

*TRAN VIET DUNG, HA VIET HUNG,
HUYNH THI LIEN HOA*

INDEPENDENT CONSULTANT GROUP

BIOGAS USER SURVEY 2007-2008

**Biogas Development Programme for Livestock Sector
in Vietnam 2007-2011**

Hanoi, 5th February 2009

CONTENT

	Page
EXECUTIVE SUMMARY.....	7
MAIN REPORT	16
PART I. GENERAL INFORMATION ON LIVESTOCK SECTOR AND BIOAGAS DEVELOPMENT PROJECT IN VIETNAM.....	18
I. GENERAL INFORMATION ON LIVESTOCK SECTOR AND BIOAGAS.....	18
1. General information on livestock sector	18
2. Biogas Information	21
II. AN INTRODUCTION OF BDP IN VIETNAM	25
PART II. BIOGAS USER SURVEY 2008.....	27
I. OBJECTIVE OF THE SURVEY	27
1. Overall Objective	27
2. Specific Objective.....	27
II. APPROACHES AND METHODOLOGY.....	27
PART III. SURVEY RESULTS	31
I. OVERVIEW OF ECONOMY AND SOCIETY OF SELECTED PROVINCES.....	31
1. Son La province	31
2. Bac Giang province.....	32
3. Ha Tay province.....	34
4. Thua Thien - Hue province.....	36
5. Dong Nai province	37
6. Tra Vinh province	39
II. GENERAL ASSESSMENT ON BIOGAS PROJECT IN THE PROVINCES.....	40
1. Advantages and difficulties of biogas project in provinces.	40
2. Results of project implementation in 6 provinces in October 2008	42
2.1. Dong Nai province	42
2.2. Thua Thien – Hue province	43
2.3. Ha Tay province.....	43
2.4. Son La province	44
2.5. Bac Giang province	44
2.6. Tra Vinh province	44
III. RESULTS OF SURVEY ON BIOGAS USERS IN 2008.....	45
1. Information about households selected to survey.....	45
1.1. Total number of households to survey	45
1.2. Information about households to survey	45
1.2.1. Some general information about households to survey.....	45
1.2.2. Average income of households to survey.....	47
1.2.3. Classify households based on income	48
1.2.4. Information about building the biogas plants of households.....	50
2. Assessing the biogas project’s service quality	51
2.1. Assessing the situation of biogas plant.....	51
2.1.1. Assessing the plants based on the construction year.....	51
2.1.2. Assessing the construction price of 1m ³ plant	52

2.1.3. Assessing the operation of biogas plants in the households.....	55
2.1.4. Assessing the maintenance of the biogas plant in the households.....	56
2.1.5. Assessing the plant quality.....	57
2.1.6. Assessment on providing gas from the plant.....	60
2.2. Assessment of the technicians and the masons.....	62
2.2.1. Assessment of the technicians.....	62
2.2.2. Assessment of the masons.....	63
2.3. Assessment of services in the use of biogas plants.....	64
2.4. Assessing the activities of training and propagandizing on using the biogas plants.....	66
2.5. Assess the technical support.....	67
3. Assess the socio-economic and environmental impacts.....	68
3.1. Impacts of the biogas plant on economy.....	69
3.1.1. The biogas plant help households save fuel and energy.....	69
3.1.2. The biogas slurry helps the household save cost of fertilizer.....	72
3.1.3. Livestock scale of many household using the expanded biogas plant.....	74
3.2. Impact of the plant on environment and health.....	75
3.3. Impact on society.....	77
4. Market development.....	78
4.1. Households' opinions on the fact and future development.....	78
4.1.1. Difficulties in building the biogas plants.....	78
4.1.2. Interests of households not using the biogas plants.....	79
4.2. Analyzing the approaching of households to the program.....	82
4.2.1. Source of information that the households get.....	82
4.2.2. Assessment of the households to build the biogas plants.....	83
5. Lesson Learnt.....	85
5.1. Strength points of Biogas programme.....	85
5.1.1. Technology.....	85
5.1.2. Organization and implementation.....	85
5.2. Weaknesses.....	86
5.2.1. Constrains of accessibility.....	86
5.2.2. Coordination and management.....	86
5.3. Challenges and issues need to be solved.....	86
5.3.1. Development of the market.....	86
5.3.2. Utilization and diversification the use of biogas.....	87
5.3.3. Improvement of technology.....	87
5.3.4. Disseminating and training.....	88
5.3.5. Consultancy for construction of biogas plant.....	88
5.3.6. Supporting activities.....	89
5.3.7. Common questions asked by farmers.....	89
PART IV. CONCLUSION AND RECOMMENDATION.....	90
I. CONCLUSION.....	90
II. RECOMMENDATION.....	91

FIGURES IN THE REPORT

	Page
Chart 1. Main occupatiog of surveyed households.....	46
Chart 2. Main income of biogas user houselhold.....	48
Chart 3. Main income of non-biogas user household.....	48
Chart 4. Average income of biogas user household	49
Chart 5. Average income of non-biogas user household.....	49
Chart 6. Average size of biogas plant (m3).....	51
Chart 7. Construction cost per 1m ³ by year of constrution (mil. VND).....	52
Chart 8. Construction cost per 1m ³ in 2008 at surveyed provinces (mil. VND)	53
Chart 9. Average Cost of 1 biogas plant in 2007-2008	53
Chart 10. Main input materials for biogas plant.....	55
Chart 11. Form of inputting material for the plant	55
Chart 12. Percentage of Household that inputting material inappropriated(%)	56
Chart 13. Stirring and breaking scum situation (% biogas plant)	56
Chart 14. Percentage of household that removed residuals (% biogas plant)	57
Chart 15. Quality of biogas palnt by year	57
Chart 16. Quality of Biogas plant by provicne.....	58
Chart 17. Number of plant having equipment failure.....	58
Chart 18. Reason of failure	59
Chart 19. Failed equipments	59
Chart 20. Level of biogas providing from the plant.....	60
Chart 21. Treatment of abudant gas.....	60
Chart 22. Number of plants that stop producing biogas	61
Chart 23. Reason of stop producing gas	61
Chart 24. Technician need to be improved.....	62
Chart 25. Maintain of equipment	63
Chart 26. Opinions that required mason group need to be improved	64
Chart 27. Time of receiving finacial support.....	64
Chart 28. Technical support from project (%)......	65
Chart 29. Assessment of guarantee quality (%).....	65
Chart 30. Number of participating time in training courses	66
Chart 31. Effectiveness of training course.....	67
Chart 32. Content of training that need to be improved	67
Chart 33. Main purpose for building biogas plant(%)	68

Chart 34.	Expenditure for fuels of households.....	69
Chart 35.	Propan gas used of household before and after having biogas plant.....	70
Chart 36.	Coal, firewood of household before and after having biogas plant.....	70
Chart 37.	Electricity consumption before and after hanving biogas plant.....	71
Chart 38.	Household using slurry for cultivation (%).....	72
Chart 39.	Form of using slurry	73
Chart 40.	Reason for not using slurry	73
Chart 41.	Percentage household recognised the reduction of insects.....	76
Chart 42.	Difficulty faced when constructing the biogas plant	78
Chart 43.	Assessment of environmental pollution from livestock waste	80
Chart 44.	Interested in biogas effectiveness of households	81
Chart 45.	Household wishes to build the biogas plant	81
Chart 46.	Households opinion on biogas.....	83
Chart 47.	Level of suport and its impact to decision making	83
Chart 48.	Possible investment of household on biogas plant	84
Chart 49.	Size of biogas plant that household prefer to build.....	84

TABLES IN THE REPORT

	Page
Table 1. The situation of livestock of Vietnam during 1995-2007	19
Table 2. Scale of ruminant and poultry until 2020	20
Table 3. Quantity of manure waste produced by livestock within 6 months	21
Table 4. Livestock situation of Son La province in 2000 - 2007	32
Table 5. Development of domestic animals in Bac Giang province	33
Table 6. Situation of domestic animals in Ha Tay province.....	35
Table 7. Scale of main domestic animals in Thua Thien – Hue province.....	37
Table 8. Table 5: Scale of main domestic animals in Dong Nai province	38
Table 9. Scale of domestic animals in Tra Vinh province.....	40
Table 10. Results of project implementation in 6 provinces up to survey.....	42
Table 11. Total number of households to survey	45
Table 12. Some information about households to survey.....	46
Table 13. Average income of households to survey	47
Table 14. Information about building the biogas plants.....	50
Table 15. Digester size and suitable level.....	51
Table 16. Detailed construction cost of the biogas plant in this survey.	54
Table 17. Monthly amount to buy fuel in the household before and after using the biogas plants.....	71
Table 18. Total of households to increase the scale of breeding before and after owning the biogas plants.....	74
Table 19. Treating wastes of Livestock in the households before building the biogas plant	75
Table 20. Activities added when building the biogas plant	77
Table 21. Average fuel and fertilizer cost of each household.....	79
Table 22. Information source that the households get about biogas	82
Table 23. Households' expectation about types of biogas plants and form of +operating.....	85

ABBREVIATION

ADB: Asian Development Bank

APO: Asian Productivity Organization

BDP: Biogas Development Project

BP: Biogas Project

BUS: Biogas User Survey

CCRD: Center of Community Research and Development

ECC: Energy Conservative Center

EU: European Union

GDP: Gross Domestic Product

NQ-CP: Government Resolution

ODA: Official Development Assistant

PBDP: Provincial Project Office

R&D: Research and Development

SNV: Netherlands Development Organisation

TA: Technical Assistant

VACVINA: Vietnam Horticulture Association

VND: Viet Nam Dong

WB: World Bank

WTO: World Trade Organization

EXECUTIVE SUMMARY

PART I. INTRODUCTION

I. INTRODUCTION

Biogas programme for Vietnam Livestock sector implemented in 2003. At the end of 2006, there were 27,000 biogas plants constructed in 20 provinces in the scope of project. Just in October of 2008 the project held an anniversary of construction of 50,000th biogas plants at Nghe An province. This is biogas project that has been evaluated as the most successful story in Vietnam and the only one project that received Global Energy Award in 2006.

With the commitment Aid from Netherlands government, during 2007-2011 the project expands and covers over 50 provinces throughout the country. Objective of this period is to build up to 140,000 units.

II. OBJECTIVES OF THE SURVEY

The first objective is to survey the products and services rendered by the BP like general information of households, training, construction, quality control, operation and maintenance, slurry used, gas used and subsidy payment.

Secondly the social, economic and environmental impacts of the use of biodigesters have to be assessed. Multiple benefits are claimed by the programme that needs ongoing verification and assessment. The impact on finance, fuel substitution, time, sanitation, health and environment will be assessed by mirroring between group of household having biodigesters and control group of comparable households without biodigesters.

The third dimension is to provide a cross section of the profile our clients, differentiated by relative poorer households, average household and well off households. This has to result in recommendations for the programme to how increase its outreach to the different types of rural households in Vietnam. The consultant is challenged to extrapolate its findings in order to make scenarios of the biogas market in Vietnam for the coming 5 to 10 years and how the BP could possibly anticipate to this.

III. METHODOLOGY

The BUS 2008 has been conducted through 4 steps : desk study, field survey, analysis and reporting. During BUS implementation, the consultants maintained close link to Central Project Office to ensure all activities are followed the plan as well as requirements.

Based on the result of desk study the consultant team was able to formulate 3 questionnaires sets (one set for biogas user; one set for non-biogas user and the third for in-depth survey), test survey has been conducted in Ha Tay.

Survey conducted at 6 provinces namely Hà Tây, Bắc Giang, Sơn La, Thừa Thiên Huế, Đồng Nai and Trà Vinh. In each province there were selected 2 districts and each district selected 2 communes and every commune have 2 villages been selected. Total number of households surveyed were 260, in which 180 households were and 80 households were non-biogas user dividing by each province of 30 biogas user households, and 12-14 non-biogas user households.

PART II. ASSESSMENT OF BUS 2007-2008

IV. GENERAL ASSESSEMENT ON BIOGAS PROGRAMME OF SELECTED PROVINCES.

1. Advantages

Advantages on dissemination and farmer support: dissemination activities on advantages and benefits of biogas plant have been organized frequently by the project as well as local government so that it helps bringing more farm households participated in the biogas project.

Advantages of having human resource: System of technicians and masons who are professional, skilled, experienced and enthusiastic was trained for biogas project in the provinces. Project staffs at all level always put themselves at high responsible manner and well coordinate with local authorities at district and commune level to ensure the implementation progress and effectiveness of project activities.

Biogas project in the provinces are always concerned and directed by People's Committee and Department of Agriculture and Rural Development at provincial level.

2. Some difficulties

At present, the provinces are carrying out concentration oriented breeding plan which gradually reduced in order to reject the Livestock in the residential areas (such as provinces of Dong Nai and Ha Tay). However, the progress of implementation is rather slow, making people feel unsecured to invest into Livestock including investing into construction of biogas plant.

Besides, cattle's epidemic diseases happening on a large scale along with highly increasing food price seriously affected Livestock of many provinces. So the provinces had difficulties in enlarging the biogas project (Dong Nai and Thua Thien - Hue provinces).

Prices of construction materials and labors speed up fast. The average construction price of 1 m³ from 0.52 - 0.60 million VND in 2005 increased from 0.74 - 1.16 million VND impacted on construction investment of biogas project.

Many households had no expenditure to cope with constructing the project while the aids still remain at 1 million/project.

Because the land use area of majority of urban households is low, many Livestock households have no enough premises to construct the biogas project.

Bad weather, rain, storm and flood are also difficulties in realizing the project construction, influencing on the progress of many provinces such as Ha Tay, Dong Nai, Thua Thien – Hue and Tra Vinh.

The construction progress of biogas project in the provinces generally gained good results although trained technicians and masons increased uncorrespondingly. Thus, supervising, supporting, propagandizing and implementing other support and consultant services also had difficulties (such as in Dong Nai)

V. SURVEY RESULTS

Through site survey as well as collected information show that the biogas project has achieved very promising results. At the time of survey (October, 2008), through 6 year in implementation, the project could be able to construct 50,000 biogas plants in 28 provinces, cities wide. Beside the project has been developed the most updated biogas technology as compared to other biogas technologies applied in Vietnam.

The survey results of 180 biogas user households from 6 selected provinces (Sơn La, Bắc Giang, former Hà Tây, Thừa Thiên - Huế, Đồng Nai and Trà Vinh) show that most of biogas users are highly appreciated biogas plant in terms of construction quality, gas producing ability, and reduction of environmental pollution. More than 70% of the biogas user confirmed that thanks to biogas plant so that their scale of raising livestock was increased as compared to before having biogas plant (majority increase number of pig). In addition, biogas user also recognized that training courses, guideline, and materials for dissemination can help them in operation and maintenances of the biogas plant.

The clear benefits of biogas plant from survey results are the use of biogas as replacement fuels for cooking and lighting. Monthly, the biogas user could able to save 200-300 thousand VND for cooking and lighting. The biogas plant also helps farmer to solve mostly the pollution of living environment causing from livestock development activities.

VI. ASSESSMENT

1. Strengths of Biogas project

The project has positive impact on process of agricultural and rural development and contributes significantly in reducing environmental pollution from livestock activities as well as creating opportunities for income increases for farmers., etc.

1.1. Technology

At present, in the biogas development market, there are many biogas producing technologies (plastic digester, pipe digester, KT type but modified...) that are being applied by biogas user. However the construction technology for KT1 and KT2 types getting user trust due to the characteristics as following:

- Insurance of quality of the plant
- High safety level
- High capacity of gas producing and stable
- Long lasting for uses

1.2. Organization and implementation

The management system of the project is well organized and function smoothly from upper to down stream level. As a result the monitoring and checking quality of the biogas plant, implementation progress can be conducted and obtained easily and highly accurate. In addition, the project also constructed web-base database information- an efficient tool for monitoring and evaluation- that helped project to gain in collection and updating data and to provide sufficient information for project's leader to make appropriated and timely decisions.

The project also was able to establish technician and mason teams with high skill level, professional character that ensure the quality and technical aspect of the plant and create the user trust and believes.

2. Weaknesses

2.1 Constrains of accessibility

- Biogas plants of project have higher cost from 1.2-1.5 times as compared to other biogas technology (plastic technology or innovated biogas technology of VACVINA¹), that why it makes a constraint of accessibility of those farmers or community having lower or midium level of income.

- Registration, insurances, and receiving support procedures are still complicated ans inappropriated with level and wishes of the users.

- Number of technician having sufficient knowledges, active and creative mind is still minimum that lead to the lack of accurate guidance, consultancy on size of plant, location for construction and oeration and maintainnace.

2.2 Coordination and management

The link between implementing agencies (extension centers, water supply

¹ Nguồn: <http://xttmnew.agroviet.gov.vn/loadasp/tn/tn-spec-nodate-detail.asp?tn=tn&id=1711945> VACVINA technology having consntruction cost of 7m³ biogas plant was about 2 million VND (2005). While from project (according to site survey) construction cost of the same size biogas plant was 0.55mill. vnd/m³ (2005) or equivalent to about 4 million VND

and sanitation center) and local authorities is still rather weak. There is a room for exploitation of propagation ability of local government, mass organization and individual farmer at grass root levels such as Farmer Union, Woman Union, Veterinary, village heads, and experience persons.

Most of technicians are holding more than one position in their career. In addition, the growth of number of technician and mason is not fit with the growth of number biogas plant. As a result, the technical supporting force for farmer becomes thinner that might lead to the unfulfilled requirements in new technical transfer and utilization of the plant, especially in the remote area or in those provinces having large area in operation.

PART III. CONCLUSION AND RECOMMENDATION

I. CONCLUSION

Biogas project implementing by joint cooperation between MARD and SNV is one of successful project in the agricultural and rural development process in Vietnam. Even though the biogas plant is not directly creating income but it can solve partly environmental pollution problem caused by livestock raising activities - a critical issue of livestock sector when it is having rapidly growth rate - and simultaneously produce the biogas that serve for living livelihood activities, create compost manure that is used for organic cultivation.

The project has developed very effective management system from central level to grassroots level and it also show clear transparency of supporting activities that brings the believes of farmers and local authorities.

The project also is doing its best effort in setting up, training the technician and mason groups that apparently contribute to the human resource for the local governments.

However, the biogas development is still facing with difficulties and challenges that need to be solved:

Firstly, Development of biogas plant and the use of it are depending a lot on livestock prices. Through survey showed that when the production price is going down, there is a tendency of down scale of raising livestock or even stop raising (especially in those farms).

Secondly, Appearances of competition in biogas development market from cheaper biogas technologies that could be able to draw number of farmers to apply these technologies.

Thirdly, concentration livestock raising scale increasing gradually (common from 30-50 head/herd as compared 10-20 heads/herd before) so that the demand for bigger size of digester with full utilization options becomes greater.

Fourthly, in the planning of livestock sector from several provinces said that the province may limit or prohibit the backyard or small scale of livestock raising and shift to concentration and big livestock raising scale. As a result it may affect to the biogas plants that already were built or going to be built of the programme.

Fifthly, number of biogas plants reached to 50,000 so that the market demand on after-biogas digester technology (refining system, pressure meter, replacements, and utilization of gas) is increasingly day by day.

II. RECOMMENDATION

1. Credit

The development of biogas user in the next few years requires credit activities. More than 70% of surveyed households said they are lacking of fund source for biogas construction. However to obtain the exact demand on loan, loan sources, term and condition of loan, acceptance of interest, organization... the project should conduct a survey on credit issues in nation wide.

Strengthening the link with other agencies, organizations, in supporting construction of new biogas plant (especially credit organization or banks)

2. Up-scaling, and increasing beneficiary

In the coming years, the project need to develop biogas plant in farm household having large scale or concentration raising (approximately >100pig heads/herd) and increase the number of biogas plants with size over 20m³, due to development direction of livestock sector is to develop concentration and big scale and reduce backyard and small scale of livestock raising. In addition, the project also should pay attention in research and development in those farm households having pattern of livestock raising + agricultural food processing. At present, the food processing villages are polluting its environment, first step development of biogas plant at combined raising livestock and food processing is a crucial demand as well as increasing number of biogas users under programme.

3. Policy development

The participation in the construction process of livestock development policies, minimizing pollution issues need to be considered and paid attention by the project. For example, those issues like supporting in study and research of environment management policy for household having large scale or participating in construction of livestock regulations, laws on livestock waste management.

Achievement of target of 140,000 biogas plants in the next few years is big challenge of the project. However the number of 140,000 biogas plant is not reflecting exactly either the ability of environmental treatment or biogas generation, because of number of large scale bio-digester increasing over time.

So that project should study on standardization of biogas plant (for example, the standard biogas plant is 6m³, so the other biogas plant with the size of 20m³ will be equivalent to 3 standard biogas plant) and should consider to present the total cubic meter against total number of biogas plants.

4. Strengthening of technician and mason groups

In the coming years of implementation, it is a need to enhance quantity and quality of the technician and mason in corresponding with the increasing number of biogas plant. Especially, project should conduct training for improving of technician's knowledge and skill of consultations.

Increasing amount of allowance for technician, innovation of administrative procedure, and encouraging technician at grassroots level putting more effort on biogas development activities.

5. Adjustment of supporting forms

Project may need to study and research on adjustment level of financial and technical supports with the aims of building bigger biogas plants and ensuring the environmental sanitation (fully use of waste from raising livestock activities).

6. More development of services after biogas digester

The project should pay more attention on research and innovation of biogas used equipments which have longer durability, diversity and reasonable prices so that farmer can buy and utilize fully the amount of generated biogas.

The project may consider to research and develop gas refining equipment in order to increase the durability of equipment and utilization as well as ensuring people health.

7. Good practice in dissemination and persuasion activities.

Selection the good, appropriate time for dissemination activities, mobilization activities, and training activities is a factor that the project should consider and apply it in practice.

Emphasizing dissemination, technical guidance activities in aiming at increase people awareness on biogas effectiveness and encouraging people in utilization of biogas (using slurry for crop production, raising livestock, biogas for electric generation...).

8. Development of biogas demonstration model through R&D

When developing biogas demonstration model, it is a need to apply the method "state and farmer working together". When duplicating the model, it needs to draw all possible financial sources to support farmer so that it may encourage and improve the effective use of biogas plant.

The project may need to develop demonstration models on biogas

utilization with many forms of biogas uses so that people can learn, study and understand more about their own demand on biogas uses.

9. Closely coordinating with authorities at all level

In order to develop and effectively use of biogas plants, it is a need to have closely coordination activities among stakeholders, clear direction and guide from leaders in technical dissemination, construction technique and utilization

MAIN REPORT

PART I.

GENERAL INFORMATION ON LIVESTOCK SECTOR AND BIOGAS DEVELOPMENT PROJECT IN VIETNAM

III. GENERAL INFORMATION ON LIVESTOCK SECTOR AND BIOGAS

1. General information on livestock sector

Livestock is one of vital sector in agricultural production of Vietnam; therefore increasing livestock proportion in agriculture is the fundamental base for maintaining and developing the value of agriculture.

Growth rate of livestock in the past few years is always at high level of development, average growth rate of 2001-2007 was 8.5%, in 2007 the livestock values achieved at 7.3% comparing with the previous year. At present, livestock proportion in agriculture accounted for 22.3% (General Statistical Office). There are 10 provinces with livestock proportion greater than 35% and another 11 provinces having more than 30%.

The prominent aspect of livestock sector in the past few years is that parallel with the traditional raising methods, there have been developing of concentrated scale for raising livestock, especially after the resolution No 03/2000/NQ-CP dated 02/02/2000 of the government on development of farmstead economics has been putting in practice. This has been seen as common development trend in the world and also is a direction for structure change in Vietnam agriculture sector.

The growth of livestock sector could be able to help in income generation, job creation and living standard improvement of farmers, especially for those are living in the remote and less developed areas. The growth of livestock also helps to increase agricultural products processing as well as to shift labor force in agriculture. However, there are some negative impacts of livestock development on environment. The solid or liquid wastes coming from livestock raising units, slaughter houses, meat processing factories are also contributing to air or soil pollution, water sources polluted and of bad impacts to human health. This issue addresses to livestock raisers, policy makers that there is a must to have appropriate policies, sanctions for livestock development as well as reduction of environment pollution from livestock.

1.1. The situation of livestock of Vietnam during 1995-2007

From 1995 up to now, the number of livestock in the country has been increased continuously; figures presented in Table 1 show that:

- Number of cow heads at present is 6.7 million; increasing 1.8 times as compared with year 1995 with average annual growth was 5.25%;
- Number of cows in dairy branch is 160.1 thousand increasing 8.5 times

compared with year of 1995 and with average annual growth of 19.6%;

- Number of pig is 26.56 million increasing 1.6 times compared to 1995 with average annual growth of 4.15%.

- Number of goats, sheep is 1.78 million heads increasing 3.2 times with average annual growth of 10.26%;

- Poultry is increasing very fast reaching to 254.06 million heads in 2003 however due to the impact of Aluvian Influenza the number of poultry was a down at 226.03 million heads.

- The number of buffaloes and horses is not significant changes.

Table 1. The situation of livestock of Vietnam during 1995-2007

Unit: 1000 head

Items	1995	2000	2005	2007	Average Growth rate 1995 - 2007 (%)
1. Buffaloes	2.960	2.900	2.920	3.000	0,11
2. Castle	3.640	4.130	5.540	6.725	5,25
3. Dairy cows	18,7	35,0	104,1	160,1	19,59
4. Horses	126,8	126,5	110,2	103,5	-1,68
5. Goat, sheep	550,5	543,9	1.314,2	1.777,6	10,26
6. Pig	16.310	20.190	27.430	26.560	4,15
7. Poultry	142.100	196.100	219.910	226.027	3,94

Sources: Livestock Department, 2007

Number of livestock during 1997-2007 is increasing rapidly, the livestock sector of Vietnam is now developing follow as the direction of concentrated and large scale with hundreds newly established feed factories, slaughterhouses factories. However the development of livestock also is creating several environmental issues with negative impact on environment.

In the year2007, the raising livestock form at small scale, backyard and fragmented was reduced rapidly due to no profit, increasing price of feeds and severe competition. In Livestock strategy of Vietnam until 2020, the DLP forecasts that in the next few years, the backyard and small scale type of livestock raising will be scaled down and replaced by big scale and concentration.

1.2. Direction of Livestock sector until 2020

Livestock strategy of Vietnam shows the direction in long term as based on the development strategies from provinces that is livestock development is a priority sector in most of province in Vietnam and therefore it is a big chance for livestock sector develop in the future..

