Improved manure management through increased utilization of manure and bio-slurry

FINAL REPORT

BIOSLURRY MANAGEMENT AND UTILIZATION AND NEED FOR TRAINING

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Contents

CURRENCY EQUIVALENTS

(as of 15 September 2015)

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LIST OF TABLES

LIST OF FIGURES

ANNEX

ABBREVIATION

BPPMU : The Biogas Programme for the Animal Husbandry sector in Viet Nam
BUS : Biogas User Survey
CCAC : Climate and Clean Air Coalition
CCRD : The Center for Rural Communities Research and Development
CMP : Calcium Magnesium Phosphate
FR : Final report
FYM : Farm Yard Manure
MARD : Ministry of Agriculture and Rural Development
RT : Retention time
TOR : Terms of Reference
ToT : Training of Trainer
VACVINA : Viet Nam Gardening Association
VBA : The Viet Nam Biogas Association
VND : Viet Nam Dong

PREFACE

This assignment on "the assessment of training needs of rural households, barriers to bio-slurry and manure usage and best practices; mapping the policy environment and non-government actors" will serve for the project "Improved manure management through increased utilization of manure including bio-slurry" aiming to raise awareness among 4000 farmers in Viet Nam about the benefits of using bio-slurry and manure and to provide them the knowledge and skills to apply this to their own crops.

This project is executed under the livestock and manure management component of the Climate and Clean Air Coalition (CCAC) and will be implemented by SNV and the Biogas Program for the Animal Husbandry Sector of Viet Nam (BPPMU).

The assignment was commenced in early August 2015 until end of September 2015. The location to implement the assessment is five provinces namely Bac Ninh, Vinh Phuc, Thanh Hoa, Dak Lak and Hau Giang in Viet Nam as requested by BPPMU.

To gain the information and data for the evaluation, 100 biogas households, ten biogas technicians, five biogas masons are interviewed with designed questionnaires (*see Annex 2*). Out of 100 households, only three household have no land for cultivation, 6 households have fishpond, 55 households have slurry pits. 69 households use slurry for crop cultivation or fishpond or both purposes.

The final report (FR) aims to (i) provide the summary on the bio-slurry and manure management in Viet Nam, (ii) assessment on bio-slurry and manure management and utilization of 100 biogas households in five provinces in Viet Nam, (iii) assessment on training need of biogas households and, (iv) the summary on the policy environment and non-government actors in biogas/bio-slurry sector in Viet Nam.

The FR comprises 4 chapters:

- Chapter 1: Overview on bio-slurry and manure management in Viet Nam and other regional countries
- Chapter 2: Bio-slurry and manure management in surveyed provinces
- Chapter 3: Training need assessment
- Chapter 4: Environment Policy and Non-government Actors

Chapter 1: Overview on bio-slurry and manure management in Viet Nam and other regional countries

1.1. Current status of bio-slurry and manure management in Viet Nam

Introduction

1. Domestic biogas plants convert animal dung and human excreta at household level into combustible gas, known as 'biogas. This gas can effectively be used in simple gas stoves for cooking and in lamps for lighting. The other main product of the process is known as 'bio-slurry'[1]. Bio-slurry can be considered as a good quality organic fertilizer. Analysis of representative cow dung and pig dung slurry samples from biogas plants has shown bio-slurry contains both macro and micro nutrients besides appreciable quantities of organic matters. Toxic heavy metal concentrate is reportedly minimal[2].

2. The utilization of bio-slurry may reduce the use of chemical fertilizers by up to 50% when apply for rice and peanut. Bio-slurry is potentially a 100% organic fertilizer suitable for natural farming systems and may qualify for organic farming. Ideal uses include the high value field and horticultural crops that are currently emerging through crop diversification as rural household search for improved income levels[3].

3. Biogas technology has been introduced in Viet Nam since the 1960's and there have been many biogas plant projects in Viet Nam since the early 1990s, all focused on small livestock households and without adequate coordination. Until the year of 2012 about half a million units were constructed and installed throughout the country to provide energy while reducing the environmental impact of livestock waste[4]. These biogas plants generate an enormous amount of bio-slurry on dry weight basis every year. Supposedly average size of the digester is 11 cubic meters and dilution ratio of 1manure 2 water is applied, approximately 41 million tons of slurry is theoretical produced as presented in below *Table 1*.

Table 1: Theoretical volume of slurry production of KT1[5]

Parameter	Unit	Different size
Size of digester	**m^3**	**11,0**
Daily feeding manure	kg/day	75
Daily water amount	litre/day	150
Volume of digester	m^3	9,0
Theoretical volume of bio-slurry production per year of one digester	ton/year	82.13
Theoretical volume of bio-slurry production per year of 500,000 digesters of the country	ton/year	41,062,500

[1] The term bio-slurry is used here for the residue that comes out of the biogas plant. Other terms sometimes used are just 'slurry', 'effluent', 'bio-manure', 'sludge', 'organic fertilizer' and 'organic manure'.

[2] Assess quality of bio-slurry under Biogas Program for Animal Husbandry Sector in Viet Nam, National Institute of Soil and Fertilizer, 2008.

[3] Study on the usage and processing of biogas sump wastes as fertilizers for paddy rice and peanut on degraded soils, Hanoi Agricultural University, 2005.

[4] Low Carbon Agricultural Support Project Document (RRP VIE 45406), ADB, 2012.

[5] Data in Table 1 is calculated basing upon i) the parameters for designing KT1 applying dilution ratio of 1 manure : 2 water; ii) assuming that the bio-digester is operating 365 days per year and, iii) the operation of biogas user is according to operation instruction.

Slurry management and handling is often unsatisfactory as the lack of proper slurry management or application procedure. As a result, big volume of slurry is discharged to the environment is likely to be substantial and along with the potential loss of valuable nutrients.

4. The fertility of Viet Nam soils is extremely variable. Most soils are depleted and declining crop yields is observed without proper fertility management. Nitrogen, phosphorus and potassium deficiencies are common throughout the country. Farmers increasingly depend on chemical inorganic fertilizers as being without understanding and adequate information on actual requirements. In the effort of gaining yield increases, the exceed application of some nutrients and under use of others reduces the efficiency of fertilizer use and creates unnecessary costs. Fertilizer application rates in irrigated rice have increased from 57kg/ha in 1983 to over 200kg/ha in 1996 and accounts for one third of the cost of production and it is estimated that the extent of overuse amounts to on average 20kg/ha while a further 12% of farmers misuse fertilizer (Truong,V.T., 2003 - Integrated Assessment of Trade Liberalization in the Rice Sector of Viet Nam). Despite progress in fertilizer use, the efficiency of utilization for nitrogen fertilizer by plants is only 35-45% while for phosphorus and potassium fertilizer efficiency levels of 50-60% are achieved. As a consequence, large amounts of nutrients are lost via leaching, erosion, volatilization and fixation. This represents not only lost investment but also to the danger of environmental pollution. It is estimated that, in Viet Nam, the annual loss of nitrogen fertilizer accounts for about 1-1.2 million tons of urea-equivalent fertilizer[6]. This has both financial and economic costs as well an as being potentially damaging to the environment.

5. To reduce poverty and malnutrition as well as to attain and sustain self-sufficiency in food and fiber crops, intensification of agricultural production by multiple cropping, increasing cropping intensity and the use of high yielding varieties is a priority. Such challenging activities that are very much needed for food security throughout the country involve a complete management package that depends heavily on plant nutrient supply and balance. Under such situations, reliance upon mineral fertilizers will result in significant increases in cost to both the economy and to farmers. Therefore, mobilization of biomass - organic nutrient sources for fertilizer is considered an attractive option for farmers to improve their incomes. Biogas technology has the potential to provide significant nutrients as well as providing access to energy. This technology not only provides energy for multiple uses, but also good quality bio-slurry that can be used as organic fertilizer.

Field trial and demonstration pilot

6. The field trial and demonstration pilots have been conducted under BPPMU and other biogas programs (ADB, WB). Under BPPMU, field trials and demonstrations on using bio-slurry for diversified purposes including crop fertilizer, fish-pond and additional pig feed. Demo-plots were set up nation-wide in more than 40 provinces that participated in the project. Setting up demo plots of bio-slurry use helps encourage and guide farmers apply this by-product. Selected households for demo plots were pioneers with a desire to adopt new techniques and willing to share their experiences with other people. *Table 2* summarizes the demonstration pilots under the BPPMU by end of 2007.

Table 2: Summary of demonstration plot in 24 provinces under BPPMU[7]

[6] "The role of fertilizer in modern agricultural production in Viet Nam". Prof.Dr. Nguyen Van Bo-Viet Nam Soil Science Society – Viet Nam News 2004.

[7] Country Report on Bio-slurry Utilization 2007 that presented in Bio-slurry Tour in Nepal from 11th – 15th September, 2007.

	Crop fertilizer					Fish pond	Pig
	Vegetable	Secondary crop	Fruit	Industrial crop	Paddy rice		
Number of demonstration plots	24	4	5	8	3	13	4
Demonstration plots in percent (%)	39	6.5	8	13	5	22	6.5
Results							After 2 month, apprx. 11 US dollar can be saved per pig head from reducing basal diet consumption
Increased yield compared to control – without using bio-slurry	2-14%	15-20%	20-30%	5-14%	7%	13%	
Economic benefit (increase income compared with control)	10-63%	0-5%	98-130%	87%	25%	13%	

7. Results of demo-plots show that bio-slurry application effects positively on both quantity and quality of products. Cabbage fertilized with bio-slurry will roll tighter. French bean is more equal and fresher. In the province of Tien Giang, liquid bio-slurry is used for watering for a garden of cherry fruit (*Malpighia glabra)*. This practice replaces 100% chemical fertilizer. Bigger fruits and lighter color fruit are recorded, which helps increase selling price 12-14% (equal to export price).

Utilization of bio-slurry among biogas users[8]

8. At the end of 2006, a small survey on bio-slurry use was conducted by BPPMU. Within the survey, data on bio-slurry use was collected from 20 provinces. The survey found that out of 8,512 households with digester only 2,720 (32%) use bio-slurry for their farming activities including cultivation and animal production (pig feed), while only 1,238 (15%) households built slurry pits. The Northern provinces have higher rate of using bio-slurry (36%) rather than the Southern provinces (26%).

