9 shows the farmers' attitude to the difficulty of using bioslurry.

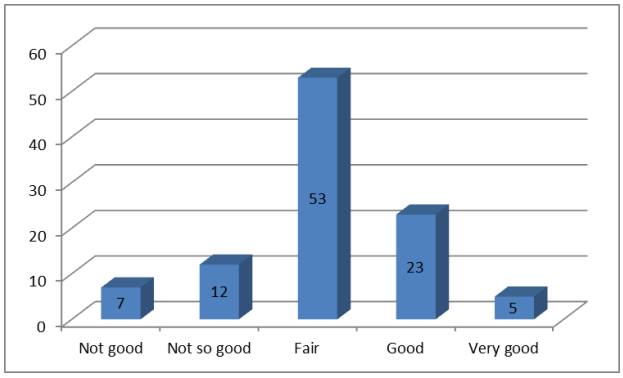
Figure 9: Difficulty for using bioslurry



According to Figure 9, no farmers consider the application of bioslurry to be 'very easy', 16 farmers think it is 'easy enough', 64 farmers think it is in between easy and complicated, 8 farmers think it is complicated and 12 farmers think it is very complication to use bioslurry for different purposes.

Bioslurry is an organic fertilizer source: Attending training courses, farmers learnt that bioslurry is not a waste product but a potent fertilizer that can be used for crops, fishponds and even feedstuff for animals when properly treated[12]. Figure 10 presents the farmers' perception on bioslurry as a fertilizer source.

Figure 10: Bioslurry is a fertilizer source



Out of 100 people interviewed, 53 people communicated that bioslurry fertilizer has fair quality; 23 think it is a good fertilizer, 12 think it is fertilizer of not so good quality; 7 do not think bioslurry is fertilizer while 5 think it is very good fertilizer. In reality, no households apply any treatment for bioslurry, only 11 households use bioslurry in replacement of water for their garden, not as fertilizer. They think bioslurry is a kind of fertilizer, but so far they have not been persuaded by any pilot or research on bioslurry use and its effects on crops, fishponds or animals.

Using bioslurry for fishponds: In Vietnam, the use of organic manure for fishponds has a long history. However, this practice, not only, causes fish diseases; as manure can contain many harmful bacteria, but also consumes dissolved oxygen in water. Thus resulting in the reduction of dissolved oxygen and head-floating increase. In addion, using fresh manure for fishponds can cause bad odour and pollution of the fishpond water. With the development of biogas technology, since 1970s, a great number of experiments have been undertaken into the use of bioslurry in fishponds, in number of countries like China, the Philipines etc. The results have displayed that the

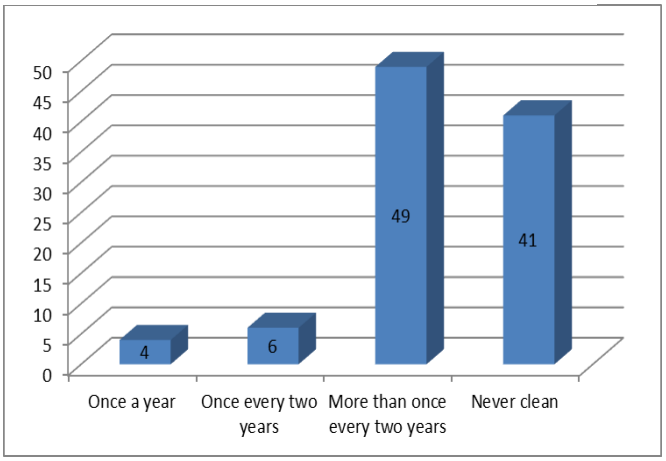
[12] *NBP's manual on biogas technology*

use of bioslury in fishponds have more advantages than the use of exrements for the same purpose[13]. The practice has remarkable benefits such as[14]:

- The use of bioslurry for fish farming is favorable to the growth of planktolic animals (algeas, water plants, mosses, water insects etc), making the fish pond more active so as to provide plenty of feedstuff for fish. As bioslurry contains abundant soluble nutrients, it is beneficial to the breeding and growth of plankton, resulting in living things growing rapidly, with 7 – 20 faster than the control;
- The use of bioslurry for raising fish is advantageous to the conservation of dissovled oxygen in water because bioslurry's organic matters have been decomposed, reducing head floating when fresh manure is used;
- The use of bioslurry for fish farming can decrease fish diseases, as after organic matters undego anerobic fermentation, its parasite eggs and aerobic pathogenesis fungi has been killed.

Ready to buy bioslurry or composting bioslurry fertilizer: 91 farmers communicate they are not ready to buy bioslurry because they already have bioslurry but are not able to arrange labour for transporting it to field. Only 9 farmers communicated that they are ready to buy composting bioslurry fertilizer if it is of good quality and be transported to the field ready for use.

Figure 11: Take scum out of biodigester



Scum in biogas plants: Previously, the livestock production of the commune was dairy cow and cow. Therefore, biogas plants need to be cleaned annually or biannually. This is because firbe in cow dung increase the build-up of scum in the digester. The scum should be removed from the digester to generate gas for use. This situation changed 7 -8 years ago. Figure 11 presents the habit of cleaning biogas digesters by farmers.

Out of 100 households, 49 empty their digesters more than once every two years; 41 have never removed the scum; 6 households empty their biogas digester once every two years while 4 take scum out of biogas digester once a year. The practice is strongly base on the type and number of cows being raised.

23% household use the scum for their crops. Scum is removed from the digester once or twice a year, especially if cows are kept. Scum is dried for from half to one day then mixed with soil whilst preparing soil. There are two different ideas surrounding this. Firstly, that scum is a potent fertilizer and able to replace chemical fertilizer by up to 20%. Secondly, that scum is not a good fertilizer, even having bad impact on crop because, before using it, they were not routed and, in fact, they did not know how to use it.

Biogas use and surplus gas treatment: Out of 100 households, 72 have surplus gas, 24 have enough gas and only 4 households do not have enough gas for use. For these 4 households, the reasons for not having enough gas to use are (i) sold all of their animals and waiting for new animals (ii) large demand for gas, such as gas for cooking wine rice or cooking animals. With surplus gas, it is normally burnt (74 households) or given to neighbours (23 households). This practice seems to be a good treatment for the current situation. Only 2 households release surplus

[13] *Biogas technolofy manual – NPB 2008*
[14] *The biogas technology in China, 1989*

gas to the air. Eventhough households have more demand to use created biogas, they lack biogas appliances such as generators or water boilers. These appliances are available in the market but are not affordable for the farmers.

Conclusion: Biogas households have qualified biogas plants which are in good operation at the the time of survey. However, the biogas plants are often overfed with water and underfed with manure. If the slurry mixture is too diluted, the solid particles could collect at the bottom of the digester. If the slurry is too thick the flow of gas could be impeded. In both cases, gas production will be less than optimum. HRT is too short in comparison with the sectorial standard. Accoring to the sectorial standard for household biogas digesters, the biogas plant is included three main tanks: input tank, digester tank and compensation tank. For the utilization of bioslurry, it is highly recommended that a bioslurry pit should be constructed under ground to save space for other activities of the households. Currently, the households take bioslurry directly from the compensation tank, this practice has a negative impact on the operation of the plant, as it makes the pressure inside the digester decrease. Thus resulting in the available generated biogas being unusable. Households are willing to use bioslurry and scum for their crops but they have no means of transportation or labour for transportation. In their opinion, using bioslurry is rather complicated in comparison to inorganic fertilizer. Training courses on using bioslurry, scum for crops and for making bioslurry composting fertilizer are highly welcomed by households.

3. PROJECT DESCRIPTION

3.1. RECOMMENDED PILOT INVESTMENT – OUTPUTS AND INVESTMENT ACTIVITIES, DETAILED DEMONSTRATION PILOT PLAN, PERFORMANCE INDICATORS

3.1.1. Rationale

The pilot will pave the way to utilization of biomass and bioslurry that is soundly environmentally friendly. The bio-slurry, when treated and properly managed, can be transformed into a valuable fertilizer– in liquid and solid forms- instead of a hazardous pollutants. “Reducing, reusing, and recycling” agricultural wastes would decrease GHG emissions and the release of harmful pollutants into the environment.

The large amounts of liquid bioslurry and solid bioslurry (scum) that are thrown away will be used up under the pilot. This practice not only saves organic resources but also contributes to the environmental improvement through the improvement of soil, ground water and air.

The expenses of inorganic fertilizer and fresh dung for household’s normally occupies 60% of investment for cultivation[15]. The pilot aims to reduce this expense by up to 40% , by replacing inorganic fertilizer with bioslurry and composting biogas fertilizer.

The pilot will improve the community relationship between people through meeting, training and co-cultivation. Households contribute to the irrigation bioslurry system and they benefit from the system. It is expected that the awareness of environmental improvement and community will be strengthened through pilot.

Through capacity building and training components, stakeholders will be provided information and knowledge on biogas technology, its benefits and impacts as well as knowledge on composting and proper fertilizer utilization. Every year, Viet Nam uses 9 – 10 million tons of inorganic fertilizer and 50% - 70% is wasted[16]. Properly constructed BPs have important benefits including: (i) reduced human and livestock disease outbreaks, methane emissions, fire wood consumption, air (in and outdoor) pollution, water and soil pollutants and, (ii) increased savings in time and money, increased quantity and quality of organic fertilizers, and potential access to carbon credit schemes.

The implementation of the pilot is also a part of the Vietnamese Good Agricultural Practices (VietGAP) of the Viet Nam Government[17]. According to VietGAP, soil should be managed, e.g. soil is analyzed to control and evaluate the quality and potential risks. Fertilizers (organic and inorganic) that are used for crops should be controlled and documented, in order to avoid the contamination of agricultural products. Organic fertilizer has to be treated and managed to ensure its quality. Fertilizer must also be kept in a specific place so as not to create any pollution risks to the cultivation area and water resource.

3.1.2. Impact and Outcome

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[15] Data and information is extracted and cited from the Report on implementation of eco-social mission, security and defense for the duration of first six months of 2013; and the focusing mission of the commune for the period of last six months of 2013. For example of maize production of 1 sao, the expense for inorganic and manure is 86$ out of 143$ as total investment.

[16] Truong Hop Tac, PhD, Department of Crop Production – MARD. It is overuse of NPK and unbalance of using NPK for the crop in Viet Nam

[17] Good Agricultural Practices (GAP) are specific methods which, when applied to agriculture, create food for consumers or further processing that is safe and wholesome. While are numerous competing definitions of what methods constitute "Good Agricultural Practices" there are several broadly accepted schemes that producers can adhere to.

The pilot impact will be reduced agricultural pollution and increased revenue of households, increased knowledge on cultivation, biogas technology and composting process, improved the community relationships. It will also be a good example for duplication.

3.1.3. Output and investment activities

Output

The outputs will be: (i) constructed information and data on biogas technology, bioslurry and composting bioslurry fertilizer, (ii) constructed irrigation bioslurry systems and expanded livestock waste management infrastructure systems, (iii) enhanced knowledge and technology development and transfer systems, (iv) use of bioslurry for fishponds and composting biogas fertilizer for vegetables, (v) set up a bioslury value chain and commercialization in the market.

To gain the above outputs, the following are key investment activities to be demonstrated and implemented.

Investment activities

Component 1: Research and Analysis for construction of information and data on biogas technology, bioslurry and composting bioslurry fertilizer[18]

Research:

- Overview and desk study on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizer.
- Analysis
- Take samples of soil before and after piloting and analyze for the following parameters: total N, volatile N, volatile P, heavy metals (Hg, Cd, Pd, As, Cu, Zn)[19], amount of humus.
- Take samples of agricultural products (vegetable) and analyze for the following parameters: appearance, heavy metals[20] and, fecal microorganisms[21].
- Take samples of composting biogas fertilizer and analyze for the following parameters of total N, Volatile P (P2O5), volatile K (K2O), OM, moisture, Fecal Coli[22].
- Analysis of organic compost components and comparision with the quality of manure.

Component 2: Construction and purchasing mobile device for selected households to utilize bioslurry

Under the pilot, a number of work needs are to be constructed and installed for piloted households, as follows:

- Construct 25 bioslurry pits having size of 3m3 each, connected with compensation tank of biogas plant at 25 piloted biogas households. Based on survey results, the average animal waste input of surveyed household is 35kg/day with dilution ratio: 1:5 (1 kg dung with 5 litres of water. In addition, the toilet is connected to the biogas digester so the total material input to digester is about 250kg/day. The households will collect bioslurry over 10days, after that they transport bioslurry to field. Half of the bioslurry will be used for crops and remaining will be used for composting.

[18] *For composting process and material, refer to annex 4 and annex 6*

[19] *QCVN 03:2008/BTNMT* National Technical Regulation on permissible limitation of a number of heavy metal in cultivation soil

[20] *QCVN 01/132/2013* National Technical Regulation on Fresh Vegetable, Fruit and Tea - Conditions for Ensuring Food Safety in Production and Packing; *QCVN 8-2:2011/BYT*National Technical Regulation on maximum limitation of heavy metals in vegetable and fruit

[21] *QCVN 8-3:2012/BYT*National Technical Regulation on maximum limitation of fecal microorganisms in vegetable and fruit

[22] *Circular 36/2010/TT-BNNPTNT regulating on production, trading and utilization of fertilizer*

- Purchase 75 barrels (100 litre/barrel) for 25 selected households (3 barrels for each household) for holding bioslurry;
- Purchase 25 improved carts for 25 piloted households to transport bioslurry from the slurry pit to the field;
- Purhase 25 aerosols for 25 piloted households to water crops with bioslurry;
- Purchase 25 water pumps for the piloted households to transfer bioslurry to the barrel to allow transportation to the field.