The table below shows the scale of livestock until 2020:

Table 2. **Scale of ruminant and poultry until 2020**

Unit: 1000 head

Items	2007	2010	2015	2020	Average Growth rate 2007 - 2020 (%)
1. Buffaloes	3.000	3.000	3.000	3.000	0,00
2. Castle	6.725	7.840	10.000	12.500	4,88
3. Dairy cows	160,1	200	350	500	9,16
4. Goat, sheep	1.777,6	2.200	3.200	3.900	6,23
5. Pig	26.560	29.900	32.900	34.700	2,08
6. Poultry	226.027	264.000	310.600	358.700	3,62

Sources: *Livestock Department*

Natural and bioecological conditions of Vietnam are not at most favorable or constrain to livestock development, especially for industrial raising livestock. However development of livestock should integrate with environmental protection and soil improvement. More development of livestock there would be more environment pollution, but if there are appropriated treatment methods that could help to solve pollution and improve soil environment and crop production...

With the increasing number of big raising scale, the livestock sector has been set the objective of reducing environmental pollution from livestock activities in its development strategy. The targets were set at follow: 12% of big scale farm household having waste treatment in 2006 will increase to 45% in 2010, 65% in 2015 and 80% in 2020.

1.3. Negative impact to environment caused from livestock

When the livestock is at small scale and fragmented the environmental issue therefore is not at critical subject. Since the livestock developed at the bigger and concentrated scale or amount of livestock became big deals there have been a critical issues of environment should be focused and paid attention. Waste from raising process like solid waste, liquid waste, feed residuals, will effect badly to water sources, air, soil, and livestock products.

Manures-the waste comes from livestock raising with large amount of quantity-will pollute not only air, soil, water surface but also pollute ground water resulting from disintegrating process that release poisonous air (CH₄, NH₃, NO₂...) and because of manure also containing nitrogen, phosphate, zinc, lead, asena,copper, niken, etc., as well as germ, parapsychology and other like Entrobacteriae, E. Coli, Salmonella, Streptococcus fecalis that can effect directly or indirectly to human health .

The quantity of manure waste produced by livestock in 6 month has been

recorded by Burton. C; Turner as following:

Table 3. **Quantity of manure waste produced by livestock within 6 months**

Kind of livestock	Weight (kg)	Manure produced by one ruminant or 100 poultry equivalent (m ³)	Dried substances (kg/m ³)
1. Dairy cow	550	9,7	100
2. Castle over 2 year olds	500	5,8	100
3. Castle from 1-2 year olds	400	4,8	100
4. Castle from 0.5-1 year olds	180	2,4	100
5. Sow Pig	200	2,0	60
6. Pig for meat	35-105	0,8	100
7. 100 hence	220	2,1	300
8. 100 chicken	220	1,1	600

Source: *Environment Protection and Sustainable Livestock Development in Vietnam, Agricultural Publishing House, 2007*

As calculating in one year the livestock herds of Vietnam will discharge an amount of 73 million tones of solid waste, 25-30 million cubic meter of liquid waste (urine, cleaning water, water from playing ground or grazing area). Most of discharged volume is used as manure fertilizer, in which 50% of solid waste and 20% of liquid waste have been treated by Biogas system or compost methods. The remaining is not treated and be released directly to environment causing environment pollution and deterioration. (*Environment Protection and Sustainable Livestock Development in Vietnam, Agricultural Publishing House*)

Even though the livestock waste is potential dangerous matter to the biological environment; however the development of livestock can not be stopped. The reason is that livestock can provide energy, job creation, income generation and improving living standard of most people who are living in rural area and earning from agriculture. The issue is that there is a must to minimize the pollution generated from livestock activities. Not only livestock sector but also any other activities regardless scale should be environmental friend approach in aiming at sustainable development.

Animal waste treatment using biogas technology is one of environmental friendly solution and be applied widely in Vietnam

2. Biogas Technology Information

2.1 The importance of Biogas Technology

Nowadays, energy become critical issues not only the world but particular in Vietnam. Carbon energy sources like coal, oil has been exhausted. Application and utilization biogas technology –a clean energy source- contribute

significantly to energy security and environment protection. Biogas is considered as huge energy source from waste. The biogas technology can help to solve several critical issues as follow:

- Safety treatment of livestock waste, environment cleaning and infectious diseases protection.

- Creating a cheap, clean gas for home consumption, convenience for uses and liberating women labor forces in home works. Especially in the remote and mountainous area, biogas help in reducing demand of fuel wood so that relatively reducing pressure on forest.

- Using slurry from biogas digester combined with agricultural by-product to produce manure compost that serves for aquaculture and crop production hence agricultural organic product can be produced and exported.

Biogas is generated from digesting process of human, animal waste or organic substances (agricultural product) in fastidious condition. Thanks to microorganism simulation, waste will be fermented and released gas. Biogas is consisting of Methane (CH_4), Carbon dioxide (CO_2), Nitrogen (N_2) and Hydro Sulphate (H_2S). Major element is CH_4 accounting for 60-70% of the total and Carbon Dioxide accounting for 30-40%. These gas can burn and provide an energy amount of 4,500-6,000 cal/m³ that equivalent to 1 liter of ethanol, 0.8 liter of gasoline, 0.6 liter of crude oil, 1.4kg of chart coal or 2.2 kW of electric. It is to hope that Biogas will be a major energy source in the future that provides not only fuel for home consumption, environment protection, mimizing pollution but also improvement of community's health and for agriculture development. In addition, biogas can be utilized for other purposes such as drying oven, lighting, heating system for cages, heating water, electric generator., etc.

After composting and fermenting, the nitrogen element in animal dung is transformed to Ammoniac that is helping crop to absorb more easily. Slurry also contains phosphate, potash, mangan and other micro elements. As a result, using slurry for crop production can help to reduce the chemical fertilizers applied for cropping plants. Another issue is that during fermenting stage under fastidious condition, all pathogenic bacteria for human are eliminated.

According to studies from China, using slurry for crop production will increase crop yield by 6.5% for rice, 8.9% for maize, 15.2% for wheat, and 17.5% for cotton comparing to animal dung directly applied. (*Environmental protection and sustainable livestock development in Vietnam, Agricultural Publishing House, 2007*)

2.2 Applied biogas technology in the world

In recent years, many counties in the world have paid attention on environment pollution caused by deforestation for fuel wood or over

exploitation of carbon energy sources like coal, oils, and atomic energy. Much international convention on environment has been recommended to reduce the use of carbon energy and shift to utilize other energy sources such as solar energy, windy energy, and geothermic energy.

Applying biogas technology from livestock waste was developed by scientists in the world from 30s of XX decade. At present biogas technology is existing in both developed and developing countries. In many countries like China, India, Nepal, Mongolia, Philippines, Thailand, etc., biogas technology is using widely to create new source of energy and to reduce environmental pollution causing from the use of untreated animal dung for crop production.

Especially in Asia, China and India are the top countries on biogas technology development. Both countries invested intensively for biogas R&D and achieved successfully on using biogas (cooking, lighting, generator, fruit and cereal preservation,..) and utilizing slurry (fertilizer, complement feeds for aquaculture, livestock and for mushroom.,etc.)

Sweden was the first European country to implement pilot project of “biogas city”. Since 2008, all public vehicles like taxi, buses have been using biogas. In this city, every 10 fuel gas stations will have one biogas fuel station. Sweden government developed tax support policy for gas to maintain the price of biogas is cheaper 30% compared to gasoline.

In Indonesia, people can save 30 USD/month from using biogas. Indonesia government is now boosting up the utilization of biogas as a measurement for environmental issues.

In the world there is a new developed technology to create biogas electric generator with capacity from 500W to 300kW. China is proceeding to test new treatment method for straw from paddy rice. Paddy straw is promising bio-energy source, especially for biogas. Before scientist assumed that there is big amount of cellulose fiber and polysaccharide which is difficult for bacteria to break up. However the Chinese scientists try to treat straw by using natri hidrocid before getting it in the digester. This treatment will help to increase the efficiency of producing biogas by 27-64.5%. If the experiment becomes successful that will be an advantage for biogas development in China.

2.3 Applied biogas technology in Vietnam

In rural area of Vietnam, people sometime do not know how to treat appropriately the waste coming from livestock or even from human being. Waste from slaughter houses, from traditional food processing villages like rice noodle, vermicelli have not being treated that leading to severe pollution, hygienic problems, spreading of diseases, affecting to human health. In recent years, thanks to the awareness of people on biogas technology efficiency in solving environmental issues and increasing income, from using it or from

biogas training, disseminating as well as financial support from several development agencies, construction of biogas plant has been drawing as many attention and response from farmers in nationwide.

Biogas technology has been applying in Vietnam through experimental programme, researches, and projects. The results show that those farmers having rather large scale of livestock raising, with abundant of manure source, the biogas plant is not only solving the waste problem but also providing fully demand of cooking or lighting. However, the development of renewable energy source is still limited and slow due to the construction cost of the biogas plant is high as compared with income and financial source of rural people. According to statistic data, at the end of 2006, most of provinces in nation wide have been developed biogas technology. Even though the number of constructed biogas is still very small against to actual demand, total amount of biogas digesters were about 90,000 plants.

At present there are approximately about 60 agencies that involved in biogas development activities in Vietnam such as projects, companies, research institutes, universities. Below are agencies or research institutes that contribute major in Vietnam:

- ECC center (Department of Industry and Commerce) constructed pilot biogas plants at livestock raising household in Hanoi suburb. These biogas plants are helping farmers in utilizing the animal waste from agricultural activities to produce biogas for not only cooking but also for lighting, milling, pumping and generator. Biogas plant of ECC is suitable for small scale livestock raising household with capacity of digester under 40m³, that might provide enough energy for electric generator of 1000-1500W. ECC planned to continue disseminating activities and constructing more pilot biogas plants that serve for duplicating the use of biogas in the future.

- Vietnam APO : with the objective of improvement living standard for people and reduction of environmental pollution, the center gave out as many as measurements to increase production yield, to treat the waste, and to control environment by using updated technology. Biogas technology is one of selected measurement that the center developed. Their biogas model has put into implemented since 2004 and expanded throughout the country.

- Center of Community Research and Development (CCRD) belonged to VACVINA (Vietnam Horticulture association) introduced the innovated biogas model that is highly appreciated by farmers especially in Thanh Hoa and Nghe An provinces. Demonstration models constructed in 1998 at Thai Nguyen, Vinh Phuc, Hai Phong province and suburb of Ha Noi, till now there were 2.800 biogas plant working effectively. The movement of construction of innovative biogas plant is duplicating into 22 provinces, cities in the country.

- Energy Research Institute: during 2002-2004, through researches and studies, the institute has assessed and analyzed the advantages and disadvantages the existing applied biogas technologies. The institute also recommended innovative biogas technology at household scale in aiming at sustainable development.

The innovative biogas technology implemented by the institute including biogas structure, using new material for improving quality, gas produced, time of uses, and convenient in construction and operation.

The innovative biogas model has been created and installed at Hong Duong, Do Doong, Thanh Oai District, Ha noi City; Hiep Hoa commune, Vinh Bao District, Hai Phong City and An Ninh commune, Binh Luc District , Ha Nam province. ..

In recent years, the Institute also studies new biogas technology from some countries and applied successfully the new biogas technology from China. The institute corporate with an Chinese research agency to transfer completely biogas technology for Vietnam and produce some equipment for using biogas in Vietnam.

However, among agencies participating in the development of biogas technology in Vietnam, Biogas Development Project - a cooperation development between MARD and SNV- is core contributor.

IV. AN INTRODUCTION OF BDP IN VIETNAM

Biogas programme for Vietnam Livestock sector implemented in 2003. At the end of 2006, there were 27,000 biogas plants constructed in 20 provinces in the scope of project. Just in October of 2008 the project held an anniversary of construction of 50,000th biogas digesters at Nghe An province. This is biogas project that has been evaluated as the most successful story in Vietnam.

It may say that, the utilization of biogas for fuel and electricity for living livelihoods can bring significantly meanings of development. This becomes more meaningful for livestock sector and other traditional food processing when the biogas technology can help in solving environmental pollution. As a result the biogas project in Vietnam has received Global Energy Awards in 2006 as a prove for its efforts and achievements in environmental protection.

With the commitment Aid from Netherlands government, during 2007-2011 the project expands and covers over 50 provinces with an objective of construction of 140,000 units to be built during this period.

Total project cost for this phase is 44.8 million, consisted of 3,5 million EU from counter part funds of provinces, 3.1 million EU of ODA from Netherlands government and 0.6 million of TA from SNV. The remaining 28 millions EU will be invested by households.

According to information from BDP office, the average cost for one biogas plant is ranging from 3-5 million VND. The project supports 1million/plant or equivalent to 25% of total investment of biogas plant to households participated in the project.

In 2007, the first year of second phase, there were 14.000 biogas plants been constructed in 25 provinces and cities that make an increase number of biogas of project from 2003 to 2007 up to 41,000 units.

Scope and activities within project are expanding, so that there is a need to understand more deeply the actual project activities at household level as well as how to improve project implementation activities. In order to meet that needs and requirements, annually, the project conducts BUS activities. In 2008 the BUS is implemented by independent consultant team from September to December 2008.

PART II.

BIOGAS USER SURVEY 2008

I. OBJECTIVE OF THE SURVEY

1. Overall Objective

The BUS 2008 is aiming at to assess the actual implementation at household level. Findings of this survey will be used to feed improvements on policies and guidelines for construction, training, quality control, subsidy payments, etc. Another purpose is to validate its current and future impact on social, economic and environmental issues by the use of biodigesters

2. Specific Objective

The first specific objective is to survey the products and services rendered by the BP like general information of households, training, construction, quality control, operation and maintenance, slurry used, gas used and subsidy payment. The programme needs to know what the actual practices are and what needs to be adjusted and improved.

Secondly the social, economic and environmental impacts of the use of biodigesters have to be assessed. Multiple benefits are claimed by the programme that needs ongoing verification and assessment. The impact on finance, fuel substitution, time, sanitation, health and environment will be assessed by mirroring between group of household having biodigesters and control group of comparable households without biodigesters.

The third dimension is to provide a cross section of the profile our clients, differentiated by relative poorer households, average household and well off households. This has to result in recommendations for the programme to how increase its outreach to the different types of rural households in Vietnam. The consultant is challenged to extrapolate its findings in order to make scenarios of the biogas market in Vietnam for the coming 5 to 10 years and how the BP could possibly anticipate to this.

II. APPROACHES AND METHODOLOGY

1. Approach

In order to meet the above objectives the consultant team applied 2 approaches in the assessment that are from people and from product.

1.1. Assessment from people point of view

The nature of this approach is to utilize the knowledge, experiences of those participated in a certain field, subject to draw opinions, judgments and recommendations on that field or subject.

Using this approach the consultant team will assess the following contents:

- Assessment on the local authorities support for the BDP
- Assessment on level of understanding and obtaining information on biogas
- Assessment on acceptance level of household toward the effectiveness of biogas plants
- Assessment on operation and maintenance, using biogas and slurry of the farmers
- Assessment on level of support from technician and mason team...

1.2. Assessment from product

This approach allows the assessment of product quality by using statistical methods, surveys and observation. The consultant is using this approach to assess the biogas product through getting related information from several sources such as from BDP office, PBDPs, and survey.

This approach will apply for analysis the below items:

- Assessment on quality of the biogas plant
- Assessment on quality of the equipments
- Assessment on quality of project services: training, support, guarantee, operation and maintenance....
- Assessment on the impact of governmental policies toward project activities.

1.3. Approach target

Project office, administrative authorities: collection information on energy, agriculture, livestock, health, environment, economics, and level of accessibility of farmers to biogas utilization.

Technician and the mason : assessment of works and activities done according to technical requirements of the plant

Biogas users and non-biogas users: conducting survey, inventory by using questionnaires to get information at household level.

2. Methodology

The BUS 2008 has been conducted through 4 steps : desk study, field survey, analysis and reporting. During BUS implementation, the consultants maintained close link to Central Project Office to ensure all activities are follow the plan as well as requirements.

2.1 Desk Study

The independent consultant group conducted reviewing of all documents that related to the content of the survey, including some of project documents,

biogas information, livestock sector of Vietnam, BUS reports of 2005, 2006 and 6 provinces proposed for field survey namely Son La, Ha Tay, Bac Giang, Thua Thien - Hue, Dong Nai and Tra Vinh. These information helped the consultant group to design survey and report writing as well.

2.2 Data collection

Based on the result of desk study the consultant team was able to formulate 3 questionnaires sets (one set for biogas user; one set for non-biogas user and the third for in-depth survey), test survey has been conducted in Ha Tay.

Result from test survey helped to complete questionnaire sets and ensure the targets of the study and requirements. After the questionnaires sets have been approved by project office, the consultant conducted training for all member of the survey team and implemented field survey in accordance with proposed plan.

2.2.1 Sample selection

Survey conducted at 6 provinces as mentioned above. In each province selected 2 districts and each district selected 2 communes and every commune have 2 villages been selected.

Sample size: For biogas user household: total number were 180 households, 30 households per each province (in statistical method, the minimum requirement of sample survey must be 30 to ensure the exact of analysis); for non-biogas user household: there were 80 households been selected and surveyed (12 - 14 household per each), and treated as one sample survey, no analysis by province.

List of household survey for biogas user made by randomly selection based on the database of Project Office and consolidated before conducting survey. However, in Thừa Thiên - Huế province, at the time of survey there was a big flood at the selected communes of Phú Vang, Hương Thủy district so that the survey team could not conduct survey. Thank to recommendation of provincial project office, the survey team selected other communes of Hương Trà, Hương Thủy district and made the new list of households based on the database of the province.

Sample for non-biogas users was made by randomly selection during field survey.

2.2.2 Defining assessment indicators:

- Indicators for assessment of quality of products and services: the consultant team used the technical requirements that were provided by project office.

- Assessment of technician and the mason: based on the opinion of farmers household.

- Poor household for survey: according to the list of poor household at surveyed communes (very poor household was not selected).

- Forecast Data in the report was obtained by survey result, secondary data or calculating results from computer seawares: SPSS, Excel...

- Using data from survey, comparison method, and estimation and verifying in statistic for assessment of quantitative factors.

2.3 Data analysis

Information and data collected in field survey were analyzed by using following method:

- Inherit: obtaining research results, data, and secondary data that officially posted on mass media, reports of related agencies and project office.

- Statistical method: Survey data were analyzed by using statistical software: SPSS, Excel...

- Specialist: Report was made by obtaining opinions from experts, experiences person in biogas development field.

2.4 Report writing

Base on the table system, documents, survey data, opinions, and report outline the report was made accordingly to requirement.

PART III.
SURVEY RESULTS

I. OVERVIEW OF ECONOMY AND SOCIETY OF SELECTED PROVINCES

1. Son La province

1.1 Socio-economic conditions

Son La is a mountainous province in Northwestern Vietnam, bordering with provinces of Yen Bai and Lao Cai to the north, provinces of Phu Tho and Hoa Binh to the east, provinces of Lai Chau and Dien Bien to the West and Thanh Hoa province to the south. It has 250 km border with Lao People's Democratic Republic.

Son La is a province with a relatively thin population density (70 people /km²). The province has 11 administrative units in district level (10 districts and 1 town) with 201 communes, wards, towns. A number of communes in Program 135 are 86 communes (accounting for 42.79 %). In province there are many ethnic groups living in which the Thai is the most populous 55.2%, the Kinh 18%, the Hmông 12%, the Muong 8.2%, the Dao 2.76%, the Xinh Mun 1.45%. The poor household rate according to new criterion in 2005 is 43.92%, the highest is Bac Yen highland district (66.54%), and following is districts of Sop Cop (58.92%) and Muong La (55.8%).

Gross Domestic Product (GDP) in the province had average growth rate of 11.59%/year in 2000 - 2005. GDP in 2005 increases by 1.73 times against one in 2000 and achieved 2,121.5 billion VND, including 27.2% industry and construction, 16.5% service and 4.96% agriculture-forestry. Son La province has a lot of key agricultural products such as tea, coffee, corn, cassavas, longans, plums and Livestock products of buffalos, cows, pigs and milk

1.2 Livestock situation

Livestock sector of Son La province has developed most drastically both scale and quality. Especially, raising cattle for meat with potential strength is natural pasture to expand cattle size in the households and gathered breeding farms. A herd of buffaloes was 162.1 thousand heads in the whole province in 2007, increasing by 42.9 thousand heads against in 2000, equivalent to average growth rate of 4.5%/year. Average annual growth rate of cows' herd was 8.9%/year in 2000 - 2007. The province's cows were 87.6 thousand heads in 2000 and 159.9 thousand heads in 2007, including 5,000 milk cows and 2,500 cows raised for food with high quality. The main raising castle areas in recent years are Moc Chau, Mai Son, Thuan Chau and Song Ma, in which Mai Chau and Moc Chau regions have suitable conditions to raise milk cows with highly economic effectiveness, supplying materials for Moc Chau and Son La milk

processing plants. Pig raising structure is in transition stage. The density of foreign pigs and lean meat oriented pigs in the herd structure is increasing gradually and continuously. In 2007, pigs was 405.1 thousand heads, a 64.7-thousand-head increase against ones in 2000, equivalent to growth rate of 2.5 %/year. The poultry was 4,848 thousand heads, a 2,832-thousand-heads increase against that of number in 2000.

Table 4. **Livestock situation of Son La province in 2000 - 2007**

Unit: 1,000 heads

List	In 2000	In 2005	In 2006	In 2007	Average growth in 2000-2007 (%/year)
Buffalo	119.2	143.8	155.2	162.1	4.49
Cow	87.6	119.9	152.5	159.9	8.98
Pig	340.4	476.0	384.5	405.1	2.52
Poultry	2,016	3,402	3,753	4,848	13.35

Source: *Son La Statistical Yearbooks (2000-2007)*

1.3 Livestock development orientation by 2020

Developing livestock and manufacture will orient highly economic value on basis of taking full advantages of a mountainous province with favourable conditions to rapidly improve all kinds of cattle such milk cows, cows with raised for high quality of meat, buffalos, goats and lean meat oriented pigs. While developing poultry Livestock will orient industry and safety according to 3 scales of industry, farm and household.

- Buffalos increase from 162.1 thousand heads to 210 thousand ones by 2020

- Cows increase from 159.9 thousand heads to 240 thousand ones by 2020 including 10 thousand milk cows, 180 thousand Zebu crossebred cows and meat cow with high quality.

- Pigs increase from 405.1 thousand heads to 450 thousand ones by 2020

2. Bac Giang province

2.1 Socio-economic conditions

Bac Giang province is a province of Northern mountainous and hilly region that re-established in 1977, near Northern economy triangle, 50km away from Hanoi. In 2005, Bac Giang province's population was 1,580,718 people (362,913 households), with 27 ethnic groups (in which the Kinh made up 87.1%), residing in 229 communes, wards and towns of 9 districts and Bac Giang City. There are 35 communes of Program 135 (accounting for 15.3%) and 30.67%.poor household rate according to new criterion.

During 5 years (2000 - 2005), Bac Giang province's economy has considerably changed, GDP's growth rate of 8.35%/year; GDP per capita from

2.32 million VND/person/year to 4.78 million VND/person/year and State budget's increase of 398 billion VND against one in 2000.

Since the provincial re-establishment, in order to exploit its strength of agriculture and goods production, Bac Giang has carried out many resolutions guidelines, policies and measures to promote main agricultural goods and products such as Thieu litchi, tobacco, vegetables of all kinds, fish, meat of cattle and poultry, forestry products and so on. Agricultural, forestry and aquaculture value in 2005 was 4,435.92 million VND (at current price). Agricultural, forestry and aquaculture value structure was 93.92% - 3.65% - 2.44% respectively. GDP of agriculture, forestry and aquaculture in 2005 was 1,829,941 million VND (fixed price), a 401,635 million-dong-increase against in 2000 with growth rate of 5.1%/year.

Total investment capital of agricultural, forestry and aquaculture development in the province was 481.2 billion VND for 5 years (2001 - 2005), was 81.3 billion VND in 2005 alone, including locally managed capital of 42.3 billion VND and centrally invested capital of 39.0 billion VND

2.2 Livestock situation

Livestock in Bac Giang province has actively changed from applying high quality and high yielding breeds as well as new breeding methods. So Livestock's production value in Bac Giang province for previous 6 years (2001 - 2006) had growth rate of 7.32%/year

Table 5. **Development of domestic animals in Bac Giang province**

Unit: 1,000 heads

List	In 2000	In 2005	In 2006	In 2007	Average growth in 2000 - 2007 (%/year)
Buffalo	125.3	92	90.7	91.2	-4.44
Cow	68.0	99.8	141.0	148.4	11.79
Pig	718.3	928.4	1,034.8	1,002.3	4.87
Poultry	7,077	9,075	10,280	10,979	6.47

Source: *Statistic yearbook of Bac Giang province in 2000 - 2007*

In 2007, there was 239.6 thousand cattle, 1,002.3 thousand pigs and about 11 million poultry. Breeding cows and pigs has developed rather quickly in recent years with growth rate of cows 11.8%/years and pigs 4.9%/year during 2000 - 2007 period. In 2007, the province had 146 breeding farms, initially setting up the Livestock and goods regions in Lang Giang, Yen Dung, Hiep Hoa, Viet Yen and Luc Nam.

Difficulties in Livestock in recent years are epidemic diseases of foot and mouth disease and bird flu on a large scale. However, because the province steered to localize the regions of epidemic diseases and took measures to settle

timely (culling the diseased cattle and poultry as well as injecting vaccine), the epidemic diseases was controlled after 2 months and announce to disappear in the province after about 3-4 months.

2.3 Livestock development orientation by 2020

Semi-industrial and industrial livestock development will be improved with suitable scale. Grass land area and industrial foods will be used for livestock to expand scale and quality of domestic animals. It is necessary to invest into the gathered regions of breeding lean-oriented pigs (scale of 1.5 million heads) and cows raised for food (scale of 150 - 155 thousand heads) in order to create goods manufacture region of high quality and disease clearance based on new technology application into livestock.

- Buffalos increase 95 thousand heads by 2010 and 103 thousand ones by 2020
- Cows increase fast with 153 thousand heads by 2010 and 242 thousand ones by 2020
- Pigs increase 1.3 million heads by 2010 and 2,58 million ones by 2020
- Poultry increase 15 million heads by 2010 and 29 million ones by 2020

3. Ha Tay province

3.1 Socio-economic conditions

Ha Tay province is near to Hanoi Capital, bordering with Hanoi City and provinces of Vinh Phuc, Ha Nam, Hoa Binh and Hung Yen. Since August 2008, Ha Tay province merged into Hanoi with a natural area of 219,629 ha, population of 2,525.95 thousand people (in 2005), 12 districts and 2 cities under the province, 322 communes, wards and towns.