9. During quality control trips in 2008, BPPMU had statistic data on bio-slurry use: within 402 household visited 262 (65.2%) households use bio-slurry as crops fertilizer and as fish-pond fertilizer. Some households apply bio-slurry as additional pig feed. People were interviewed about the benefits of bio-slurry seemed to be satisfied with this product, especially farmers from Thai Nguyen (North) and Tien Giang, Dong Nai (South). Within households that do not use bio-slurry, there was 92% have no land for cultivation, 5% do not have labor for transportation while 3% do not know how to use bio-slurry. In Dak Lak, a central highland province, people use bio-slurry for industrial crops like pepper, cashew, coffee and fish-pond. 100% households constructed slurry pit for storage of bio-slurry. In particular, people also use scum as fertilizer, more common with household use cattle dung for feeding digester. For example, at a village in suburban of Hanoi (Tam Xa village) 680 out of total 970 households (70%) install bio-digesters. Many households use scum as basal fertilizer. Before growing crops, people open digester and take all scum. Normally a 10 cubic meter digester provide 1.5 tons of scum. Scum will be dried for 2 – 3 days before taken to the field for soil preparation.

[8] Data and information from Country Reports 2006, 2007 and 2008, Bios-slurry workshops and Study Tours in Thailand (2006), Nepal (2007) and Bangladesh (2008).

The villagers report that using scum helps reduce chemical fertilizer use by 30-40%. In addition plant grows better with higher quality. These impacts were confirmed by a research on scum that was conducted by a German intern and a Vietnamese co-worker in 2006 - 2007 in Hanoi and Ha Nam province[9].

10. According to the annual bio-slurry report of BPPMU (2010), among biogas users, nearly 40% uses bio-slurry. Out of this 40%, 88% use bio-slurry for watering vegetable and 7% use bio-slurry for fish-pond, 5% use for watering garden.

11. According to a survey conducted in Thai Nguyen province[10] by a Dutch internship student and Vietnamese lecturer in 2006, bio-slurry is mainly used for productive purposes. Using bio-slurry in commercial tea production resulted in a higher yield of tea. After using bio-slurry, farmers harvested higher yield, i.e. 2.41 kilograms of tea per sao[11] more in summer and 1.59 kilograms of tea per sao extra in winter compared to before they used the slurry. The use of slurry also appears to result in a higher price. In summer the average price of 1 kilogram of Trung Du tea was 0.03 USD higher than before the slurry was used, in the winter period this difference was 0.2 US dollars in favor of the slurry tea. The average price of 1 kilogram of Trung Du tea was 2 dollars for summer and 2.5 dollars for winter respectively. The savings on chemical fertilizer due to slurry use amounted to 130 US dollar per year per sao, the savings on pesticides amounted to 32 US dollars per year per sao. Therefore in total the bio-slurry has an income saving effect of 162 US dollars per year per sao. The bio-slurry causes an increase in the amount of tea produced, and at the same time generates a higher price per kilogram of tea. This results in an increased income. The total income generating effect of using bio-slurry in tea production is 230 US dollars per sao per year[12].

12. Biogas user survey (BUS) is an annual activity to make a comprehensive assessment of the operation of the biogas plants of the households participating the BPPMU, including the impacts on energy, health and sanitation, bio-slurry use, and other environmental and socioeconomic conditions of the households. From 2005 to 2013, there were seven BUSes have been conducted by different organizations or independent consult groups. *Table 3* below presents summary of bio-slurry use findings from BUS reports.

Table 3: Bio-slurry utilization of households from BUS reports

Code	Year of BUS conduction	Bio-slurry utilization (%)	
		Use	Not Use
1	2006	40.5	59.5

[9] Scum formation in the biogas digester, Luu Minh Cuc and Matthias Hesse, 2007.

[10] *Thai Nguyen* is one of the 63 provinces in Viet Nam. The reason for doing the research here is that there are a lot of tea producers in Thai Nguyen. This experiment was conducted in Dong Hy District (Thai Nguyen). An experimental and control plot was used. The experimental plot received bio-slurry as means of fertilization and the control plot received chemical fertilizer. The experimental plot produced on average 3.33 kg more tea than the control plot, resulting in 0.8 kg more per sao (360m^2). The cost of input materials for the control plot was 78,400VND higher per sao of land. The gross income for 1 sao of land for the experimental plot was also 30,000 VND higher in comparison to the control plot. The income generating and income saving effect from using bio-slurry for tea instead of chemical fertilizer together amounted to 108,400 VND. In this research it will be assessed whether or not bio-slurry can help generate additional income for tea producers.

[11] 1 sao = 360m^2. 1 ha = 27.7 sao.

[12] Dong for Dung: the economic impact of using bio-slurry for tea production on a household level in Thai Nguyen Province, Steven von Eije, 2007.

2	2007 - 2008	45.5	54.5
3	2009	31.5	68.5
4	2010 - 2011	38.9	61.1
5	2012	57	43
6	2013	40.3	59.7

According BUS reports, bio-slurry is commonly used for crop cultivation or fishpond (fewer cases) without any treatment. Farmers commonly do not rely on any recommended application formula or instruction. Major barriers for not using slurry are having no crops, lacking labor for slurry transportation or far away crop fields. In case of using slurry for crops or fishpond, one or a number of slurry pits are constructed for storing slurry. However, these pits are too small in comparing with actual using requirement.

Handling bio-slurry

13. Nutrient content of bio-slurry is easily lost due to the specific weather conditions of Viet Nam. It is necessary to handle with bio-slurry to prevent nitrogen loss.

- Handling bio-slurry with phosphate fertilizer

14. One of the most popular ways is handling bio-slurry with phosphate fertilizer (super phosphate or Calcium Magnesium Phosphate (CMP). Adding phosphate fertilizer to bio-slurry can help protect nitrogen content. Experiments carried out at Institute of Energy showed that by adding phosphate fertilizer of 2-5% according to weight. Nitrogen content in phosphate-added bio-slurry is 2.45 fold higher than that in non-added bio-slurry after 50 days of storage. Nitrogen can be maintained basing on the chemical reaction of phosphate with ammonia in bio-slurry to form sustainable ammonium as in the below chemical reactions: $CaSO_4 + (NH_4)_2CO_3 = CaCO_3 + (NH_4)_2SO_4$ or $H_3PO_4 + NH_4OH = (NH4)_2H_2PO_4 + H_2O$

- Composting

15. Another method is composting. This method is familiar with rural peasants as they normally practice with animal manure to have organic fertilizer sources. The below *Table 4* presents a research result of making compost from liquid slurry and organic material (manure and straw) in 2005 by BPPMU[13].

Table 4: Nutrient contents in the composts made from liquid slurry and organic materials in 2005 winter-spring

Unit: (%)

No.	Fertilizers	N	P_2O_5	K_2O
1	Compost 1	0.25	0.24	0.30

[13] Study on the usage and processing of biogas sump wastes as fertilizers for paddy rice and peanut on degraded soils, Hanoi Agricultural University, 2005

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

16. *Table 4* shows that bio-slurry compost fertilizer has the better quality with gaining P while keeping N compared to animal manure without any treatment.
Compost 1: rice straw + bio-slurry
Compost 2: green materials (weeds, fresh organic residues) + bio-slurry
Compost 3: rice straw (is cut in 3 – 4 cm) + lime, superphosphate + bio-slurry
The adding of superphosphate in compost 3 explains the gaining P in fertilizer.

17. VACVINA, a local organization in Viet Nam is very interested in processing organic fertilizer from bio-slurry. They use a product named BIOVAC[14] to speed up the process of fermentation and digestion of compost. Given that much of Viet Nam's agricultural production is still done by individual households, the solution had to come from family-scale practices. By this orientation the The Center for Rural Communities Research and Development (CCRD) has designed a method of utilizing the bio-slurry to produce large quantities of solid and fully composted bio-fertilizer in a short period of time using readily-available and free agricultural wastes. BIOVAC is added to large quantities of agricultural waste and liquid slurry from bio-digester or fresh manure in order to produce compost to be used as bio-fertilizer. The compost process will allow individual farmers to produce a significant amount of bio-fertilizer in a reasonably short time of about two months and at a very affordable cost[15]. *Table 5* presents materials used for producing one ton of bio-fertilizer.

Table 5: Materials used for producing 1 ton of Bio-fertilizer at household scale

Material	Unit	Quantity
1. Agricultural & domestic waste (Rice husk, rice straw, weeds, water hyacinth, bean residues)	m^3	2 - 2.5
2. Bio-slurry (if available)	litre	600 – 700
3. Animal Dung (if no digester)	kg	600 – 700
4. Peat (if available)	kg	100 – 120
5. BIOVAC Bio-additive (gram)	gram	500
6. Labor for collecting waste	man day	3

Source: VACVINA Viet Nam

[14] BIOVAC is CCRD's bio-product, produced in conjunction with The Centre of Physical-Chemistry & Centre of Environmental Technology – Hanoi National University.
[15] Total cost of production of bio-fertilizer: US$ 150/1 ton (2013).

Transportation of bio-slurry

18. Due to the fact that field and gardens in the rural area are far from digester, farmers have to transport bio-slurry to the place of application. Farmers have to take advantage of locally available means of transportation including a pond and two hangers, improved cart, pack-bike and motor-bike). Some households built several slurry pits in each garden. Then they use water pumps to water crops. Nowadays, a number of households bought power-generator run by biogas. With this device, they can increase income from saving money from reducing electricity cost including electricity for pumping. There are challenges for biogas users as many households lack of money for installation of pipeline for bio-slurry or labor for transportation.

1.2. Bio-slurry utilization in some other Asian countries[16]

In Lao

19. Farmers understanding and knowledge of using bio-slurry is limited since the technology of bio-slurry extension is new for them. But most of the farmers who have biogas plant doing similar to what they had been practiced with raw animal dung directly to their farms. According to monitoring reports, most farmers are practicing of using bio-slurry as followings:

- Farmers usually keep bio-slurry in the tanks and from the tanks they use in the field directly. Many farmers drain out slurry to the surrounding areas.
- Mix husks, saw dust, leaves and grass with the bio-slurry and leave it to digest and dry it, after that put it in the bags and keep it under shade.
- Some households even do not use it, they just leave it and make dirty around the areas.
- Some households use bio-slurry to mix with dirt and nursing the nurseries.
- Some households use bio-slurry to mix with water and watering their growing crops, plants, trees, fruit trees, garden, flower vases and rice farms.
- Some farmers use bio-slurry in seed bed for growing vegetables, trees and fruit trees.

20. The Lao BPP Biogas User Survey reported the following findings regarding use of bio-slurry:

- About 75% of the users were using bio-slurry in one or other ways. The reasons for not using were the lack of agricultural land or crops to use (10%) and bio-slurry not-coming out of the biogas digester (15%). The users who did not use the slurry drain it directly to surrounding areas and watercourses.
- Though the users are yet to realize the effects of bio-slurry, still, 85% of the users who used slurry on farm reported that it is of high nutrient value than the farmyard manure and the remaining 15% reported that the nutrient value of bio-slurry is somewhat same as the FYM. The use according to them were: use as organic manure without composting (70%), use as manure with composting (15%) and use wet slurry directly to the crops (15%). Though the users expressed their views that the production of crop has increased after the use of bio-slurry, they could not exactly quantify the increment.