Component 3: Construction and purchasing of mobile devices for woman/farmer union for making biogas composting fertilizer

A contract with commune woman/farmer union to make composting fertilizer from bioslurry and scum. The composting fertilizer will then be used for vegetables and sold to the local market and other households. For this purpose, the following should be invested:

- After 10 days, 37.5m^3 bioslurry will be collected from 25 households; for composting, the households must have prepared a collective amount of agriculture waste, the construction of 2 bioslurry pits, of 40m3, for storing bioslurry and agriculrure waste at field will be completed.
- Construction of a 10 m2 of house for storing compost.
- Purchase 3 composite barrels, having capacity of 200 litres each, to transport bioslurry.
- Purchase 1 improved cart.
- Purchase 5 aerosols for watering compost heap during composting process.
- Purchase 1 water pump.
- Purchase 1 packing machine, for packing composting organic fertilizer.
- Purchase material to print 1000 bags, to contain composting organic fertilizer for selling to the market and other households.
- Promote composting organic fertilizer in public media (2 times in an extension program on television and 1 time in agriculture product exhibition).

Component 4: Use of bioslurry for crop

24 selected households will use bioslurry and composting for maize (one season) and vegetables (2 seasons). The maize and vegetables will be applied in 3 categories: (i) using of chemical fertilizer only (farmer practice); (ii) Using 50% bioslurry and 50% composting; (iii) 25% bioslurry + 25% chemical fertilizer + 50% composting

Component 5: Use bioslurry for fishponds

To prepare for using bioslurry for fishponds, the following works need to be done:

- Pond preparation: The pond should be cleared of bushes, dried for 3 days and disinfected with 7 – 10 kg of lime/100 m2. Pond water is filtered through a sieve to get rid of trash fish coming into pond;
- Fish breed preparation
  - Choose healthy fish, no deformities and free of disease;
  - Fish are bathed with diluted concentration of salt 2 – 3% (2-3 kg of salt/100 litres) in 10 minutes before stocking;
  - Fish should be stocked when the weather is cool. On stocking, temperature of pond water and transportation water should be balanced. If stocking when sunny, fish should be stocked in a cool place (shade of tree) and pond water should be stired from the lower layer to ged rid of temperature shock for fish.
- Installation of 10m long plastic pipeline to transport bioslurry to fish pond.

Component 6: Capacity building and training for enhanced knowledge and technology development and transfer systems

There are 5 types of stakeholders for capacity building and training (i) commune officers, (ii) masons, (iii) biogas households, (iv) non-biogas households and (v) woman/farmer union. The bellow table presents the arrangement of necessary capacity building and training.

Table 9: Number of capacity building and training

No	Training Course	Objective	Participation
1	Before pilot implementation (2 training courses)	To provide: – benefit of a biogas plant; – information on selection of suitable biogas plant; – how to supervise construction of biogas plant; – cost and qualified masons in the region.	Non- biogas household, mason, commune officer and woman/farmer union
2	2 Training courses on O&M biogas digester	To provide: – how to operate well a biogas plant; – how to use biogas and biogas appliance; – how to maintain and deal with trouble shootings.	Biogas household , mason and woman/farmer union
3	4 Training courses on bioslurry utilization	To provide: – how to utilize liquid and solid (scum) bioslurry; – how to make composting fertilizer from bioslurry and scum; – how much bioslurry can replace inorganic fertilizer and to calculate the amount of inorganic fertilizer need for specific crops; – - how to calculate financial saving of a harvest for specific crops.	Biogas households, non-biogas households, masons, commune officers and woman/farmers union
4	2 Training courses on marketing and sale for woman/farmer union	– Method to promote product; – Marketing skill – Sale skill – After sale service	Woman/farmers union

3.1.4. Detailed demonstration pilot plans

Implementation unit:

Consulting firm: The consulting firm is responsible for the pilot demonstration and implementation, consisting of 5 people. In which, (i) 1 project coordinator is responsible for the overall work plan and general implementation, as well as reporting to Landell Mills Ltd; (ii) 2 technicians are responsible for the implementation of the pilot with the project partners (i.e. consultants and firms); (iii) 1 project officer is responsible for procurement, consultant selection and contract implementation observation; (iv) 1 accountant is responsible of financial issues.

Household selection

The households who meet the following criteria are considered as potential and qualified households for the demonstration pilot (i) have a standard biogas plant(s) that is/are normally operating, (ii) have a crop field, (iii) have efficient labour (at least 1 person) to operate the biogas plant, pump and bioslurry system as well as irrigate field with liquid bioslurry on a daily basis, (iv) willing to join the project and (v) willing to co-invest in the project.

25 potential biogas households will be selected from a short-list of potential biogas households (24 households will have applied bioslurry and composting for maize and vegetables, one household will be use bioslurry for fishponds). The selected households will be implemented based on guidiline and monitoring of consulting firm and the support of local officers.

Woman/farmer union

The woman/farmer union will be introduced to the method of composting. They will produce and sell for selected households and users. Based on market price of the same composting product, the woman/farmer union will decide the price of this product. Selected households will be paid 50% of expenses directly for woman/farmer union and the remaining 50% will be paid to woman/farmer union via the subsidy of project.

In the selected commune the woman/farmer union will be playing a promotions and sales role in composting organic products. The union needs to be trained in participating in bioslurry value chain, operation of the biogas digester, how to produce organic compost. These union staff should be trained in promotion, marketing and sales skills.

Table 10: Implementation arrangement plan

Component	Aspect	Arrangement plan	Time consumed
Component 1	1. Consulting service review on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizer	Consulting firm	2 weeks
	2. Take samples and analyze after and before	Quality- and cost-based selection	2 weeks
Component 2	3. Construction of 25 bioslurry pits having size of 3 m3 each close to biogas digesters	Consulting firm and construction mason	2 weeks
	4. Procurement for purchasing 75 barrels, 25 improved carts, 25 aerosols, 25 household waster pumps for 25 selected households	Government /ADB procedures	2 weeks
	5. Monitoring at least 30 days of each selected biogas digester to ensure that digester is correctly operaton,	Consulting firm	5 weeks
Component 3	6. Construction of 2 bioslurry pits having size of 40 m3 at field and 10 m2 of house for composting	Consulting firm and construction mason	2 weeks
	7. Procurement for purchasing 3 barrels, 1 improved cart, 5 aerosols, 1 waster pumps and 1 packing machine, 1000 nylon bags for woman/farmer union	Government /ADB procedures	2 weeks
	8. Consulting service for composting bioslurry fertilizer	Consulting firm and woman/farmer union	3 weeks
	9. Composting bioslurry fertilizer production	Consulting firm and woman/farmer union	8 weeks
	10. Contribute to the manuals on bioslurry use and composting bioslurry fertilizer	Consulting firm and woman/farmer union	1 week
	11. Promote composting product in public media	Consulting firm, woman/farmer union and media company	2 weeks
Component 4	12. Prepare soil for pilot demonstration	Selected households	1 week
	13. Buy sowing seeds	Consulting firm and selected households	1 week
	14. Monitoring during pilot implementation	Consulting firm	26 weeks
Component 5	15. Prepare pond for pilot implementation	Consulting firm and	2 weeks

	(including chosing healthy fish)	selected household	
	16. Construct a bioslurry pit of 3m3 and 10 long pipeline	Mason group	1 week
	17. Use bioslurry for fishpond	Consultant firm and selected household	26 weeks
	18. Monitoring during pilot implementation	Consulting firm	26 weeks
Component 6	19. Prepare training documents	Consulting firm	1 week
	20. Conduct 2 training courses on biogas technology and its benefits	Consulting firm and selected participants	1 week
	21. Conduct 2 O&M training courses	Consulting firm and selected participants	1 week
	22. Conduct 4 training courses on bioslurry utilization	Consulting firm and selected participants	2 weeks
	23. Conduct 2 training courses on sale and marketing skills	Consulting firm and selected participants	1 week

3.1.5. Performance indicators

The performance indicators are established based on activities that will be arranged and carried out during the pilot as per the below table 11.

Table 11: Performance Indicators

No.	Performance	Indicator
1	Household selection	25 qualified biogas households are selected
2	Review and desk study on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizer	i. Report on current legislation, policy, strategy, target program, national standards, national technical regulation, sectoral standard on bioslurry and composting fertilizer; ii. a manual on bioslurry and composting bioslurry utilization, process.
3	Analyze parameters	i. Parameters for soil before and after plotting including: total N, volatile N, volatile P, heavy metals (Hg, Cd, Pd, As, Cu, Zn), amount of humus: ii. Parameters of maize quality; iii. Parameters of vegetable including: appearance, heavy metals, fecal microorganisms; iv. Parameters of composting bioslurry fertilizer including total N, Volatile P (P2O5), volatile K (K2O), OM, moisture; v. Analysed organic compost components and compared it with manure.
4	Making composting bioslurry fertilizer	i. Process of composting bioslurry fertilizer production is developed; ii. Formula of composting bioslurry fertilizer and inorganic fertilizer applied for specific crops in projected area is developed; iii. Economical analyze is done.
5	Construction	i. 25 bioslurry pits having size of 3m3 at 25 piloted biogas households is constructed; ii. 2 centralized bioslurry pits of 40 m3 at field is constructed;

		iii. 10 m2 of house for composting is constracted;
6	Equipment purchase	i. 75 barrels (100 litter/barrel), 25 improved carts, 25 aerosols and 25 household water pumps for 25 selected households are purchased; ii. 3 barrels, 1 improved card, 5 aerosols, 1 water pumps, 1 packing machine and 1000 nylon bags are purchased for woman/farmer union.
7	Promotion composting product	2 advertisements will be posted in television and agriculture product exhibiion.
8	Using bioslurry for maize and vegetable	i. Maize and sowing seeds are selected; ii. Parameters as total yield (t/ha), Economic efficiency, Pests and disease situation are evaluated.
9	Use bioslurry for fish pond	i. Fish pond is cleaned; ii. Fish are stocked when cool weather; iii. Feed for fish are controled; iv. Twice a month, environment of fish pond are monitored; v. Monthly fish health are monitored
10	Selling composting product in the market	i. Number of composting product are sold in the market; ii. Potential market for this product is evaluated iii. Revenue from this business is evaluated.
11	Capacity buidling for stakeholders	i. 2 training courses on biogas technology and its benefits for 40 participants are organized; ii. 2 training courses on O&M for 40 participants are organized; iii. 4 training courses on bioslurry utilization are organized; iv. 2 training courses on sale and marketing skills are organized

3.2. WORK PLAN, IMPLEMENTATION ARRANGEMENTS

3.2.1. Work Plan

The work plan is a crucial tool to ensure that the feasibility study achieve its goals, stays within budget, and remains on schedule. The team leader is responsible for mapping out all tasks, determining who does what and when, and defining the deliverables for each step. Once the project begins, the team leader will use the work plan to troubleshoot the processes, the deliverables, and the schedule.

The FS will be tentatively implemented within 8 months.

3.2.2. Implementation Arrangement

The Consulting firm (CF) will be selected. The CF is responsible for the pilot demonstration and implementation, consisting of 5 people. In which, (i) 1 project coordinator is responsible for the overall work plan and general implementation as well as reporting to Landed Mill Ltd (LML); (ii) 2 technicians are responsible of implementation of pilot with the project partners; (iii) 1 project officer is responsible for procurement and consultant selection and contract implementation observation; (iv) 1 accountant is responsible for financial issues. During project implementation, the CF will establish synergies with the ongoing ADB project and LML requirement for knowledge transfer and capacity sharing. The CF also will work closely, with TA 7833 project, NFP and relevant stakeholders to select the piloted households and sign contracts with said households as well as work with woman/farmer union to provide professtional support in the implementation of marketing and the business plan.

The households will participate:

- Before pilot implemetation, a training course will be conducted to share the benefits of biogas plant, how to choose suitable biogas plant, how to supervise construction step of biogas plant as well as cost and qualified mason;
- During pilot implementation, a training course will be organized to share how to operate a biogas plant well, how to use biogas and biogas appliance, how to maintain and deal with trouble shooting, how to use bio-slurry. The woman/farmer union will be incharge of bioslurry value chain. They will participate in above-mentioned training courses and sales and marketing skills to promote composting product and sale it in the market.

The woman/farmer union will produce and sell compost. They will use collected revenue to maintain this system.

CF will sign a contract with consultants and other service providers will be recruited by them, in accordance with Government procedures or ADB's Guidelines on the Use of Consultants (2010, as amended from time to time) to assist in project implementation. They will provide sample analysis, construction and other services to achieve the project's intended targets and ensure that safeguarded issues are properly dealt with. The PMU will procure goods, civil works, and other contracts in accordance with ADB Procurement Guidelines (2010, as amended from time to time). The project will be implemented from November 2013 to May 2014. Implementation arrangements are summarized in Table 12.

Table 12: Implementation Arrangements

Aspects	**Arrangements**
Implementation period	November 2013 - June 2014 (8 months)
Estimated completion date	30 June 2014
Management	
Implementing unit	Selected consulting firm
Procurement	Government procedures and ADB guideline

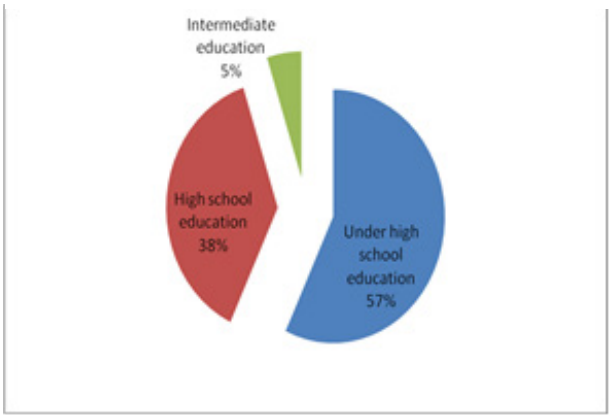
The achivements of the pilot will be reported to TA 7833 quarterly. Regular monitoring and reporting shall be carried out by CF.