Before merging into Hanoi, Ha Tay province's total additional product value was 9,168 billion dong (at fixed price in 1994). Its average economic growth rate was 9.7%/year in 2000 - 2005 (including 13.1%/year industry and construction, 10.4%/year service and 5.5%/year agriculture). Average GDP per capita was 6.0 billion VND/ person/ year in 2005.

Its economy has many advantages such as producing vegetables and foodstuffs and breeding pigs (Ha Tay province has the highest pork output nationwide, accounting for 6.67% of total output in 2005), concentrated poultry breeding and aquaculture farming linked with rice growing.

The province's direct export value has rather accelerated in past years including export 46.8 million USD in 2000 and 94.76 million USD in 2005, increasing twice against in 2000 (in which export agricultural products made up low rate of about 2-3 million USD/year).

3.2 Livestock situation

Livestock is developing very drastically, especially for milk cows and pork. Ha Tay province becomes a center of providing breeds of poultry, pigs, meat cows and milk cows for surrounding provinces, at the same time leads in pigs, poultry and total output of meat product.

Table 6. **Situation of domestic animals in Ha Tay province**

Unit: 1,000 heads

Lists	In 2000	In 2005	In 2006	In 2007	Average growth in 2000-2007 (%/year)
Buffalo	34.4	22.8	18.3	18.0	-8.84
Cow	90.5	140.3	161.7	162.6	8.73
Pig	896.8	1,320.2	1,134.3	1,208.7	4.36
Poultry	7,743	10,766	10,070	10,820	4.90

Source: Statistic Department of Ha Tay province in 2007

Results of sector structure transfer: In 2007, production value of Livestock was 2,986 billion VND, accounting for 45% in production value of agriculture; growth rate of 12.5%/year including 76.4% cattle breeding, 12.0% poultry breeding and 11.6% others.

Production organization according to form of breeding farms is developing strongly in quantity, scale and annual production value with 217 breeding farms in the province up to 2006.

Ha Tay province is assessed as one of the leading provinces nationwide in the veterinary task and prevention of epidemic diseases. The veterinary system has been strengthened from province to communes, so epidemic diseases of cattle and poultry are usually discovered and organized to prevent timely (the province was a focus of bird flu but in 2006 but it no longer appeared in the province in 2004 and early 2005).

3.3 Livestock development orientation by 2020

The concentrated goods industrial Livestock regions will be founded with medium and big sized breeding farms and concentrated goods poultry and pig breeding accounting for 50% of total herd.

- Cattle have about 255 thousand heads including 240 thousand cows. The breeding regions focused on the hilly province and some riverside communes.
- Pigs have total herd of over 2.5 billion heads
- Poultry have over 15 billion heads

4. Thua Thien - Hue province

4.1 Socio-economic conditions

Thua Thien - Hue province is in Northern Central Vietnam, contiguous to the sea to the East, leaning against Truong Son mountain range, bordering with Lao People's Democratic Republic to the west, Quang Tri Province to the north and Quang Nam province and Da Nang City to the south.

Thua Thien - Hue province consists of Hue City and 8 districts with 150 communes, wards and towns (including 32 communes of Program 135). The rural inhabitants account for 68.7% in population structure (nearly 780 thousand people). According to new criterion in 2005, rate of poor households in the rural regions made up nearly 23%, the districts with high rate are A Luoi 52.6% and Nam Dong 60.3%. The agricultural land (including forestry and aquaculture) accounts for 62.2% of the province's natural area.

In 2000 - 2005, average GDP growth rate in Thua Thien - Hue province was 9.6%/year (from 2,199.5 billion VND to 3475.8 billion VND at the comparative price in 1994), in which agricultural economy area increased 4.2%/year (from 536.8 billion VND to 660.3 billion VND).

In the province's total product structure in 2005 (at the current price), economic density of agriculture - forestry - fishing accounted for 21.7%, 34.8% and service with the highest density 43.5%. In comparison with 2000, Thua Thien - Hue province's economic structure trended the progressive transfer such as density of agriculture - forestry - fishing from 24.1% to 21.7%, industry - construction increase from 30.9% to 34.8% and service still remains the lead with density from 45% to 43.5%. The active change of economy clearly reflected strengths which have been bringing into play in Thua Thien - Hue province.

4.2 Livestock situation

In past years, scale of cattle and poultry are trending to increase with slow speed (excluding pigs). The cattle put up slowly due to strongly declined pulling demand and limited ppastures. Besides, more and more increasing investment capital is difficulty for breeding households, particularly for ethnic groups of Nam Dong and A Luoi mountainous areas which are favorable to develop cattle. The poultry has recently speeded up unstably due to impacts of bird flu. Only pigs have increased the highest and rather stably due to suitable conditions to invest into production and sale market. The net meat output increased robustly against total output because of broad application of advanced techniques into Livestock(breeds, food, veterinary tasks...).

Table 7. Scale of main domestic animals in Thua Thien - Hue province

Unit: 1,000 heads

Lists	In 2000	In 2005	In 2006	In 2007	Average growth 2000-2007 (%/year)
Buffalo	32.0	32.2	36.9	38.0	2.49
Cows	22.2	23	28.2	28.0	3.37
Pig	203.2	264.8	270.5	266.8	3.97
Poultry	1,414	1,722	1,400	1,632	2.07

Source: *Statistic Yearbook of Thua Thien - Hue province in 2000 - 2007*

The pig breeding regions with considerable goods scale are Phong Dien, Huong Tra and Phu Vang (43 - 45.5 thousands heads each, making up about 50% of total number of pigs in the province). A herd of buffaloes concentrate on Phong Dien and Phu Loc (7.5 to more 8 thousand heads each, making up 48.3 of total number of pig in the province). Provinces of Nam Dong, A Luoi and Phong Dien has the biggest scale of cows from 3 thousand to 4.4 thousand heads each, making up 48.7% of total number of pig in the province). So far, Thua Thien - Hue province's livestock products mainly serve for domestic market.

4.3 Livestock development orientation by 2020

Thua Thien - Hue province's key livestock products are defined to be high quality beef and lean meat oriented pork, in which a part of meat output will be used to meet demand of constructing Binh Dien cattle processing plant in the province.

- Buffaloes develop stably from 38 - 40 thousand heads
- Cows are 30 thousand heads by 2010 and 35 thousand heads by 2020
- Pigs are 355 thousand heads by 2010 and 420 thousand heads by 2020
- Poultry are 2.95 million heads by 2010 and 4 million heads by 2020

5. Dong Nai province

5.1 Socio-economic conditions

Dong Nai province is located in Southeast Vietnam and Southern key economic zone, bordering Lam Dong province to the north, Binh Thuan province to the east, Ho Chi Minh City and Binh Duong province to the west, Ho Chi Minh City and Ba Ria - Vung Tau province to the south.

The province's socio-economy in recent years has changed actively for industrialization and modernization. The province's GDP growth in 2001-2005 achieved 12.8%/year, increasing 1.7 times as high as average national growth (7.5%/year) and strongly developed in 3 zones including zone I 6%/year, zone II 16.0%/year and zone III 12.1%/year; especially foreign invested economic zone

with high growth rate (20.7%/year).

The economic structure transfer pushed up acceleration of urban population structure from 29% (1995) to 30.81% (2005) and non-agricultural labor structure from 46% (2000) to 54.3% (2005); annually average non- agricultural labor force multiplied 1.66%. Average GDP per capita in 2005 was 12.7 million dong, equivalent to 806 USD and equal to 57% of average rate of Southern key economic zone (1,424 USD) and 1.3 times as high as average rate nationwide (640 USD). Rate of poor households in the province reduced very promptly from 12.59% (2000) to 0.89% (2005); rate of electricity and hygienic water using households in 2005 gained 97% and over 90% respectively.

5.2 Livestock situation

Because of traditional livestock regions together with advantages of ecological conditions, near sale market and particularly drastically improved feedstuffs processing company, the province’s Livestock in recent years has continued to robustly promote and achieved the following significant results:

Table 8. **Scale of main domestic animals in Dong Nai province**

Unit: 1,000 heads

List	In 2000	In 2005	In 2006	In 2007	Average growth 2000-2007 (%/year)
Buffalo	7.9	6.0	6.0	5.7	-4.56
Cow	53.2	86,6	98.5	107.4	10.56
Pig	580.8	1,140.1	1,235.2	1,105.2	9.63
Poultry	6,101	5,166	5,756	4,975	-2.87

Source: Statistic yearbook of Dong Nai province in 2003 - 2007

In 2000 - 2007, growth rates of pigs and cows were 9.6%/year 10.6%/year respectively, poultry alone decreased 2.9%/year but increased 5%/year before bird flu. Noticeably, livestock mode in the province in recent years has transferred strongly according to orientation of industrial Livestock, especially breeding pigs and fowl. The province had many breeding farms with scale of thousands of pigs and ten thousands of fowl, applying advanced breeding technique and ensuring hygiene and food safety. A number of pigs and fowl focus on the farms accounting for 40% of total herd in 2007.

5.3 Livestock development orientation by 2020

Livestock continues to promote and mainly concentrate on scale of farms and big enterprises. Close breeding procedures ensure requirements of environmental hygiene and food safety. It is expected to be 110 thousand cows, 1.4 million pigs, 7 million fowls by 2010 and 120 - 130 thousand cows, 1.8 - 2.2 million pigs and 11 - 13 million poultry by 2020.

6. Tra Vinh province

6.1 Socio-economic conditions

Tra Vinh province is located in the South of Mekong Delta, bordering Vinh Long province to the north, the sea to the south, Ben Tre province to the east and Soc Trang province to the west with a total natural area of 229,283 ha. The province has 8 administrative units under the province, including 1 town (Tra Vinh town) and 7 districts (Cang Long, Chau Thanh, Cau Ke, Tieu Can, Cau Ngang, Tra Cu and Duyen Hai).

Thanks to bringing into play strengths of natural conditional (no flood, rich land and various sea resources) and infrastructure preferred for past years, Tra Vinh province's economy achieve growth rate of 11.46%/year, 1.5 times as high as total average growth rate nationwide in 2001 - 2005

The province has active economic growth, in which growth rate of industry and construction is preponderant against ones of agriculture and service. Annually average growth rate (at the fixed price in 1994) was 20.5%/year in industry and construction, 17.01%/year in service and 8.35%/year in agriculture. However, Tra Vinh province is basically a poor agricultural one.

The agricultural sector has been upgrading strongly and deeply, the processing industry has changed and the service sector has operated rather well, especially export-import activities. The fields with favorable conditions developing quickly in agriculture, forestry and aqua-culture are to manufacture rice, sugar-cane, vegetables and secondary crop, fruit trees and aqua-cultural farming (shrimp, field fish, slippery skin fish...). Together with promoting its advantages of producing key goods of kinds mentioned above, it attached importance to constructing the agricultural and aqua-cultural product processing plants, most significantly processing aqua-cultural products and exporting rice and sugar.

6.2 Livestock situation

Livestock gained growth rate of production value much higher than cropping and it is an important factor in developing and transferring structure of agricultural production value.

A number of pigs increase drastically, development of farm breeding is attached importance and the farms' efficiency is rather high.

A number of buffaloes lessened but cows speed up very fast from 50.5 thousand heads in 2000 to 145.4 thousand ones in 2007. Tra Vinh province is the most successful in developing of buffaloes and cows in Mekong Delta.

Poultry rather developed in 2000 - 2003, and then seriously declined due to effects of bird flu from 3.75 billion heads in 2002 to 2.48 million ones in 2005 and 3.23 million one in 2007.

Table 9. Scale of domestic animals in Tra Vinh province

Unit: 1,000 heads

List	In 2000	In 2005	In 2006	In 2007	Average growth 2000-2007 (%/year)
Buffalo	7.6	2.8	2.5	2.4	-15.18
Cow	50.5	117.9	141.8	145.4	16,31
Pig	225.2	370.5	351.5	380.9	7.80
Poultry	3,422	2,431	2,991	3,232	-0.81

Source: *Statistic yearbook of Tra Vinh province in 2007*

The most obvious limitations in the province's livestock development are scattered small sized production, passive food distribution, undeveloped processing, not having concentrated breeding zones, limited treatment and usage of Livestock waste, uncontrolled epidemic diseases, rather high Livestock price and not expanding export market. Besides, the sale market of pork and poultry meat is Ho Chi Minh City facing with severe competition of Livestock in Southeastern region.

6.3 Livestock development orientation by 2020

Livestock need to develop with main domestic animals of pigs and cow for food, recover and strongly promote a herd of fowl, move from scattered livestock to farm livestock, construction the breeding zones far from residential areas, gradually apply medium and large sized livestock, improve product quality, deduct livestock price, attach importance to waste treatment in order to reduce environmental pollution and supply energy for production and living.

Its scale is expected 150 thousand cows, 450 thousand pigs, 3.8 million poultry by 2010 and 180 - 200 thousand cows, 520 - 550 thousand pig and 4.2 - 4.5 million poultry by 2020

II. GENERAL ASSESSMENT ON BIOGAS PROJECT IN THE PROVINCES.

1. Advantages and difficulties of biogas project in provinces.

1.1. Advantages

Propagandizing benefits of biogas project includes activities of disseminating, broadcast on the mass media, organizing disseminating, popularizing for potential households through seminars, distributing materials and field works... held annually by the officer and staffs of biogas project in the provinces, helping many households take part in the project. In addition, the relevant authorities often propagandize and popularize active impacts of biogas plant to people, contributing to improving people's awareness on benefit of biogas plant as well as their participation in the program.

System of technicians and masons who are professional, skilled, experienced and enthusiastic was trained for biogas project in the provinces. This is an active force in propagandizing and mobilizing the households to

participate the project.

The members of biogas project office in the provinces always take high responsibilities for implementing the program actively supported by Central office of biogas project closely coordinated with local authorities of districts and communes, ensuring to organize and perform the program's activities synchronously and effectively.

Biogas project in the provinces are always concerned and directed by People's Committee and Agriculture and Rural Development Department of the provinces.

1.2. Some difficulties

During 2 initial years of realizing WTO commitment to reducing import tax of cattle meat, Vietnam slowed down import tax of meat products lower than committed level when accessing to WTO, making purchasing price of Livestock products drop. Even the import meat's price was lower than domestic production price and this made a range of the breeders gave up this job.

Up to now, Government has adjusted the import tax. Thus, livestock is more profitable, people started to breed again and expand the livestock scale. And the construction size projects in previous years are now very small (such as provinces of Tra Vinh and Dong Nai).

At present, the provinces are focus on concentrated and industrial raising method and gradually reduced and stop raising livestock in the residential areas (such as provinces of Dong Nai and Ha Tay). However, the progress of implementation is rather slow, making people feel unsecured to invest into livestock including investing into construction of biogas project.

Besides, cattle's epidemic diseases happening on a large scale along with highly increasing food price also seriously affected livestock of many provinces. So the provinces had difficulties in enlarging the biogas project (Dong Nai and Thua Thien - Hue provinces)

Prices of construction materials and labors also increased rapidly and unmanageable. The average construction price of 1 m³ from 0.52 - 0.60 million VND in 2005 increased to 0.74 - 1.16 million VND in 2007, 2008 impacted on construction investment of biogas project. Many households had no financial source to cope with constructing the project while the aids still remain at 1 million/project.

Because the land use area of majority of urban households is low, many livestock households have not enough space to construct the biogas project.

Bad weather, rain, storm and flood are also difficulties in realizing the project construction, influencing on the progress of many provinces such as Ha Tay, Dong Nai, Thua Thien - Hue and Tra Vinh.

The construction progress of biogas project in the provinces generally gained good results although trained technicians and masons increased uncorrespondingly. Thus, supervising, supporting, propagandizing and implementing other support and consultant services also had difficulties (such as in Dong Nai)

2. Results of project implementation in 6 provinces in October 2008

Among 6 provinces selected to survey, Dong Nai and Thua Thien - Hue provinces took part in the project in the initial years (period I), Ha Tay and Son La province in 2006 (bridging year), Bac Giang and Tra Vinh in 2007 (the first year of period II). The results of project implementation in 6 provinces as from date of participating until survey time are as follows:

Table 10. Implementation results from 6 selected provinces

Criterion	Dong Nai	TT - Hue	Ha Tay	Son La	Bac Giang	Tra Vinh
1. Total number of plants built	2,049	2,226	2,239	446	1,044	286
2. Number of trained technicians	14	16	23	15	12	12
3. Number of trained mason	30	36	43	36	18	25
4. Number of articles, televisions, broadcasts and field trips	169	105	118	80	20	5
5. Number of folded papers printed	7,000	1,500	8,600	2,550	1,000	542
6. Models built	8	9	3	2	-	1

Source: Offices of Biogas Project in the provinces

2.1 Dong Nai province

Dong Nai is one of 12 provinces took part in the project during the initial years. So far, almost the peasants in the provinces have understood practical benefits of the biogas project. The extension system from provincial level down to districts and grassroot level (communes, villages) was operated largely, closely coordinated and took highly responsibility for the tasks assigned.

The results of project implementation from 2003 to now in Dong Nai PBPD are as follows:

- Construct 2,049 plants all over the districts and towns.
- Organize over 100 seminars on disseminating and 330 user training courses in the basic units;
- Train 14 technicians and over 30 masons for the province and districts. This staff was trained regularly, experienced and enthusiastic to work;
- Build 8 models using by-products of biogas project and these models

have been bringing active efficiencies for people.

2.2 Thua Thien - Hue province

Thua Thien - Hue province has taken part in the project during the initial years. The province often has impacts of annually heavy rains. Especially from October to November, the plant can not be implemented due to flood and high underground water level, affecting the process of project implementation in the province. So far, the results of project implementation in the province are as follows:

- Construction of 2,226 plants in 122 communes and wards under 8 districts and town in the province (accounting for 80% of total communes and wards in the province)
- Organization about 50 seminars on disseminating and 250 user training courses;
- Training 16 technicians and 36 masons;
- Periodically hold discussions to exchange experiences between technicians and masons in the provincial project (2 times/ year)
- Building 8 models using by-products and 1 model using biogas in the whole province;
- Receiving the international delegations such as Dutch Ministry of Foreign Affairs, Dutch Embassy and delegations of UK House of Lords

2.3 Ha Tay province

Ha Tay province has participated in the project since 2006 (bridging year). Now the plants are well operating and people are so happy. Their awareness on effectiveness of building biogas plants is improved. They are considered it as one of the effective measures to protect rural environment and supply fuel for their daily uses.

The results of Ha Tay PBPD are:

- Construction of 2,239 plants, mainly kinds of plants KT1 in 15 districts and towns.
- Organizing over 50 seminars on disseminating and nearly 200 user training courses for people in order to help them learn the project, benefits of biogas plant, how to operate, maintain the biogas plant and how to use the by-products of biogas.
- Frequently monitoring and checking the quality of biogas plants during project implementation.
- Training 23 technicians in the province and districts and 43 masons. They are the key staff in the basic units to help the districts to perform the project

effectively.

- Frequently hold the seminars on exchanging the project implementation and proposing the solutions for the next years between technicians, masons and provincial project management board (3 times/ year)

- Building 02 models using by-products and 1 model using biogas. These models help people be conscious of the project's benefits.

2.4 Son La province

Son La province - a mountainous one of Northwestern Vietnam has taken part in the project since 2006 (bridging period). During 2 years, the project is highly appreciated by people, society and relevant agencies and local government for its efficiency and practical benefits. So far, there is one village that has 100% households constructed biogas plants. Son La PBPD made efforts to gain the following results:

- Construction of 2,226 plants in 10 communes and towns in the province

- Organization of 14 seminars on disseminating and 57 user training courses for households to build the biogas plants;

- Training 15 technicians in province and districts and 36 masons in the districts;

- Building 2 models using by-products

2.5 Bac Giang province

Bac Giang province is one of the provinces taking part in the project since 2007 (the first year to implement the project of period II). From the first year to participate in the project, the province completed the plans assigned with the following results:

- Construction of 1,044 plants in 10 communes and towns in the province

- Organization of 20 seminars on disseminating and 64 user training courses;

- Training 12 technicians in province and districts and 18 masons;

- Frequently organizing the delegations to evaluate the project's quality in the districts and towns;

2.6 Tra Vinh province

Tra Vinh province located in Mekong Delta has taken part in the project since 2007. During the process of implementation the project, Tra Vinh province has disadvantages of unstable geological structure, bad weather (heavy rains) and high underground water level, bringing about slowly executed progress, materials losses and high labor cost. However, Tra Vinh PBPD tried incessantly to complete the proposed criteria, specifically:

- Construction of 286 plants in 8 communes and towns in the province;
- Organization of 10 seminars on disseminating and 25 user training courses;
- Training 12 technicians in province and districts and 25 masons;
- Building 1 models using by-products of biogas in the households.

III. RESULTS OF SURVEY ON BIOGAS USERS IN 2008

1. Information about households selected to survey.

1.1. Total number of households to survey

The survey on biogas users in 2008 was carried out with survey scale of 260 households, including 180 households of biogas user and 80 non-biogas user households spreading in 6 provinces of Son La, Ha Tay, Bac Giang, Thua Thien - Hue, Dong Nai and Tra Vinh. The households selected randomly according to list provided by the project office. However, Thua Thien - Hue province had some household to be changed due to flood in the survey process.

Table 11. Total number of households to survey

No	List	Total number	Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
	Total number of households	260	43	42	49	42	44	40
1	Biogas user households	180	31	30	31	30	31	27
2	Non biogas user households	80	12	12	18	12	13	13

Source: BUS survey 2008

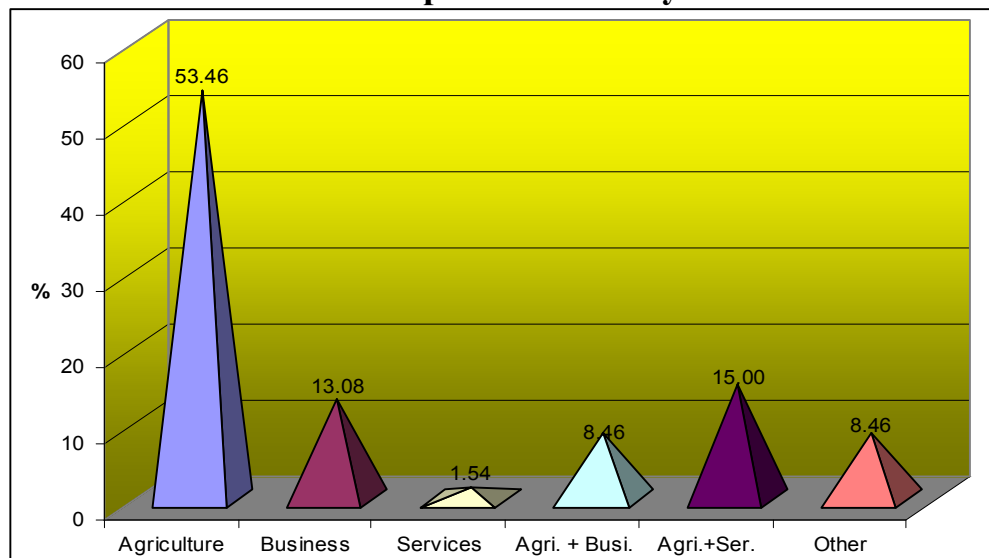
1.2. Information about households to survey

1.2.1. Some general information about households to survey

An average number of members in a household are from 4 to 5 people, including about 2-3 people at working age. An average number of members and people at working age in the household using and not using the biogas plants have a considerable difference between the survey provinces. Scale of people in a household is at average level. With this scale, if a household raises 4 pigs for food (total weight of 150 kg) and builds a biogas plant with capacity of 4 - 5 m³, they will meet requirements of treating livestock waste daily and provide energy to serve for activities such as cooking and lighting.

The householder's main occupation: among surveyed 260 households, a number of the sole agricultural households account for 53.5%, the business households 13.1%, the agriculture and service households 15.0%, the agriculture and business households 8.5%, other households (employing or working as a worker in other places...) 8.5%. The main occupational structure of households using and non using biogas are not much different.

Chart 1. Main occupation of surveyed households



The household’s educational level is high school education (making up 96.9% of total households to survey), including 52.7% household heads under the high school education and 44.2% household heads at the high school education. The household head with intermediate education only account for 3.1%. Due to the household head’s limited educational level, disseminating on using the biogas plant must be realized frequently, applying direct communication methods with the easiest and most effective presentation.

Table 12. Some information about surveyed households

No	List	Unit	Total	Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
1	Average number of members								
-	Biogas user household	people	4.8	4.5	4.6	5.0	5.1	5.2	4.4
-	Non-biogas user household	people	4.8	4.5	5.2	5.1	4.3	4.8	4.6
2	Average number of labor								
-	Households using the biogas plants	people	2.7	2,6	2.7	2.8	2.5	3.0	2.9
-	Households not using the biogas plants	people	2.9	2.8	3.1	2.7	2.8	2.8	3.2
3	Main occupation	%	100	100	100	100	100	100	100
	Agriculture	%	53.46	58.14	78.57	34.69	54.76	52.27	45.00
	Business	%	13.08	-	-	32.65	2.38	20.45	20.00
	Service	%	1.54	4.65	2.38	2.04	-	-	-
	Agriculture + Business	%	8.46	4.65	9.52	8.16	9.52	9.09	10.00
	Agriculture + Service	%	15.00	9.30	9.52	16.33	19.0	13.64	22.50
	Others	%	8.46	23.26	-	6.12	14.3	4.55	2.50

No	List	Unit	Total	Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
4	Household's education	%	100	100	100	100	100	100	100
	Under the high school education	%	52.69	74.42	80.95	8.16	73.8	13.64	75.00
	High school education	%	44.23	20.93	14.29	91.84	19.1	86.36	22.50
	University education	%	2.69	2.33	4.76	-	7.14	-	2.50
	Over university education	%	0.38	2.33	-	-	-	-	-

Source: BUS survey 2008

1.2.2. Average income of surveyed households

Average income of biogas user households is 69.66 million VND/household/year, including income per capital 14.49 million VND/person/year (equivalent to 1.2 million VND/person/ month). Among the provinces to survey, Tra Vinh province is the highest per capita average income of biogas user households of 21.02 million VND/person/year and Thua Thien – Hue province is the lowest 9.5million VND/person/year. This difference is mainly due to the households' breeding scale in Tra Vinh province larger than other provinces.