In Cambodia

21. Farmers manage their bio-slurry as they managed their farm yard manure (FYM) before construction of bio-digester (only making a pile of FYM without boundary and shade). Fifty four digester owners had been interviewed as a part of study conducted by a student from the

[16] International Bio-slurry Workshop and Study Tour Bangladesh November 2008.

Royal University of Agriculture in Kompong Cham province. The result showed that 43 digester owners of 54 have one big slurry pit near by the outlet. 35 owners of 54 built boundary surrounding slurry pit. Only 13 owners of 54 have built composting hut with proper shade. However, the other farmers have planned to build good composting hut but now they do not have enough money. After digester construction, the average volume of organic fertilizer has been increased from 4.46 ton to 6.68 ton/ year. About 50% of digester owners used bio-slurry crop fields and fish pond (5 owners used in rice, 9 in vegetables, 7 in fruit trees, and 5 in fish pond. The digester farmers have reduced chemical fertilizer 39 kg per hectare in rice. Moreover, the rice yield had been increased from 1992 kg to 2046 kg/ha. Most of digester owners are aware of the advantage of bio-slurry and use it in both rice field and vegetable garden. Normally, farmers prefer to use bio-slurry as basal in rice fields and, basal and top dressing for vegetable cultivation. Bio-slurry is used as fish feed mixing with other materials like bran, broken rice, and vegetable.

In Bangladesh

22. According to a survey conducted in 2007, most of the users either have one (42%) or two (42%) pits for storing slurry. A few of them (16%) have no slurry pit at all. No standard sized slurry pit was found in the biogas user households. The users store bio-slurry in the slurry pits for on average of 53 days which range from 14 to 97 days. The variation of storing time depends on the type of use, practice of drying, and depth of slurry pit. The fish farmers use slurry within an interval of 14 days as fish feed. In other case, those who sell bio-manure used to dry in semi-dried condition spread on the ground. They transfer a small quantity of slurry from the primary pit to a secondary pit of shallow depth for a few days and then take it from the secondary pit to spread it on the ground for drying. Seventy five percent of the users dry slurry; 95% of them dry under the sun and the rest dry it in the shade. Most of the users (78%) do not add any other materials with slurry for decomposition. Only 22% add other organic materials with slurry in the slurry pit. From among these users who add other materials 90% add kitchen waste, waste of livestock fodder (straw), ash, water hyacinth and green compost manure (10%). Seventy four percent of the users use bio-manure (slurry) for field crop cultivation, home gardening (32%), fish cultivation (43%) and for selling (8%) purposes. Twenty eight percent of the users have not yet used bio-manure, as their manure is not yet dry. They are willing to use it for crop production in the coming season (Boro). From among the users, however, 57%, 31% and 11% use bio-manure respectively in dried, semi-dried and liquid form.

In Nepal

23. The biogas users' survey was regularly being conducted last few years, has also shown that majority of the biogas users having compost pits. However the number of pits varies with households. The size of the biogas plant and the availability of the space generally determine the number and size of the pit. Biogas users' survey (2008) confirmed the popularity of pit method of composting and found that among the biogas users more than 2% of the respondents follow pit method. Generally biogas users keep compost in the pit or 3-4 months. The composting period is perhaps more determined by the time of application rather than decomposition.

Besides the composting, some users have practice to use the bio-slurry in liquid form. Biogas User Survey 2008 shows that about 10 percent biogas users were use as liquid form. The liquid form of bio-slurry is use in the kitchen garden.

Bio-slurry storage: The crop cultivation is seasonal while the bio-slurry production is continuous. Before the application, the bio-slurry compost is store by the users' in different ways. Some users have storage the compost properly and some are incorrectly. However the biogas user survey (2008) has identified the following storage and application modes being practiced by Nepalese farmers.

- Spread and dried on the ground
- Keep in heap uncovered
- Keep covered in heap
- Piled under a shed
- Piled temporarily in the field
- Spread in the field into small heaps uncovered
- Transported and spread in the field with cover until field application
- Transported to the field, spread and incorporated immediately
- Transported to the field and spread during slack season and incorporated into soil only at time of land preparation.

24. The practices of slurry compost storage and application popularly being followed by Nepalese farmers can be termed quite unscientific as the quality of the compost is greatly affected due to direct exposure to the sun and also the valuable nutrients are washed away by rain. The scientific practice is to incorporate in the soil immediately after transporting to the field. As a part of the bio-slurry extension program, this message was diffused through various mass media like radio, TV, leaflet distribution, users' training … which seemed to have brought about positive result. The bio-slurry can be applied in the field in different forms as described below. Biogas Users' Survey 2008 has reported that around 64% of the sample households utilize it in compost form, 12% in dried form, only 10% in liquid form and the rest 14% do not use the slurry at all. One of the main reasons attributed for not using the slurry is – latrine connection to the plants, bad odor and refusal by labor to handle the bio-slurry produced from latrine attached plants. In some area farmers are use the bio-slurry as insecticide. They mix bio-slurry and water at the ratio of 1:4 and stir thoroughly then spray in vegetable crop like bean to control the aphids. Some users have sprayed this slurry concentration in potato during the cloudy weather for preventing the leaf rot. Bio-slurry has been successfully used as fish feed in some fishpond of biogas farmers. The farmers used bio-slurry in two ways, first as a fertilizer in the fishpond and second as a feed to fish. Bio-slurry was applied at a dose of 100-150 kg/kattha[17] initially before water irrigation in the pond. The fingerlings stocked in the pond need highly nutritious feed in first month. The first month feed was prepared with the wheat or maize flour, soybean, fish meal and mustard cake. The mixture of 20% of each of these ingredients was fed to the fish at the rate of 3 percent of the total body weight. From the second month 20 percent slurry was added to the total weight of the feed; and from the third and fourth month 30 percent slurry, 20 percent flour and 50 percent rice bran were mixed for preparing the fish feed. The fish were fed twice a day, once in the late morning and next in the afternoon. The feeding was done in the form of balls of the feed mixture, which were inserted into the pond by keeping in pans and suspending in the pond

[17] A katha is a unit of area in Bangladesh and Nepal, 1 kattha = 338.57 m²

water at a depth of one foot from the surface. Water hyacinth was also grown in the pond to purify water.

Chapter 2. Bio-slurry and manure management in surveyed provinces

2.1. Survey location

25. Five provinces namely Bac Ninh, Vinh Phuc, Thanh Hoa, Dak Lak and Hau Giang are selected for the survey as requested in the Terms of Reference (TOR)[18] of the assignment. As number of biogas plants of provinces is different, number of households for interview is determined according to constructed biogas plants of each province with a minimum of 10 households per province. Project database and/or expert's experience is used for this purpose. Households are selected for the survey by the following criteria i) having normal animal production; ii) having at least one operational bio-digester; iii) having crops, or garden cultivation and/or fish pond. A number of 100 households were visited and interviewed during the field survey (see *Annex 5* for details of households). *Table 6* presents number of households to be visited and interviewed during the survey.

Table 6: Number of households to be visited and interviewed

Code	Province	District	Number of constructed biogas plant	Number of households are interviewed
1	Bac Ninh	Luong Tai	797	27
2	Vinh Phuc	Tam Duong	527	20
3	Thanh Hoa	Hoang Hoa	530	25
4	Dak Lak	Eakar	310	18
5	Hau Giang	Chau Thanh A	72	10
	Total		2,236	100

2.2. Survey stakeholders

26. Three sets of questionnaire have been developed for the survey, one for biogas households one for mason and technician and the third for policy maker (see also *Annex 4*) and bio-slurry specialist. The field survey was mainly conducted at noon or end of the day when farmers have come home already after doing cultivation in the field.

Occupation of interviewees

27. Most household interviewees are farmers and only two of them have other occupation such as teacher or worker.

[18] See Annex 1 for ToR.

28. Four biogas masons, four district technicians and 3 provincial technicians, 1 provincial director and 1 commune officer were interviewed during field survey. Besides, one policy maker and two biogas experts were also interviewed (see *Annex 6* for details).

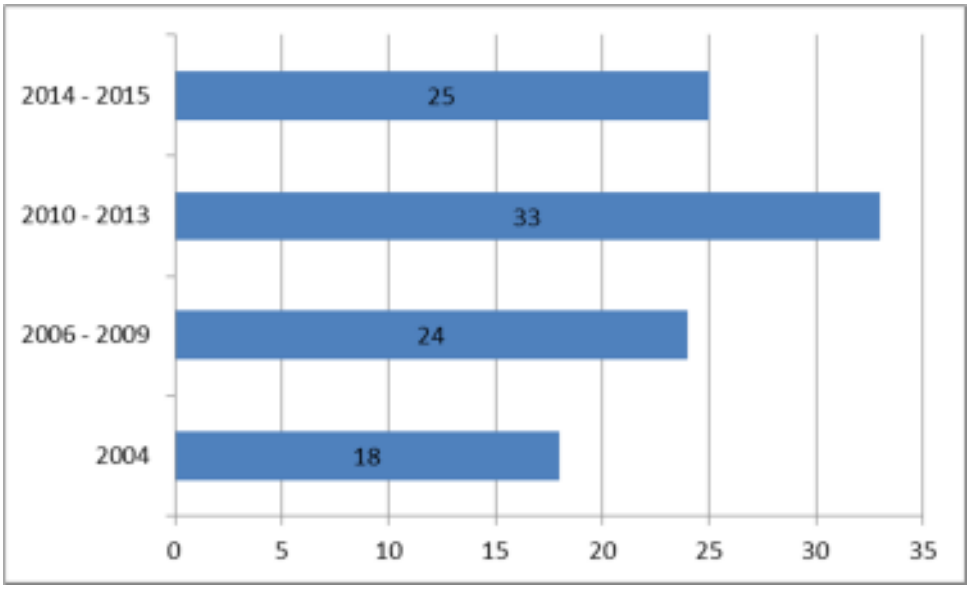
2.3. Bio-slurry management and utilization

Biogas plant

29. *Digester model*: KT1 is chosen for construction in Northern provinces and Dak Lak (total 90 plants) and KT2 is chosen by farmers in Hau Giang (total 10 plants).

30. *Year of construction*: the biogas plants are both newly and long ago constructed. 18 biogas plants in Dak Lak were constructed 11 years ago. 99% biogas plants are in good operation even though some households have temporarily paused their (pig) production due to livestock disease. One biogas plant produces less gas due to gas leaking. *Figure 1* presents construction year of surveyed biogas plants.