No.	Activity	November				December					January					Febuary				March					April				May					June			
		1	2	3	4	1	2	3	4	5	1	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2	3	4
1	Review FS report																																				
2	Overview and desk study on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizers																																				
3	Select the piloted households																																				
4	Conduct 2 training courses for stakeholders																																				
5	Take samples of soil, agricultural products, bioslurry, composting fertilizer before implementation																																				
6	Construct 25 bioslurry pits having size of 3 m^3 each																																				
7	Construct 2 centralized bioslurry pits of 40 m^3 at field and m2 of house for composting																																				
8	Purchasing 75 barrels (100 litter/barrel), 25 improved carts, 25 aerosols and 25 household water pumps for 25 selected households																																				
9	Purchasing3 barrels, 1 improved card, 5 aerosols, 1 water pumps, 1 packing machine and 1000 nylon bags for woman/farmer union																																				
10	Installation of 10 m long plastic pipeline to transport bioslurry to fish pond																																				
11	Purchasing maize, sowing seeds and small fish																																				

No.	Activity	November				December					January					Febuary				March					April				May					June			
		1	2	3	4	1	2	3	4	5	1	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	5	2	3	4	5
12	Prepare soil for pilot demonstration																																				
13	Improvement of current fishpond																																				
14	Conduct 2 O&M training courses for stakeholders																																				
15	Mornitoring during construction and installation																																				
16	Monitoring the selected household during operation and maintenance biogas plant																																				
17	Take samples of soil, agricultural products, bioslurry, composting fertilizer after one month well operation																																				
18	Conduct 4 training courses on utilization bioslurry for stakerholders																																				
19	Using bioslurry for specific crops and fish pond																																				
20	Making composting and selling in the market																																				
21	Conduct 2 selling and marketing skill training courses for woman/farmer union																																				
22	Advertisement in the television and agriculture exhibition																																				
23	Analysis efficiency of pilot implementation																																				
24	Consolidated report																																				

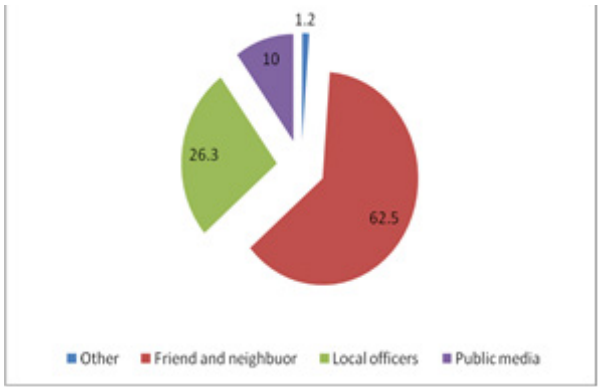
3.3. CAPACITY BUILDING NEEDS

Figure 12: Surveyed household's education level



In general, the training activities on using the biogas plants are often organized by the project. Biogas technicians and masons are trained by the biogas program in order to provide future users with enough knowledge and expertise. Biogas program staff are also there to transfer information to current users of the technology, and to assist households during the construction and the purchase of building materials, during the first filling of the plant and later operation and maintenance, as well as biogas appliances selection. In the biogas programs, users should receive pre and post construction training, future users and users of biogas are invited to take part (in groups) in the training and receive leaflets, a handbook and instructions on bioslurry usage.

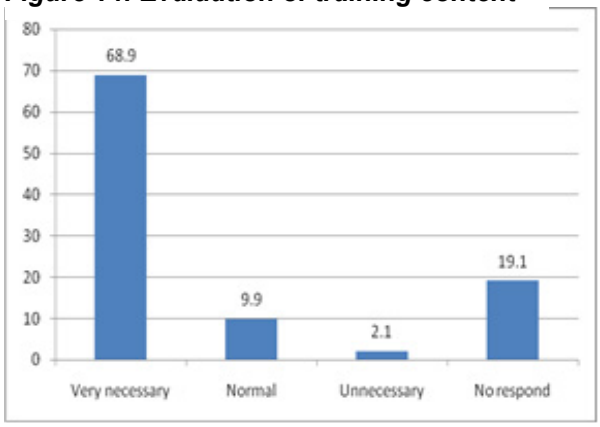
Figure 13: Reference source for biogas plant



The user's satisfaction about their biogas digesters is owed to the fact that they have already realized and experienced many benefits. When potential users decied to construct digesters, they mentioned several other reasons. The impact is not always visible in the first observation, for instance, financial savings might help households to educate their children, or improve their productive capabilites. In the following, the diverse impacts observed by the program are described.

The household's educational level is only to a medium level, including 57 heads of household (57.0%) not having completed high school education, 38 heads of household (38.0%) completing high school education. The heads of household with intermediate education only account for 5.0%. Due to the limited educational level of the heads of household, disseminating on using the biogas plant must be realized frequently, applying direct communication methods with the easiest and most effective presentation.

Figure 14: Evaluation of training content



Some of the sources of information that influence the decision to construct a biogas plant among evaluated users are; the biogas program itself, public media, local officers, friends and neighbours. It was recorded that information about biogas technology, its benefits and operation was accessed through friends and neighbour (account for 62.5%), local officers (account for 26,3%), public media (account for 10%) and other information through biogas projects which have been implementing in their province (1.2%). 86% of households think these types of biodigester leak less gas and are quick to install. The majority of households interviewed evaluated the training as very necessary (68.9%), 9.9% thought that it was normal, 2.1% of households stated that the training courses are not unnecessary, 21.2% of households had no answer (majority had not yet participated in any training classes so there was no assessment).

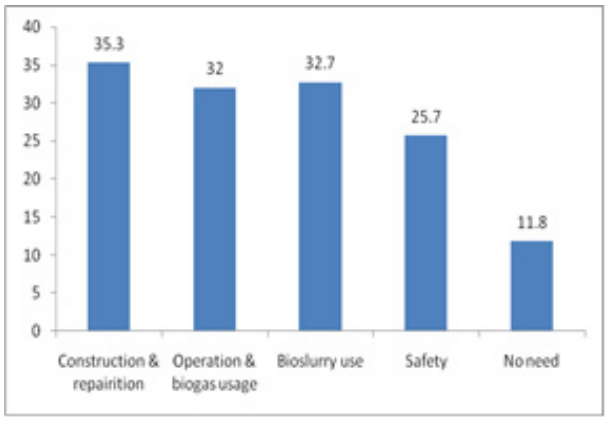
In general, the biogas households greatly appreciated the quality of the training, information and knowledge sharing with each household was very necessary and practical.

As a requirement for any biogas programme, training needs to be provided to plant owners and users to ensure proper operation of the system. However, the survey shows that only around half of the surveyed biogas users (56.3%) received either pre- or post-construction training. The remaining reported that they have never taken part in any training courses.

Most selected biogas households participated in at least one training course on biogas technology, operation and maintenance of biogas digesters or utilization of bioslurry. However, they said that these training courses were conducted a long time ago and sometimes they were combined with another training course so they did not remember much of the content. They were willing to participate in more training courses on biogas technogy and its befefits.

When users were asked about further improvements of the training, 35.3% of the users suggested a more in-depth explanation of technical issues, concerning repairs and construction. This was followed by 32.7% that would like more information on bioslurry use. 32% wished to have more information about operation of the biogas plant and usage of biogas. The safe operation of biogas plants was mentioned by 25.7% and 11.8% thought that neither the training or handbook needed any further improvements, since they are already explicative enough.

Figure 15: Training content for improvement



As part of the improvement of training qualities, according to the interviewees, a user handbook should have a stronger focus on some common technical problems that users might come across. These included issues with digester cover and gas pipe, so that users would be able to fix the problems right away if technicians or masons were not available.

3.4. MONITORING AND REPORTING

Monitoring is done across the pilot on the 6 designed components, including (i) research and analysis, (ii) construction and equipment installation; (iii) using bioslurry making compost; (iv) use bioslurry and composting for crop; (v) using bioslurry for fishponds and, (iv) Capacity building and training.

Bioslurry is also sampled and tested regularly for a wide variety of parameters. Monitoring takes the form of in house sampling and testing by employees, to outside sampling and analysis by externally certified laboratory personnel.

The key parameters monitored regularly in bioslurry include pH, colour, suspended solids, and dissolved solids. On regular, but less frequent occasions, more detailed analysis of bioslurry, ground water quality are conducted on a wider range of parameters.

Monitoring nutrients, heavy metals, microbial content such as E.Coli, Salmonella, coliform and ascarid eggs which may effect on safety of vegetables, food safety (based on decision No. 99/2008/QĐ-BNN, dated 15 October 2008 on safety vegetable issued by MARD) and economics efficiency of using slurry and composting.

Management of pond and feed: Fish are fed twice a day with feed pellets of 3-10% of body weight. During culture, daily notes on precise volume of feed consumed will be taken, in order to calculate

the feed consumed coefficient, monitoring and feed management in order to minimize losses and achieve economic efficiency. The depth of pond is maintained of 1.5 – 2 m.

Monitoring of environment and fish health during culture:

- Culture environment: Observating the water colour of farming pond, if the farming pond has a light colour, more bio-slurry can be added and vice versa. Checking hydration and physical factor of water environment: temperature, dissolved oxygen in water, pH, NH3, NO3 by using test analysis kits, for timely treatment of the pond;
- Fish health: Monitoring fish health during farming duration, in case of disquality of the environment, timely solutions such as using lime processing environment or using drugs, chemicals, biological products that are licensed by the MARD are used to prevent diseases.

4. TOTAL INVESTMENT, CAPITAL STRUCTURE AND FINANCIAL PLAN

The total investment for pilot project is USD 77, 302, in which:

- The contribution from TA 7833 project is USD 69,702 (account for 90.16%). It will include the research study, taking sample for analysis, construction, purchasing of equipment, as well as the organization of training courses;
- The contribution from the commune is USD 7,600 (account for 9.83%). It mainly is for contribution to the land use, electricity fees and expense for operation and maintenance staff.

4.1. SUMMARY OF PILOT COSTING

Summary investment cost for pilot is described in Table 13

Table 13: Summary of Project Costs

No	Activity	Total	Project Budget	Comnune's Contribution Budget
1	Component 1: Research and analuze for constructed information and data on biogas technology, bioslurry and composting bioslurry fertilizer	2,360	2,360	
2	Component 2: Construction and mobile device purchasing for selected households to utlize bioslurry	21,160	21,160	
3	Component 3: Construction and purchasing mobile device for woman/farmer union for making biogas composting fertilizer	21,262	13,662	7,600
4	Component 4: Use bioslurry for crop	20,400	20,400	
5	Component 5: Use bioslurry for fishpond	5,940	5,940	
6	Component 6: Capacity building and training for enhanced knowledge and technology development and transfer	3,580	3,580	
7	Prepare final report	2,600	2,600	
	Total	77,302	69,702	

4.2. DETAILED OF PILOT COSTING

Detailed pilot investment cost is described as below:

4.2.1. Component 1

Research and Analysis for constructed information and data on biogas technology, bioslurry and composting bioslurry fertilizer

Table 14: Detailed Project Cost of Component 1

No	Activity	Unit	Quantity	Price	Total	Project Budget	Comnune's Contribution Budget
Component 1: Research and Analyze for constructed information and data on biogas technology, bioslurry					2,360	2,360	-

and composting bioslurry fertilizer							
1	Review FS report	Manday	3	130	390	390	-
2	Overview and desk study on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizer	Manday	7	130	910	910	-
3	Select the piloted households	manday	2	130	260	260	-
4	Take samples of soil, agricultural products, bioslurry, composting fertilizer before implementation	parameter	20	20	400	400	-
5	Take samples of soil, agricultural products, bioslurry, composting fertilizer after implementation	parameter	20	20	400	400	-

4.2.2. Component 2

Construction and mobile device purchasing for selected households to utilize bioslurry

Table 15: Detailed project cost of component 2

No.	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Component 2: Construction and mobile device purchasing for selected households to utilize bioslurry					21,160	21,160	-
6	Construct 25 bioslurry pits having size of 3 m3 each	pit					-
	Brick (500 bricks/pit x 25 pits)	brick	12500	0.08	1,000	1,000	-
	Cement (1500 kg/pit x 25 pits)	kg	37500	0.08	3,000	3,000	-
	Sand (5m3/pit x 25 pits)	m3	125	5	625	625	-
	Construction fee (6 mandays/pit x 25 pits)	manday	150	15	2,250	2,250	-
7	Purchase 75 barrels (100 litter/barrel) for 25 selected households	barrel	75	25	1,875	1,875	-
8	Purchase 25 improved carts for 25 piloted households to transport bioslurry from slurry pit to the field	cart	25	50	1,250	1,250	-
9	Purchase 25 aerosols for 25 piloted households to watering bioslurry for crop	aerosol	25	10	250	250	-
10	Purchase 25 household water pumps to take bioslurry to barrel for transporting to field.	pump	25	400	10,000	10,000	-

11	Mornitoring during construction and installation	manday	7	130	910	910	

4.2.3. Component 3

Construction and purchasing mobile device for woman/farmer union for making biogas composting