Average income of non-biogas user households is 47.05 million VND/household/year, including income per capital 10.17 million VND/person/year (equivalent to 850 thousand VND/person/ month). Among the provinces, Son La province is the lowest per capita average income of non-biogas user households of 15.98 million VND/person/year and Thua Thien – Hue province is the lowest 6.52million VND/person/year.

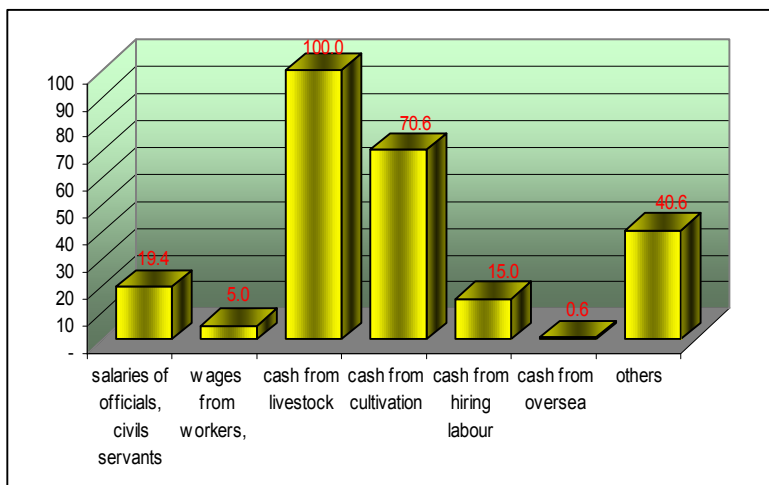
Table 13. Average income of surveyed households

<i>Unit: mill.VND</i>								
No	List	Total number	Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
1	Average income of household per year							
-	Biogas user households	69.66	80.48	69.39	50.16	48.43	79.78	91.86
-	Non -Biogas user households	47.05	69.63	46.03	42.78	27.25	51.11	47.25
2	Average income of household per year							
-	Biogas user households	14.49	17.82	15.09	9.97	9.50	15.46	21.02
-	Non -Biogas user households	10.17	15.98	9.17	8.14	6.52	11.16	10.92

Source: BUS survey 2008

Average income of non-biogas user households is lower than biogas user households in all provinces because this survey paid attention to assess the considerable poor households and they are also non-biogas user households.

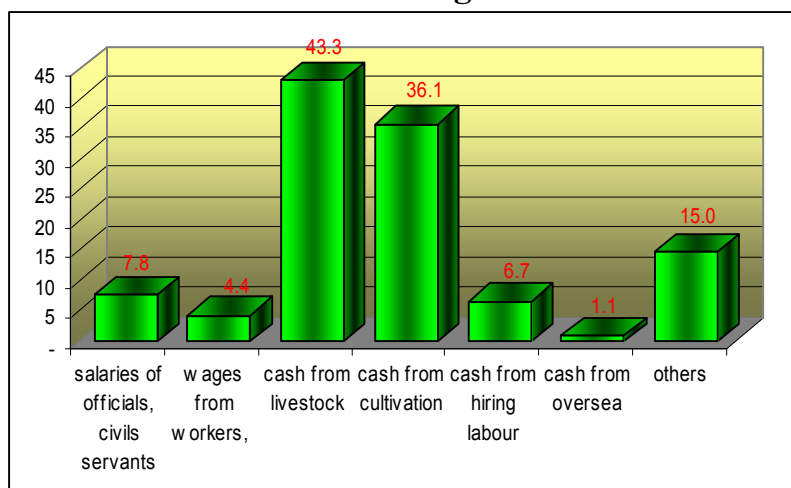
Chart 2. Main income sources of biogas user household



The main income of biogas user households is from livestock (100% of total households), cultivation (70.6% of total households), worker wage (19.4% of total households) and others such as business, service and hired labor (40.6% of total households)

Chart 3. Main income sources of non-biogas user household

The main income of non-biogas user households is from livestock (43.3% of total households), cultivation (36.1% of total households), worker wage (7.8% of total households) and others (15.0% of total households)



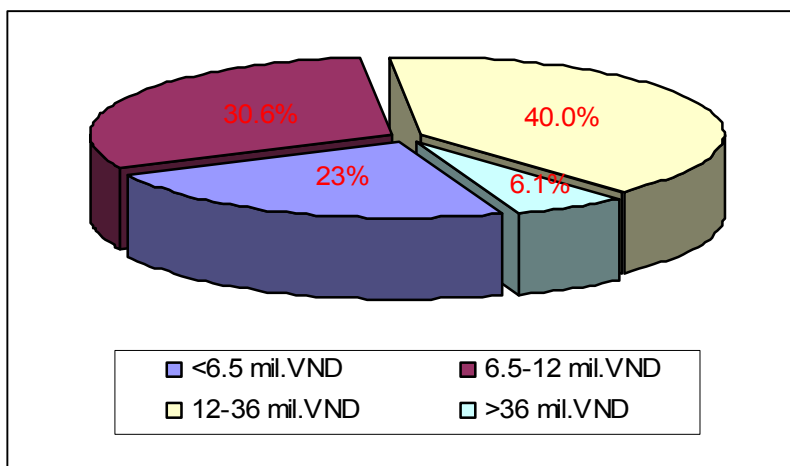
1.2.3. Classify households based on income

According to poor household defining convention of this survey, the poor household is with average income per capita of less than 540.000 VND/person/ month, equivalent to 6.5 million VND/ person/ year. The medium household is with average income per capita from 6.5 to <12 million VND/ person/ year. The fair household is with average income per capita from 12 to <36 million VND/ person/ year; the rich household is with average income per capita of 36 million and over

Among 180 biogas user households , the poor households made up 23.33% of total households (with average income per capita of less than 6.5 million VND/ person/ year); the medium households occupied 30.56% of total households (with average income per capita from 6.5 to <12 million VND/

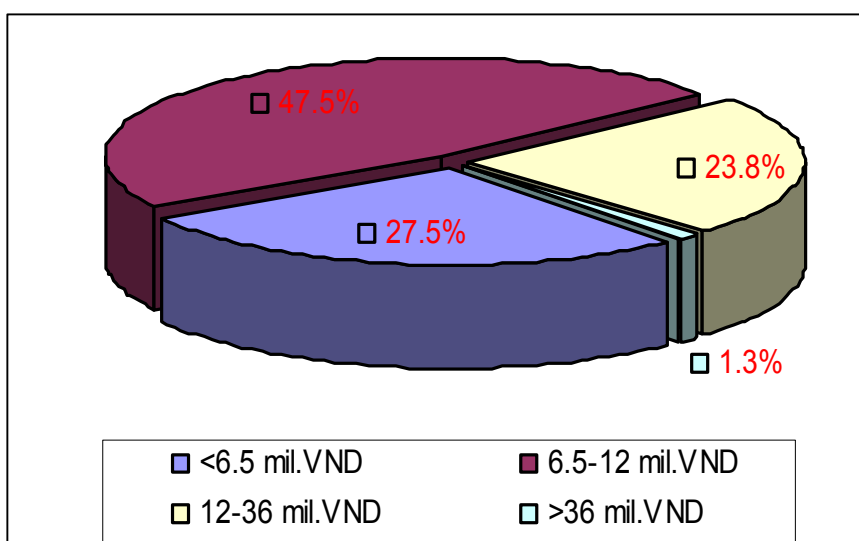
person/ year); the better off households accounted 40% of total households (with average income per capita from 12 to 36 million VND/ person/ year) and the rich households consisted of of 6.11% of total households (with average income per capita more than 36 million VND/ person/ year).

Chart 4. Distribution of average income of biogas user households



Among 80 non-biogas user households, the poor households made up 27.50% of total households (with average income per capita of less than 6.5 million VND/ person/ year); the medium households 47.50% of total households (with average income per capita from 6.5 to <12 million VND/ person/ year); the fair households 23.75% of total households (with average income per capita from 12 to 36 million VND/ person/ year); the rich households 1.25% of total households (with average income per capita more than 36 million VND/ person/ year).

Chart 5. Distribution of average income of non-biogas user households



It is very clear to see that the average income of biogas user households is higher than those of non-biogas user household. There were 46,11% of biogas user household with income more than 12mill/person/year as comparing with that of 25% of non-biogas user households.

1.2.4. Information on construction of biogas plants from biogas user households

This survey is to collect assessment opinions of representatives from the households participating in the project since the first years. Among 180 biogas user households had been assessed, there were 6 households that built the plants in 2003, 16 built in 2004, 15 households built them in 2005, 32 households built them in 2006, 58 households buildt them in 2007 and 53 households built them in 2008.

Dong Nai and Thua Thien - Hue provinces have participated in the project during the first years. The selected households using the biogas plants in these provinces included 19 households building the plants before 2005, 15 households building them in 2005, 8 households building them in 2006, 7 households building them in 2007 and 9 households building them in 2008.

Ha Tay and Son La provinces took part in the project in 2006 with 24 households building the plants this year inquired in 2 provinces, 40 households building them in 2007 and 7 households building them in 2008.

Bac Giang and Tra Vinh provinces took part in the project in 2007, with 23 households building the plants this year and 37 households in 2008

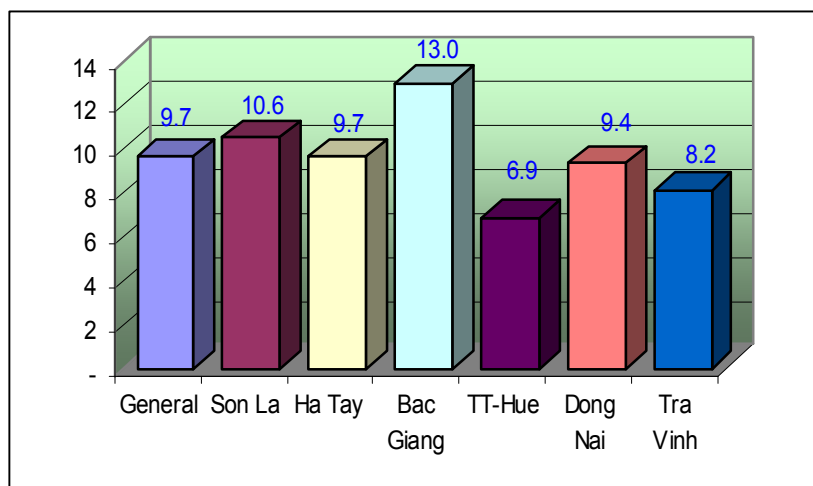
Table 14. Information on surveyed biogas plants by provinces and by year of construction

No	List	Unit	Total number	Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
1	Plant construction year	Plant	180	31	30	31	30	31	27
	In 2003	Plant	6	0	0	0	1	5	0
	In 2004	Plant	16	0	0	0	5	11	0
	In 2005	Plant	15	0	0	0	11	4	0
	In 2006	Plant	32	11	13	0	4	4	0
	In 2007	Plant	58	18	12	15	6	1	6
	In 2008	Plant	53	2	5	16	3	6	21
2	Average volume of the plant	Cubic meter	9.7	10.6	9.7	13.0	6.9	9.4	8.2

Source: BUS survey 2008

Average size of the biogas plant in the households is 9.7m³, in which the largest average is the 13m³ plant of the households in Bac Giang province and the smallest is the 6.9m³ plant of the households in Thua Thien - Hue province.

Chart 6. Average size of constructed biogas plant (m³)



2. Assessing the biogas project’s service quality

2.1 Assessing the situation of biogas plant

2.1.1 Assessing the plants based on the construction year

Average volume of the biogas plant trends to increase. It was 6,7 m³ in 2003, 8.3 m³ in 2006, 8.83 m³ in 2006, 10.8 m³ in 2007 and 9.9m³ in 2008.

Assessing the suitable level of plant size: 88.3% of total households thought that their plant size is appropriate to their family’s usage, 1.1% of total households evaluated it was too big and 10.6% of total households evaluated it was too small. The plant size in previous years was small but now majority of the households appreciated the plant with suitable volume. In 2008, there were 2 household in Tra Vinh province (3.8% of the sample survey) assessed it was too small and 1 household in Bac Giang province (accounting for 1.9% of total households) evaluated it was too big.

Table 15. Digester size and its suitable level

No	Criteria	Unit	Total	2003	2004	2005	2006	2007	2008
1	Average digester size per plant	m ³ /plant	9.68	6.71	8.74	8.22	8.83	10.81	9.91
2	Assessing the suitable level of digester size	100	100	100	100	100	100	100	100
-	Suitable	%	88.33	83.33	93.75	93.33	71.88	89.66	94.34
-	Too big	%	1.11	-	-	-	3.13	-	1.89
-	Too small	%	10.56	16.67	6.25	6.67	25.00	10.34	3.77
3	Rate of the plant having connection to the toilet	%	48.33	33.33	25.00	40.00	62.50	58.62	39.62

Source: BUS survey 2008

Rate of biogas plants attached with the latrine is 48.3% total number of plants; in which in 2003 there was 33,3%; that of percentage in 2004 was 25,0%, and 40% in 2005; 61.3% in 2006 and 58.6% in 2007 but reduced to 39.6% in 2008. This rate depends on additional work built in the households. At present, if any household has not built the additional work yet, the breeding area will be required to build near the latrine in order to gather stools into the input tank and save construction cost of the digester tank.

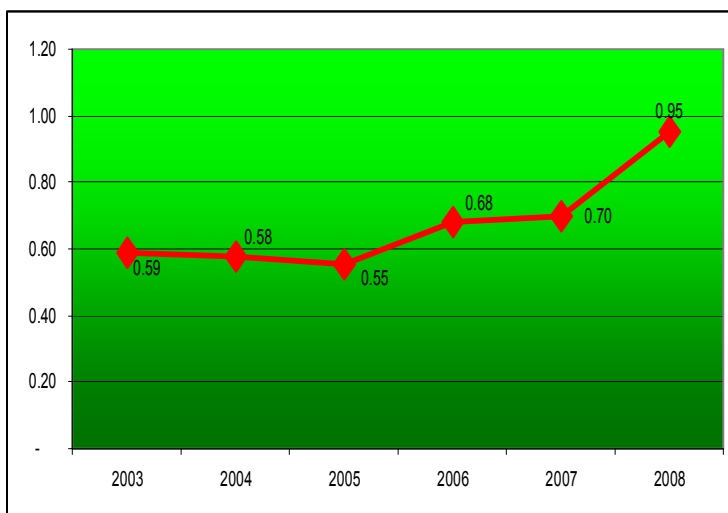
Average construction cost of the biogas plants is increased from 3.88 million VND/plant (for the plant built in 2003) to 9.05 million VND/plant (in 2008). The households building the plants were supported 1 million VND/plant but in Son La province alone, the households were added 0.5 million VND from counter part fund. The remaining cost was paid by the households.

In recent years, the prices of materials and labor are increasing that also made construction cost rising too. Even the supported amount of 1million VND/plant from project hasnot yet changed over past years, however the households have learnt that all benefits from the biogas plants support for their life and they continue to participate to the project enthusiastically. In 2008, apart from the project’s investment capital to build the plants, each households must pay 7.02 million VND and get support 1 million VND.

This amount is rather big for majority of the peasant households. According to Mr. Ta Van Tan (in Chieng Pan commune, Yen Chau district, Son La province), his family completed a 12-m³ plant with 8 million VND. When receiving the project’s aid, he was ready to register to build the plant. However, he tried to save money to build the biogas plant because he realized obvious benefits of the biogas plant. An amount of gas from the biogas plant in his family is now redundant. He uses it not only to cook rice but also to cook mash for pigs, making local wine and light by the biogas lamp.

2.1.2 Assessment on construction cost of 1m³ of biogas plant

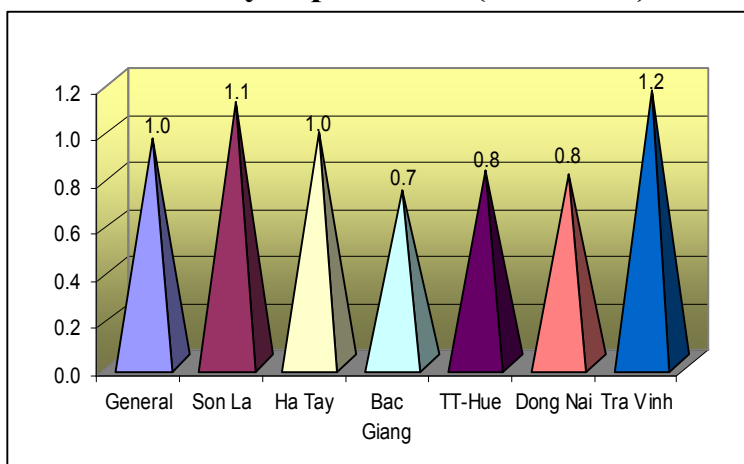
Chart 7. Construction cost per 1m³ by year of construction (mil. VND)



In prior years, the construction cost of 1m³ plant had not much difference among the provinces. But the cost is 0.95 million VND in 2008, double against in 2005 (0.55 million VND). On other hands, there was a considerable difference in the cost of 1m³ plant among the provinces from 2007 to 2008.

In 2007, constructing 1 m³ plant cost 1 million VND in Dong Nai province but 0.62 million VND in Bac Giang province. The difference was 0.38 million VND. The difference in construction cost of a 9 - 12m³ plant between 2 provinces was 3.5 - 4.5 million VND/ plant.

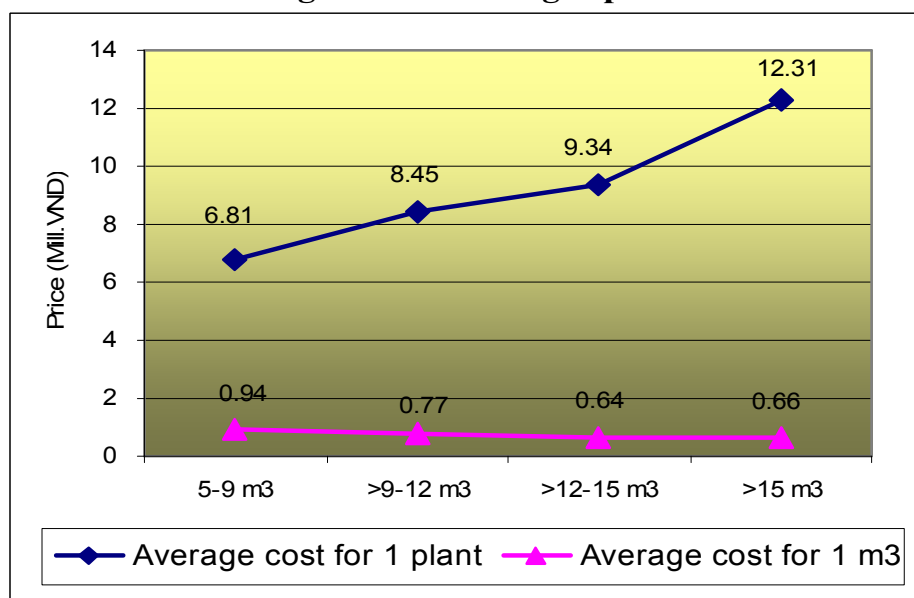
Chart 8. Construction cost per 1m³ in 2008 at surveyed provinces (mil. VND)



In 2008, construction cost of 1m³ plant was 1.16 million VND in Tra Vinh province but valued 0.74 million VND in Bac Giang province. The difference was 0.42 million VND. The difference in construction cost of a 9 - 12-m³ plant between 2 provinces was 3.8 - 5.0 million VND/ plant.

It can be said that the construction cost of the plants in the Southern provinces is rather higher than that of Northern provinces in the same year.

Chart 9. Average Cost of 1 biogas plant in 2007 - 2008



The construction cost of a biogas plant includes cost of materials, labor (digging and building the plant) and buying the biogas appliances (biogas cooker and lamp). In this survey, the consultant group inquired the detailed cost to build the biogas plant in each locality. The following is the construction cost of the 6 - 6.5m³-biogas plant in Thua Thien - Hue and Tra Vinh provinces.

Table 16. Detailed construction cost of the biogas plant in survey time (for bigas plant 6-6.5m³).

No	Item	Unit	Thừa Thiên - Huế			Trà Vinh			Compared (1000VND)
			Quantity	Unit price (1000VND)	Amount (1000VND)	Quantity	Unit price (1000VND)	Amount (1000VND)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)=(9)-(6)
I	Cost of materials				3,072.0			3,475.0	403.0
1	Cement	Ton	0.9	1,050.0	945.0	0.8	1,200.0	960.0	15.0
2	Solid brick	brick	900.0	1.3	1,170.0	2,100.0	0.7	1,470.0	300.0
3	Sand	m ³	2.0	55.0	110.0	2.0	100.0	200.0	90.0
4	Gravel	m ³	2.0	120.0	240.0	0.7	250.0	175.0	-65.0
5	Entrance and exit pipes	m	3.0	70.0	210.0	2.8	120.0	336.0	126.0
6	Steel 6	kg	6.0	17.0	102.0	5.0	16.0	80.0	-22.0
7	Gas collecting pipe	m	1.0	30.0	30.0	1.5	30.0	45.0	15.0
8	Conductor wire	m	20.0	6.0	120.0	15.0	6.0	90.0	-30.0
9	Manometer	piece	1.0	45.0	45.0	1.0	45.0	45.0	0.0
10	Valve T, cuzee	set	1.0	100.0	100.0	1.0	74.0	74.0	-26.0
II	Cost of biogas using devices				420.0			640.0	220.0
1	Biogas double-cooker	piece	1.0	350.0	350.0	1.0	520.0	520.0	170.0
2	Lamp	piece	1.0	70.0	70.0	1.0	120.0	120.0	50.0
III	Cost of labor				1,800.0			2,040.0	240.0
1	Main building	Manday (Skilled)	6.0	120.0	720.0	12.0	100.0	1,200.0	480.0
2	Additional building	Manday (Skilled)	6.0	100.0	600.0	7.0	60.0	420.0	-180.0
3	Digging the earth	Manday (Un-skilled)	8.0	60.0	480.0	7.0	60.0	420.0	-60.0
	Total				5,292.0			6,155.0	863.0

Source: BUS survey 2008

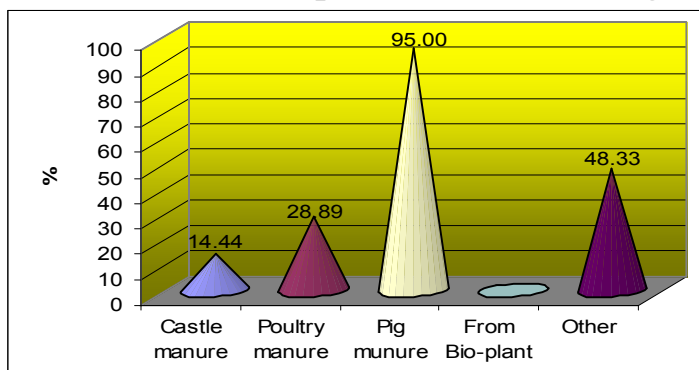
In order to have biogas plant of 6m³, people in Tra Vinh should pay more 863 thousand VND if comparing to Thua Thien - Hue province. The reasons are below:

- Material costs in Tra Vinh is more expensive than that of Thua Thien Hue. Unit cost of sand and gravel in Tra Vinh are 2 times higher than in Thue Thien Hue; Expences on biogas consumed equipment or biogas appliances also is 1,5 times higher.

- The unit price of the labor cost in Tra Vinh province is lower than one in Thua Thien - Hue province, however the cost norm for main mason is higher than Thua Thien - Hue that lead to the labor cost in Tra Vinh increasing 240 thousands VND compared to that of Thua Thien Hue.

2.1.3 Assessment on biogas plants operation in the households.

Chart 10. Main input materials for biogas plant



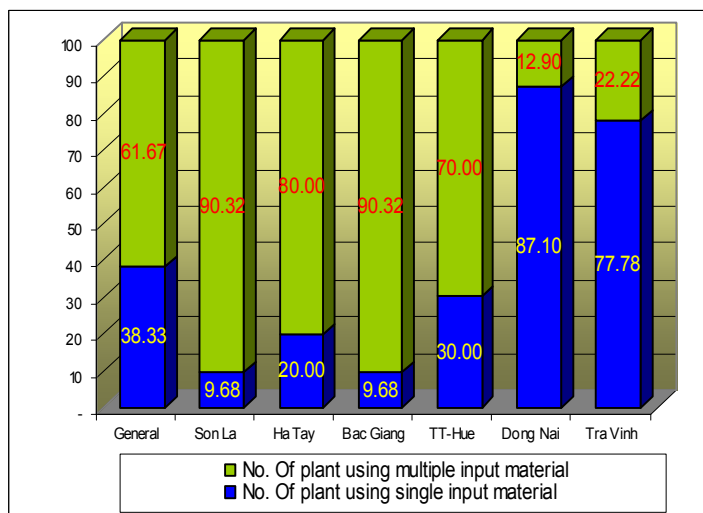
The raw materials to provide for the biogas plants in the households are stool and dung. No households use vegetation. The main materials used are dung of pigs (90 - 100% of total plant); and stool (48.3% of total plant coupled with latrine).

61.7% of the household inquired use mix materials (manure waste of several animals) and 38.3% the remaining only use single type of material. The Northern provinces of Son La, Ha Tay, Bac Giang and Thua Thien - Hue use many kinds of raw materials to provide for the plant (70 - 90% of the households inquired in each province). Majority of the households in Tra Vinh and Dong Nai provinces (78 - 87% of the households inquired) only use a single kind of raw material (often dung of pigs). In general, Northern provinces tend to use combined input material for biogas plant while in Southern provinces, farmers use single type of input material.

Chart 11. Form of inputting material for the plant

Almost the households evaluated that the quantity of raw material to supply for the plant is enough. Only 6 households said that it is not enough, including 3 households in Ha Tay province, 2 ones in Thua Thien - Hue province and 1 one in Dong Nai province.

When building the biogas plant, the households was trained the method to provide the raw materials. The biogas handbook distributed by the project also gave the specific instructions of steps how to provide the raw materials.