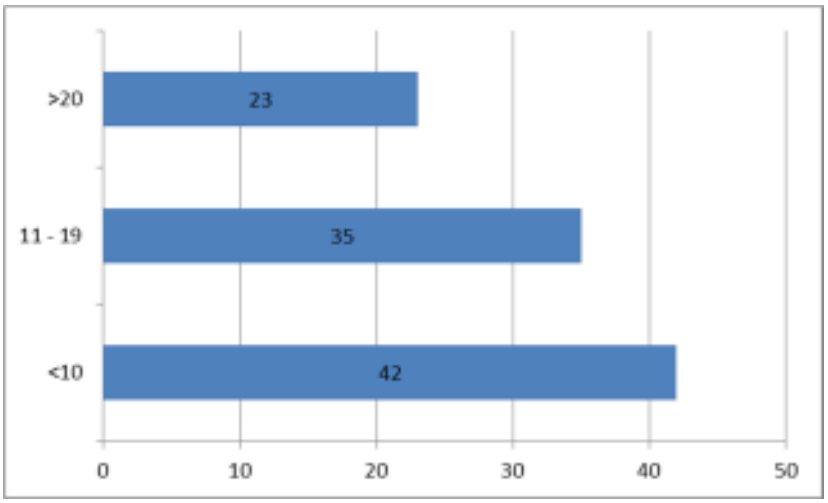
Figure 1: Construction year of surveyed biogas plants



31. *Connect to toilet:* 75% biogas plants are connected to toilet while 25% biogas plants are not connected.

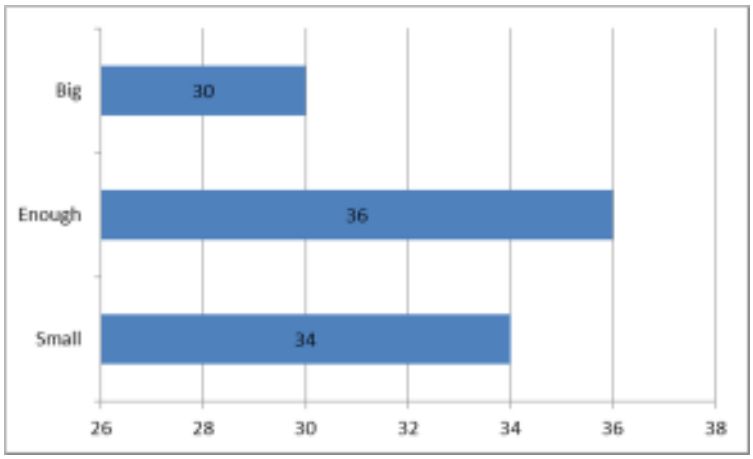
32. *Digester size:* In reality, size of digester does not reflect livestock scale of households. Digester size is normally decided by "coping exactly neighbor biogas plant", mason or investment source. For instance, 15 out of 18 biogas plants in Dak Lak are 6.5 cubic meters dealing with even animal waste from 50 – 100 pig heads at the survey time. The most important reason is biogas technology was new for both the villagers and mason at that time and they did not dare to select a bigger one. *Figure 2* presents classification of biogas plants by size.

Figure 2. Classification of biogas plants by size



33. Suitable size: Suitable size is determined by three factors: i) volume of daily feeding manure ii) volume of daily water diluting volume and iii) theoretical retention time (RT). According to sectoral standard for small scale biogas plants 10TCN 97-102 – 2006 issued by the Ministry of Agriculture and Rural Development (MARD), 40 days RT is regulated for Bac Ninh, Vinh Phuc and Thanh Hoa and 30 days RT is regulated for Dak Lak and Hau Giang. In the questionnaire, three categories are classified as follow: i) Small ii) Enough and iii) Big. If the actual size of the digester is 10% less or 10% more than the optimal size the digester is defined as small or big respectively. *Figure 3* presents suitable size of surveyed biogas plants.

Figure 3: suitable size of surveyed biogas plants



34. Dilution ratio: According BPPMU technical guideline, two dilution ratios (1:1 and 1:2) are applied for selection of suitable size of biogas plants. In reality, these dilution ratios are hardly followed. The thing is 100% households use pumps to clean animal stable. Depending on daily temperature, cleaning times and washing time are applied. Except few farmers collect manure first and then clean stable then water amount is saved, most farmers pump water until the stables are cleaned. Daily water amount is calculated as per below formula:

Water amount (m3) = P * T * t

In which:

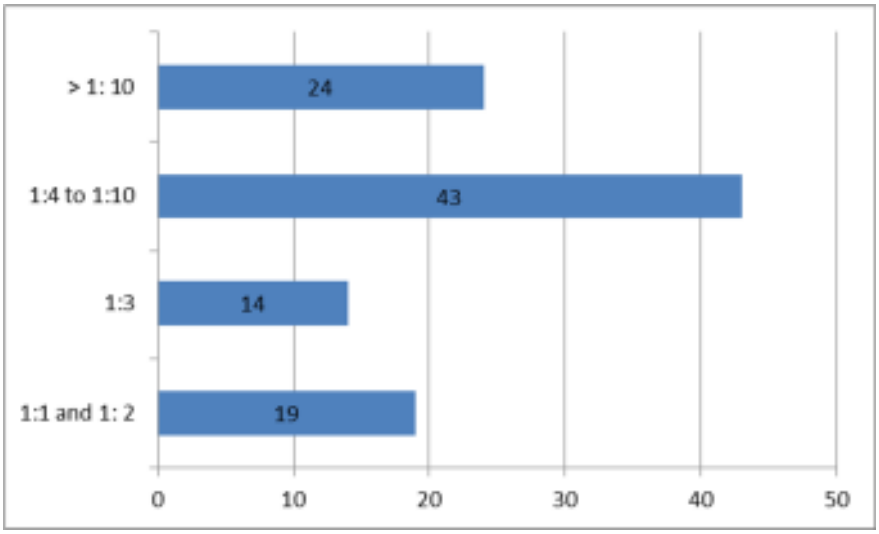
P (m3/h): Capacity of pump

T (h): Time for one stable cleaning

t: Times of stable cleaning of one day

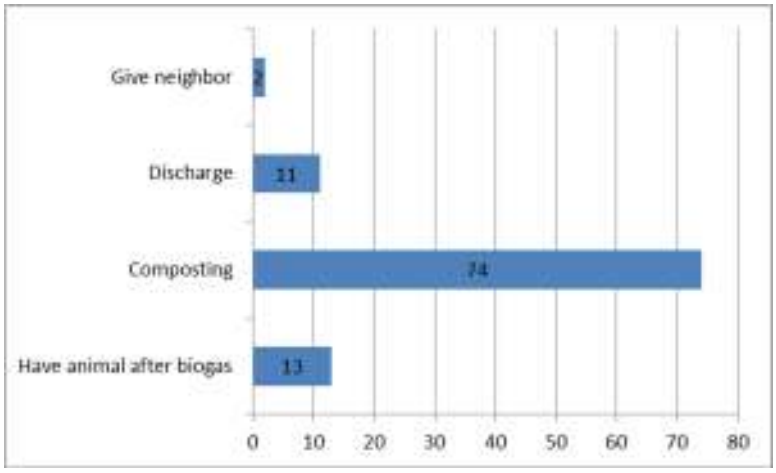
Figure 4 presents dilution ratio of surveyed biogas plants. Out of 100 households, 67% usually use too much water for diluting. This practice causes the reduction of RT, meaning quality of bio-slurry is badly effected and also causes environment pollution.

Figure 4. Dilution ratio of surveyed biogas plants



35. *Manure treatment before biogas digester*: Before biogas construction, manure is often collected at stable or transported to field for simply composting. 13% households have animals after biogas construction. Only 2% households give manure to their neighbor while 11% households (mainly in Hau Giang) discharge manure directly to family's ponds. *Figure 5* presents manure treatment before biogas digester.

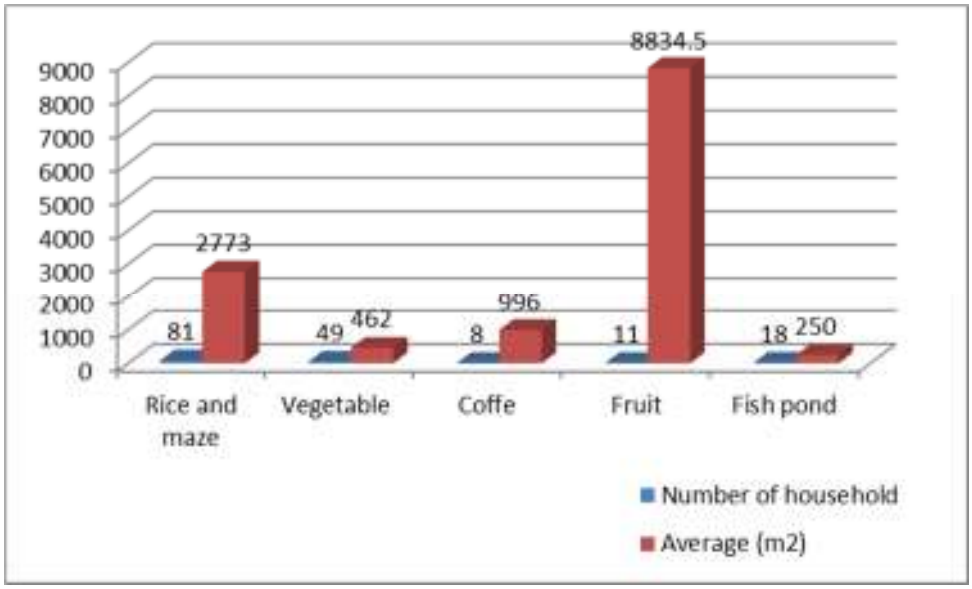
Figure 5. Manure treatment before biogas digester



Bio-slurry management and utilization

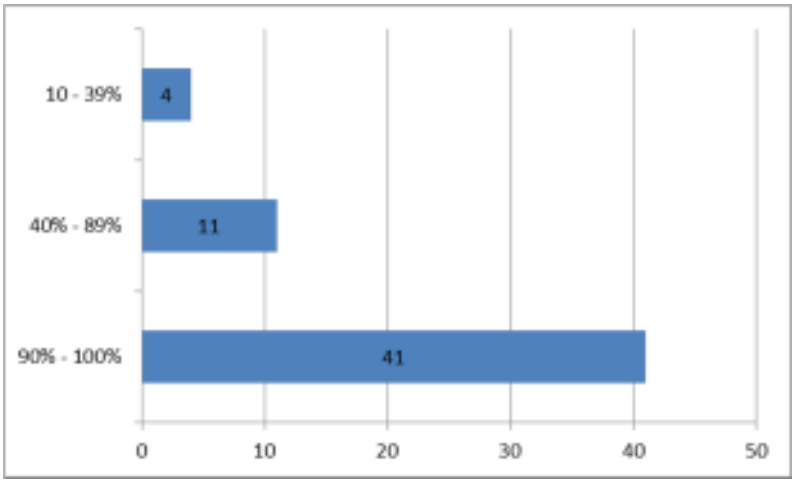
36. *Crop cultivation*: Out of 100 households, only 3% have no land for cultivation. Figure 6 presents the status of cultivation land of surveyed households.