Table 16: Detailed project cost of component 3

No.	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Component 3: Construction and purchasing mobile device for woman/farmer union for making biogas composting fertilizer					21,262	13,662	7,600
11	Construct 2 centralized bioslurry pits of 40 m3 at field to store liquid bioslurry						
	Brick (6600 bricks/pit x 2 pits)	brick	13200	0.08	1,056	1,056	-
	Cement (20,000 kg/pit x 2 pits)	kg	40000	0.08	3,200	3,200	-
	Sand (70m3/pit x 2 pits)	m3	140	5	700	700	-
	Construction fee (70 mandays/pit x 2 pits)	manday	140	15	2,100	2,100	-
	Arrange the land for 2 centralized bioslurry pits	pit	2	2,000	4,000	-	4,000
12	Construction of a 10 m2 of house for composting						
	Brick (70 brick/m2 x 10 m2)	brick	700	0.08	56	56	-
	Cement (13 kg/m2 x 10 m2)	kg	130	0.08	10	10	-
	Sand (0,5m3/m2 x 10m2)	m3	5	5	25	25	-
	Roof (including steel)	roof	1	300	300	300	-
	Door (main door and window)	door	2	50	100	100	-
	Construction fee (20 mandays)	manday	30	15	450	450	-
	Arrange the land for contruction compositing house	house	1	3,000	3,000		3,000
13	Purchase 3 composite barrels having capacity of 200 litter each to transport bioslurry	barrel	3	35	105	105	
14	Purchase 1 improved cart	cart	1	50	50	50	
15	Purchase 5 aerosols to watering composting heap during composting process	aerosol	5	10	50	50	
16	Purchase 1 water pumper	pumper	1	400	400	400	
17	Purchase 1 packing machine for packing composting organic fertilizer	machine	1	1,000	1,000	1,000	
18	Purchase material to print 1000 bags to contain composting organic fertilizer for selling to the market and other households	bag	1000	1.5	1500	1500	-
19	Fuel for running pumpers and operation staff fee	month	6	100	600	-	600
20	Promote composting organic fertilizer in public media	time	2	500	1,000	1,000	

21	Mornitoring during construction and installation	manday	12	130	1,560	1,560	-

4.2.4. Component 4

Use bioslurry and composting for crops

Table 17: Detailed project cost of component 4

No	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Component 4: Use bioslurry for crop					20,400	20,400	-
22	Support selected households (8months x 25 hhs)	month	200	50	10,000	10,000	-
23	Monitoring the selected household during operation and maintenance biogas plant	manday	80	130	10,400	10,400	-

4.2.5. Component 5

Use bioslurry for fishponds

Table 18: Detailed project cost of component 5

No	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Component 5: Use bioslurry for fishpond					5,940	5,940	-
24	Installation of 10 m long plastic pipeline to transport bioslurry to fish pond	pipeline	1	40	40	40	-
25	Improvement of current fishpond	fishpond	1	200	200	200	-
26	Purchase fish breed	fish	1	500	500	500	
27	Mornitoring during construction and installation	manday	40	130	5,200	5,200	-

4.2.6. Component 6

Capacity building and training for enhanced knowledge and technology development and transfer

Table 19: Detailed project cost of component 6

No	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Component 6: Capacity building and training for enhanced knowledge and technology development and transfer systems					3,580	3,580	-
28	Conduct 8 traing courses for stakeholders (20 trainee/course)	course					
	Renting training room	room	8	100	800	800	-
	Develop training documents	manday	6	130	780	780	-
	Trainer	manday	8	130	1040	1040	-
	Photo training documents	copy	160	1	160	160	-

	Renting projector	projector	8	30	240	240	-
	Stationery	person	160	1	160	160	-
	Fee for trained households	person	160	3	400	400	-

4.2.7. Final Report

Table 20: Detailed project cost of reporting

No.	Activity	Unit	Quantity	Price	Total	Project budget	Comnune's contribution budget
Prepare final report					2,600	2,600	-
29	Consolidated report	manday	20	130	2,600	2,600	-
	Total				77,302	69,702	7,600

5. SUMMARY POVERTY REDUCTION AND SOCIAL STRATEGY AND INDIGENOUS PEOPLES DEVELOPMENT PLAN

5.1. SUMMARY POVERTY REDUCTION AND SOCIAL STRATEGY (SPRSS) AND INDIGENOUS PEOPLES

Comprehensive Strategy for Growth and Poverty Reduction Strategy (CPRGS) was approved by the Prime Minister of Viet Nam on May 21, 2002. CPRGS has been developed through extensive consultation processes, many due to inter-ministerial committee headed by the Ministry in charge of Planning and Investment (MPI). Poverty Task Force (PTF) of the Government-Donor-governmental organizations has operated as group counseling and technical assistance to the Government during document preparation CPRSG.

Comprehensive Strategy for Growth and Poverty Reduction focuses on the following objectives: 1) To promote rapid economic growth and sustainability, ensuring progress and social equity, focusing on the rural and ethnic minority areas; 2) Create an equal business environment for the enterprises in all economic sectors; 3) Continue structural reforms enterprises, banks and credit institutions and financial ...;4) Implementation of the reform of public administration and public finance; 5) Encourage the development of human resources and reduce inequalities; priorities for the quality and the ability of people to access the health services, education and development, environmental protection, infection control HIV/AIDS, gender equality and improving the lives of ethnic minorities; 7) Reduce vulnerability by developing and expanding the network of sponsors and social welfare for the poor; 8) Establish a system of indicators of socio-economic development and poverty reduction (regarding the factors gender and social groups) to monitor and evaluate the implementation of the CPRGS.

5.2. LINK TO THE NATIONAL POVERTY REDUCTION STRATEGY AND COUNTRY PARTNERSHIP STRATEGY

Poverty reduction is a strategic goal in the socio-economic development strategy. Also, Viet Nam has committed to achieve international development goals approved at the 2000 Earth Summit conference. The process of economic development and reducing poverty in Viet Nam attained remarkable achievements and is highly appreciated worldwide. Reducing poverty is an elementary factor to ensure social justice and stable development. Thus, reducing poverty is considered a constituent part of Ten-Year Social & Economic Development Strategy (2001-2010), Five-Year Strategic Plan (2001-2005), National Target Programme for Sustainable poverty reduction period 2012 – 2015 and annual plans of provinces and country.

The project will improve rural productivity in the project areas by (i) reducing: disease outbreaks, methane and CO2 emission, water, air and land pollutants; (ii) providing sustainable clean energy technology; (iii) increasing time, money saving and availability of organic fertilizers; and, increasing yields and profitability.

5.3. SOCIAL-ECONOMIC SITUATION IN THE PROJECT COMMUNE

The project will positively impact approximately 1,280 households with 4,700 beneficiaries in two villages east and ranged ruling at the commune, Dong Anh district, Hanoi city outskirts, where the poverty rate is not high (1.2%), but the majority of people living by growing crops and raising dragons should not considered high risk and vulnerable to the effects of climate change. Approximately 25/1280 households (accounting for 1.9% of total households) will be the direct beneficiaries. A state test project, using waste from biogas will contribute to improving people's lives and bring economic benefits through following project components:

Assessment on household biodigester management, biogas utilization, bioslurry management & utilization and environmental pollution

91% of interviewees in Tam Xa commune were farmers, showing that livestock and cultivation are two main sources of income for local people in the town centre. Since this society benefits from the construction project of biogas plants, the number of households increased, livestock scales in the extended family, while residential land for each family society can not be extended to the handling and use of by-products of biogas. This overloaded the infrastructure of the villages in the commune. Therefore the project implementation will bring more opportunities for people to use the product, in order to save costs and protect the environment.

Options for bioslurry utilization and management towards environmentally sound friendly management

The people of the Tam Xa commune, especially middle aged residents, lived mainly on feeding and vegetable farming, providing meat products and vegetables for Hanoi. Survey results also showed that 48.6% of interviewees said that their living environment is polluted from livestock raising; that people are not aware of the effectiveness of using bioslurry product. After seeing the investment costs, operation and benefits of biogas waste management, people will be directed to choose a model of investment and use of animal waste that is environmentally friendly, convenient and time saving.

Proposal for a pilot investment for animal farms and households and bioslurry generation to biogas and bioslurry utilization towards environmentally sound friendly management and food security for community

The use of bioslurry in crops will help people to obtain clean and safe products, to meet the needs of food safety for consumers today. Safe meat and vegetable products will bring regular and stable income for farmers who produce products of this nature. (why do only 11% use bioslurry?) Does not mention to benefit of using scum?

The project will also provide a potential expansion process from farming, producing, supplying, to continuous consumption from families scale to family groups and farm complex. Therefore, there will be a combination of manufacturing and enterprise planning inputs and outputs for the production and consumption of products, market-oriented development and mutually beneficial cooperation.

Training program for stakeholders and farmers on capacity building

The project will also contribute to improving the capacity of commune staff, workers, builders, producers as well as small and medium-sized businesses operating in the field of production and consumption of agricultural products from products with biogas residues and investment gas biological techniques. The builders will continue to improve the skills of professional practice and transmission to others, to expand the investment model, using the biogas residues to surrounding areas.

A number of households in the village will benefit directly through acquiring knowledge about the technical operation, use and maintenance of biogas plants and use of biogas waste.

Human resource development, staff's capacity building, particularly the level of trainers is a key factor to improve the guidance; expent communications on the use of the biological product, production development and environmental protection of the suburban communes.

5.4. THE IMPACT OF THE PROJECT TO ALLEVIATION AND REDUCE POVERTY

The project will contribute to achieving the objectives in the economic and social development plan of the Tam Xa commune, Dong Anh district, Hanoi. All production development policy follows the Poverty Reduction Strategy and inclusive growth with economic development linked to social justice launched by the government of Vietnam.

The impact of the project will upgrade village infrastructure, build models using gas, construction of biogas tunnel for household group, use of biogas residues for crops, improve knowledge, skills for commune managers, builders and users of biogas. These will all contribute to the overall impact of attracting increasing numbers of people to use the biogas model for farming, feeding and encouraging environmentally-friendly cleaning products.

5.5. THE PARTICIPATION OF THE COMMUNITY

The project will support community groups and household groups, and participate in planning and management of biogas of household groups. The project will (i) facilitate and strengthen the capacity of communities in the planning, management, operation and maintenance of biogas household level and group level, leading to construction larger scale if possible, (ii) improve community awareness about the risks of social production and social environment, (iii) create equal opportunities for all groups involved in activities within the framework of the project, (iv) improve the capacity of poor and low income communities so they can mobilize themselves to increase livelihoods and quality of life, (v) ensure that communities have their voice and participate in the process of monitoring and evaluation of project activities.

During the project preparation phase, the project will apply the approach of encouraging community consultation at the maximum level.

An annual work plan will be developed, based on discussions between implementing agencies, project staff and the community to build local priorities, and reflect the changes in the requirements of the community. The implementation of components and the results will also be discussed with beneficiaries in a conference, usually held at the end of the project.

Through the above approach and activities, the community will have more confidence to engage in social activities; thereby they can have a stronger voice in the decision-making processes of governments, contributing to these decisions with for more accurate reflection of urgent needs and priorities of the community.

5.6. EFFECTS RELATED TO ETHNIC MINORITY GROUPS

At the Tam Xa commune, Dong Anh District, Hanoi does not have ethnic minorities so there are no negative effects related to ethnic minority groups. Thus the feasibility report would not need to mention this issue.

5.7. CAPACITY BUILDING FOR STAFF MANAGEMENT

For successful implementation of the biogas program in the coming years, training and capacity building for staff management, and implementation of the biogas model for the central level and local provinces is especially necessary. The point that put people in the centre of the process of economic development-social development in general and in particular biogas development was supported by the Vietnam Government and donor. Recognizing the importance of this issue, the project was designed to focus on capacity building activities. After piloting in Tam Xa, participants will enhance their knowledge and skills in the construction and operation of biogas and the planning and monitoring process.

5.8. GENDER EFFECT

A certain percentage of women beneficiaries join in all project activities such as training, small biogas scale infrastructure building, raising awareness in the project area.

In addition, the project will improve the support for equal rights for women by increasing their participation in social activities, planning, community development, operation and maintenance of

small biogas projects to encourage them to participate more in the process of planning and implementation of activities within the framework of sub projects.

The Project has special attention to job creating for women. Characteristics of the construction of biogas are feeding, in which the proportion of women working in feeding and cultivation is very high compared to other sectors. The project will be designed to ensure that women enjoy equal employment opportunities as men. The project will create employment opportunities for women as livestock expansion, selling products, diversification of crops.

Main activities in the project should be technical training for women on avoiding hazardous substances in production, technical support to improve productivity, training to use biogas equipment, Enhance womens' understanding and awareness on their rights in family and community living, measures to promote the positive effects of the use of biogas on women and family life.

5.9. SOCIAL SAFEGUARD ISSUES AND OTHER SOCIAL RISKS

The construction of the project will be built on the private land of households and communal land mass of the Tam Xa commune. Therefore the project will not cause clearance and involuntary resettlement.

People in the effected area of the proposed project plan will define the present structure they agree to during construction on their land and treatment.

Labour: The project will provide training and employment opportunities for local contractors, builders, farmers without land, and the other poor. The project will promote equal opportunities and pay for women and men through ensuring gender issues in the components of the project.

Affordability: The project will have no impact and no relevance for affordability in any cases

Other risks and/or vulnerabilities such as HIV/AIDS, human trafficking and others will not impact on the project.