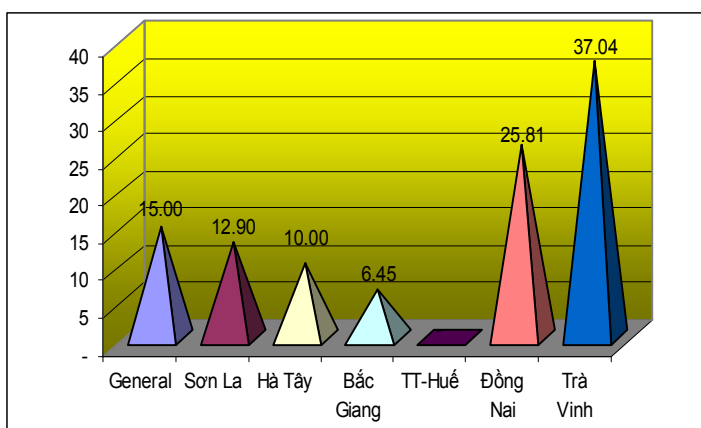


The correct method is to put the manure in the input tank, add water to dilute in the ratio of 1l - 2l water of 1 kg manure, stir and mix regularly, and then open the cover so that the mixture flow into the digester tank. When being asked how to provide the raw materials, 35.6% of the households provide quantitatively; 49.4% of the households provide approximately and 15% of the

households (27 households) provided inappropriately (not follow correctly the project’s guidances) .

A number of households providing wrongly concentrate in Tra Vinh province (10 households of 27 ones providing wrongly). This is a new province participating in the project, so the users are inexperienced. Yet, Dong Nai province taking part in the project during the initial years has 8 households providing wrongly.

Chart 12. Percentage of Household that inputting material inappropriately(%)



The water source to provide for the plant: among 180 households inquired, 165 ones use the drilling well-water and deep well water to dilute the mixture; 10 one use the tap-water, 1 one uses the rain-water and 4 ones use other water sources. According to the households’

assessment, the water source used to dilute the mixture, ensuring the project’s correct instructions. The households must not be discharged the soapy water or other detergent and not let water for bathing people and pigs flow into the biogas plant...in order to avoid killing the fastidious bacteria or the surplus water pushing amount of disintegrated manure out.

2.1.4 Assesment on maintenance of the biogas plant in the households

Stirring the solution and breaking the scum are technical requirements in operation and maintaining the biogas plants. The biogas handbook mentions that the households must stir the solution and break the scum daily by using a pole, at the same time scoop the disintegrated solution from the compensation tank into the input tank in order to stir and break the scum.

Chart 13. Stirring and breaking scum situation (% biogas plant)

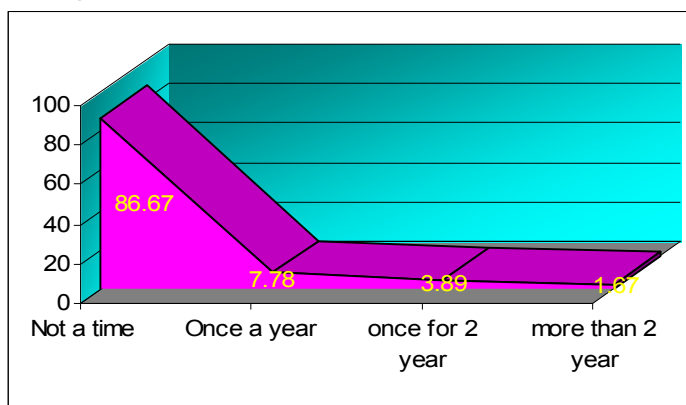
As the actual survey, the households learnt consequences of scum and sediment. The scum prevents the air from escaping and the sediment makes the digester tank be reduced its cubic capacity and block the entrance pipe... However, among 180 households



asked, 140 ones (77.8% of total households) never stir the solution and break the scum; 15 ones performed once several days and 22 ones forget how often to implement. Only 3 households in 3 provinces of Ha Tay, Bac Giang and Tra Vinh carry out this task everyday.

Besides, the biogas user households must leave scum and deposit sediment. This technical requirement is also interested by many biogas user households. 156 households of 180 households studied said that they never left scum and deposited sediment; 14 ones did once a year; 7 ones did once 2 years and 3 ones did once over 2 years.

Chart 14. Percentage of household that removed residuals (% biogas plant)

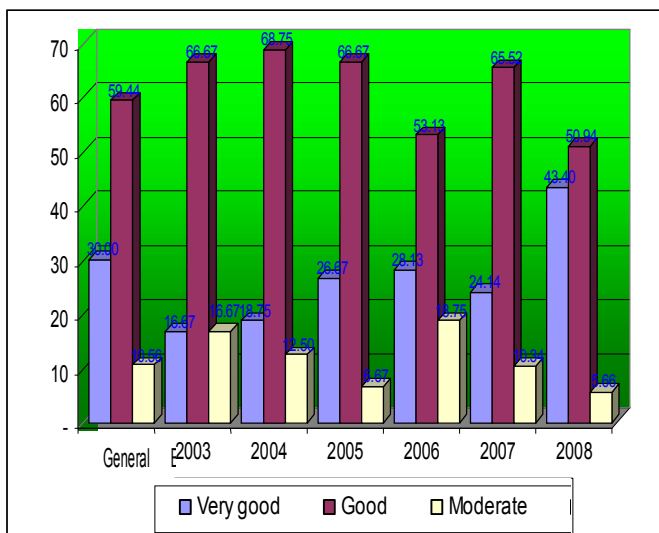


2.1.5 Assessment of the plant quality

The biogas plant quality is assessed through the process of operating the plant in each household. The households inquired will evaluate the plants using at the levels such as extremely good, good, normal and degraded.

According to evaluation of biogas user households, the extremely well operating plants are 30%, the well operating ones are 059.4% and the normally operating ones are 10.6%. No plants are degraded.

Chart 15. Quality of biogas plant by year



Yearly assessment: 6 biogas used households built in 2003 indicated 16,7% of very well-operating biogas plants, 66,6% of well- operating biogas plants and 16,7% as of normal condition. For 16 household having the plant built in 2004, they assessed that : 18,7% of very well- operating biogas plants, 68,8% of well- operating biogas plants and 12,5%

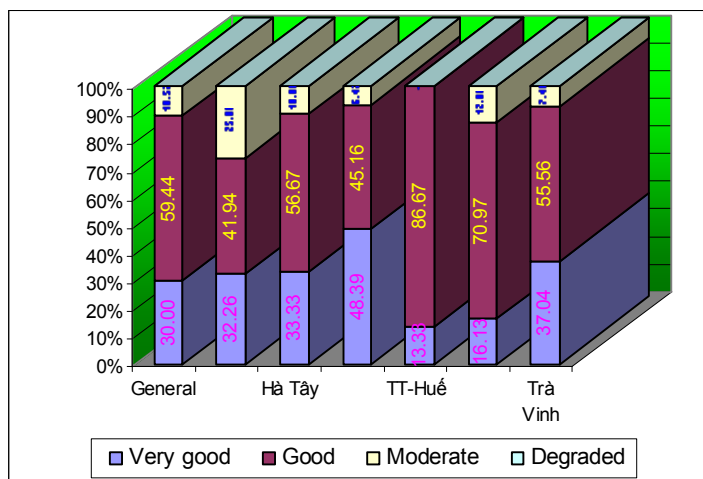
as of normal condition; for those 15 households in 2005: 26,7% of very well-operating biogas plants, 66,7% well- operating biogas plants and 6,6% as normal condition.

31 households using the biogas plants in 2006 evaluated 28,1% the extremely well operating plants, 53,1% the well operating ones and 18,8% the normally operating ones. 58 households using the biogas plants in 2007 assessed the extremely well operating plants (24.1%), the well operating ones (65.5%) and the normally operating ones (10.3%).

Among 53 households using the biogas plants in 2008, 43.4% ones appreciate the plants operating extremely well, 50.9% ones assess them operating well and only 5.7% on think they are operating normally.

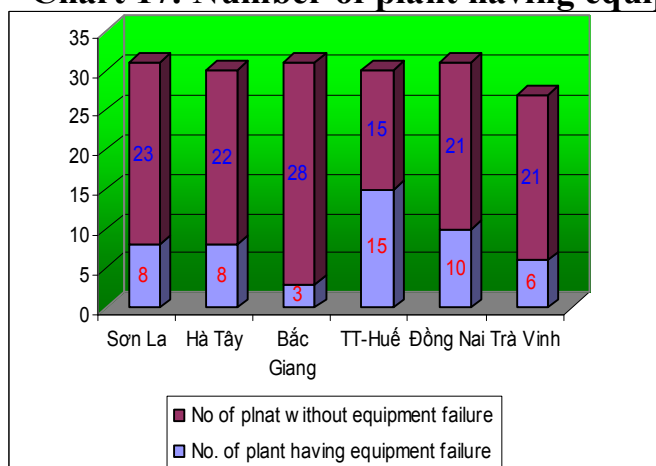
Chart 16. Quality of Biogas plant by province

There is much different from evaluating quality of the using plants. Majority of households claimed that the plants are well operating and extremely well. Thua Thien - Hue province has 86.7% the well-operating plants and 13.3% the extremely-well operating ones. The households in provinces of Bac Giang, Tra Vinh, Ha Tay and Dong Nai assessed that 87 - 94% plants are operating well and extremely well and the others are operating normally. Son La province had 74.2% plant operating very well and 25.8% ones operating normally.



While the plants operating extremely well provide enough biogas for use demand of the households with ceaseless biogas production time and undamaged equipment, some plants has period stopping biogas production and damaged equipment and appliances which needs to be repaired and replaced.

Chart 17. Number of plant having equipments or appliances failure

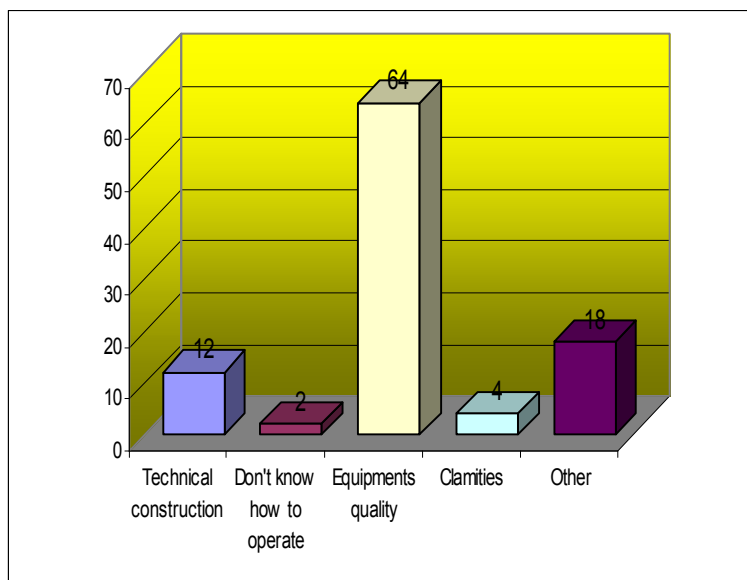


Studying operation of the plant's equipments concluded that 50 among 180 households told that their plants have ever been damaged equipments or appliances. Thua Thien - Hue has the greatest number of plants damaged equipments or appliances (15 plants) and Bac

Giang province has the least with 3 plants damaged equipments or appliances.

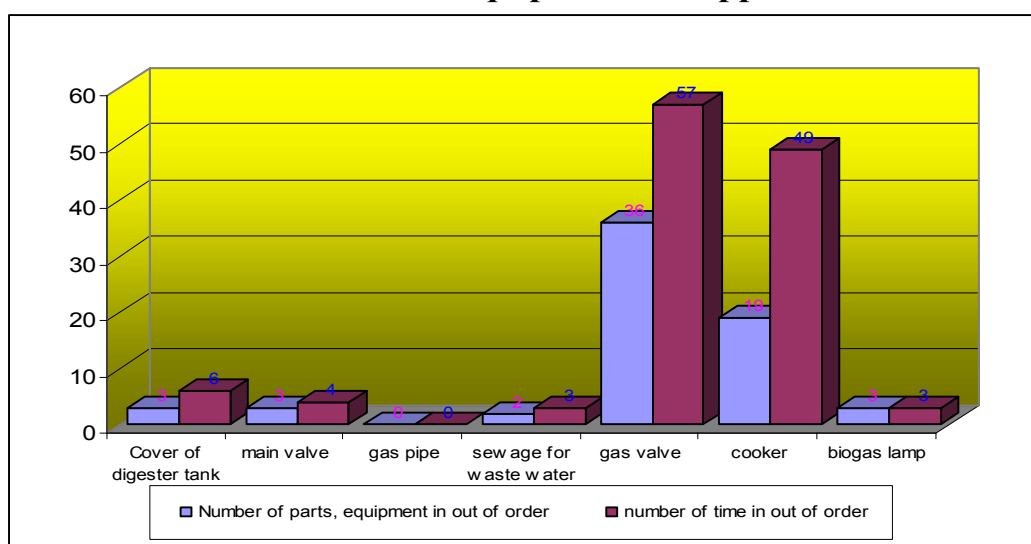
Chart 18. Reason of failure

64% of the households mention the main reason for damaging equipment, appliances is due to its quality. In Bac Giang province, all 3 plants had damaged equipment due to its quality; and with this reason, there is 83.3% plants in Tra Vinh province; 75.0% ones in Son La province and 73.3% ones in Thua Thien - Hue... Other reasons make up small rate with faults of constructions technique 12%, not know how to operate the plant 2%; flood 4%...



Among equipments (including the body and equipments or appliances), the biogas cooker and lamps is the most damaged. 20% households told that their biogas cookers have ever been damaged and 10.6% ones damaged the biogas lamps. The other equipments such as main valves, gas pipeline and gas valve ... has a lightly damaged rate (2 - 3%). (see table 9,10 in annex)

Chart 19. Failed equipments or appliances



The plant's body also has a lightly damaged rate. Only 1 - 2 housed have ever damaged one of the parts of the input tank (1 household), the biogas digester (2 households), cover of the biogas digester (1 household) and gas escaping pipe (1 household).

2.1.6 Assessment on providing gas from the plant

When asking about the gas generation from biogas plant, 60.6% of surveyed households indicated that their biogas plant provided enough for home consumption; 7.2% households only enough gas in summer time; 5.6% households not enough gas for use and 26.7% having abundant of gas.

Đồng Nai is province that has highest number of households having enough or gas abundant, only 1 household not enough gas. Trà Vinh, Hà Tây has 3 households not enough gas.

Chart 20. Level of biogas providing from the plant

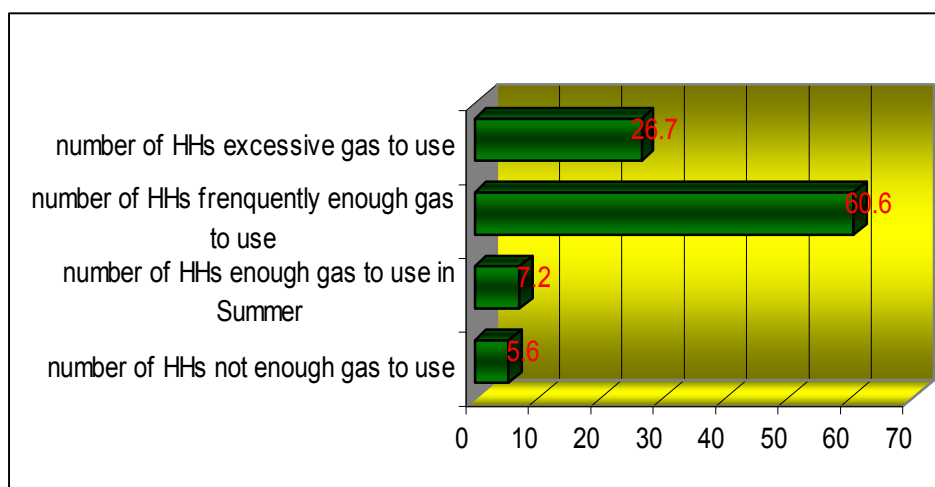
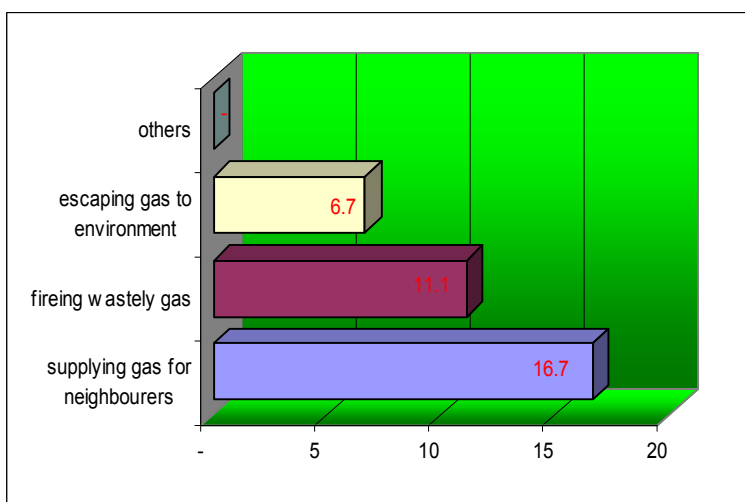


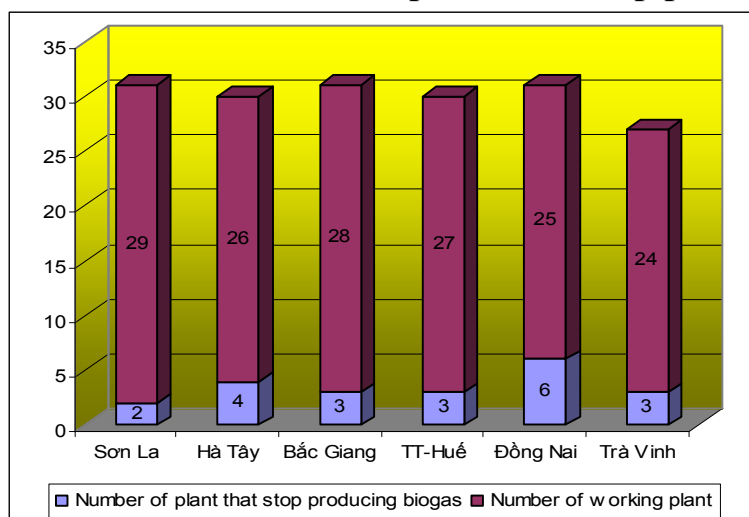
Chart 21. Treatment of abundant gas

For the abundant amount of gas, normally household shared with neighbor or burned out, but there is some households release biogas to open air. Percentage of household sharing the abundant amount was 16.7% of sample survey, 11.1% households using burned out. Number of households release the abundant biogas to open air was 12 (accounted for 6.7% of total sample). However, households said that the burning or releasing amount of abundant gas was not much and occurred only in summer time.



Beside the well operated biogas plants (providing enough gas for uses, no stopping time, unbroken facilities) there are some biogas plants that have to stop operation for sometimes, or broken appliances.

Chart 22. Number of plants that stop producing biogas

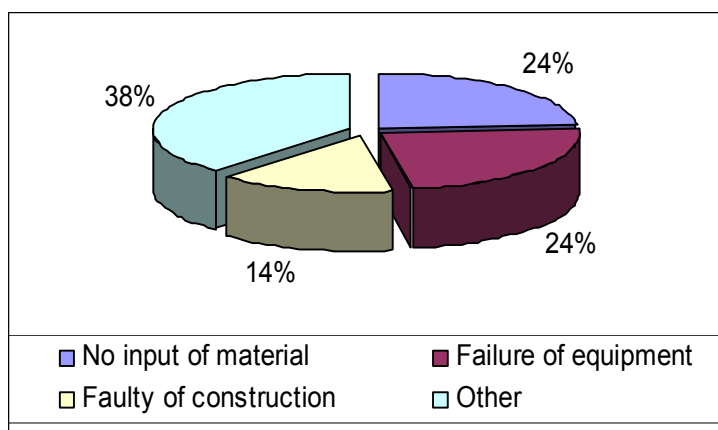


Among 180 households have 21 ones (11.7% of total households) told that their plants had a period stopping biogas production due to many reasons, mainly concentrating in Dong Nai province with 6 plants and others with 2 - 4 plants.

Average period stopping biogas production of each plant was about 10 days. The

plant of household Mr. Nguyen Manh Tien in Minh Nghia hamlet, Dai Dong commune, Thach That district, Ha Tay province has the longest period stopping biogas production of 60 days and the plant of householder of Mr. Huynh The Tu Thuong Thon in Huong Xuan commune, Huong Tra district, Thua Thien – Hue province has the shortest period stopping biogas production of 1 day, all due to lack of input materials. In Son La and Ha Tay province, there were few plants stopping biogas production but the average period stopping biogas production was 17 - 18 days. In Bac Giang and Dong Nai provinces, the average period stopping biogas production was 2 - 3 days.

Chart 23. Reason of stop producing gas



The reasons for stopping biogas production are due to not having materials (5 households), damaged equipments (5 households), faults in construction (3 households) and others such as not breaking the scum, flood and so on (8 households).

In the event of calculating based on the construction years, it can be showed that factor of the plant life has no impact on situation of the plant stopping biogas production. The reason is that all the plants are newly built for 5 years while their proposed life is over 15 years. A number of the plants with the period stopping biogas production in the construction years are different including 4 plants in 2008, 5 ones in 2006 and 2 ones in 2005, 3 plants in 2004 and 1 plant in 2003.

2.2 Assessment of the technicians and the masons

2.2.1 Assessment of the technicians

The selected district technicians for the Project are the link between the Project Office and the households. They not only help the households register to join the Project, introduce the masons trained by the Project, but also guide the households to operate, maintain the biogas plants and use the biogas equipments, appliances. By working with the district technicians in the field trip, the consultants have found the important role of the technicians in introducing the Project to the households, in consulting and assisting the households for operation and buying the biogas equipments, guaranteeing and maintaining the biogas plants...

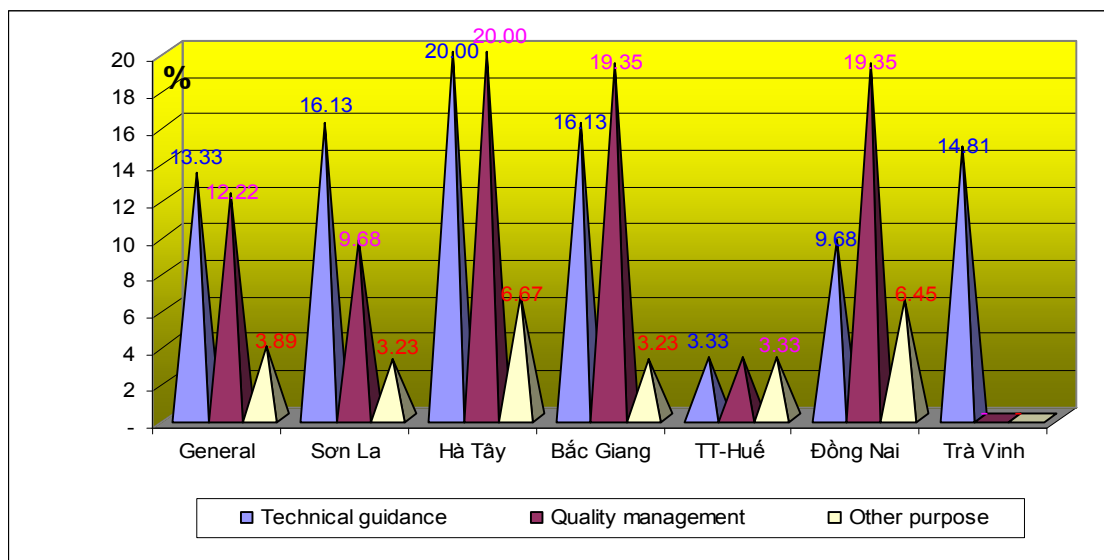
The district technicians are also responsible for managing the masons, monitoring the construction of the biogas plants, internal checking and solving any related problems and the guaranteeing of the masons.

In general, the households who use biogas give good comment about the district technicians. They have contact phone number to solve any problems related to biogas and they always receive enthusiastic help and consulting.

The district technicians follow close the plants; they come to check the biogas plants twice or three times a month (see table 24-annex). This frequency is quite high; it means that they are very responsible staffs. In Tra Vinh province, the district technicians visit the plants 3.5 times a month; the rate in Ha Tay province is 3.0 and in Son La province is 1.3.

The purpose of technician's visit were technical guidance (41.6% of visits), quality control (53.9% of visits) and other purpose (4.5% of visits). However, biogas users needed more support from technician, 13,3% needs further guidance on operation and maintainance ; 12,2% of the users wished to have guidance on quality control of the plant.

Chart 24. Aspects that technician need to be improved



2.2.2 Assessment of the masons

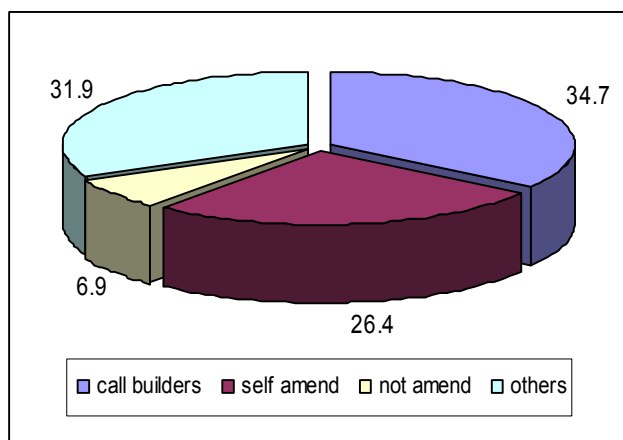
The Project’s masons are trained and certificated by the Project to build the biogas plants when needed. Their quality is evaluated by the construction and guaranteeing quality and the households’ evaluation.

Construction quality is the most reliable index to evaluate the masons’ works. At the time of doing the research, nearly 90% of the biogas plants are in good conditions, 10% is in normal condition. Out of 21 biogas plants that stop producing gas (equivalent to 11.7% of the total asked biogas plants), 3 plants broke due to building fault (2 ones is in Ha Tay province and 1 one is in Tra Vinh) (see table 11-annex). They were repaired by the masons and are now in good condition.

Out of 50 biogas plants having failure equipments including main body and appliances(which are 27% of the total interviewed biogas plants), there was only 6 plants having equipment failure related to building technique (making up 12% of 50 biogas reported having the equipment failure or equivalent to only 3.33% of total 180 households sample survey) and most of them are is Ha Tay province (4 plants) and in Thua Thien-Hue (2 plants)(see table 11-annex). The masons also timely have repaired those broken equipment ones.