Figure 6. Cultivation land of surveyed households



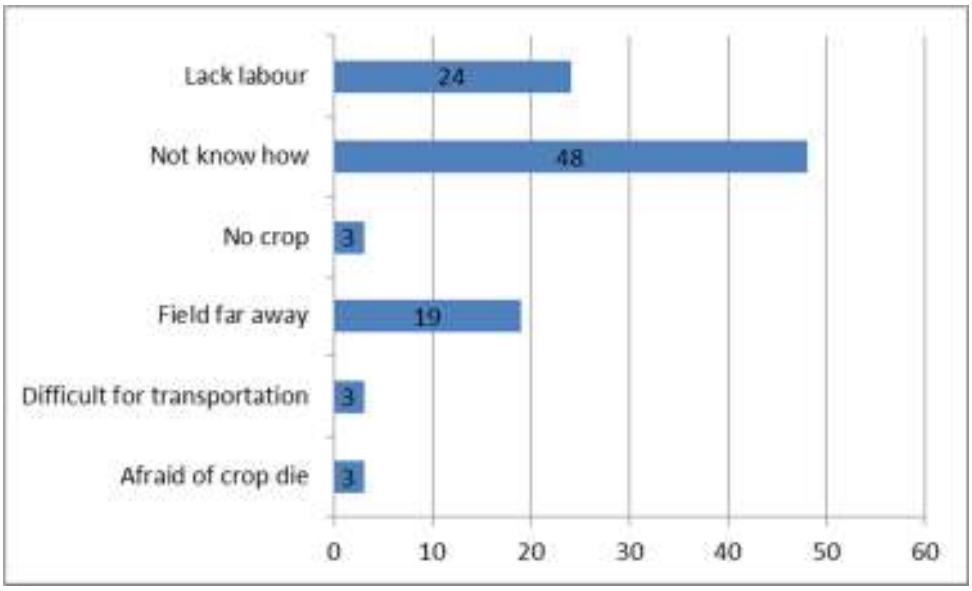
37. Slurry disposal: Even though having land for cultivation or fishpond, only 44% households use all bio-slurry for their farming activities while 56% still dispose bio-slurry to environment from 4 to 41% of bio-slurry production. The total slurry production of the whole 100 households is 42.5 m^3 per day. *Figure 7* presents rate of slurry disposal of surveyed households.

Figure 7. Rate of slurry disposal of surveyed households



38. Reason for not applying slurry: Households who discharge slurry to sewage system or environment, there are so many reasons such as lack of labor, having no crop or field is far away from slurry pit. Figure 8 presents most important reason of not using slurry of households.

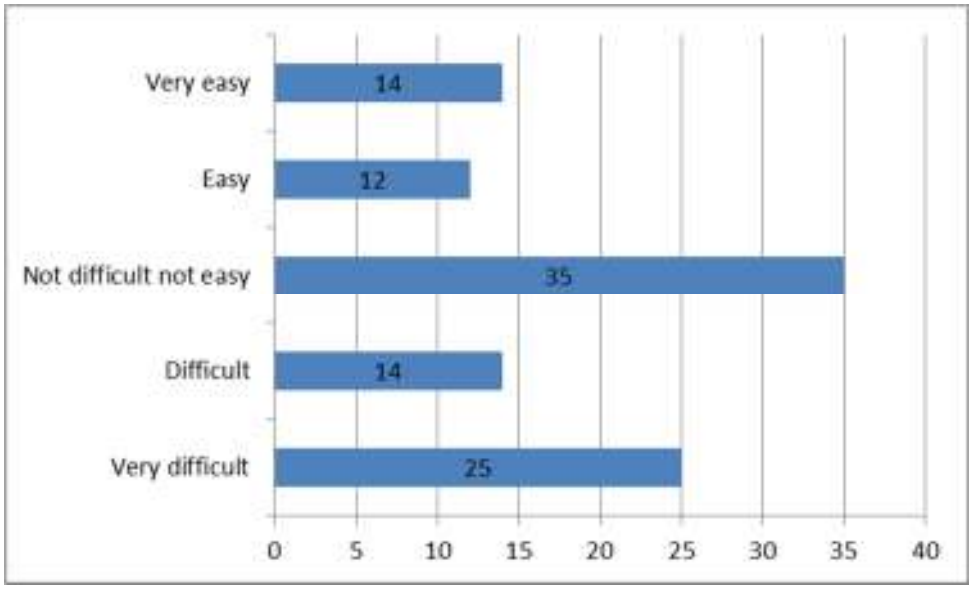
Figure 8. Important reason of not using slurry



39. Slurry pit: 55 households have at least one slurry pit. 19 households have 5 slurry pits for storing slurry. Slurry pits are commonly constructed by households with cheap and family available construction material. Cost of slurry pit is normally occupies 5 – 10% investment cost of the whole biogas system.

40. *Difficulty when using slurry*: In the questionnaire, to assess the difficulty of bio-slurry use, the digitals of 1, 2, 3, 4, 5 are for very difficult, difficult, not difficult not easy, easy, very easy. *Figure 9* presents the assessment of households on difficulty when using slurry.

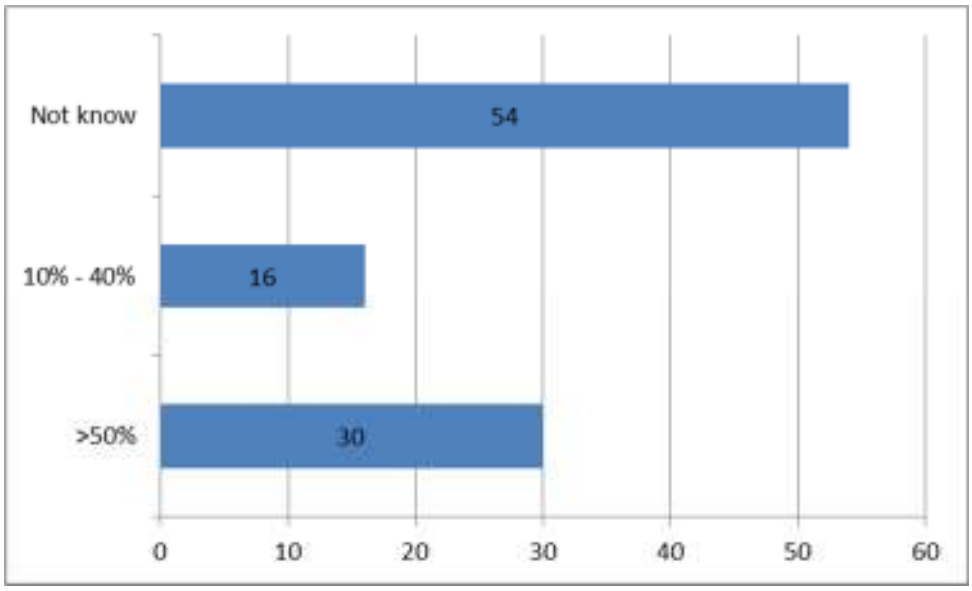
Figure 9. Assessment of households on difficulty when using slurry



41. Slurry replaces chemical fertilizer: Out of 63 households using slurry, 44 households use all slurry generated per day for cultivation or fishpond. However, most farmers do not know

application formulas for crops or fishpond. When being asked to calculate themselves how much replacement and saving from the replacement, farmers seem face difficulty. The *figures10* below presents the replacement of slurry and saving of households per year in Viet Nam Dong (VND). Only 19 households can save from using slurry to replace commercial inorganic fertilizer while 71 households do not save from bioslurry. In average each household can save nearly half a million VND per year.

Figure 10. Replacement of bio-slurry



42. *Best practice*: Out of 69 household using slurry, mainly (84%) apply directly slurry for crops or fishpond, only 7% makes composting and other 7% use pipeline and drip system. 7% household give slurry to their neighbor.

43. Scum removal and utilization: 35% households have opened their digesters from 1 to 3 times. Scum is commonly used for soil or directly for crop.

Chapter 3: Training need assessment

44. In general, the activities of training on using the biogas plants are often organized by the project. Biogas technician and mason are trained by the biogas program in order to provide future users enough knowledge and expertise. Biogas program staff is also there to transfer information to current users of the technology, and to assist households during construction and purchase of building materials, during the first filling of the plant, and later operation and maintenance, besides 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 of the (in groups) training and receive leaflets, handbook and instruction about usage of bio-slurry. User's satisfaction about their biogas digesters is owed to the fact that they have already realized and experience many benefits. When potential users take the decision of construction, they mentioned several reasons as well. The impact it is not always visible in the first observation, for instances savings in financial resources might help households in educating the children, or improving their productive capability. In the following the diverse impacts observable in the program are described. In general, biogas households highly appreciated the quality of the training, sharing information and knowledge to each household is very necessary

and practical. They also are happy with current training documents and leaflets of the project. All farmers who have ever received and read training documents commented that the documents are friendly illustrated and easily understandable.

45. *Training course participant*: As a requirement of BPPMU, training needs to be provided to plant owners and users to ensure proper operation of the system. However, the survey shows that only 79% of the surveyed biogas users received either pre- or post-construction training. The remaining (21%) reported that they have never taken part in any training courses. Almost selected biogas households were participated at least one training course on biogas technology or operation and maintenance biogas digester or utilization bio-slurry but they communicated as the training was combined with many topics so they did not much remember any particular topic. They are willing to participate more training courses on biogas technology and its benefits.

46. Commented on understanding benefits of bio-slurry and how to use slurry for different purposes, 83% said they know the benefits of slurry (mainly as fertilizer); 74% know how to use (mainly direct watering); 46% have suggested others to use.

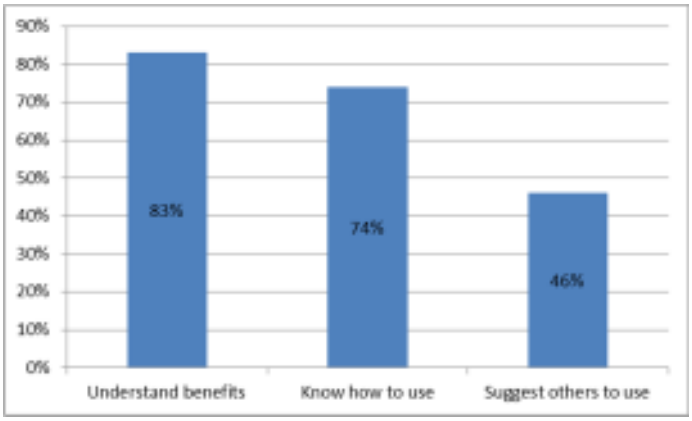


Figure 11. Understanding of slurry benefits, know how to use and suggest other to use

47. When users were asked about further improvements of the training and necessary of more training in the future, 60% of the users expressed their need to have more training and suggested a more in depth explanation about technical issues concerning repairs and construction. They also would like to learn more about bio-slurry use, more information about operation of the biogas plant and usage of biogas and safe operation of biogas plant. 40% users thought they do not need any further training course as they are already explicative enough or do not have time for this.