6. INITIAL ENVIRONMENTAL EXAMINATION

6.1. NATIONAL LEGISLATION AND STANDARD

Several laws, technical regulations, conventions and strategies concerning the environment are applicable in Vietnam since the early 1990s. The most important ones concerning the present LCASP project are presented briefly here below.

The Vietnam Law on Environmental Protection was first approved in 1993 and consisted of five chapters. At that time the law was mainly regulating the following environmental issues: Prevention of environmental degeneration, Definition and regulation of environmental pollution, Environmental degeneration of the nature, State tasks concerning the environmental protection and international relationship concerning environmental protection. In 2005, the Law on the Environment was revised and extended into a final version of 15 chapters containing 136 articles. The issue of renewable energy is now also included in the Law (article 33) which indicates the Government's concern in this area.

In 2003, the National Strategy for Environment Protection until 2010 and orientation until 2020 was approved by the Prime Minister with the issuance of Decision No 256/2003/QD-TTg dated December 2, 2003. The purpose of the strategy is to limit the increase of environmental pollution and to improve environmental quality. A number of important targets were set up, such as 100% of new facilities have to apply clean technology or have to be equipped with pollution mitigation equipment, and waste matters have to be treated until they meet environmental regulations by 2010; 100% of the urban population and 95% of the rural population have to have access to clean water.

The National Target Program in Response to Climate Change, 2008 version describes incentives for emissions reduction and low carbon economic development while the 2010 version outlines an action plan (Ministry of Industry and Trade). The National Target Programme to Respond to Climate Change is the consequence of the implementation of the Government's Resolution No. 60/2007NQ-CP (Dec. 3, 2007) by the Ministry of Natural Resources and Environment. The strategic objectives of this National Target Programme are to:

- Assess the impacts of climate change on sectors/areas and regions in specific periods
- Develop feasible action plans to effectively respond to climate change in each short-term/long-term period to ensure sustainable development of Vietnam
- Adopt opportunities to develop towards a low-carbon economy
- Join international community's effort to mitigate climate change impacts and protect global climatic system.

The Viet Nam's Green Growth Strategy was ratified by the Government of Viet Nam in September 2012, aiming to accelerate the process of economic restructuring in order to use natural resources efficiently, reduce greenhouse gas emissions through research and application of modern technologies, develop infrastructure to improve the entire efficiency of the economy, cope with climate change, contribute to poverty reduction, and drive economic growth in a sustainable manner. The VGGS is an effort to synthesize the green action plans of major sectors and society in order to:

- Promote "green production" via more efficient use of resources and new technologies. This objective aims to facilitate sustainable production, green existing business, and create new green businesses.
- Reduce the intensity of greenhouse gas emissions by 8-10 percent as compared to the 2010 level; and reduce energy consumption per unit of GDP by 1-1.5 percent per year. Reduce greenhouse gas emissions from energy activities by 10 percent to 20 percent compared to the business as usual case. This commitment includes a voluntary reduction of approximately 10 percent, and an additional 10 percent reduction with additional

international support. This objective underlines Vietnam's commitment to low carbon growth and to global efforts to mitigate climate change.
- Stimulate green lifestyles and promote sustainable consumption.

In the following, some other relevant Vietnamese Regulations and Standards are listed.
- QCVN 09/2009 BTNMT: National Technical Regulation on Underground Water;
- QCVN 14/2009 BTNMT: National Technical Regulation on Domestic Wastewater;
- QCVN 24/2009 BTNMT: National Technical Regulation on Industrial Wastewater;
- TCVN 5945/2005: Vietnam National Standard on Industrial Wastewater Discharge;
- TCVN 6772/2000: Vietnam National Standard on Water Quality – Domestic Wastewater Standards – Permissible Pollution Limits;
- Sectoral standard.

6.2. INITIAL ENVIRONMENTAL EXAMINATION SCREENING MATRIX

ADB's policy

ADB requires the consideration of environmental issues in all aspects of its operations, and the requirements for environmental assessment are described in ADB SPS, 2009. This states that ADB requires environmental assessment of all project loans, program loans, sector loans, sector development program loans, and loans involving financial intermediaries, and private sector loans.

Screening and Categorization. The nature of the environmental assessment required for a subproject depends on the significance of its environmental impacts, which are related to the type and location of the subproject, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects which are screened for their expected environmental impacts are assigned to one of the following four categories[23]:

i) Category A: A proposed project is classified as category "A" and an EIA is required if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works.

ii) Category B: A proposed project is classified as category "B" and an IEE is required if its potential adverse environmental impacts are less adverse than those of category "A" projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category "A" projects.

iii) Category C: A proposed project is classified as category "C" if it is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.

iv) Category FI: Projects involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all Projects will result in insignificant impacts.

The Project has been identified as category C Project as per below Table 21 Initial Environmental Examination screening matrix.

Table 21: Initial Environmental Examination screening matrix

Screening Questions	Yes	No	Remarks
A. Project Sitting Is the Project area adjacent to or within any of the following environmentally sensitive areas?		X	The project site is in the plain area, in Tam Xa commune, Dong Anh district, Hanoi

[23] *ADB SPS (2009)*

Cultural heritage site		X	There is no cultural heritage in the project site
Legally protected Area (core zone or buffer zone)		X	There is no legally protected area in the project site
Wetland		X	There is no wetland in the project site
Mangrove		X	There is no mangrove in the project site
Estuarine		X	There is no estuarine in the project site
Special area for protecting biodiversity		X	There is no special area for protecting biodiversity in the project site
Potential Environmental Impacts Will the Project cause			
Impairment of historical/cultural areas; disfiguration of landscape or potential loss/damage to physical cultural resources?		X	There will be no such impairment
Disturbance to precious ecology (e.g. sensitive or protected areas)?		X	The pilot is not situated in such sensitive or protected areas
Alteration of surface water hydrology of waterways resulting in increased sediment in streams affected by increased soil erosion at construction site?		X	Construction of cannel and pipeline generally does not alter surface water hydrology, but will improve surface water quality
Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?		X	No worker-based camps and much chemicals is expected to be used under the pilot
Increased air pollution due to project construction (using brick, cement …)?		X	Dust emissions should be reduced as best as possible (e.g. cover of storage sacks with plastic slides, opening of only one sack for usage, avoid working with cement when windy or stormy, use water sprayers to precipitate dust etc.). To protect the workers, respiration masks should be applied. When working with cement, the doors and windows of houses in the surrounding neighborhood should be closed. The same applies for livestock pens/stables.
Increased air pollution due to project operation (in terms of bioslurry leakages resulting from the bio-digester; slurry pits, pipeline/cannel)?			The bio-digesters and bioslurry pits must be checked for gas-tightness. All valves, pipe connections, pumps (if used) and devices that have contact with bioslurry should regularly be checked for tightness.
Noise and vibration due to project construction or operation?		X	– Transport of surplus earth and other waste only to legally registered dump sites. If the soil is distributed on the farm itself, it should be dumped in a way that plants and houses are not affected. – Machine working hours and truck traffic should be reduced to a minimum but without causing unnecessary delay of the construction. Sound and noise filters for excavators should be applied. – The machines and trucks should not be maintained on-site (e.g. no oil change). Oil leakages should

			immediately be excavated with the affected soil and put in sealed metal barrels. These contaminated barrels must be discharged to a legal disposal site or the contaminated soil must be burned in adequate incinerators. – Before starting earth works very close to houses and stables, the stability of the underground and the soil structure must be investigated and checked (pole piling). – Compression of surrounding soil should be avoided in a manner that trucks and machines are only allowed to drive on pre-selected tracks and areas.
Involuntary resettlement of people? (physical displacement and/or economic displacement)		X	No resettlement foreseen: biogas is constructed at existing farms
Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	Only positive impact
Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?		X	Number of workers very small, no camps;
Creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents (inadequate substrate preparation)?		X	The storage tanks and beds should be closed to avoid bad smells. They also should be underground-sealed to avoid penetration of leachate into the soil and groundwater. The side walls of the beds should be high enough to resist against flooding. To avoid biodegradation in the tanks, a simple aeration system (air pump with disburser) can be installed.
Social conflicts if workers from other regions or countries are hired?		X	Only local labour required
Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	Number of labour at construction maybe 10 to 20 persons only
Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?		X	– Transport of surplus earth and other waste only to legally registered dump sites. If the soil is distributed on the farm itself, it should be dumped in a way that plants and houses are not affected. – Machine working hours and truck traffic should be reduced to a minimum but without causing unnecessary delay of the construction. Sound and noise filters for excavators should be applied. – The machines and trucks should not be maintained on-site (e.g. no oil change). Oil leakages should immediately be excavated with the

			affected soil and put in sealed metal barrels. These contaminated barrels must be discharged to a legal disposal site or the contaminated soil must be burned in adequate incinerators. – Before starting earth works very close to houses and stables, the stability of the underground and the soil structure must be investigated and checked (pole piling). – Compression of surrounding soil should be avoided in a manner that trucks and machines are only allowed to drive on pre-selected tracks and areas. – Work should not be conducted during windy and stormy weather in order not to distribute dust into the wider environment. – The workers should be provided with adequate labour and security clothing and devices (e.g. closed shoes, ear and eye protection, masks and helmets etc.) to be protected as well as possible against accidents.
Risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		X	– Windows and doors of nearby houses and stables should be closed during working hours.
Community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	– Accidents can be avoided when the entrance holes of a bio-digester and slurry pits are kept closed and locked at all times. – Use of closed dung storage tanks and drying beds.
Generation of solid waste and/or hazardous waste (inadequate disposal of bioslurry)?		X	– Sedimented solids have to be periodically removed from the bio-digester. They can be composted and then used as fertilizer.- Depending on the intended use of the effluents, testing for health risks, or standardized pre-treatments, should be required.
Use of chemicals?		X	– There are no chemicals involved in construction and operation of biogas plants
Concentration of heavy metal in bioslurry that are not used and disposed to environment	X		Bioslurry should be managed and treated properly
Ground contamination if too much bioslurry is use for a certain area of crop	x		Amount of bioslurry that used for a certain area of crop should be carefully canculated.

Climate Change and Disaster Risk Questions **The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.**	Yes	No	Remarks
Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes?		X	floods and storms may occur
Could changes in precipitation, temperature, salinity, or extreme events over the Project lifespan affect its sustainability or cost?		X	Nothing foreseen in lifespan of 10-20 years
Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g. high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?		X	Households are ranked moderate
Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., increasing traffic or housing in areas that will be more prone to flooding, by encouraging settlement in earthquake zones)?		X	Definitely not. No such impact can be imagined

Environmental impacts of existing biogas plants in Vietnam:
In households, the gas is mainly used for cooking and less for lighting purposes. The produced gas volume corresponds mainly with the households' demand. Surplus gas is burned or sometimes released un-burned to the atmosphere. In some cases, surplus gas is shared with the households of neighbours and relatives. Due to the fact that most of the biogas produced by households is not used for cooking/lighting/electricity production, the farmers do not maintain the biogas plants properly and continuously. This results in leakages of biogas (consisting mainly of methane), which are released to the atmosphere. Non-maintained biogas plants are therefore of high risk for the atmosphere (methane, carbon monoxide, carbon dioxide, di-hydrogen sulphide, organic ketones and aldehyds etc.) and the localized pollution can be high.

Bio-slurry produced by household biogas plants is in general not re-used for irrigation of fields but discharged into the sewer. Generally, the groundwater was reported to have a depth of 3 to 4.5m only. Most of the farmers/households reported that they use groundwater for drinking water purposes. In case the groundwater layer is very close to the soil surface (e.g. in a depth of approx. < 5m) or not far from the soil's surface (in approx. 5 to 15m depth), intoxications with hazardous compounds (see here below) or pathogenic micro-organisms and other biological vectors can not be excluded if this groundwater is used as drinking water. In addition, compounds like nitrate, nitrite, ammonia etc. resulting from the bio-slurry can also be incorporated when drinking such water. Groundwater for drinking water purposes should therefore be abstracted from the deeper groundwater layers. Widely, the underground soil structure could not be evaluated as no geological investigation could be carried out during the field visits. However, it seems that in some cases the underground soil consists mainly of clay layers. In some cases it was reported that the soil also consisted of sand and sandy clay. The latter two layers easily allow the penetration of rainwater (and wastewater, bio-slurry) into the deeper soil, transporting biological and chemical pollution to the groundwater layers, and, as a consequence in the course of time, also into the deeper groundwater layers. Bio-slurry for fertilisation should – in these cases – be carefully applied (as technical fertilisers) to avoid groundwater contamination.

As presented above, most of the interviewees mentioned that the slurry is not used for additional fertilization, but discharged to the sewer. Direct discharge to a sewer or to surface waters results in the most adverse environmental impacts. However, in most questionnaires presented to the interviewees, the final discharge of the bio-slurry could not be evaluated due to lack of information. The hydraulic retention time of the dung in the biogas plant is in most cases too short or often very short. This results in bio-slurry which is smelly and which still contains a higher organic charge suitable for biodegradation (methanisation). It was estimated that the retention time of the dung in

the plants ranges between 10 and 30 days. The retention time should not be below 15 days and in the range of 30 to 50 days depending on the biogas plant's size. The field visits revealed that most of the biogas plants are presumably gas tight; this is at least what the farmers and households responded. Of course, measurements on gas tightness could not be performed during the visits. All biogas plants are built underground, to be unable one to directly check if gas comes out of the plant (bubbles). However, this does not take into consideration that the gas is mainly collected on top of the plants (which is not under water) and the fittings and connections of the gas pipes. It is doubtful that the received statements are correct and gas tightness of the plants should therefore be investigated. Non-gastight biogas plants are of high risk for the environment as they release strong GHGs into the atmosphere.