Chart 25. Maintainance of equipments and appliances

Survey shows that the masons also repair the biogas plants’ equipments, appliances such as stoves, biogas lights, gas pipelines, main valves, digester tank cover, ventilator pipes, surge tanks. 35% of the broken equipments are repaired by the masons, 32% is repaired by the households (most of the broken equipments are stoves and biogas lights).

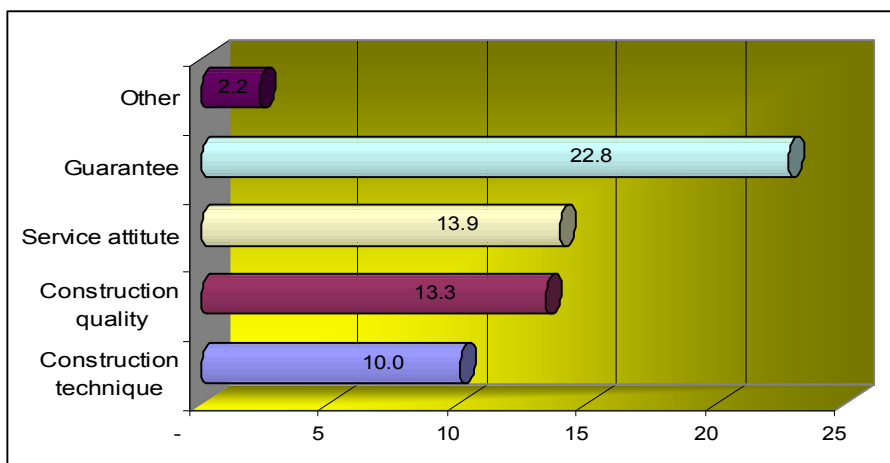


After completing the biogas plants, the masons are responsible for provide the households the warranty and guaranteeing the plant. Only 51.7% of the total investigated households received warranty, 33.9% of the households did not receive the warranty, 8.9% does not know about the warranty and 5.6% does not care about it. Most of the households who have not received warranties do not worry about it since they have the masons’ phone number to contact any time.

According to the households’ evaluation, 85.0 % of the households give good comment about the masons’ works, 13.9% said that their works are normal and two households in Yen Chau district (Son La province) give not very good feedback.

It is necessary for the masons to improve their works in the future by improving the building technique and quality (feedback of 23.3% of the households), the better behavior in serving (13.9%) and the guaranteeing quality (22.8%) and other comments.

Chart 26. Opinions that required mason group need to be improved (%/ total sample survey)



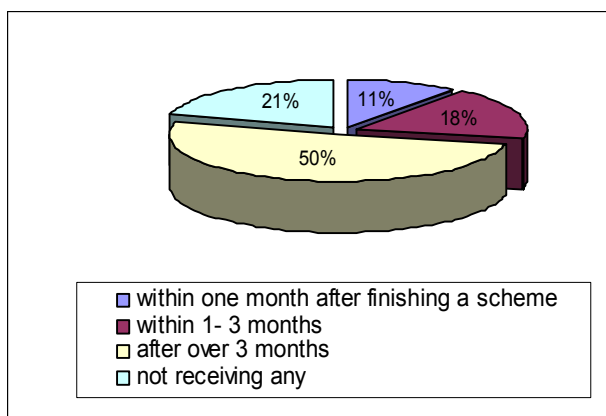
2.3 Assessment of services after biogas plants construction

After registering to build the biogas plants, the households will be supported by the Project (including finance, techniques and warranty...). That support is very necessary for the households to build and operate the plants technically and effectively.

According to the Project’s commitment, each household who joins the Project will receive 1 million dong for construction biogas plant and also receive technical supports and guidances on operation.

In this survey, 143 among 180 households received the financial aid but 37 ones has not received this amount (accounting for 20.6% of total households inquired), concentrating in Tra Vinh province (12 households), Ha Tay province (15 households) and other province (2-5 households).

Chart 27. Time of receiving financial support



The period to receive financial aid lasts and is different in the provinces. After one month of operating the plant, only 10.6% the households received that assitant amount. 1 - 3 months later, there were only more 17.8% ones receiving that amount and over next 3 months, there were only more 51.1% ones receiving that amount. The main

reasons for 51% households receiving financial support after 3 months was that time spending for preparation of documents after acceptance of the work and submission to PBDP accounted for 1 month mainly due to biogas plants constructed not simultaneous so that provinces tend to report construction progress and financial support in a bulkiness form (batch production) rather than in individual biogas plant.

Among the province inquired, Thua Thien - Hue implement the most effective financial aid. After one month of completing the plant, 43.3% the households received that amount but 16.7% ones has not received. Bắc Giang has 93,6% of households received assistant amount eventhough after 3 month of construction.

The project’s technical support is activities of technicians and masons. The households highly appreciated the technical assistance staff from the project. 93.9% of total households received the technical assistance during the construction process, 71.1% households received after finishing the plant and 63.9% households received this support before and after building the plant.

Chart 28. Technical support from project (%)

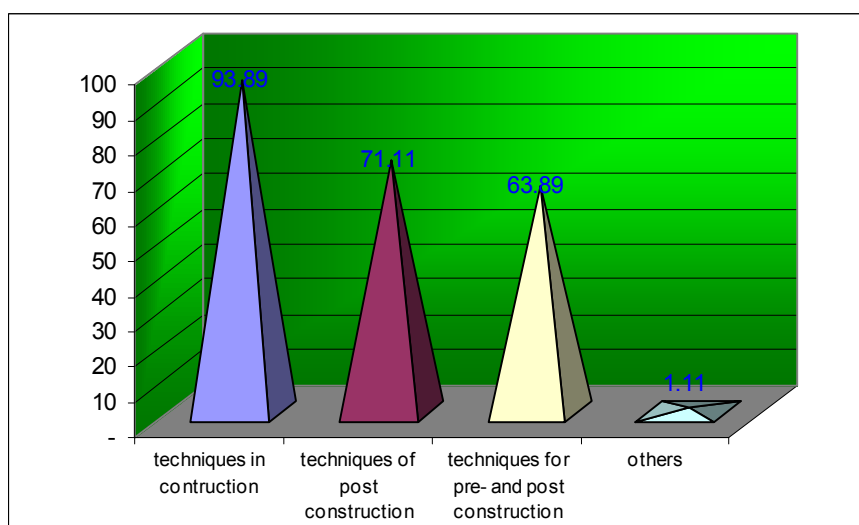
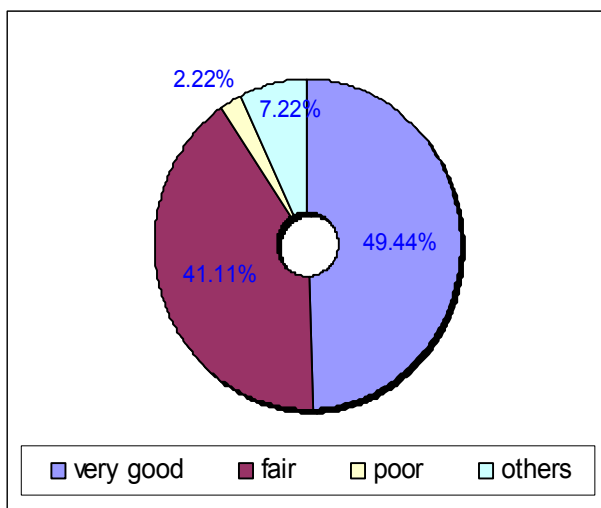


Chart 29. Assessment of guarantee quality (%)



Quality of maintenance service is highly appreciated by the biogas user households. Nearly 50% the households evaluated the masons served the maintenance very well and 41% one assessed well. Only 4 households feel unsatisfactory to maintenance service of the masons (including 2 households in Son La province, 1 household in Ha Tay

province and 1 household in Thua Thien - Hue)

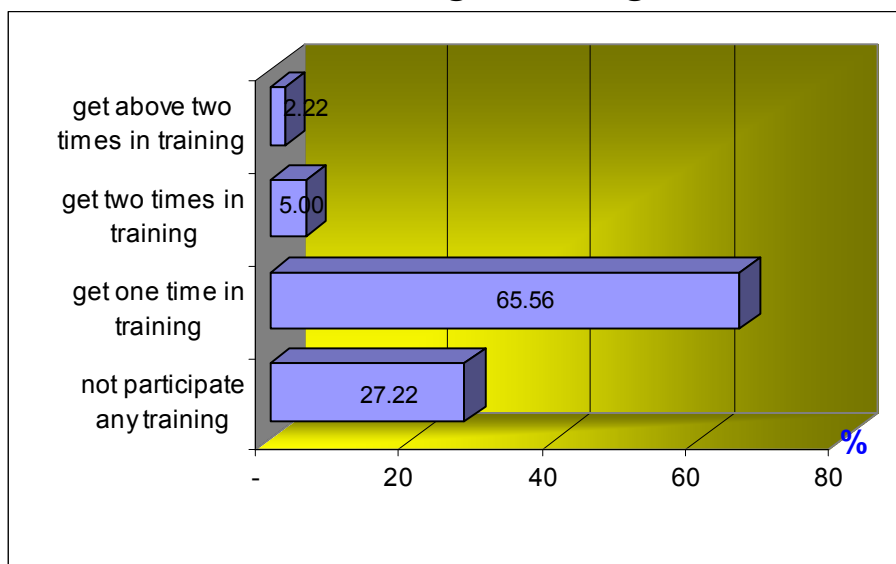
2.4 Assessing the activities of training and propagandizing for biogas users .

The activities of training and propagandizing on using the biogas plants are often approved by the project office through seminars on propagandizing, training and visiting the operating plants, popularizing the biogas technology along with the training courses of Livestock or clean water and rural environment hygiene...In the seminars, the training courses and the field trips, participants are issued books and materials related to the biogas technology edited, printed and distributed by the Central Project office and the provincial and district project office. Besides, all the households taking part in the project also receive the instructive books and materials of the project.

For assessing the project’s instructive books and materials, 87.8% the households understand and perform the instructions correctly, 5% ones has not yet understood or felt complicated and 7.2% ones give no comment.

131 households took part in the training courses, making up 72.8% of total households, in which 133 households training once (65.6% of total households), 9 ones training twice (5% of total households) and 4 ones training over twice (2.2% of total households). The greatest number of the households trained is in Ha Tay province (94.7% of total households inquired in the province), and the lowest is in Thua Thien – Hue province (46.7% of total households inquired in the province).

Chart 30. Number of time attending in training courses of the households



For assessing the training courses of the households, 118 ones felt them very easy to understand, perform and follow but only 2 - 3 ones felt them difficult to understand and implement.

Impacts of the training courses on the households using the biogas plant is very essential (opinions of 68.9% the households); 9.4% ones felt normal and

some households felt unnecessary to train or thought that the training courses need to change their content (opinions of 2.2% the households). 19.4% the households had no answer (majority was not yet participated in any training classes so that there was no assessment)

Chart 31. Effectiveness of training course

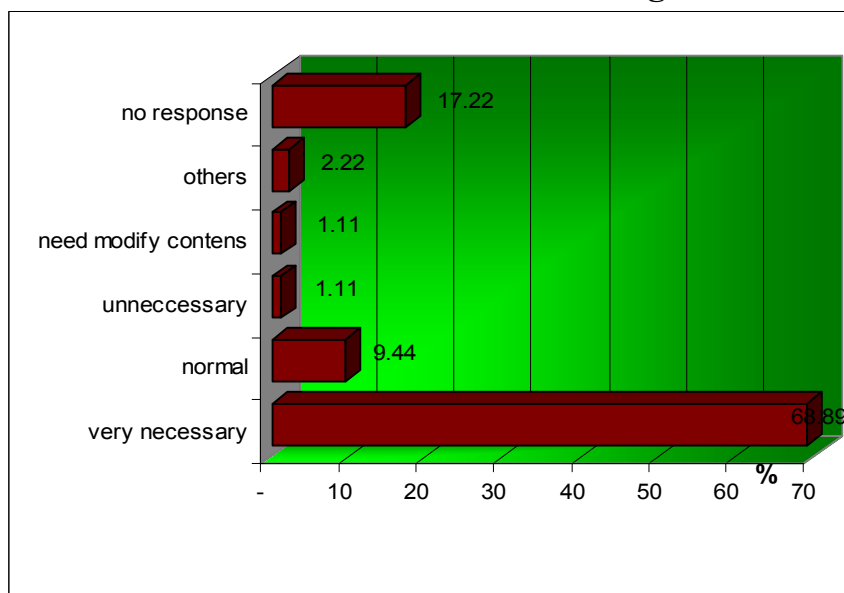
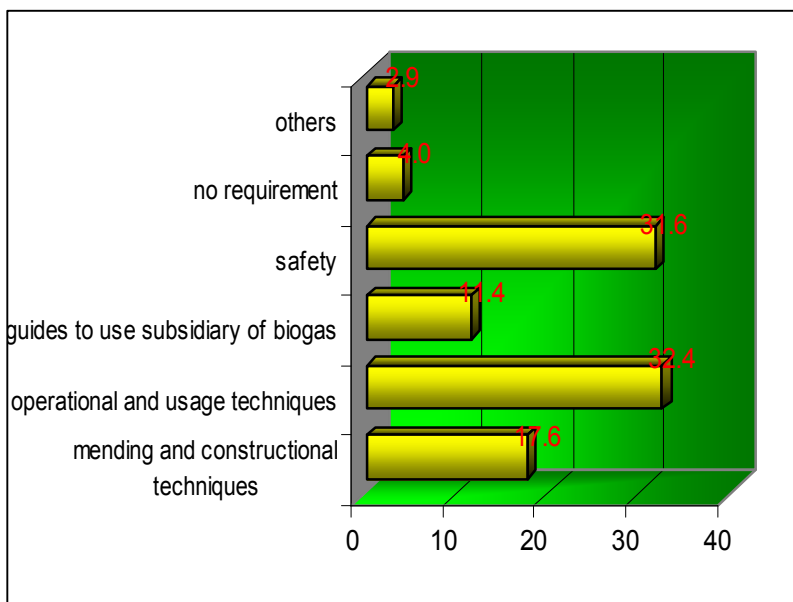


Chart 32. Content of training that need to be improved



For contributing to the content of training courses, 17.6% the households told that it is necessary to improve content on construction technique and repairing the plants; 32.4% one thought that the training content on operating and using the biogas project needs to add; 11.4% one expected to be more trained the usage of biogas slurry; 31.6% ones

wanted to develop the instructions of methods to operate the biogas plant safely and 6.9% ones had other opinions.

2.5 Assess the technical support

The technical support of the project is through activities of technicians and masons. The households highly appreciate the technical support from the

project. Almost the households received this assistance during the construction process of the plant, many households received it after completing the plant and a lot of households were supported the technique before and after building the plant.

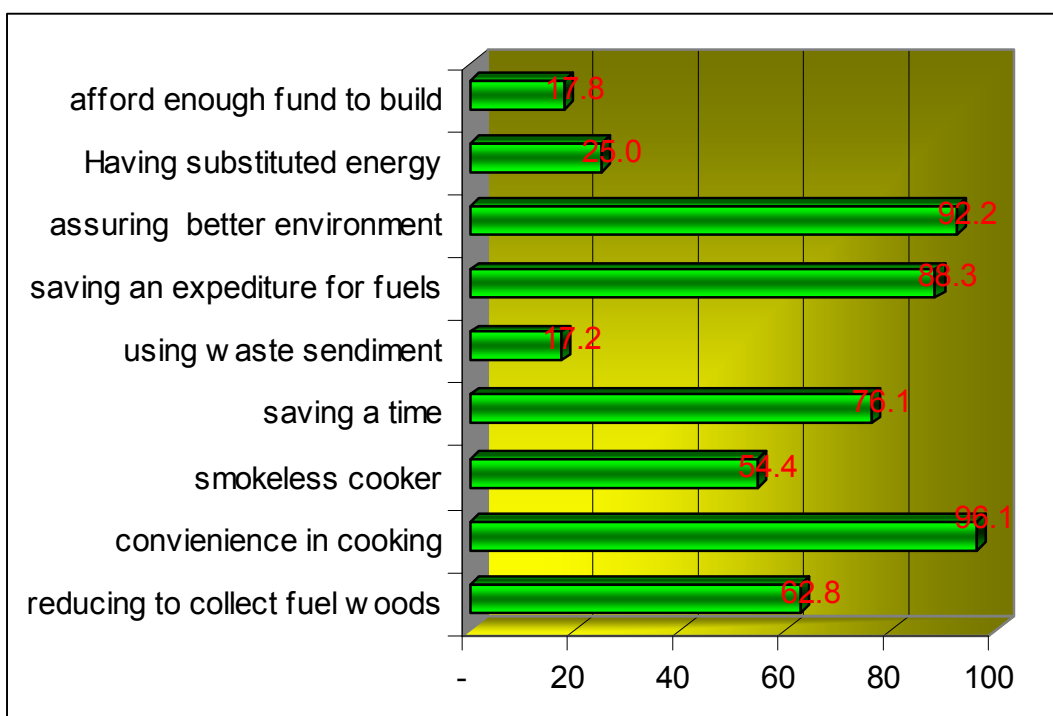
The households using the biogas plants not only received the handbook on using the biogas plant from technicians and masons, but also were offered advice to buy equipments such as cooker, pipeline, spare parts and replacement equipments. These small support and advice are very necessary for the households using the biogas plant.

3. Assess the socio-economic and environmental impacts.

During recent years, propagandizing and organizing the pilot plants has been implemented well so that people understand considerable benefits of the biogas plants and in fact, people are self-aware and mobilize one another. The project’s model has been come into the life and is accepted by the rural people. It is a model linked with the socio-economic and environmental benefits.

Before deciding to build the biogas plants, the households undertook the benefits of the plant. Over 92% the households thought that the biogas plant is a good solution to ensure environmental hygiene when developing Livestock, 96% one expected to better the living activities such as cooking more comfortably, non-smoke cooker and save cost of fuel. 17.8% ones have enough money to be ready to build the plant because they undertook the biogas plant’s benefits clearly.

Chart 33. Main purpose for building biogas plant(%)



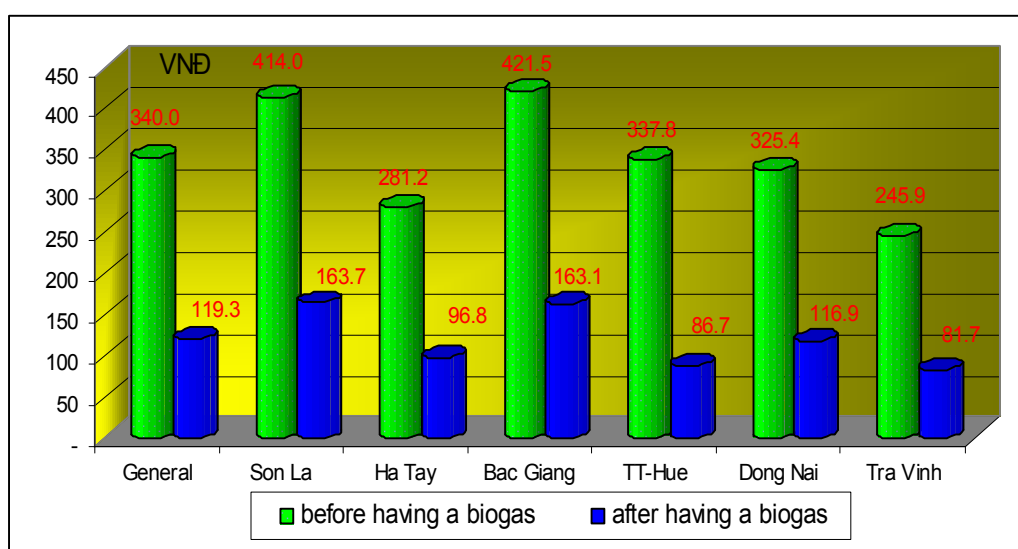
3.1 Impacts of the biogas plant on household economy

The most practical effectiveness makes many people actively build the biogas plant because of its economic benefit. The economic benefits of the biogas plant are to save fuel in cooking as well as electricity, use the biogas slurries as a complement fertilizer making contribution to increase the yield and improve people’s income through promoting values of the agricultural products.

3.1.1 The biogas plant help households save fuel and energy.

Using the biogas will bring the economic benefit manifold against using the normal fuel (firewood, coal, petroleum, straw and rice husk ...) and industrial gas

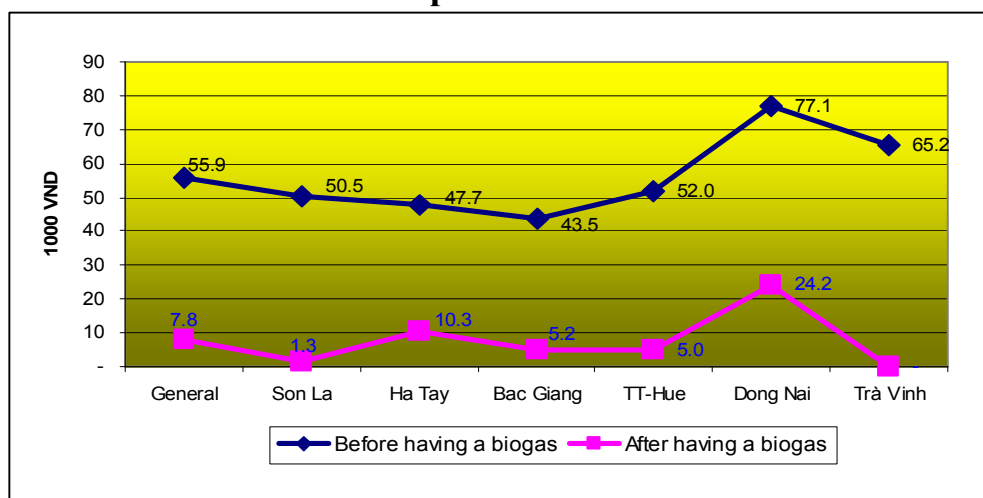
Chart 34. Expenditure for fuels of households



The results of survey on an average amount to buy fuel of one month in the households using the biogas plants show that before having the plant, they paid 340 thousand VND a month for cooking and serving daily activities, in which money to buy fuel for cooking is main including 155.7 thousand VND for firewood; 45.2 thousand VND for coal and 55.9 thousand VND for bottled gas.

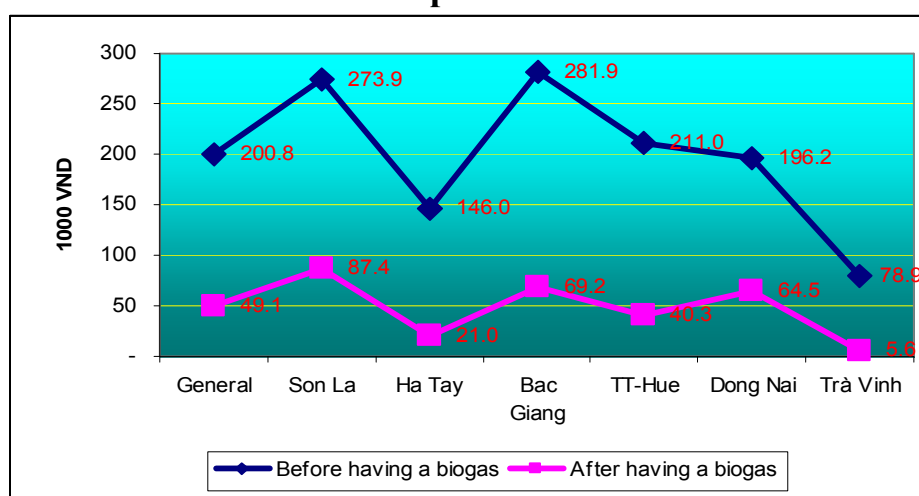
The expense for firewood of the households in Son La and Thua Thien - Hue provinces is from 200 - 210 thousand VND/ household/month, higher than one in other provinces. In Tra Vinh province, each household must pay 79 thousand VND to buy firewood, the lowest among the provinces inquired. Cost to buy the bottled gas in the households made up a high rate but the difference between the provinces is not much. The highest cost for bottled gas is in Dong Nai province (77 thousand VND/ month) and the lowest is in Bac Giang province (43.5 thousand VND/ month). The households must pay 181 thousand VND/ month in Bac Giang province and nearly 64 thousand VND/ month in Son La province. This expense in other provinces is not considerable.

Chart 35. Propan gas used of household before and after having biogas plant



When the biogas plant came into operation, using the biogas helped the households considerably reduce cost to buy fuel monthly. The monthly fuel cost in a household decreased including for bottled gas 86%, firewood 80.7% and coal 57.6%. The households in Tra Vinh province fully saved cost to buy bottled gas and the households in Son La, Thua Thien - Hue and Bac Giang provinces also saved by 92 - 93% of amount to buy firewood and this cost also reduced considerably in other provinces. Cost to buy coal in Bac Giang province is still high, but reduced to about 70% since the biogas plant was used while this cost in other provinces lessened strongly. Cost of petroleum, straw, rice husk ...is also little and the households in Son La, Dong Nai, Bac Giang and Thua Thien - Hue provinces must no longer pay this cost after using the biogas plant.

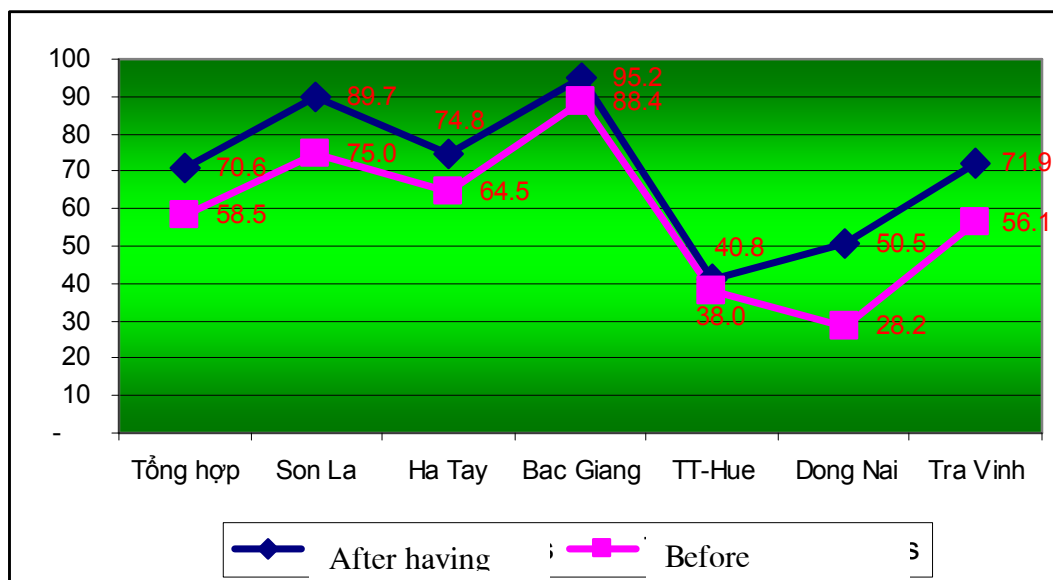
Chart 36. Coal, firewood of household before and after having biogas plant



According to Mr. Nguyen Duc Trung in Moc Chau town, Son La province, using fuel from the biogas plant for cooking is useful and effective. Formerly, when not having the biogas plant, his family felt costly to cook by propan gas

and paid 350,000 VND/ month. When his children forgot to stop cooking, he scolded. But cooking by gas is now comfortable and even though his family even sometimes forgets to stop cooking and burn the pot, he must not pay for the gas.