48. When farmers were asked about "know how to apply bio-slurry that fit to the household", only 2% said "yes" but they cannot improve after that a practical application plan or formula of using slurry that fit to their households.

49. Training document: 88% households communicated that they have received training document while 7% have not yet received any book or leaflet. 5% communicated that they are not sure about having biogas books or not. Most of farmers who have documents found they are well illustrated and easily understandable. Strictly follow instructions can help good operation of the digester and bio-slurry use.

50. The interview with masons and technicians shows that, bio-slurry training document contain too much scientific information but lack of how to design a good bio-slurry plan for specific family. The document is focused mainly on Northern crops but still lack of instructions for Southern crops.

51. Comments from biogas technicians also stress on BPPMU should mobilize knowledgeable and experienced trainers for ToT training courses. More pilots on bio-slurry use should be constructed for farmers, masons and technicians to visit under the program of a training course.

52. Bio-slurry topic seems to be not prioritized in the curriculum of training courses for technicians. Presentations have not been updated with information knowledge.

4. Environment Policy and Non-government Actors

4.1. Environment Policy

Standards on bio-slurry

53. Special legislation for bio-slurry is available at sector level. The sector standard 10 TCN 678-2006 stipulating regulations on animal waste from livestock farms. However, the bio-slurry resulting from bio-digesters can be applied as fertilizer on agricultural fields if no over-fertilization results. Regulations for that kind of use should be developed at national level for implementation replacing sector standards. In Viet Nam, sector regulations and standards were no longer in use since 1st July 2014 The bio-slurry must be taken as highly polluted effluents which need treatment prior to discharge to the environment. The sector standard 10 TCN 678-2006 is presented in *Annex 3*.

54. The Ministry of Agriculture and Rural Development has also issued the sector standard 10TCN 97 – 102 regulating general technical requirements on small size biogas plants (KT1 and KT2) in 2006. The article 8 - Environmental sanitation requirements – regulates a number of quality and characteristics of bio-slurry after coming out of biogas plants. *Table 7* below presents the important requirements for bio-slurry as water waste.

Table 7. Sector standard regulations for bio-slurry as water waste

Code	Parameter	Regulation/requirement	
		10 TCN 678-2006 (column B[19])	10TCN 97 – 102
1	pH	5 - 9	
2	Dissolved sulfide, mg/l	1	
3	Total nitrogen, mg/l	150	
4	Total phosphorus, mg/l	20	
5	Amonia (by NH3), mg/l	5	
6	COD, mg/l	400	
7	BOD5, mg/l	300	
8	Total suspended solids (TSS), mg/l	500	
9	Coliform, MPN/100ml	5000	<=106
10	Samonella	Not found	
11	Bad odour		Not detected
12	Mosquito/fly larvae		Not found
13	Organic matter volume		Reduces minimum by 50 %
14	Parasite, *ankylostoma* and *plagiorchis arcuatus* ova		Reduces minimum by 95 %

[19] A regulation for receiving body of waste water is agricultural water resources.

55. In the following, some other relevant Viet Namese Regulations and Standards are listed below that can be applicable:

- QCVN 40/2011/BTNMT: National Technical Regulations on Industrial waste water.
- QCVN 08/2009 BTNMT: National Technical Regulation on Surface Water
- QCVN 09/2009 BTNMT: National Technical Regulation on Underground Water
- QCVN 14/2009 BTNMT: National Technical Regulation on Domestic Wastewater
- TCVN 5945/2005: Viet Nam National Standard on Industrial Wastewater Discharge
- TCVN 6772/2000: Viet Nam National Standard on Water Quality – Domestic Wastewater Standards – Permissible Pollution Limits.

56. A number interviews are conducted with policy makers showing that, not actual standard or technical regulation can be applied for bio-slurry or animal waste. If the status cannot be improved in the future it will cause difficulties for animal farms and households to apply those above standards and regulations in terms of animal waste and slurry management as the control parameters are too high to be gained only by biogas technology. Many dispute and discussion have been happened among scientists, policy makers and farmers on what should be done after biogas system. Many people agree that if only apply biogas technology, it cannot deal with livestock waste completely.

57. 2nd Draft National Technical Regulation on Livestock waste has been constructed by the Ministry of National Resources and Environment (MONRE).

58. In case of violating standards and regulations, no strong- enough punishment is taken. In some localities, the environment protection (also biogas construction for animal households) is considered as a criterion for title "new rural village".

Viet Nam legislation for organic fertilizer

59. In Viet Nam, organic fertilizer is considering as a good and put under the State management. Viet Nam has issued applicable standards applies to organic fertilizers. To be traded or being used for crops under VietGap standard, traditional organic fertilizers must be processed up to organic fertilizer standards. *Table 8* presents the Viet Nam legislation for organic fertilizer management.

Table 8. Viet Nam legislation for organic fertilizer management

No.	Legislation	Code	Brief description	Note
I. Decree, circular and official dispatch				
1	Law	05/2007/QH12 dated 21st Nov, 2007 by The Parliament XXII session 2	Law on quality of goods and product	Article 23
2	Decree	113/2003/NĐ-CP, dated 07 Oct, 2003 of the Prime Minister	Regulations management of fertilizer production and trading	
3	Decree	191/2007/NĐ-CP dated 31 Dec, 2007 of the Prime Minister	Amending and supplementing some articles of *Decree* No. 113/2003/ND-CP	

4	Circular	36/2010/TT-BNNPTNT dated 24 June 2010 of the Agricultural Minister	Regulations on produce, trade and use fertilizer	Article 6 and Appendix 3 of the Circular
5	Circular	05/2005/TT-BCN dated 31st Oct, 2005 by the Ministry of Industry	Guidance on implementation of Decree No.113/2003/NĐ-CP, dated 07 Oct, 2003 of the Prime Minister on regulations management of fertilizer production and trading	
6	Draft decree	Issued on quarter IV 2012 by MARD and replace Decree 113 and Decree 191	Regulations on produce, manufacture, trade, import and export fertilizer	
7	Decree	12/2006/NĐ-CP dated 23th Jan 2006 by the Prime Minister	Detailed provisions for implementation of the Commercial Law with respect to international purchasers and sales of goods; and agency for sale and purchase, processing and transit of goods involving foreign parties	
8	Circular	88/2011/TT-BNNPTNT dated 28 December 2011 by Agricultural Minister	Guidance on implementation of the Decree No. 12/2006/NĐ-CP dated 23th Jan 2006 by the Prime Minister on detailed provisions for implementation of the Commercial Law with respect to international purchasers and sales of goods; and agency for sale and purchase, processing and transit of goods involving foreign parties	
9	Circular	52/2010/TT-BNNPTNT dated 9th Sep, 2010 of the Agricultural Minister	Guidance on testing, recognition and name of new fertilizer	
10	Decision	129 /2008 /QĐ-BNN dated 31st Dec, 2008 by Agricultural Minister	Regulations on testing, recognition and name of new fertilizer	
11	Decision	100 /2008/QĐ-BNN dated 15th Oct, 2008 by Agricultural Minister	Regulations on testing, recognition and name of new fertilizer	
12	Decision	50/2006/QĐ-TTG dated 7th March 2006 by the Prime Minister	List of products and goods have to be tested for quality	
II. Standard and Technical Regulation				
13	National standard	TCVN 6169:1996	Microbial fertilizer - Terms	
14	National Standard	TCVN 6167:1996	Phosphate -solubilising microbial fertilizer	

15	National Standard	TCVN 6168:2002	Cellulose-degrading microbial fertilizer	
16	National Standard	TCVN 7185-2002	Microbial organic fertilizer	
17	National Standard	TCVN 6166:2002	Nitrogen fixation micro-organic fertilizer	
18	National Standard	TCVN 7159:2002	Fertilizers and soil improvement substances. Classification	
19	National technical regulation	QCVN : 2009/BNNPTNT	National technical regulation on toxic parameters and harmful micro-organism in fertilizer	
20	Sectoral standard	10TCN 525-2002	Organic micro-organism fertilizer produced from sugarcane sludge	
21	Sectoral standard	10TCN 526-2002	Organic micro-organism fertilizer produced from domestic waste	

60. VAC and manure management: The integration of the homelot, garden, livestock and fishpond is called the VAC system (VAC in Viet Namese is vuon, ao, chuong which means garden/pond/livestock pen).

The widespread promotion of the VAC system, referred to as the VAC movement, began in the early 1980s. The importance of small-scale integration was emphasized by the late Pres. Ho Chi Minh in the late 1960s. The objective of the movement was to increase and stabilize the nutritional standard of the rural poor. Because of adoption of the VAC system, the dietary standard of the rural poor significantly improved, particularly in the isolated villages in the high mountainous regions. This farming system is family-managed, with practically all labour coming from the household. VAC farms can be found in various agroecological conditions, including irrigated lowlands, rainfed uplands and peri-urban areas (Figure 1). Ponds are usually constructed primarily for raising land for the home and garden. Traditionally, the water collected in the de facto pond was used for domestic purposes and to produce aquatic weeds for feeding to pigs. Most pig and other manures are used on field crops, especially rice, although as fish production grows in importance, more is diverted for use there.

It is estimated that 85-90 percent of the rural families maintain a garden and livestock pen, with 30-35 percent of these having fishponds. In many villages, 50-80 percent of families have the full VAC system.

61. Regarding to manure management, MARD has issued Decision No. 3194/QD-BNN-CN dated August 11th 2015 on Technical instruction application of biogas technology and biological livestock bedding for poultry production. MARD also issued a handbook instructing composting for poultry litter in December 2013.

4.2. Non-government Actors

62. The Viet Nam Biogas Association (VBA): VBA is a social – occupational organization which is possessed by Viet Namese individual or organization and voluntarily established to cooperate, connect and mutually support in developing occupation and protecting legal rights of members in biogas sector. VBA plays role in connecting individuals, organizations in biogas sector with government offices in raising ideas to improve the institutional system, policy. It also integrates into international economy with biogas organizations in the world following respectful, equal and mutually beneficial principal and following ese law; contributes to the economy growth and greenhouse emission reduction. Currently, about 100 individuals/ organizations sent application form to join VBA. With a view to bring together all biogas actors, the Advocacy Group expects a successful term of executive board that were elected in the First Congress of VBA held in April 9th 2011. That event reated the opportunity for all individuals/ organizations to meet share and unite each other toward the common block and a developed biogas sector generating more benefit for the socio-economic of Viet Nam.