In cases where bioslurry is used for crops there may be a groundwater contamination, if too much slurry is applied on a certain area without keeping the necessary intervals between subsequent application periods.

Conclusion: The biogas plants should be regularly maintained, to ensure there are not releases methane into the atmosphere due to leakages. The investments in appliances and generators are advisable to make sure that the farmers are able to use the produced biogas. The bio-slurry coming out of the digesters should also be managed. In most cases, KT1 technologies (fixed dome technology) are applied to household plants. Biogas plants will become old and often not gas-tight and surplus gas is often burned or released un-burned to the atmosphere. Currently, a National Standard for 'Discharged Animal Waste Water' does not yet exist, but will probably be developed soon in cooperation with MARD, MoNRE and the Directorate for Standards, Metrology and Quality (STAMEQ).

6.3. RECOMMENDATIONS

The Project has been identified as category C Project, e.i. no EIA or IEE are required although environmental implications need to be reviewed. However, the biogas plants and bioslurry pits should be checked at regular intervals to ensure they are water-tight.

Besides the investment in new biogas plants, it is obvious that the existing plants should, when necessary, be rehabilitated to be properly functional and not release methane into the atmosphere, through leakages. Secondly, investments in appliances and generators are advisable to make sure that the farmers are able to use the produced biogas (see below). Thirdly, a big field of investment is the secondary treatment of the bio-slurry coming out of the digesters.

The utilization of liquid bioslurry and composting bioslurry fertilizer should be follow the instruction to reach the maximum benefit and get rid off overuse of these products, resulting in negative impacts on the environment.

7. RISKS, ASSUMPTION AND UNCERTAINTIES

In developing this project, a detailed risk assessment was conducted, in order to identify the areas that need to be addressed during the development and operation of the project. The different risks and uncertainties identified are delineated as below:

- Unavailability of animal dung: After construction, biogas plants need to be fed daily with the required amount of animal dung. In some cases the amount of dung available to the household will decrease because of declining animal population; negatively affecting the gas production. This is can be caused by the animal production of households, which are affected by market. The declining demand will cause the decline of animal production at household level;
- Technical risks: Low efficiency (lower than expected) of biogas digester, even if technical requirements are met; the low quality of construction, especially when farmers construct biogas digester themselves causes the biogas digester to be inefficiency. These risks can be mitigated by ensuring that appropriate technologies are supported in different projects and by providing training and technical assistance to farmers;
- Infrastructure risks: Lack of appliances for biogas (gas stoves, gas generators) would limit potential benefits. The thermophilic bio-digester may produce more biogas than needed by the owner and, if infrastructure is weak and biogas demand is low, this would mean biogas is not used to its' potential;
- Capacity and commitment risks to the commune: There is a risk that the main partner (people's committee) has limited capacity to implement this complex project, and notably is unable to mobilise resources (land fund, human…) or to facilitate coordination across households. Related to this, there is a risk that the partners do not allocate sufficient time to the project;
- Risks of ability of the community to engage in the process and take ownership. The community is poor and stressed, and may have difficulty finding time and resources to participate whole process of project. This risk would increase significantly if a large-scale natural disaster (floods or cyclone) affected the project intervention area during implementation – as communities would have to allocate all time and resources to deal with the impact.134. Risk relates to the short time allowed for the project, during which the project aims to develop capacity and initiate behaviour change in communities. Typically such aims take time to achieve, and the one and a half years of the Project may not be sufficient. This risk is increased as several factors threaten to cause delays, notably: initial challenges in signing MOUs with project partners; natural disasters; and limited planning/management skills in project partners.

APPENDIX 1: LIST OF SURVEYED BIOGAS HOUSEHOLDS

Code	Full name	Address	Phone number	Amount received in VND	Signature
1	Nguyễn Thị Sớn	Thôn Trại TXã	397 403 2765	45,000	Sớn
2	Lê Đức Quang	nt	0164 576 1939	45,000	Quang
3	Hoàng Việt Quyết	nt	0983 055 476	45,000	Quyết
4	Nguyễn Văn Hải	nt	0169 6868 762	45,000	Hải
5	Lê Thị Lý	nt	0979 903 019	45,000	Lý
6	Lê Văn Duy	nt	-	45,000	Duy
7	Lê Thị Xuân	nt	0127 615 5997	45,000	Xuân
8	Hoàng Thị Phương	nt	0166 619 4628	45,000	Phương
9	Lê Thị Khá	nt	—	45,000	Khá
10	Hoàng Hữu Ninh	nt	01699 164 033	45,000	Ninh
11	Hà Xuân Phúc	nt	—	45,000	HXP
12	Lê Thị Hoa	nt	—	45,000	Vân
13	Lê Thị Vân	nt	—	45,000	Hoa
14	Lê Thị Vui	nt	09 850 1805	45,000	Vui
15	Hoàng Thị Khái	nt	0166 589 5569	45,000	Khái
16	Lê Thái Sáng	nt	0169 624 3759	45,000	Sáng

By:

Code	Full name	Address	Phone number	Amount received in VND	Signature
17	Hoàng Hữu Lợi	Thôn T Xá	01968 724 950	45,000	Lợi
18	Lê Văn Sáng	nt	—	45,000	Sáng
19	Lê Thị Thuyên	nt	0166 4766 085	45,000	Thuyên
20	Nguyễn Thị Khuôn	nt	0167 435 8247	45,000	Khuôn
21	Phạm Thị Khoa	nt	—	45,000	Khoa
22	Lê Đức Tiệp	nt	0163 479 3795	45,000	Tiệp
23	Lê Thị Bảng	nt	—	45,000	Bảng
24	Lê Xuân Thường	nt	01682 493 995	45,000	Thường
25	Đỗ Thị Chinh	nt	0434 85 0043	45,000	Chinh
26	Hoàng Hữu Sỹ	nt	0167 877 7196	45,000	Sỹ
27	Lê Thị Hồng Thuỷ	nt	0979 115 219	45,000	Thuỷ
28	Lê Thị Lài	nt	—	45,000	Chí
29	Hoàng Hữu Văn	nt	0166 622 8143	45,000	Văn
30	Lê Thị Xuân	nt	0165 65 96 276	45,000	Xuân
31	Lê Thị Chinh	nt	0168 50 40 37	45,000	Chinh
32	Lê Thị Mơ	nt	0127 55 16 042	45,000	Mơ
33	Hoàng Thị Nhung	nt	—	45,000	Nhung

2

By:

Code	Full name	Address	Phone number	Amount received in VND	Signature
34	Le Thi Cieu	Dong - TXa'	01696542919	45,000	
35	Hoang Hieu Doan	Dg - Tan xa'	0906478356	45,000	
36	Le Thi Thanh	Dg - TXa'	-	45,000	
37	Pham Thi Hau	Dg - TXa'	-	45,000	
38	Hoang Thi Gay	Dg - TXa'	0986354388	45,000	
39	Le Thi Hoa	Dg - TXa'	01239147668	45,000	
40	Hoang Thi Lieu	Dg - TXa'	0169299822	45,000	
41	Le Thi Luan	Dg - TXa'	01646338151	45,000	
42	Hoang Hieu Cieu	Dg - TXa'	016 58987334	45,000	
43	Tran Thi Thuc	Dg - TXa'	016 57269 578	45,000	
44	Hoang Thi Lan	Dg - TXa'	01685554809	45,000	
45	Le Van Phuc	Dau - TXa'	39501678	45,000	
46	Tran Thi Huong	Dg - TXa'	01695908988	45,000	
47	Le Thi Tuat	ut	0916190407	45,000	
48	Tran Ngoc Hai	ut	094 4533172	45,000	
49	Tran Ngoc Khiem	ut	01662A4420	45,000	
50	Le Thi Hoa	Dau - Tan xa'	0163 479 3829	45,000	

By:

Code	Full name	Address	Phone number	Amount received in VND	Signature
51	Nguyen Thi Thanh	Thon Dau TXa	-	45,000	
52	Nguyen Van Loi	Yen Loi - Xuan Cam	0904 410 771	45,000	
53	Hoang Thi Lien	T.Dau T.Xa'	0166 2616628	45,000	
54	Nguyen Thi Tiet	T.Dg . T.xa'	016777 96883	45,000	
55	Le Van Thuc	ut	01666144328	45,000	
56	Hoang Huu Quy	ut	0165229 4015	45,000	
57	Le Duc Kien	ut	01276396609	45,000	
58	Le Van Hai	ut	0166260520	45,000	
59	Hoang Huu Hung	ut	0163313870	45,000	
60	Le Ba Trung	ut	0164796034	45,000	
61	Hoang Viet Cuong	ut	-	45,000	
62	Le Thi Thuong	ut	-	45,000	
63	Le Duc Huong	ut	0975124465	45,000	
64	Le Thi Tinh	Dg - TXa'	01639417551	45,000	
65	Le Duc Nhu	ut	-	45,000	
66	Hoang Viet Anh	ut	0936117398	45,000	
67	Hoang Huu Khi	ut	01672693496	45,000	

4

By:

Code	Full name	Address	Phone number	Amount received in VND	Signature
68	Đặng Thị Mai	Thôn Bưới - Tân Xã		45,000	
69	Lê Thế Sỹ	Thôn Bưới - Tân Xã	0188667766	45,000	
70	Lê Thị Sáu	Thôn Bưới - Tân Xã	0975.336632	45,000	
71	Hoàng Thị Lam	Thôn Bưới - Tân Xã	0162992 4655	45,000	
72	Đinh Văn Nước	Thôn Bưới - Tân Xã	098.7517.616	45,000	
73	Lê Xá Dị	Thôn Bưới - Tân Xã	0125.283.6539	45,000	
74	Lê Xá Lương	Thôn Đồng - Tân Xã	—	45,000	
75	Nguyễn Thế Đồng	Thôn Bưới - Tân Xã	01662281189	45,000	
76	Hoàng Văn Hưng	Thôn Đồng - Tân Xã	01277135738	45,000	
77	Hoàng Thị Nhung	Thôn Đồng - Tân Xã	01681194052	45,000	
78	Ngô Thế Yết	Thôn Đồng - Tân Xã	—	45,000	
79	Lê Thị Hoa	Thôn Đồng - Tân Xã	—	45,000	
80	Hoàng Thị Hoa	Thôn Đồng - Tân Xã	0164.580.6905	45,000	
81	Nguyễn Thị Liên	Thôn Đồng - Tân Xã	0168 3738 972	45,000	
82	Trần Thế Lai	Thôn Đồng - Tân Xã	0919.587.209	45,000	
83	Đồng Văn Tiến	Thôn Đồng - Tân Xã	098 639 495	45,000	
84	Lê Thế Lam	Thôn Đồng - Tân Xã	0976.439635	45,000	

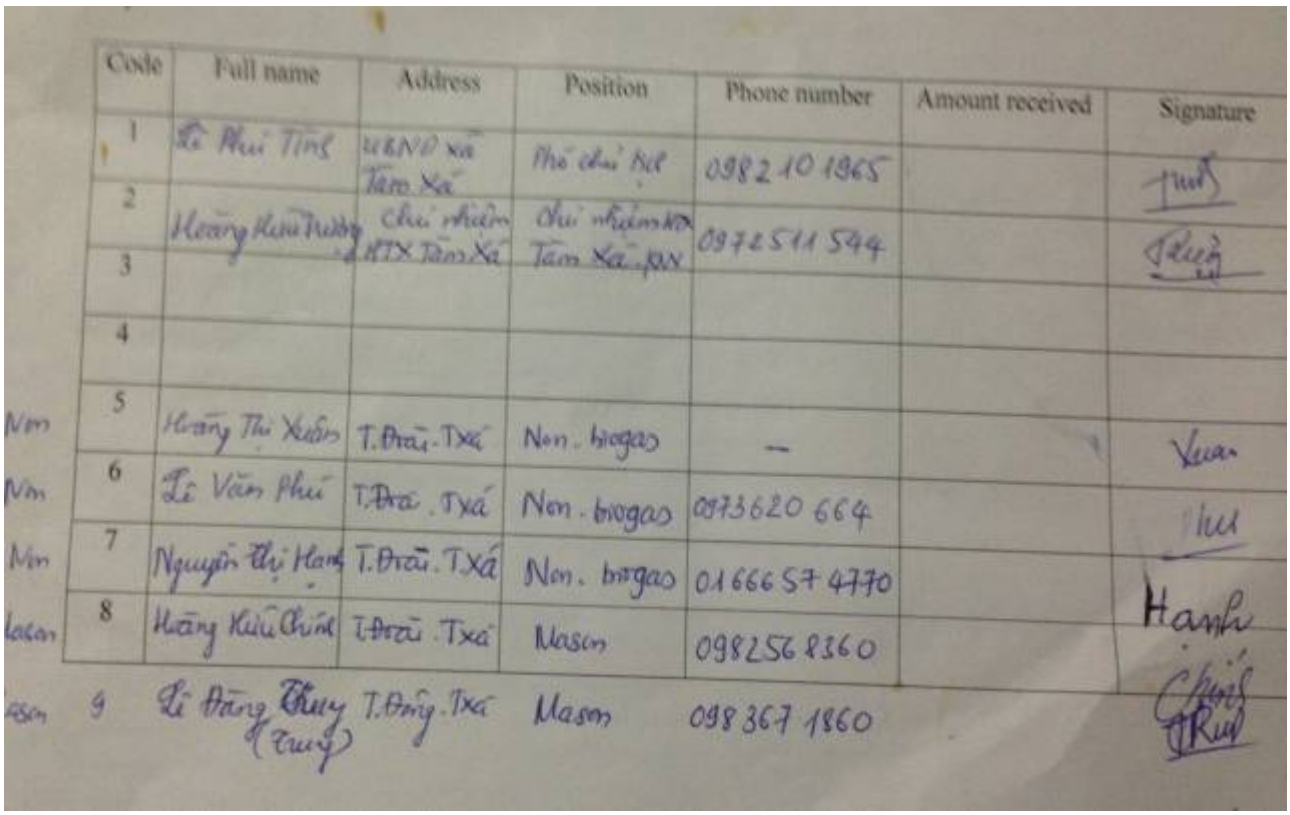
5

By:

Code	Full name	Address	Phone number	Amount received in VND	Signature
85	Lê Văn Hùng	T.Đồng - Txã	01635223042	45,000	
86	Lê Văn Thắng	T.Đồng - T.xã	—	45,000	
87	Hoàng Văn Vân	T.Đồng - Txã	0948115066	45,000	
88	Hoàng Thị Quý	nt	—	45,000	
89	Hoàng Thị Hoàng	nt	0165 811 2030	45,000	
90	Lê Thế Bình	nt	016 777 29573	45,000	
91	Lê Thị Thanh	nt	0904 840 196	45,000	
92	Hoàng Thị Ngọc	nt	0166 2810 100	45,000	
93	Lê Đồng Thính	T.Thái - T. Xã	0167 9624 528	45,000	
94	Hoàng Hữu Thái	nt	0912501569	45,000	
95	Lê Đồng Bình	nt	0165 652 1115	45,000	
96	Hoàng Hữu Bình	nt	0167 4555241	45,000	
97	Hoàng Hữu Bối	nt	0163 390 3147	45,000	
98	Lê Xuân Đồng	nt	0125 763 8587	45,000	
99	Hoàng Thị Tài	nt	043 9500 980	45,000	
100	Nguyễn Đức Bản	nt	0167 824 0528	45,000	

6

APPENDIX 2: LIST OF SURVEYED NON BIOGAS HOUSEHOLDS AND BIOGAS MASON



	Code	Full name	Address	Position	Phone number	Amount received	Signature
	1	Lê Phú Tĩnh	UBND xã Tân Xã	Phó chủ tịch	0982101965		
	2	Hoàng Hữu Thắng	Chủ nhiệm HTX Tân Xã	Chủ nhiệm HTX Tân Xã - PX	0972511544		
	3						
	4						
Non	5	Hoàng Thị Xuân	T. Trái - Txã	Non. biogas	–		
Non	6	Lê Văn Phú	T. Trái - Txã	Non. biogas	0973620664		
Non	7	Nguyễn Thị Hạnh	T. Trái - TXã	Non. biogas	01666574770		
Mason	8	Hoàng Hữu Chính	T. Trái - Txã	Mason	0982568360		
Mason	9	Lê Đăng Thuỷ (Thuỷ)	T. Trái - Txã	Mason	0983671860		

APPENDIX 3: SPSS'S OUTPUT

General Information

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	45	45,0	45,0	45,0
	Female	55	55,0	55,0	100,0
	Total	100	100,0	100,0	

Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Famer	94	94,0	94,0	94,0
	Other	6	6,0	6,0	100,0
	Total	100	100,0	100,0	

Participate biogas project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NBP	86	86,0	86,0	86,0
	QSEAP	11	11,0	11,0	97,0
	Other	3	3,0	3,0	100,0
	Total	100	100,0	100,0	

Living standard

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	4	4,0	4,0	4,0
	Near poor	6	6,0	6,0	10,0
	Average	71	71,0	71,0	81,0
	Fair	19	19,0	19,0	100,0
	Total	100	100,0	100,0	

Connect with toilet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	79	79,0	79,0	79,0
	No	21	21,0	21,0	100,0
	Total	100	100,0	100,0	

Suitable size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	too big	71	71,0	71,0	71,0
	enough	29	29,0	29,0	100,0
	Total	100	100,0	100,0	

Animal husbandary

Pig husbandry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	77	77,0	77,0	77,0
	No	23	23,0	23,0	100,0
	Total	100	100,0	100,0	

Number of pig head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	4	4,0	5,2	5,2
	3	4	4,0	5,2	10,4
	4	4	4,0	5,2	15,6
	5	5	5,0	6,5	22,1
	6	8	8,0	10,4	32,5
	7	3	3,0	3,9	36,4
	8	5	5,0	6,5	42,9
	9	4	4,0	5,2	48,1
	10	24	24,0	31,2	79,2
	12	2	2,0	2,6	81,8
	13	1	1,0	1,3	83,1
	14	1	1,0	1,3	84,4
	15	2	2,0	2,6	87,0
	20	4	4,0	5,2	92,2
	21	2	2,0	2,6	94,8
	28	1	1,0	1,3	96,1
	30	2	2,0	2,6	98,7
	32	1	1,0	1,3	100,0
	Total	77	77,0	100,0	
Missing	System	23	23,0		
Total		100	100,0		

Number of cow

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	1,0	1,7	1,7
	1	15	15,0	25,0	26,7
	2	27	27,0	45,0	71,7
	3	7	7,0	11,7	83,3
	4	8	8,0	13,3	96,7
	5	1	1,0	1,7	98,3
	6	1	1,0	1,7	100,0
	Total	60	60,0	100,0	
Missing	System	40	40,0		
Total		100	100,0		

Number of cow head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	1,0	1,7	1,7
	1	15	15,0	25,0	26,7
	2	27	27,0	45,0	71,7
	3	7	7,0	11,7	83,3
	4	8	8,0	13,3	96,7
	5	1	1,0	1,7	98,3
	6	1	1,0	1,7	100,0
	Total	60	60,0	100,0	
Missing	System	40	40,0		
Total		100	100,0		

Cow and pig husbandry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	38,0	38,0	38,0
	No	62	62,0	62,0	100,0
	Total	100	100,0	100,0	

Animal waste use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	1,0	1,0	1,0
	10	15	15,0	15,0	16,0
	15	4	4,0	4,0	20,0
	20	8	8,0	8,0	28,0
	25	13	13,0	13,0	41,0
	30	15	15,0	15,0	56,0
	35	2	2,0	2,0	58,0
	40	11	11,0	11,0	69,0
	45	5	5,0	5,0	74,0
	50	12	12,0	12,0	86,0
	60	4	4,0	4,0	90,0
	70	2	2,0	2,0	92,0
	75	4	4,0	4,0	96,0
	80	3	3,0	3,0	99,0
	100	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Treatment and dulition ratio

Dillution ratio

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1,00	3	3,0	3,0	3,0
	1,10	1	1,0	1,0	4,0
	1,14	1	1,0	1,0	5,0

	1,20	2	2,0	2,0	7,0
	1,25	1	1,0	1,0	8,0
	1,30	1	1,0	1,0	9,0
	1,50	1	1,0	1,0	10,0
	1,60	4	4,0	4,0	14,0
	1,70	1	1,0	1,0	15,0
	1,80	1	1,0	1,0	16,0
	2,00	6	6,0	6,0	22,0
	2,20	1	1,0	1,0	23,0
	2,30	1	1,0	1,0	24,0
	2,50	4	4,0	4,0	28,0
	2,67	1	1,0	1,0	29,0
	2,70	1	1,0	1,0	30,0
	2,80	1	1,0	1,0	31,0
	3,00	1	1,0	1,0	32,0
	3,30	2	2,0	2,0	34,0
	4,00	3	3,0	3,0	37,0
	4,40	1	1,0	1,0	38,0
	5,00	8	8,0	8,0	46,0
	5,30	1	1,0	1,0	47,0
	6,00	1	1,0	1,0	48,0
	6,25	1	1,0	1,0	49,0
	6,70	1	1,0	1,0	50,0
	7,00	3	3,0	3,0	53,0
	7,20	1	1,0	1,0	54,0
	8,00	2	2,0	2,0	56,0
	8,20	1	1,0	1,0	57,0
	10,00	6	6,0	6,0	63,0
	11,10	1	1,0	1,0	64,0
	12,00	3	3,0	3,0	67,0
	12,50	1	1,0	1,0	68,0
	13,00	3	3,0	3,0	71,0
	13,30	3	3,0	3,0	74,0
	14,00	2	2,0	2,0	76,0
	14,20	1	1,0	1,0	77,0
	14,30	1	1,0	1,0	78,0
	15,00	1	1,0	1,0	79,0
	16,00	1	1,0	1,0	80,0
	16,70	4	4,0	4,0	84,0
	20,00	1	1,0	1,0	85,0
	25,00	1	1,0	1,0	86,0
	28,00	1	1,0	1,0	87,0
	30,00	1	1,0	1,0	88,0
	33,00	2	2,0	2,0	90,0

	37,50	1	1,0	1,0	91,0
	40,00	2	2,0	2,0	93,0
	50,00	4	4,0	4,0	97,0
	60,00	2	2,0	2,0	99,0
	150,00	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Animal waste treatment ratio

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1,20	6	6,0	6,0	6,0
	1,25	1	1,0	1,0	7,0
	1,30	2	2,0	2,0	9,0
	1,50	1	1,0	1,0	10,0
	1,60	1	1,0	1,0	11,0
	1,70	3	3,0	3,0	14,0
	1,78	1	1,0	1,0	15,0
	2,00	1	1,0	1,0	16,0
	2,10	3	3,0	3,0	19,0
	2,40	2	2,0	2,0	21,0
	2,50	1	1,0	1,0	22,0
	2,70	1	1,0	1,0	23,0
	3,00	2	2,0	2,0	25,0
	3,10	6	6,0	6,0	31,0
	3,20	1	1,0	1,0	32,0
	3,50	1	1,0	1,0	33,0
	3,60	6	6,0	6,0	39,0
	3,75	2	2,0	2,0	41,0
	3,80	2	2,0	2,0	43,0
	3,90	3	3,0	3,0	46,0
	4,20	3	3,0	3,0	49,0
	4,80	3	3,0	3,0	52,0
	5,00	2	2,0	2,0	54,0
	5,20	2	2,0	2,0	56,0
	5,30	1	1,0	1,0	57,0
	5,36	1	1,0	1,0	58,0
	5,40	2	2,0	2,0	60,0
	5,50	2	2,0	2,0	62,0
	5,90	1	1,0	1,0	63,0
	6,00	6	6,0	6,0	69,0
	6,10	1	1,0	1,0	70,0
	6,20	1	1,0	1,0	71,0
	6,25	1	1,0	1,0	72,0
	6,30	2	2,0	2,0	74,0
	6,40	1	1,0	1,0	75,0

	7,00	2	2,0	2,0	77,0
	7,20	1	1,0	1,0	78,0
	7,40	1	1,0	1,0	79,0
	7,70	2	2,0	2,0	81,0
	8,00	3	3,0	3,0	84,0
	8,30	1	1,0	1,0	85,0
	9,00	2	2,0	2,0	87,0
	9,30	1	1,0	1,0	88,0
	9,41	1	1,0	1,0	89,0
	9,52	1	1,0	1,0	90,0
	10,00	1	1,0	1,0	91,0
	11,00	3	3,0	3,0	94,0
	11,70	2	2,0	2,0	96,0
	11,90	1	1,0	1,0	97,0
	12,30	1	1,0	1,0	98,0
	18,00	1	1,0	1,0	99,0
	31,00	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Disposal of bioslurry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	95	95,0	95,0	95,0
	No	5	5,0	5,0	100,0
	Total	100	100,0	100,0	

Cultivation activities

Having land for crop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	97	97,0	97,0	97,0
	No	1	1,0	1,0	98,0
	Not use (for renting)	2	2,0	2,0	100,0
	Total	100	100,0	100,0	

Land area for crop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1080	5	5,0	5,0	5,0
	1440	4	4,0	4,0	9,0
	1620	3	3,0	3,0	12,0
	1800	9	9,0	9,0	21,0
	2160	17	17,0	17,0	38,0
	2520	1	1,0	1,0	39,0
	2700	8	8,0	8,0	47,0
	2860	1	1,0	1,0	48,0

	2880	6	6,0	6,0	54,0
	3060	2	2,0	2,0	56,0
	3240	6	6,0	6,0	62,0
	3400	1	1,0	1,0	63,0
	3600	26	26,0	26,0	89,0
	4320	4	4,0	4,0	93,0
	4500	1	1,0	1,0	94,0
	4680	1	1,0	1,0	95,0
	5040	1	1,0	1,0	96,0
	5400	1	1,0	1,0	97,0
	7200	1	1,0	1,0	98,0
	20000	1	1,0	1,0	99,0
	46800	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Maize crop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	92	92,0	92,0	92,0
	No	8	8,0	8,0	100,0
	Total	100	100,0	100,0	

Vegetable crop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	24,0	24,0	24,0
	No	76	76,0	76,0	100,0
	Total	100	100,0	100,0	

Fruit crop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	22,0	22,0	22,0
	No	78	78,0	78,0	100,0
	Total	100	100,0	100,0	

Cum quat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	24,0	24,0	24,0
	No	76	76,0	76,0	100,0
	Total	100	100,0	100,0	

Using bioslurry

Slurry use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	87	87,0	87,0	87,0
	10	1	1,0	1,0	88,0
	20	9	9,0	9,0	97,0

	40	1	1,0	1,0	98,0
	50	1	1,0	1,0	99,0
	800	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Slurry collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	23,0	23,0	23,0
	No	77	77,0	77,0	100,0
	Total	100	100,0	100,0	

Difficulties with using bioslurry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	16	16,0	16,0	16,0
	3	64	64,0	64,0	80,0
	4	8	8,0	8,0	88,0
	5	12	12,0	12,0	100,0
	Total	100	100,0	100,0	