Chart 37. Electricity consumption before and after hanving biogas plant



Using the biogas helps the households save the monthly electricity cost. Thank to using the biogas lamp, each household saved the electricity cost of 22 thousand VND in Đông Nai province and 16 thousand VND in Trà Vinh province.

For the agricultural production households, these above amounts are economical. On other hands, using the biogas from dung and wastes of cattle, poultry... is more and more significant for people in the remote areas when the energy sources of petroleum, bottled gas, electricity... are difficult for them to use.

Table 17. Fuel expences in the household before and after using the biogas plants

Unit: 1,000 VND

Fuel	Before using the biogas	After using the biogas	Saved amount	
			Amount	% saved
Total	339.98	119.25	220.73	64.92
1/ Firewood	155.68	30.06	125.62	80.69
2/ Petroleum	0.31	0.06	0.25	81.82
3/ Gas	55.86	7.83	48.03	85.98
4/ Coal	45.17	19.08	26.08	57.75
5/ Electricity	70.58	58.50	12.08	17.12
6/ Others	12.39	3.72	8.67	69.96

Source: BUS survey 2008

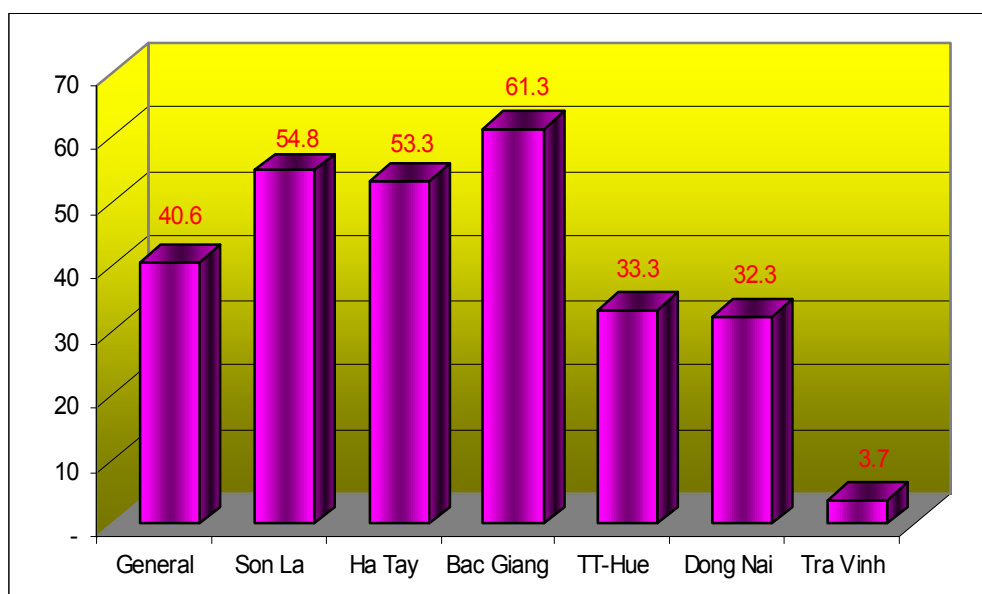
3.1.2 Using biogas slurry helps the household save cost of fertilizer

When putting dung of cattle and poultry into the tank, a part is converted into fuel gas, the remaining is water and wastes. If being used in the right way, they will help the households reduce cost to buy chemical fertilizer and insecticides, enhancing the crop productivity and safer agricultural product quality. Using waste water for pigs and waste solution and sediment for fish helps the households save cost of food, improving income and domestic animals' weight.

Before building the biogas plant, many households were unaware of benefits of the biogas slurries. Some households wondered if using the biogas plant has no fertilizer for the field. This is fully wrong because the biogas plant will convert dry manure into the liquid one which is more hygienic for the environment. Before building the biogas plant, 31 among 180 households inquired (17% of total households) believed that the wastes from the biogas plants can be used. However, 73 ones used the wastes from the biogas plants to produce fertilizer for the crop and 9 ones used them to feed for aquaculture. In Northern provinces, famers used biogas slurries (53-61% of households in those Northern provinces) more than those in Southern provinces (3-33% households of Southern provinces)

Among the province inquired, Bac Giang province has the greatest number of households using the biogas slurries with 19 households (61.3% of total households inquired in the province), 17 ones in Son La province (54.4%) and 16 ones in Ha Tay province (53.3%). Although Dong Nai and Thua Thien – Hue provinces participated in the project during the initial years, a number of households using the biogas slurries in this survey made up more than 30% of total households inquired. Tra Vinh province had only 1 household using the biogas slurries for the crop.

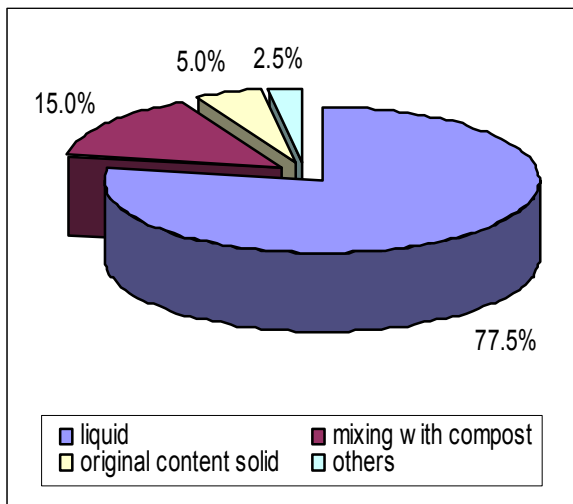
Chart 38. Household using slurry for cultivation (%)



Initially evaluating effects of wastes from the biogas plant on cultivation and Livestock is good. Thus, a lot of households will learn benefits of wastes and take fully advantages of the biogas slurries in the future.

Chart 39. Form of using slurry

According to the survey, majority of households using the liquid wastes to manure the crop (77.5% of total households), some households mixed with compost (15% of total households) and some used the pure and solid wastes.



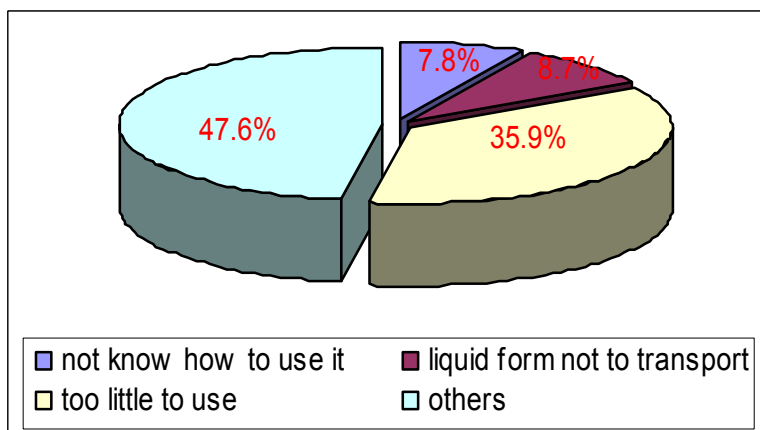
Assessing impacts of the biogas slurries on the crop in the households using the biogas slurries for cultivation showed that it is useful for the crop (opinion of 93.2% of total households using). Some thought that its impact was normal.

Among 9 households using the biogas slurries for aquaculture (7 households in Ha Tay province and 2 ones in Tra Vinh province), only one (in Ha Tay province) evaluate its impact at the normal level.

A number of households not using the biogas slurries for fertilizer made up 59.4% of total households inquired, especially 96.3% ones in Tra Vinh province, 67.4% ones in Dong Nai province and 66.7% ones in Thua Thien - Hue...

The main reason for this was that they had no the cultivated land and had enough fertilizer (opinion of 47.6% of total households). Some told that amount of by-products was not used because they were little left. Other reasons are that it is difficult to transport and use the liquid biogas slurries (opinion of 7.8% of total households), or they do not know how to use the biogas slurries appropriately (opinion of 8.7 of total households).

Chart 40. Reason for not using slurry



3.1.3 Expanding raising scale of many biogas user households

Using the biogas plant helps the household orient their family's close economy development because having much fuel must be to develop livestock, improving livestock must need food and raw materials and these are from the biogas plants.

In this survey, scale of cattle and poultry in many households using the biogas plants has increased since the plants came into operation stably. The households said that they felt safe to promoted livestock because the wastes were well-treated after building the plant. 88 households increase pigs (19 ones in Ha Tay province, 17 ones in Dong Nai province and 11-15 ones in others) and 28 households accelerated poultry (8 ones in Bac Giang province, in Son La and Ha Tay province 6 ones each and 2-4 ones in others). In addition, 4 households raised more cattle and one household enlarged an area of farming aqua-culture.

Table 18. **Total of households to increase the scale of breeding before and after owning the biogas plants**

No.	Work items	Total	Son La	Ha Tay	Bac Giang	TT-Hue	Dong Nai	Tra Vinh
1	Number of households to increase the scales	120	22	25	24	16	19	14
	Number of the households to raise cows and buffaloes	4	1	-	2	-	-	1
	Number of the households to raise pigs	88	15	19	14	12	17	11
	Number of the households to raise poultry	28	6	6	8	4	2	2
	Number of the households to raise aquatic products	1	-	1	-	-	-	-
	Number of the households to raise other domestic animals	-	-	-	-	-	-	-
2	The rate of the households to increase the breeding scale/total of investigated households (%)	67.22	70.97	86.67	77.42	53.33	61.29	51.85
	Number of the households to raise cows and buffaloes	2.22	3.23	-	6.45	-	-	3.70
	Number of the households to raise pigs	48.89	48.39	63.33	45.16	40.00	54.84	40.74
	Number of the households to raise poultry	15.56	19.35	20.00	25.81	13.33	6.45	7.41
	Number of the households to raise aquatic products	0.56	-	3.33	-	-	-	-
	Number of the households to raise other domestic animals	-	-	-	-	-	-	-

Source: BUS survey 2008

3.2 Impact of the plant on environment and health

The biogas plant helped the localities to settle a part of the environmental pollution issues from livestock, contributing to improve people’s health by reducing bad smelling and air pollution at home and bettering the toilet and the breeding farms.

According to Mr. Nguyen Van Thanh, a staff of Thong Nhat district’s Agricultural Bureau (Dong Nai province), Thong Nhat district has tradition of livestock with big scale in the province. The total number of cattle always remains with about 170 thousand pigs, about 564 thousand poultry and 3 thousand cows, so treating the domestic animals’ wastes is always concerned by the relevant authorities. Formerly, there was terribly bad smelling around the district’s breeding areas. But in a few recent years, the district has ensured the environmental hygiene and implemented prevention of epidemic diseases effectively by broad application of building the biogas plants.

Before building the biogas plants, treating wastes of livestock in the households is unclear and polluted. Many household kept dung outside or in the farm. Some discharge wastes directly into common sewer and ditches. Thua Thien - Hue province has the greatest number of households treating wastes of livestock by keeping dung outside and discharging into the common sewer. Tra Vinh province has not discharged waste of livestock into the environment directly without treating.

Table 19. **Treating wastes of Livestock in the households before building the biogas plant**

No	List	Total	Rate %/total households inquired					
			Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
	Total households inquired	100	100	100	100	100	100	100
1	Keep dung in the farm	23.33	19.35	40.00	32.26	10.00	29.03	7.41
2	Keep dung outside	43.33	58.06	30.00	58.06	66.67	19.35	25.93
3	Discharge into the common sewer and ditch	22.22	12.90	10.00	16.13	40.00	9.68	48.15
4	Directly feed fish	6.11	-	10.00	3.23	3.33	6.45	14.81
5	Sell	11.67	6.45	10.00	-	3.33	45.16	3.70
6	Others	13.33	19.35	23.33	9.68	10.00	9.68	7.41

Source: BUS survey 2008

Using the same questions for asking non-biogas user households on how the farmers treated their livestock waste, the result gave similar percentage outputs to those biogas user households before they had biogas plant.

Table 20. Waste treatment of non-biogas user households

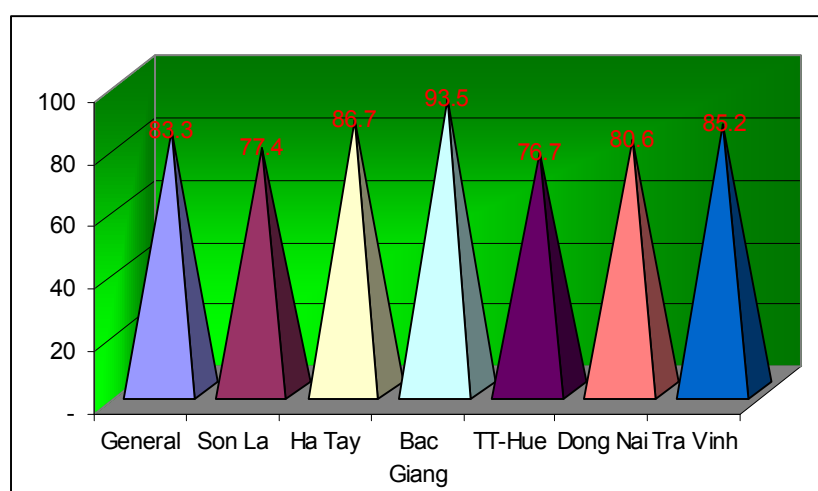
%/total non-biogas user sample

T T	Item	Total	Son La	Hà Tây	Bắc Giang	TT- Huế	Đông Nai	Trà Vinh
	Total households inquired	100	100	100	100	100	100	100
1	Keep dung in the farm	35.00	33.33	50.00	50.00	25.00	23.08	23.08
2	Keep dung outside	37.50	50.00	25.00	16.67	66.67	38.46	38.46
3	Discharge into the common sewer and ditch	31.25	16.67	16.67	16.67	66.67	46.15	30.77
4	Directly feed fish	11.25	16.67	8.33	5.56	-	30.77	7.69
5	Sell	11.25	-	8.33	11.11	8.33	-	38.46
6	Others	8.75	16.67	-	16.67	-	15.38	-

Source: BUS survey 2008

When building the biogas plant, dung of cattle and poultry will be gathered into the tank and then transferred into the disintegrated tank reduced the bad smelling in breeding and parasitical worms’ eggs and pathogen are also gathered and destroyed in the tank in order to scattering the surrounding. Mr. Nguyen Trong Duc in Minh Nghia hamlet, Dai Dong commune, Thach That district, Ha Tay province said that after using the biogas plant, his family has fuel gas, reduce cost to buy firewood, and more importantly, decrease the environmental pollution of 80% with clean farm, pigs growing fast without contracting any diseases, the additional works reducing the bad smelling, fresh atmosphere and people’s health in the family and the surrounding households improved obviously.

Chart 41. Percentage household recognized the reduction of insects



The households evaluated impact of the biogas plant that after building the plant, there is a decrease of flies and mosquitoes in the living environment.

3.3 Social Impacts

Using the biogas plant brings not only the financial and environmental benefits but also the social benefit such as reducing the workload for women and children in gathering firewood to cook and saving time for women in their housework, washing pots... These shown in evaluation of households using the biogas plant are to decrease firewood gathering and non-smoke cooker using, cook comfortably and save time. According to households assessment, the average time saving after having biogas plants was 1.8 hours. In Bac Giang the average time saving per household was 2.2 hours, highest in those surveyed provinces, following were Tra Vinh 2 hours, Son La 1.8 hours, Dong Nai 1.7 hours, Thua Thien Hue 1.7 hours and Ha Tay 1.6 hours.

Mrs. Ly Thi Tam in Hung My commune, Chau Thanh district, Tra Vinh province compared that formerly, she spent an hour cooking a meal but it now takes her half an hour to cook by gas. She feels comfortable, her kitchen and pots are clean.

There are many active activities of the households increased when building the biogas plant such as social activities, family caring, activities of sports and entertainment... 69.4% the households told that they had more time to look after their family, 57.2% ones improve their income, 33.3% ones had time to relax and 15% ones had time to participate in the social activities

According to Mr. Chu Van Ba in Quang Minh commune, Viet Yen district, Bac Giang province, he uses the biogas to cook satisfactorily. Only by putting dung into the plant can he use the biogas to cook and light without spending time burning the oven or setting fire. Now he can both cook and watch TV.

Table 21. **Activities added when building the biogas plant**

No	List	Total	%/ total households inquired					
			Son La	Ha Tay	Bac Giang	TT - Hue	Dong Nai	Tra Vinh
1	Activities to increase income	57.22	45.16	33.33	41.94	66.67	64.52	96.30
2	Social activities	15.00	25.81	6.67	6.45	43.33	6.45	-
3	Read books and newspapers	5.56	16.13	3.33	3.23	3.33	6.45	-
4	Other entertainment activities	33.33	29.03	23.33	22.58	56.67	48.39	18.52
5	Family caring	69.44	77.42	56.67	80.65	86.67	51.61	62.96
6	Others	11.11	-	6.67	3.23	6.67	45.16	3.70

Source: BUS survey 2008

4. Market development

Because the biogas plant’s model to treat dung and other wastes is perfect, the households participating in the project feel safe to develop the Livestock. Applying this model successfully helps to popularize and mobilize people to build more biogas plants in the project framework, creating conditions to achieve the project’s long-term objective of building 140,000 biogas plants. This model must be popularized broader and deeper to effectively exploit technology related to producing and using the biogas with a large scale in order to improve the project’s efficiency. This is an important task to develop the project’s market in next years.

4.1 Households’ opinions on the fact and future development

4.1.1 Difficulties in building the biogas plants

According to assessment of the biogas users, over 82% of total households said the shortage of capital is a difficulty for building the biogas plant and this difficulty is mentioned most (50.9% of total opinions). About 30% opinions showed that the second difficulty is a small size livestock. Other difficulties such as lacking construction area and complicated techniques... made up a low rate.

According to the evaluation of non biogas user, the biggest difficulty for building the biogas plant is shortage of capital (66.3% of total opinions); small scale breeding size is a second rank of difficulty (occupied 12.9%) and 5.9% said lack the construction area. Other difficulties like lack of labor, technical matters were not much.

Chart 42. Difficulty faced when constructing the biogas plant



Again, the biogas user households also have the same opinion with non-biogas user about their difficulties met before construction that were lacking capital (50.9%), small breeding size (17.9%) and not yet known effectiveness of biogas (11.3%)

Both biogas user and non-biogas user households said that their most difficulty was lack of finance when making decision for constructing biogas plant. Notably, more than 20% of the biogas user households and about 10% non-biogas user households mentioned that another difficulty is that the householders feel unnecessary and unaware of the biogas plant's benefits. The major were households that are lack of labor force or small scale of raising livestock or they are living in the area where they could easily collect fuelwood (Huong Tra District, Thua Thien Hue province). These households knew about the advantage of biogas plant for cooking but not knew about environment protection aspect of biogas plant. This showed that the disseminating must be carried out effectively in the future.

4.1.2 Interests of households not using the biogas plants

The survey on expense to buy fuel and fertilizer for the households not using the biogas plants showed that each household must pay 273 thousand VND a month to buy fuel including 85 thousand VND firewood, 81 thousand VND electricity, 56 thousand VND coal and gas 37 thousand VND gas....

Table 22. Average fuel and fertilizer cost of each household

Unit: 1000 dong

No	Average cost/household	Total	Son La	Ha Tay	Bac Giang	TT-Hue	Dong Nai	Tra Vinh
1	Fuel (monthly)	272.9	270.4	380.0	331.4	245.0	166.0	228.2
	1/ Firewood	85.1	125.0	19.2	32.2	175.0	71.5	113.1
	2/ Agricultural by-product	13.4	13.3	10.0	-	8.3	9.2	43.8
	3/ Electricity	80.8	62.5	213.3	82.6	49.2	46.5	36.6
	4/ Coal	56.1	16.7	66.7	191.7	-	-	3.1
	5/ Gas	37.4	52.9	70.8	25.0	12.5	38.5	31.5
	6/ Others	0.0	-	-	-	-	0.2	-
2	Fertilizer (monthly)	3,576	6,650	3,742	1,635	2,340	1,740	6,116

Source: BUS survey 2008

The monthly average fuel cost of the households in Bac Giang province is highest compared to other provinces (331,000d/month), the lowest is in Dong Nai province (166,000 d/month). Cost for fertilizer is 3.5 million dong/household/year on average, the highest cost is in Son La province, 6.6 million dong/household/year, 6.1 million dong/household/year in Tra Vinh

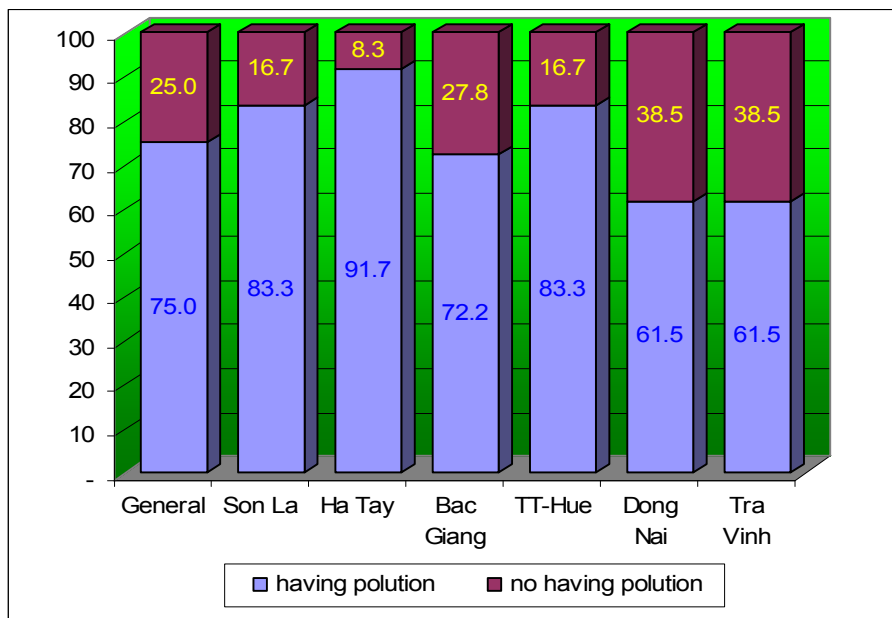
province, and the lowest cost is 1.6 million dong/household/year in Bac Giang province.

Referring to the benefits of biogas, 76% of the households hope that the biogas plants will help them save fuel cost, 28% thinks that they can decrease fertilizer cost by using the wastes from biogas plants as a kind of fertilizer and 25% expects to have spare power from biogas plants.

At present, the households use the forms of processing the wastes from breeding unhygienic which cause pollution on the environment. 37% of the households compost breeding wastes outdoor, 35% composts in the breeding facilities, over 31% discards breeding wastes to public sewers ... In Thua Thien - Hue province, 66.7% of the households compost breeding wastes outdoor, discards wastes to public sewers. In Son La, Bac Giang and Ha Tay province, 50% of the households compost breeding wastes in the breeding facilities or outdoor, causing bad odor.

Assessment of pollution causing from livestock waste from non biogas users shows that 75% of the households are aware of the bad effect of the breeding wastes on their own environment. The rate in Ha Tay province is over 90% and in Thua Thien - Hue is over 83%.

Chart 43. Assessment of environmental pollution from livestock waste of non-biogas user households

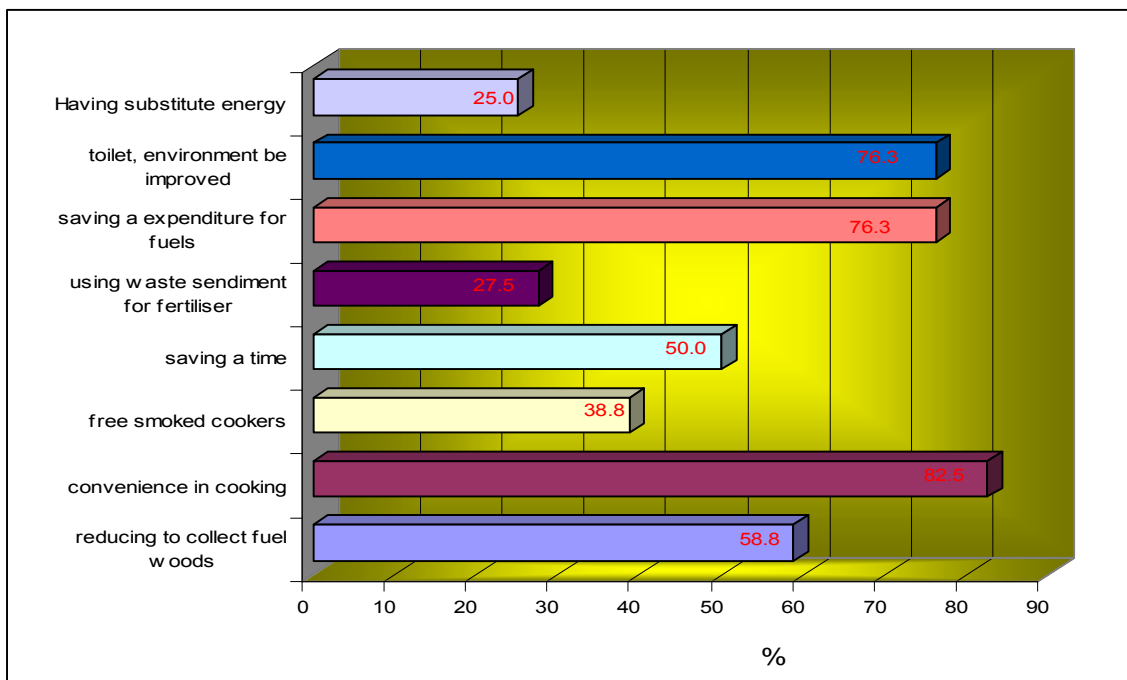


Due to the present level of environment pollution, 76% of the households that have not used the biogas plants wish their own environment and toilets would be improved after using biogas plants.