63. BPPMU: The project “Biogas Program for the Animal Husbandry Sector of Viet Nam” is implemented by Livestock Production Department (under MARD) in cooperation with Netherlands Development Organization – SNV. The Biogas project makes contribution to implement the national strategy on environment protection in the period of 2010 – 2020 with the main orientation of to "halt pollution acceleration, remedy degraded areas and improve the environment quality and ensure sustainable development of the country is achieved; guarantee that all people are entitled to live in an environment with good quality of air, land and water measuring up to standards stipulated by the State. Up to now, nearly 150,000 biogas units have been constructed by the BPPMU.

64. Composite producers: Many companies are involved in producing in composite bio-digesters. The following companies can be listed as:

In Thai Binh: Hung Viet company, Moi Truong Xanh company, Thanh Loc company. Moi Truong Xanh also have developed and promoted for recycle plastic bio-digester.

In Ha Noi: Quang Huy company, Hung Vuong company

In Ha Tinh: Bao Chung company

In Dong Nai: Cam Tuan Phat company

The above companies have their own composite models that have been registered with MARD as approved new technology. Via these companies, thousands of composite bio-digesters have been installed all over the country.

65. CCRD – VACVINA: Center for Rural Communities Research and Development (CCRD) have designed, developed and promoted for VACVINA.

CONCLUSION AND RECOMMENDATION

66. Almost visited biogas plants are in good operation, including the biogas plants were constructed 11 years ago, producing both gas and bioslurry for farming households. The total slurry production of the whole 100 households is 42.5 m^3 per day. If this slurry is not proper treated or used up, it will cause the potential environment pollution such as ground water, air and soil pollution.

67. Even though having land for cultivation or fishpond, 63 households use bio-slurry for their farming activities while 37% still dispose bio-slurry to environment. Out of households who use bioslurry, there are 56 households do not use up bio-slurry but dispose bio-slurry to environment from 4 to 41% of bio-slurry production. Theree top main reasons include i) Do not know how to use bio-slurry; ii) Lack labor and iii) Crop field is far away from bio-slurry storage.

68. Only 19 households can save from using slurry to replace commercial inorganic fertilizer while 71 households do not save from bioslurry. In average each household can save nearly half a million VND per year.

69. The improper dilution ratio of manure and water, e.i. excessive water, is the main factor that negatively impact quality of bio-slurry. The survey shows that 67% usually use too much water for diluting, especially 24% apply ratio of more than 1 manure to 10 water.

70. Both farmer and biogas technicians have need for training on bio-slurry and manure management, especially need to being trained on treatment methods on manure and bio-slurry and how to apply for crops and fish cultivation.

Annex 1: Terms of Reference

Consultancy opportunity for bioslurry expert

For the project "Improved manure management through increased utilization of manure including bio-slurry" the Biogas Programme for the Animal Husbandry sector in Vietnam (BP PMU) is offering a short term consultancy assignment.

Background

The project "Improved manure management through increased utilization of manure including bio-slurry" aims to raise awareness among 4000 farmers in Vietnam about the benefits of using bioslurry and manure and to provide them the knowledge and skills to apply this to their own crops.
This project is executed under the livestock and manure management component of the Climate and Clean Air Coalition and will be implemented by SNV and the Biogas Program for the Animal Husbandry Sector of Vietnam.

The BP PMU is looking for a consultant to perform part of this project: an assessment through a field based survey with regard to training needs of rural households, barriers to bioslurry and manure usage and best practices. In addition the selected consultant will map the policy environment & non-government actors and act as a trainer in the four ToT trainings.

Expected time period

10th of April – 15th of August
Total expected time investment is around 50 working days.

Eligible entities

The assignment may be performed either by a qualified individual or by a research institute. In the latter case CVs and time investment for each of the team members should be submitted.

Requirements

- Knowledge about and experience in waste management, organic fertilizer, agriculture, soil quality and policy.
- Relevant Master degree.
- Prior experience with field based surveys in Vietnam.
- Knowledge about and experience with biogas is an advantage.
- Sufficient time availability between 10th of April and 30th of June.
- Proven track record in delivering high quality reports in short time periods.
- Excellent command of the English language

Detailed activity description

This assignment consists of two activities, the detailed output per activity is listed below

Assessment of training needs, barriers to bioslurry use and best practices through field based survey:

- Review available documents within BP PMU.
- Develop assessment methodology (prior approval on this methodology of SNV/BP PMU will be required).
- Develop questionnaires for field work
- Perform key informant interviews
- Perform interviews with households in 5 provinces: Hau Giang, Vinh Phuc, Thanh Hoa, Bac Ninh, Dak Lak, a minimum of 100 interviews are required.
- Perform interviews with technicians to assess their skills and knowledge gaps so this can be taken into account in the ToT training.
- Analyse information from interviews and questionnaires.
- Write report in English about the training needs, barriers to slurry use and current best practices with regard to bioslurry use.
- Present the training needs to SNV and BP PMU, including the recommendation on training package and the training M&E plan.
- Handover of knowledge to bioslurry expert who will develop the training program.
- Provide input to content development of the ToT training.

- The quality of the report will be assessed by staff both SNV and the biogas project. Payment is contingent upon acceptance of the quality of the report.

Mapping policy environment & non-government actors:

- Perform desk research to find all relevant existing policy with regard to bioslurry/manure use.
- Perform desk research to assess all non-government actors active in the field of bioslurry use/manure management.
- Perform key informant interviews with policy makers and experts on the topic of manure management, bioslurry use, and waste disposal criteria.
- Combine all information to come to a comprehensive overview in English of all policy related to bioslurry use and manure management in Vietnam.
- The quality of the report will be assessed by staff of both SNV and BP PMU. Payment is contingent upon acceptance of the quality of the report.

Act as lecturer in the ToT training

- Based on the training needs assessment a training expert with a bioslurry background will develop the ToT training. The consultant will be required to act as a lecturer in the 4 ToT courses that will take place from mid-July until mid-August

Payment

The payment will be based on performance. For the total assignment a maximum lump sum budget is available of 5,000 USD. In the evaluation of bids price will be an important factor. Payment can take place upon completion of the following activities and upon approval of BP and SNV, the amounts indicated below are the maximum amount for each activity.

- Research design complete: 250
- Field work complete and data delivered in excel file: 2000
- Training needs, barriers and best practices report complete and input for training development provided: 1000
- Policy environment and non-government stakeholder report complete: 750
- Lectures given in the four ToT courses: 1000

Application

Interested candidates are encouraged to send their application, including at least a CV and cover letter to bpovn@biogas.org.vn before the 7th of April 2015.
For more information contact Steven von Eije via svoneije@snvworld.org or 01696540648.

Annex 2: **BIOGAS HOUSEHOLD SURVEY QUESTIONNAIRE**[20]

Date of survey:
Time for survey: (should not be over 30')

1 Identification

1.0 Household

1.01 Name		Sex: Male Female
1.02 Province		

[20] For questions using likert scale, digitals of 1, 2, 3, 4, 5 are for Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree.

1.03	District	
1.04	Commune	
1.05	Telephone number	
1.06	Occupation	
1.07	Digester Model	

2. Bio-slurry management and utilization

2.0 Adequate size bio-digester

2.01	Number of animal	a) Pig ___ head b) Cow ___ head c) Buffalo etc.etc..head d) Other (specifyetc.etc.etc.etc..) ___ head
2.02	Average weight of animal	a) Pig ___ kg/head b) Cow ___ kg/head c) Buffalo etc.etc.etc.kg/headc) Other ___ kg/head
2.03	Daily water use for biodigester	_____ lit/day
2.04	Amount of animal waste use for feeding biodigester	_____ kg/day
2.05	Size of biodigester	
2.06	Current status	
2.07	Biodigester connects toilet	Y☐ N ☐; If Y, elaborate about toilet management (using water, disinfection/soap etc., how often use disinfection?.)
2.08	Use of antibiotic for animal stable	- Y N; If yes, what kind and how often - If is there a separate flow for antibiotic from animal stable?
2.09	Suitable size of bio-digester	Too small Too big Enough

2.10 What reasons made you decide to invest biogas plant?

1/☐ Clean and convenient cooking 2/☐ to reduce pollution ranch/home
3/☐ Save cooking expenses 4/☐ residue waste instead of using fertilizer
5/☐ Saving time 6/☐ Other (specify)etc.etc.etc.etc.etc.etc.etc.etc.

2.1 Bio-slurry management

2.10	What did you do with the manure before you bought the biogas digester	
2.11	How much bio-slurry created per day	_____ lit/day
2.12	Having land for crop/garden cultivation	Crop: Y N; if Y _____ m^2?

		Garden, (from 100 m^2) : Y N; if Y _____ m^2?				
2.13	What kind of crop and harvest time per year	(Please elaborate)				
2.14	Having fish-pond	Y N; if Y _____ m2?				
2.15	Disposal of bioslurry	Y N; if Y _____ lit/day and skip to Q.2.16; If No but having fishpond/cultivation, skip to 2.17				
2.16	How much percent was discharged	(by estimation)				
2.17	Why you do not apply bio-slurry					
2.18	Slurry use	a) For crop ___ lit/day b) For fishpond ___ lit/day c) For composting ___ lit/day d) Other ___ lit/day				
2.19	Slurry collection	(please elaborate)				
2.20	Having bioslurry pit	Y N; if Y _____ m^3?				
2.21	How is bioslurry treated	____ Composting (%) _____ Drying (%) _____ Use directly (%) Other (%)				
2.22	Difficulties with using bioslurry[21]	1	2	3	4	5
2.23	Preferences for bioslurry treatment	(please elaborate)				
2.24	How much slurry replace chemical fertilizer by percent					
2.25	Do you have any savings on chemical fertilizer/pesticides due to bioslurry use and if so, by how much					
2.26	Bioslurry is an organic fertilizer better than chemical fertilizer	1	2	3	4	5
2.27	How to apply bioslurry for crop	(please elaborate) (what is the best practice?)				
2.28	How to apply bioslurry for fish pond	(please elaborate) (what is the best practice?)				
2.29	Give bioslurry to other	Y N; if Y _____ lit/day				
2.30	How often household empty the biodigester for having scum/sediment					

3. Training need assessment

3.01 Have you attended any bioslurry training course?

[21] Digitals of 1, 2, 3, 4, 5 are for Very Difficult, Difficult, Not Difficult nor Easy, Easy, Very Easy.