Bioslurry is an organic better than chemical

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	7,0	7,0	7,0
	2	12	12,0	12,0	19,0
	3	53	53,0	53,0	72,0
	4	23	23,0	23,0	95,0
	5	5	5,0	5,0	100,0
	Total	100	100,0	100,0	

Bioslurry is an organic better than chemical

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	7,0	7,0	7,0
	2	12	12,0	12,0	19,0
	3	53	53,0	53,0	72,0
	4	23	23,0	23,0	95,0
	5	5	5,0	5,0	100,0
	Total	100	100,0	100,0	

Slurry replace chemical fertilizer by percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	100	100,0	100,0	100,0

Give bioslurry to other

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	4,0	4,0	4,0
	No	96	96,0	96,0	100,0
	Total	100	100,0	100,0	

Willing to pay for bioslurry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	91	91,0	91,0	91,0
	2	2	2,0	2,0	93,0
	3	2	2,0	2,0	95,0
	5	5	5,0	5,0	100,0
	Total	100	100,0	100,0	

Know how to use bioslurry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	28,0	28,0	28,0
	No	72	72,0	72,0	100,0
	Total	100	100,0	100,0	

Using biogas

Biogas production

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enough	72	72,0	72,0	72,0
	Redundant	24	24,0	24,0	96,0
	Not enough	4	4,0	4,0	100,0
	Total	100	100,0	100,0	

Treatment of redundant biogas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	burning	74	74,0	74,0	74,0
	release to the air	2	2,0	2,0	76,0
	Give to other	23	23,0	23,0	99,0
	other	1	1,0	1,0	100,0
	Total	100	100,0	100,0	

Biogas use for cooking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	100	100	100	100
	Total	100	100,0	100,0	

Double Biogas stoves

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	40,0	40,0	40,0
	No	60	60,0	60,0	100,0
	Total	100	100,0	100,0	

Number double stoves

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	60	60,0	60,0	60,0

	1	40	40,0	40,0	100,0
	Total	100	100,0	100,0	

Single biogas stoves

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	67	67,0	67,0	67,0
	No	33	33,0	33,0	100,0
	Total	100	100,0	100,0	

Number single stoves

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	31	31,0	31,0	31,0
	1	32	32,0	32,0	63,0
	2	37	37,0	37,0	100,0
	Total	100	100,0	100,0	

Number of cooking hours per day

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	17	17,0	17,0	17,0
	3	25	25,0	25,0	42,0
	4	34	34,0	34,0	76,0
	5	12	12,0	12,0	88,0
	6	5	5,0	5,0	93,0
	7	3	3,0	3,0	96,0
	8	2	2,0	2,0	98,0
	10	2	2,0	2,0	100,0
	Total	100	100,0	100,0	

Know how to use biogas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	86	86,0	86,0	86,0
	No	14	14,0	14,0	100,0
	Total	100	100,0	100,0	

Know how to use biogas appliances

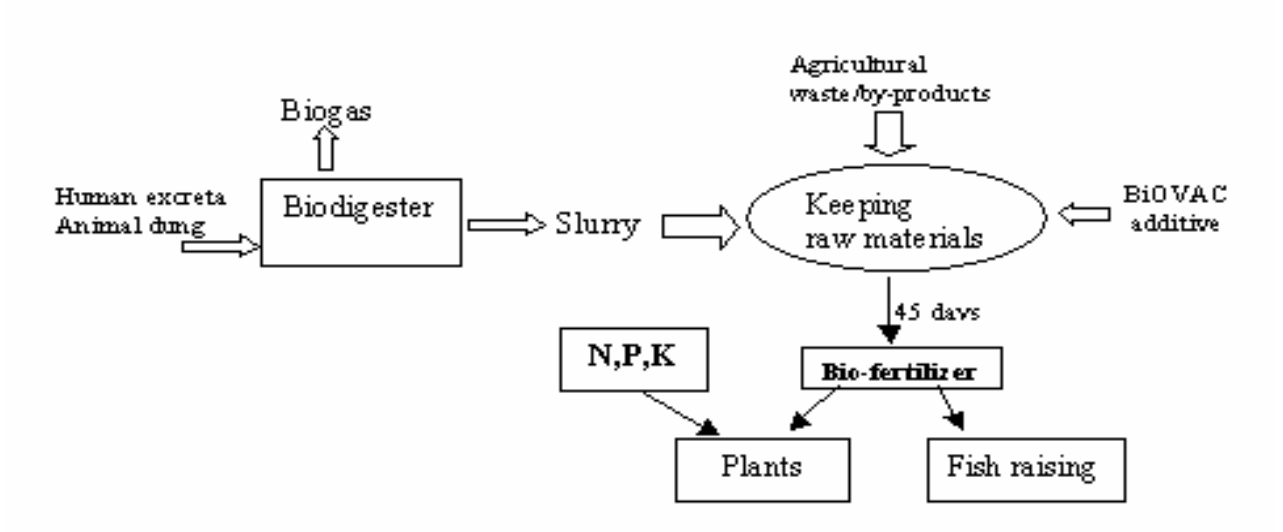
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	83,0	89,2	89,2
	No	10	10,0	10,8	100,0
	Total	93	93,0	100,0	
Missing	System	7	7,0		
Total		100	100,0		

APPENDIX 4: COMPOSTING PROCESS AND NECESSARY MATERIAL ACCORDING TO VIETNAM ASSOCIATION OF GARDENING (VACVINA).

1. MATERIAL

No.	Material	Amount
1	Agricultural and domestic waste (rice husk, rice straw, weeds, water hyacinth, bean residues)	2 – 2.5m3
2	Biodigester slurry	600 – 700 litres
3	Peat (if available)	100 – 120 kg
4	Bio-additive(gram)	500 gram
5	Labor for collecting waste	3 labor,day

2. PROCESS



APPENDIX 5: TABULATED REFERENCE

No.	Feasibility task	Reference
1	Confirm the provincial and district within which the pilot bioslurry program will be implemented with the TFP and NFP	Preface – paragraph 1
2	Establish protocols for working in each province, district and commune through the TFP-biogas and NFP	
3	Complete an assessment of biodigester management that includes: – Adequate sizes of an household digester for the given type and size of animal husbandry, – Slurry disposal or use, and a biomass availability assessment based on secondary data on land use.	 Chapter 2, paragraph 26, 27 Chapter 2, from paragraph 31 to paragraph 39
4	The survey will provide data that is gender and ethnicity disaggregated and wealth ranked and will support the preparation of: a socioeconomic baseline; Summary Poverty Reduction and Social Strategy (SPRSS) for the follow-on investment phase, and; Stakeholder perceptions and preferences for shaping the design of the pilot and its implementation. Stakeholders will include at least farmers, farmer cooperatives, and commune members.	 Chapter 5, part 5.3 Chapter 5, part 5.1 Chapter 3, part 3.1.4
5	The survey will also identify bioslurry management preferences and the attributes that are desired in the use of bioslurry within their livelihood options, including options linked to its use in aquaculture.	Chapter 2, part 3.1
6	Define capacity building needs and recommend capacity building program.	Chapter 3, part 3.3
7	Define a range of bioslurry treatment options that are integrated with household livelihood options and preferences including the use of treated slurry in composts, liquid fertilizers, fish feeds – both solid and dried. The consultant shall also assess the option of a slurry collection option where slurry is aggregated for treatment and use	Chapter 2, part 3.1 and part 3.2
8	Define demonstrations as farm plots or experiments (such as a dried aquaculture feed) within each slurry management option to use treated slurry in a treatment versus control demonstration to be used for creating awareness and capacity for bioslurry management.	Chapter 3, component 1
9	Develop and complete an IEE screening matrix of bioslurry treatment and treated slurry uses according to ADB guidelines	Chapter 6
10	For each pilot district, prepare a work plan, detailed activities, implementation arrangements, performance and monitoring indicators, and costings	Chapter 3, part 3.2 and chapter 4
11	Prepare a capacity building program	Chapter 3, part 3.3
12	Prepare a consolidated report including a risk assessment	Chapter 7

APPENDIX 6: COMPOSTING METHOD

Composting method and process by SNV biogas project

As nutrient contents in bio-slurry are easily lost due to the specific weather conditions of Vietnam. It is necessary to handle bio-slurry cautiously, to prevent nitrogen loss.

Handle bio-slurry with phosphate fertilizer
Add phosphate fertilizer to bio-slurry can help protect nitrogen content. Experiments carried out at IE showed that add phosphate fertilizer of 2-5% according to weight. Nitrogen content in phosphate-added bio-slurry 2.45 fold higher than that in non-added bio-slurry after 50 days of storage. Nitrogen can be maintained as in the below chemical reaction:

$CaSO4 + (NH4)2CO3 = CaCO3 + (NH4)2SO4$

Composting method
Another method is composting. This method is familiar to rural peasants as they normally practice with animal manure to have organic fertilizer sources.

Nutrient contents in the composts made from liquid slurry and organic materials in 2005 winter-spring Unit: (%)

No.	Fertilizers	N	P2O5	K2O
1	Compost 1	0.25	0.24	0.30
2	Compost 2	0.26	0.21	0.27
3	Compost 3	0.30	0.32	0.40
4	Manure (control)	0.35	0.15	0.30

The table shows that compost fertilizer processed from bio-slurry have the quality with that made from animal manure.

Bioslurry composting process:

- Dry rice straw and grass until they get withered. Put them in layers on the hard ground (or in pits) with roofing next to the compensation tank. Add 0.5 to 0.7% by weight of lime.
- Apply digested effluent onto organic layers and mix well these layer so that the effluent imbue the organic material well. The amount of digested effluent should be 3 times more than organic material.
- Attention must be paid to the keeping up the humidity of the heap, by watering digested effluent; 15 kg of digested effluent per 100 kg of material should be applied for the heap. When the temperature of the heap reaches 40-50o, more digested effluent will be needed. It is important to compress well to avoid nutrientloss.
- After 2 to 3 weeks, mix the heap thoroughly and add 2% of supephosphate (by volume), then compress well, as before.
- After 1-2 months of composting, the compost fertilizer will have the characteristics similar to manure and they are ready for use.
- The rationally combined application of bio-slurry and chemical fertilizer can make up for each other's deficiencies and alleviate the contradiction between the needs of crops, for nutrient elements, and the fertilizer supply to the soil. The mixed application can accelerate the solution and adsorption of chemical fertilizer in soil and stimulate the crop to assimilate nutrients, thus lessening the loss of nitrogen and enhancing the utilization ratio of chemical fertilizers. This can also reduce the consumption of chemical fertilizers, increase the efficiency use of fertilizer as well as cut down the investment for chemical fertilizers.

Composting method by Nepal

In order to overcome the demerits of farm yard manure, the extension workers of the Department of Agriculture (DOA) of Nepal Government have been motivating and preaching to the farmers to enhance the quality of their organic manure by making improved compost. In this regard, the farmers are advised to make compost either in a heap or in a pit according to their convenience. Pit method of composting is preferred by the farmers to heap method. In brief, all composting materials are put in layers and the farmers are advised to turn the composting materials at least 3 times to enhance the rate of decomposition. Practically, this programme has not picked up in full momentum.

It should also be noted here that in the past, Biogas Support Progam (BSP) had made several attempts to convince DOA to join in the promotion of bio-slurry. Unfortunately, DOA, which has wide network of agricultural extension workers at the grass root level, was interested in cooperating with BSP for the promotion of bio-slurry as fertilizer.

Slurry Compost

Slurry Compost refers to the compost prepared by using digested slurry in conjunction with vegetable/agricultural residue. If the slurry is composted by mixing it with various dry materials, such as dry leaves, straw, etc, the following advantages can be realized (Ref: FAO/CMS, 1996):

- Dry waste materials around the farm and homestead can be utilized;
- One part of the slurry will be sufficient to compost about four parts of the plant materials. Thus, increased amounts of compost will be available on the farm;
- Water contained in the bio-slurry will be absorbed by dry materials. Thus, the manure will be moist and pulverized. The pulverized manure can easily be transported to the fields.

The average values of N, P and K in slurry compost as quoted by Demont et al (1991) are 0.75, 0.65, and 1.05 respectively (see Table below)

N (%)	P (%)	K (%)	Author
0.5-1.0 (0.75)	0.5-0.8 (0.65)	0.6-1.5 (1.05)	Demont et al. 1991

Figures in parenthesis indicate the average value.

Gupta (1991) analyzed the major plant nutrients-NPK- in composted manure, FYM and digested bio-slurry. The result of the analysis has been presented in Table below:

Nutrients Available in Composted Manure, FYM, and Digested Slurry

Nutrients	FYM		Composted FYM		Digested Slurry	
	Range (%)	Average (%)	Range (%)	Average (%)	Range (%)	Average (%)
Nitrogen (N)	0.5 to 1.0	0.8	0.5 to 1.5	1.0	1.4 to 1.8	1.60
P2O5	0.5 to 0.8	0.7	0.4 to 0.8	0.6	1.1 to 2.0	1.55
K2O	0.5 to 0.8	0.7	0.5 to 1.9	1.2	0.8 to 1.2	1.00

The data presented in the above table suggests that the value of the effluent can outweigh the benefit accrued from the value of biogas, as it is rich in major plant nutrients, compared to traditional FYM and compost. Both percentage range and average figures for digested slurry are appreciably high compared to FYM and composted manure or slurry. This is true only under ideal conditions. Where slurry-handling techniques are not favorable or very negligent, almost all of the nitrogen may be lost, due to volatilization of ammoniac nitrogen that is soluble in liquid slurry. Likewise, other nutrients too get lost when slurry is exposed to the sun for a quite long time.