TT	Name of training courses	Duration

3.02 Do you know about the benefit of bioslurry?

Yes ☐ No ☐

If yes, what are they?

……..……..……

……..……

……..……

3.03 Do you know how to use bioslurry?

Yes ☐ No ☐

If yes, how?

……

…….……etc.……

……

3.04 Would you recommend others to use bio-slurry?

Yes ☐ No ☐

If yes, how?

……

…….……

……

3.05 Do you feel there should be more training/information on bio-slurry use?

Yes ☐ No ☐

If YES, what would you like to know more about?

……

…….……

……

3.06 Will you willing to construct slurry pit? ?

If no, why?

……

…….……

……

3.07 Do you willing to join the coming bioslurry training

Yes No If NO, why?

Yes ☐ No ☐

If yes, how?

……..……..……

…….……..……

……

3.08 Do you know <u>how to apply bioslurry that fit to the household</u>*?*

……..……..……

…….……..……

……

3.09. What would be a hurdle for you to apply bioslurry?

……..……..……

…….……..……

……

3.10 Which biogas technology topics do you want to participate

No.	Training course	Yes	No	Why	By whom
1	Biogas technology				

2	Biogas construction				
3	Biogas O&M				
4	Using bioslurry for crop				
5	Using bioslurry for fish				
6	Using bioslurry for composting				

3.11 What are (training) documents do you have? What most do you (dis)like and why?
……
……..……..……
……

3.12 What training(s) do you like most and why (content? Good trainer? Training method? Training duration? Where (at home or village house?)
……
…… ……..……..……
……

4. Other opinion/comment?

Annex 3:

QUESTIONNAIRE FOR BIOGAS TECHNICIAN/MASON

Date of interview: …….

Interviewer: …….

Time of interview: (max. 45') …….

1. Full name of interviewee: ……. Phone number: …….. Email: ……
2. Province.....District……..
3. Number of biogas plants in the province/District? ……
4. Kinds of biogas plants? ☐ KT☐ Brick square shape ☐ Composite ☐ Nylon bag and which type has highest number
5. How many biogas hh have slurry pit? ……..
6. Why HHs does not invest for slurry pit? ……..
7. What is the cost of adding a slurry pit. (what cost for brick tank, land tank, cement tank, and other (specify). The investment of slurry pit occupies how many percent of a total investment of biogas system?

……
……

Do biogas hh use bioslurry? For what purpose? ……

……
……

Which purpose is prevalence? ……..

……

Do biogas hhs use any treatment for bioslurry before application or dischargement?

……
……
……
……

What punishment if discharge untreated?

……
……

1

.....
.....

Why hh does not use bio-slurry?

.....
.....
.....

Any suggestion for improvement of bio-slurry application?

.....
.....
.....

8. Any suggestion for improvement of bioslurry training?

.....
.....
.....

9. Other opinion?

.....
.....
.....

2

Annex 4: Topics to be discussed with Ministry representatives/Bioslurry experts

Name of interviewee:

Date of interview:

Time of interview:

1. Environmental legislation:
- What are environmental law concerning bio-slurry and livestock waste?

……

……

- What are environmental requirements (national standards and national technical requirements) concerning bio-slurry and livestock waste?

……

……

- Any action plan if if national standards do not (yet) exist?

……

……

- Technical guideline for bioslurry treatment

……

……

- Any national guideline for composting from bioslurry?

……

……

- Other guidelines?

……

……

- How national law is enforced?

……

……

- Is there any procedure to check illegal discharge of slurry and if so what are the associated fines?

……

……

3. Any other suggestion/opinion?

……

……

Annex 5: List of 100 households for survey

Code	Name	Province	District	Commune	Occupation
001	Bùi Thị Nơi	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
002	Bùi Văn Triển	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
003	Lê Văn Định	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
004	Hoàng Thị Thoa	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
005	Lê Văn Trang	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
006	Bùi Huy Chức	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
007	Phan Thị Mạn	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
008	Đinh Thị Nhi	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
009	Bùi Thị Vĩnh	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
010	Bùi Văn Tấn	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
011	Bùi Văn Tĩnh	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
012	Phạm Văn Tuấn	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
013	Bùi Văn Giang	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
014	Đỗ Thị Trúc	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
015	Phạm Văn Toán	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
016	Phan Văn Thiết	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
017	Phạm Thị Nhiên	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
018	Phan Văn Thánh	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
019	Phan Hồng Quân	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
020	Bùi Văn Tý	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
021	Hoàng Văn Phong	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
022	Bùi Duy Lich	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
023	Bùi Văn Thoa	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
024	Bùi Văn Thuấn	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
025	Bùi Văn Thanh	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
026	Bùi Hải Đường	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
027	Bùi Duy Dũng	Bắc Ninh	Lương Tài	Trung Kênh	Farmer
028	Dương Văn Kiên	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
029	Đặng Thị Đường	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
030	Nguyễn Văn Phương	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer/Biogas mason
031	Vương Thị Luyến	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
032	Nguyễn Thị Lan	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
033	Nguyễn Văn Thành	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
034	Nguyễn Văn Định	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
035	Nguyễn Văn Tuấn	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
036	Nguyễn Văn Sang	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
037	Nguyễn Trọng Thành	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
038	Trần Thị Phương	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
039	Lê Thị Hạnh	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
040	Bùi Đức Long	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
041	Nguyễn Thị Đức	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
042	Bùi Đức Lương	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer

043	Trần Thị Như	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer/Restaurant
044	Phạm Thị Minh Huệ	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
045	Trần Tiến Hùng	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
046	Trần Văn Thảo	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
047	Nguyễn Văn Chanh	Vĩnh Phúc	Tam Dương	Hoàng Lâu	Farmer
048	Nguyễn Văn Huệ	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
049	Nguyễn Văn Dũng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
050	Nguyễn Thị Tính	Thanh Hóa	Hoằng Hóa	Hoằng Phương	Farmer
051	Nguyễn Duy Phú	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
052	Đào Xuân Thao	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
053	Lương Quốc Lượng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
054	Nguyễn Duy Dũng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer/commune security
055	Đào Khắc Hưng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
056	Nguyễn Gia Kiều	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
057	Nguyễn Trọng Tấn	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
058	Đào Khắc Âu	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
059	Nguyễn Đức Tuyến	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
060	Hàn Minh Thắng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
061	Nguyễn Đình Hùng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
062	Nguyễn Tất Tâm	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
063	Lê Thị Hồng	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
064	Nguyễn Văn Tân	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer
065	Nguyễn Thị Hoài	Thanh Hóa	Hoằng Hóa	Hoằng Phượng	Farmer/worker
066	Vũ Đình Tới	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
067	Nguyễn Hữu Quang	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
068	Tạ Công Sơn	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
069	Lường Thị Điền	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
070	Lê Xuân Huệ	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
071	Nguyễn Danh Hùng	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
072	Vũ Gia Quế	Thanh Hóa	Hoằng Hóa	Hoằng Hợp	Farmer
073	Phạm Gia Hiền	Đăk Lăk	Eakar	Eakmut	Farmer
074	Nguyễn Văn Lịch	Đăk Lăk	Eakar	Eakmut	Farmer
075	Nguyễn Văn Dinh	Đăk Lăk	Eakar	Eakmut	Farmer
076	Nguyễn Trí Thức	Đăk Lăk	Eakar	Eakmut	Farmer
077	Nguyễn Xuân Khoát	Đăk Lăk	Eakar	Eakmut	Farmer/Shop
078	Nguyễn Văn Quế	Đăk Lăk	Eakar	Eakmut	Farmer
079	Nguyễn Văn Bễ	Đăk Lăk	Eakar	Eakmut	Farmer
080	Vũ Văn Nơm	Đăk Lăk	Eakar	Eakmut	Farmer
081	Nguyễn Văn Toán	Đăk Lăk	Eakar	Eakmut	Farmer
082	Nguyễn Xuân Bằng	Đăk Lăk	Eakar	Eakmut	Farmer
083	Nguyễn Văn Bí	Đăk Lăk	Eakar	Eakmut	Farmer
084	Phan Minh Tuấn	Đăk Lăk	Eakar	Eakmut	Farmer
085	Vũ Văn Vang	Đăk Lăk	Eakar	Eakmut	Farmer
086	Nguyễn Văn Lý	Đăk Lăk	Eakar	Eakmut	Farmer
087	Nguyễn Ngọc Sáu	Đăk Lăk	Eakar	Eakmut	Farmer

088	Nguyễn Xuân Thừa	Đăk Lăk	Eakar	Eakmut	Farmer
089	Nguyễn Thị Thu Loan	Hậu Giang	Châu Thành A	Tân Phú Thạnh	Farmer
090	Nguyễn Thị Kim Thoa	Hậu Giang	Châu Thành A	Rạch Gòi	Farmer
091	Đặng Văn Hết	Hậu Giang	Châu Thành A	TT Một Ngàn	Farmer
092	Đoàn Văn Huế	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
093	Phạm Văn Chánh	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
094	Nguyễn Văn Bảo	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
095	Lê Thanh Bình	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
096	Bùi Kim Hai	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
097	Huỳnh Văn Tâm Em	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
098	Trần Văn Tỏ	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
099	Nguyễn Thế Hoàng	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer
100	Nguyễn Nhật Trường	Hậu Giang	Châu Thành A	Trường Long Tây	Farmer

Annex 6: List of biogas technicians/mason, biogas experts and policy maker for survey

Code	Name	Province	Position
1	Hoang Van Quan	Luong Tai – Bac Ninh	Biogas Mason
2	Nguyen Van Vien	Tam Duong – Vinh Phuc	Biogas Mason
3	Le Dinh Hinh	Thieu Hoa – Thanh Hoa	Biogas Mason
4	Le Van Nghia	Dak Lak	Biogas Mason
5	Nguyen Manh Dinh	Bac Ninh	Director
6	Nguyen Thi Tin	Luong Tai – Bac Ninh	District Technician
7	Nguyen Thi Huong Loan	Vinh Phuc	Provincial Technician
8	Le Khac Trung	Hoang Hoa – Thanh Hoa	District Technician
9	Nguyen Van Long	Thanh Hoa	Provincial Technician
10	Nguyen Van Kien	Dak Lak	Provincial Technician
11	Tran Hoang Phuc	Hau Giang	Provincial Technician
12	Tran Van Tuan	Hau Giang	District Technician
13	Ngo Van Chu	Dak Lak	Commune Officer
14	Nguyen Quynh Hoa	DLP	Policy maker
15	Vu Thi Khanh Van	National Institute of Animal Science	Biogas expert
16	Bui Van Chinh	Viet Nam Biogas Association	Biogas expert