Besides, the households hope the biogas plants will help them save the time of collecting firewood, the cooking will be easier and the cookers will not

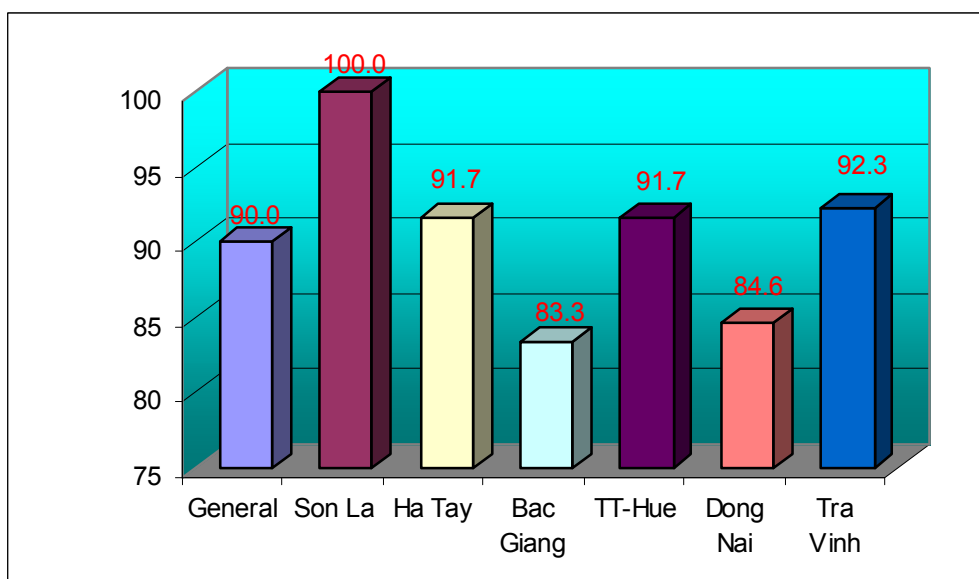
release smoke and time is saved. It is sure that they are aware of the advantages of biogas plants. 84% of the interviewed households highly appreciate the biogas plants, 13% thinks that they are quite good.

Chart 44. Interested in biogas effectiveness of households



Those considerations lead many households to build the biogas plants. Out of 80 investigated households, 72 ones wish to have biogas plants as soon as possible (equivalent to 90%), and 100% of the households in Son La province want to own biogas plants.

Chart 45. Household wishes to build the biogas plant (%/total sample survey)



4.2 Analysis of households approached to the program

4.2.1 Source of information that the households obtained

The biogas user households obtained information - that supported them in making decision of biogas plant construction- from mass media, disseminating of the Project, friends and neighbors...81% of the households obtained information from the Project, 55% from mass media, 45% from friends, neighbors and 11.1% finds the information themselves.

After building the biogas plants and enjoy their benefits, many households become the volunteer propagandists of the Projects. 90% of the interviewed households retransmit the effect of biogas plants to their neighbors and friends.

65% of non-biogas user households were getting information from friends and neighbors; 49% got it from the Project and 46% from mass media... Besides, 85% of non-biogas user households got information about benefit of biogas plants from the biogas user households.

Table 23. **Information source that the households obtained about biogas**

No	Work items	Total	%/ total of investigated households					
			Son La	Ha Tay	Bac Giang	TT-Hue	Dong Nai	Tra Vinh
1	Biogas user HHs							
	Mass media	55.00	45.16	66.67	58.06	60.00	51.61	48.15
	Project	81.11	93.55	86.67	87.10	90.00	70.97	55.56
	Friends, neighbors	45.00	32.26	36.67	41.94	53.33	54.84	51.85
	Find it themselves	11.11	6.45	23.33	19.35	13.33	-	3.70
	Others	2.22	-	3.33	-	-	6.45	3.70
2	Non-bioga user HHs							
	Books, newspapers	28.75	16.67	33.33	22.22	58.33	30.77	15.38
	TV, radio	46.25	50.00	58.33	61.11	58.33	15.38	30.77
	Commune staffs	47.50	25.00	75.00	61.11	50.00	30.77	38.46
	Project staffs	48.75	66.67	75.00	61.11	16.67	30.77	38.46
	Friends, neighbors	65.00	75.00	75.00	44.44	75.00	76.92	53.85
	Others	1.25	-	-	5.56	-	-	-

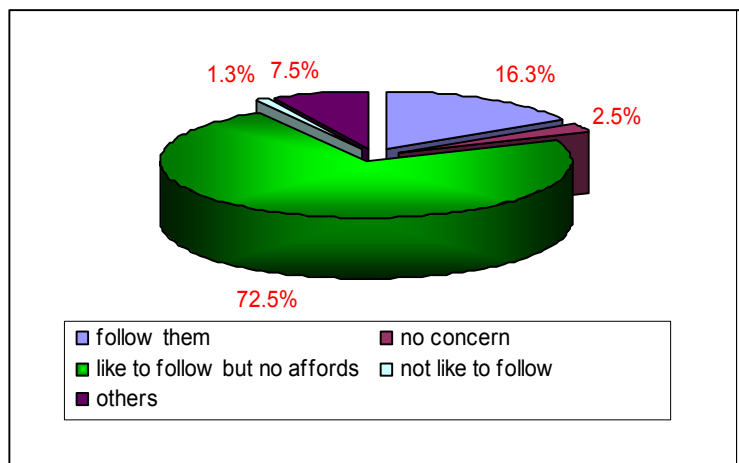
Source: BUS survey 2008

It is very clear to say that biogas user household obtained biogas related information (technique, training, operation, maintenance..) from project information channel. While non-biogas user households obtained such information through channel of neighbor or commune officers. Therefore to develop and increase number of biogas user household in the future, the project should pay more attentions on dissemination activities through channels of biogas user households and local officers.

4.2.2 Assessment of acceptance level of non-biogas user households to build the biogas plants

Through interviewing 80 non-biogas users, when being introduced about the project and its benefits, only 16.3% can be able to build biogas plants, 72.5% wishes to build but they are unable to do it, the remaining were not interested or gave no answers.

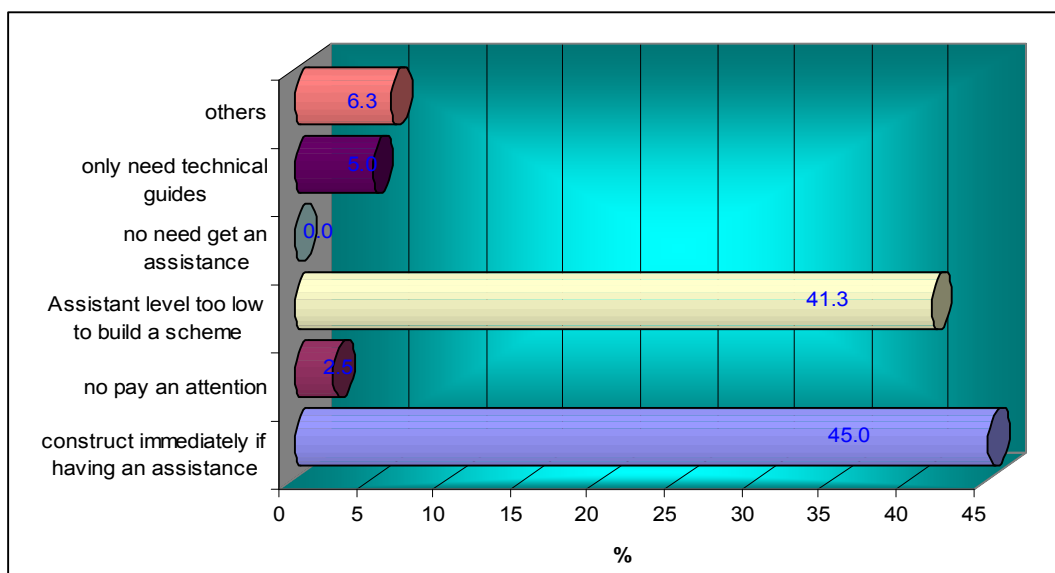
Chart 46. Households acceptance level on building biogas plant



Referring to the construction cost, 55% of non-biogas user households thought that the cost is too high, 40% thought that it is normal and 5% gave no answer.

Mentioned to Project’s support that effects on making decision for building the biogas plants, 45% of the households satisfy with the support and can build it at once if they got supports from project; 41% thought that the level of support is too low for them to build it, and 5% only needs technical assistance.

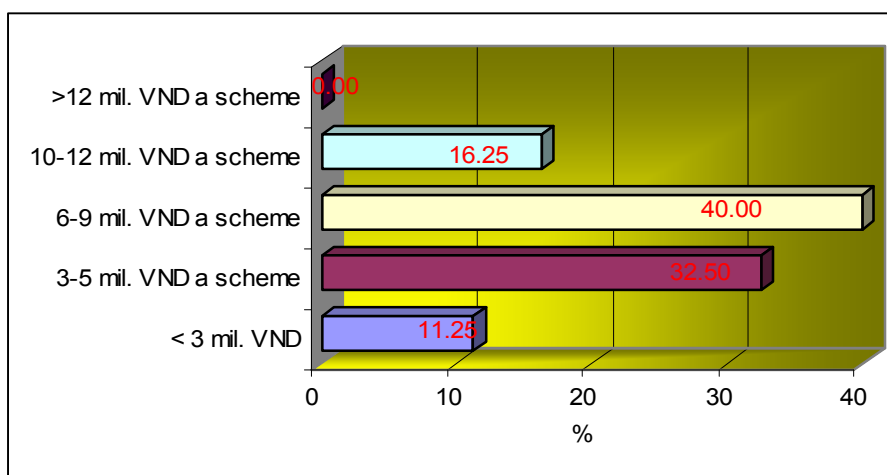
Chart 47. Level of suport and its impact to decision making



Assessment of the willingness to build the biogas plants of non-biogas user household:

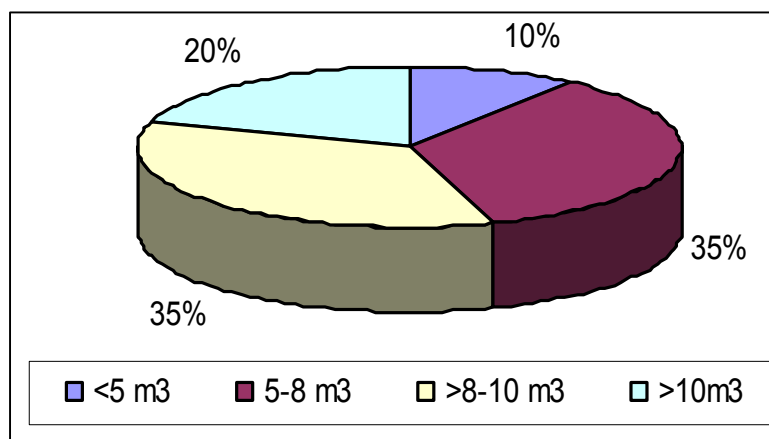
- Most of the households can invest 6-9 million dong/a biogas plant (making up 40% of the interviewed households), and 32.5% can invest 3-5 million dong/a biogas plant.

Chart 48. Willingness of non-biogas household on biogas plant construction investment



- The most suitable scale of the plants for many households is 5 - 8 m³, and 9 - 10 m³, the scale of 10 m³ is chosen by 20% of the households and only 10% chooses 5 m³.

Chart 49. Size of biogas plant that non-biogas user household prefer to build



- Design of biogas plants that they are going to build: 91.3% chooses the plants as the same as the Project design; the remaining chooses other technologies.

- Manner of operating and using: 90% of the households need the instruction and only 10% can do it themselves.

Table 24. **Non-biogas user households' wishes to have biogas plant design and way of operating***Unit: %/total of investigating households*

No.	Items	Total	Son La	Ha Tay	Bac Giang	TT-Hue	Dong Nai	Tra Vinh
1	Biogas plant Design							
	Follow project's design	91.25	100.00	83.33	88.89	91.67	100.00	84.62
	Use other technologies	8.75	-	16.67	11.11	8.33	-	15.38
2	Way of operating and maintainance							
	With instructions	90.00	91.67	83.33	94.44	83.33	92.31	92.31
	Without instructions	10.00	8.33	16.67	5.56	16.67	7.69	7.69

Source: BUS survey 2008

5. Lesson Learnt

5.1 Strength points of Biogas programme

The biogas development programme has effectively contributed to the reduction of environmental pollution from livestock activities, income generation for farmers.

5.1.1 Technology

At present, in the biogas development market, there are many biogas producing technologies (plastic digester, pipe digester, KT type but modified...) that are being applied by biogas user. However the construction designs of KT1 and KT2 types getting user trust due to the characteristics as following:

- Insurance of quality of the plant
- High safety level
- High capacity of gas producing and stable
- Long lasting for uses

5.1.2 Organization and implementation

The management system of the project is well organized and function smoothly from upper to down stream level. As a result the monitoring and checking quality of the biogas plant, implementation progress can be conducted and obtained easily and highly accurate. In addition, the project also constructed web-base database information- an efficient tool for monitoring and evaluation- that helped project to gain in collecting, updating data and to provide sufficient information for project's leader to make appropriated and timely decisions.

The project also was able to establish technician and mason team with high skill level, professional character that ensure the quality and technical aspect of the plant and create the user trust and believes.

5.2 Weaknesses

5.2.1 Constrains of accessibility

- Biogas plants of project have higher cost from 1.2-1.5 times as compared to other biogas technology (plastic biogas plant costs 1.2-2 million, VACVINA technology in 2005 cost for 7m³ biogas plant was about 2 millions VND while cost for the same size biogas plant from project in 2005 was about 4 million VND or 0.55mill/m³ ²), that why it makes a constraint of accessibility of those farmers or community having lower or midium level of income.

- From in-depth survey several famers and local authorities said registration, insurances, and receiving support procedures are still complicated and inappropriated comparing to level and wishes of the users.

- Number of technician having sufficient knowledges, active and creative mind is still minimum and not stable that lead to the lack of accurate guidance, consultations on size of plant, location for construction and operation and maintainnace.

5.2.2 Coordination and management

The link between implementing agencies (extension centers, water supply and sanitation center) and local authorities is still rather weak. There is a room for exploitation of propagation ability of local government, mass organization and individual farmer at grass root levels such as Farmer Union, Woman Union, Veterinary, village heads, and experience persons.

Most of technicians are holding more than one position in their career. In addition, the growth of number of technician and mason is not fit with the growth of number biogas plant. As a result, the technical supporting force for farmer becomes thinner that might lead to the unfulfilled requirements in new technical transfer and utilization of the plant, especially in the remote area or in those provinces having large area in operation like Dong Nai, Son La.

5.3 Challenges and issues need to be solved

5.3.1 Development of the market

Environmental Pollution in food processing villages is becoming critical issue in the rural area. At present some of households in Thua Thien Hue and Ha Tay provinces have been experimented in combination of livestock waste and waste from food processing activities as an input for the biogas digester and the result come out to be promising. The development biogas plant in households that have both livestock raising and food processing need to be and applied in processing villages. It is recommended that the project should research and study in this aspect.

² Nguồn: <http://xttmnew.agroviet.gov.vn/loadasp/tn/tn-spec-nodate-detail.asp?tn=tn&id=1711945>

With considered the increase of livestock raising scale at present and future, the common practice biogas plant may become small. The residual left over will be treated as the same as before (composting in open air, composting in the cages, or directly feed for aquaculture) so as the positive impact of biogas plant toward environmental protection may be limited. Therefore in the next steps the programme should research and develop on the larger scale greater than 50m³ for application and development at those farm household having scale of 200 - 1.000 heads.

Livestock planning direction of provinces in the near future will be focused on concentration raising so as backyard and small scale livestock raising types will be narrow. As a result, the development of biogas plant to poor farm household will be big challenge to programme especially in that very poor farmer who is not raise livestock. With current tendency, when raising livestock in the residential area is prohibited, it is probably impossible for poor household to invest in planned concentration area.

5.3.2 Utilization and diversification the use of biogas

Most of surveyed households use biogas for cooking and some for lighting as a replacement of propane gas, fuel wood, coal and electricity. The benefit is clear, however the use of biogas at present is not full utilized and potential of biogas.

Excluding the benefit addressed above, the biogas can utilize for water heating, refrigerator, running motors that using gasoline, diesel. The utilization of biogas in these motors needs a little innovation. For example, there are some motors or machines using fuels. Now if use biogas as a replacement fuels, there is a need to innovate the carburetor, refining system.... That is reason why many biogas user households use biogas only for cooking.

In order to improve the utilization of biogas the programme may need to develop several demonstration models on biogas utilization at full options (biogas for cooking, lighting, electric generator, pumping, water heating....) so that the household can be utilize the use of biogas at their ability and wishes. At that time, the biogas plant will help not only in solving waste problem of livestock activities but also in saving energy for society, and saving cost of energy uses in each household.

5.3.3 Improvement of technology

It is a need to develop research and study on biogas refining system or equipments in order to improve the use of biogas and the durability of biogas used equipments.

Quality of gas oven, lamp is not good. Many households shift to use the home-made or Chinese made oven (cheap price) that may reduce the level of safety and inconvenient during operation.

The research on development of motors, equipments for livelihoods and

machineries for production that using biogas parallel with low cost, high durability, convenient and safety is the most driving force that encourage farmers to invest in biogas plant and more number of biogas plant to be built and more lager scale biogas plant being applied.

Beside the project may need to collect information and assess of quality and manufactured places of biogas equipments or appliances so that project might be able transfer these information to biogas users for their demands.

5.3.4 Disseminating and training

The dissemination activities are significant mean for project implementation. Strengthening in dissemination activities with the aims of increase people awareness on biogas benefits; introduction of new biogas technology; more advocacy on mass media is an aspect need to be emphasized. There is a need to tight up and integrated between biogas avocation and water supply and sanitation in rural area.

Most of households only figure out the benefit of biogas in very sole subject that is saving fuels and cooking convenient. The benefit of using biogas for eclectic generator, drying facilities is not yet reach to the potential users. Some farmers are still pending investment due to suspicious or even unknown the benefit of utilization.

Using slurry for livestock raising is still limited. That may be of insufficient information provided and doubtfulness of users.

During operation, majority of biogas user is not stirring as recommended that may be affecting to biogas generation, however the biogas is still enough for home consumption. The issue is if the households follow the guidance there will be abundant of gas and farmer doesn't know how to deal with it except releasing to environment that may get harmful to the environment.

It is a need to have guidance or document materials on using biogas used equipments as well as technical standard of equipments that will help farmers easier in buying and using properly.

In answering the question of the effectiveness of training courses and materials, the percentage of household reply "easy to understand, easy to implement" was 74% and 88% respectively. However, during in-depth survey, some households are still not well understood about technical matters, operation and maintenance as well as safety and biogas benefits. The consultant recommend project to prepare guidance in big size paper (A3, A1 size) in decoration and easy to understanding manner so as farmer could paste it on the wall around the house so as increasing positive impact of dissemination activities.

5.3.5 Consultancy for construction of biogas plant

Livestock raising scale of farm households is depending a lot on market

price of feed, input materials and output production, therefore the consultancy on size of biogas plant should be based not only on demand of use, economic ability but also livestock raising potentials rather than consideration the current raising scale at the time of persuasion. On the other hand, when consulting farmers, technician or the mason should know about the livestock planning of the province in order to avoid the risk of the stop operating of biogas plant due to changes in livestock raising location.

5.3.6 Supporting activities

One million supports from project to biogas users is very necessity. However, the money always be transferred after completion of construction of biogas plant for several months so that this amount of money sometimes was not meaningful as contribution to the construction cost and not being used as it supposed to be used (several household use this amount of money for celebration of the biogas plant while they still in debt).

Supporting equally one million per biogas plant may be not appropriate. For some better off household this amount of money is small but for medium or lower level of income household this amount of money have greater meaning in support and making construction decision... In general, most of farm household's opinions show that the supporting level is considered low as compared to the increasing construction materials prices.

At present some province has combined the support fund from project and loan from Policy Bank (Ha Tay is an example) to develop biogas plant. This combination brings a good achievement, especially for medium and lower income level households. Development of credit programme toward medium and lower income level may be also a challenge for the programme, if it wanted to do so.

5.3.7 Common questions asked by farmers

- At current time, there are some chemicals using for stimulation of disintegration process. It is recommended that the project may study the issue and conclude where the farmer may use it or not.

- There are some information said that using biogas to cook meat may cause cancer (information from Hue, Dong Nai).

- Using pressure meter (majority made by China) instead of U-type pressure measurement equipment (made by plastic pipe) is not correct according to technical draws, so that is there any technical or safety matter that may occur?

- Conducting research on stirring facilities so that could help more convenient in operation.

- Research on container tank for abundant gas and waste left over.

- Research how to get the over inputting materials so that farmer can draw some from digester for manure.

PART IV.
CONCLUSION AND RECOMMENDATION

I. CONCLUSION

Biogas project implementing by joint cooperation between MARD and SNV is one of successful project in the agricultural and rural development process in Vietnam. Even though the biogas plant is not directly creating income but it can solve partly environmental pollution problem caused by livestock raising activities - a critical issue of livestock sector when it is having rapidly growth rate - and simultaneously produce the biogas that serve for living livelihood activities, create compost manure that is used for organic cultivation.

At this point of time (October, 2008), through 6 year in implementation, the project could be able to construct 50,000 biogas plants in 28 provinces, cities wide. Beside the project has been developed the most updated biogas technology as compared to other biogas technologies applied in Vietnam.

The survey results of 180 biogas user households from 6 selected provinces (Sơn La, Bắc Giang, former Hà Tây, Thừa Thiên - Huế, Đồng Nai and Trà Vinh) show that 96% of biogas users are highly appreciated biogas plant in terms of construction quality, gas producing ability, waste treatment ability and reduction of environmental pollution. More than 70% of the biogas user confirmed that thanks to biogas plant so that their scale of raising livestock was increased as compared to before having biogas plant (majority increase number of pig). In addition, biogas user also recognized that training courses, guideline, and materials for dissemination can help them in operation and maintenances of the biogas plant.

The clear benefits of biogas plant from survey results are the use of biogas as replacement fuels for cooking and lighting. Monthly, the biogas user could able to save 200-300 thousand VND for cooking and lighting. The biogas plant also helps farmer to solve mostly the pollution of living environment causing from livestock development activities.

The project has developed very effective management system from central level to grassroots level and it also show clear transparency of supporting activities that brings the believes of farmers and local authorities. 100% biogas user households in this survey certified that they have been received and ongoing to receive financial support from the project.

The project also is doing its best effort in setting up, training the technician and mason groups that apparently contribute to the human resource for the local governments. 94% households said they got technical support on construction guidances in which 70% confirmed they got technical support, monitoring technique before, during construction and after completing construction. This

showed the working ability as well as great efforts from technicians, mason teams and project officers at all level.

However, the biogas development is still facing with difficulties and challenges that need to be solved:

Firstly, Development of biogas plant and the use of it are depending a lot on livestock prices. Through survey showed that when the production price is going down, there is a tendency of down scale of raising livestock or even stop raising.

Secondly, Appearances of competition in biogas development market from cheaper biogas technologies that could be able to draw number of farmers to apply these technologies.

Thirdly, concentration livestock raising scale increasing gradually (common from 30-50 head/herd as compared 10-20 heads/herd before) so that the demand for bigger size of digester with full utilization options becomes greater.

Fourthly, in the planning of livestock sector from several provinces said that the province may limit or prohibit the backyard or small scale of livestock raising and shift to concentration and big livestock raising scale. As a result it may affect to the biogas plants that already were built or going to be built of the programme.

Fifthly, number of biogas plants reached to 50,000 so that the market demand on biogas equipment (refining system, pressure meter, replacements, and utilization of gas) is increasingly day by day.

II. RECOMMENDATION

❖ Credit

The development of biogas user in the next few years requires credit activities. More than 70% of surveyed households said they are lacking of fund source for biogas construction. However to obtain the exact demand on loan, loan sources, term and condition of loan, acceptance of interest, organization... the project should conduct a survey on credit issues in nation wide.

Strengthening the link with other agencies, organizations, in supporting construction of new biogas plant (especially credit organization or banks)

❖ Up-scaling, and increasing beneficiary

In the next phase, the project need to develop biogas plan in farm household having large scale or concentration raising (approximately >100pig heads/herd) and increase the number of biogas plants with size over 20m³, due to development direction of livestock sector is to develop concentration and big scale and reduce backyard and small scale of livestock raising. In addition, the project also should pay attention in research and development in those farm

household having pattern of livestock raising + agricultural food processing. At present, the food processing villages are polluting its environment, first step development of biogas plant at combined raising livestock and food processing is a crucial demand as well as increasing number of biogas users under programme.

❖ Policy development

The participation in the construction process of livestock development policies, minimizing pollution issues need to be considered and paid attention by the project. For example, supporting in study and research of environment management policy for household having large scale or participating in construction of livestock regulations, laws on livestock waste management.

Achievement of target of 140,000 biogas plants in the next few years is big challenge of the project. However the number of 140,000 biogas plant is not reflecting exactly either the ability of environmental treatment or biogas generation ability. So that project should study on standardization of biogas plant (for example, the standard biogas plant is 6m³, so the other biogas plant with the size of 20m³ will be equivalent to 3 standard biogas plant) and should consider to present the total cubic meter against total number of biogas plants.

❖ Strengthening of technician and mason groups

In the future activities of project, it is a need to enhance quantity and quality of the technician and mason in corresponding with the increasing number of biogas plant. Especially, project should conduct training for improvement of technician on knowledge and skill of consultancy.

Increasing amount of allowance for technician, innovation of administrative procedure, and empower for technician at grassroots level.

❖ Adjustment of supporting forms

Project may need to study and research on adjustment level of financial and technical supports so that farmers can be able to construct bigger biogas plants and ensuring the environmental sanitation (fully use and treat of waste from raising livestock activities).

❖ More development of services after biogas digester

Research and innovation of biogas used equipments which have longer durability, diversity and reasonable prices so that farmer can buy and utilize fully the amount of generated biogas.

Research and development the gas refining equipment in order to increase the durability of equipment and utilization as well as ensuring people health.

❖ Good practice in dissemination and persuasion activities.

Selection the good, appropriate time for dissemination activities,

mobilization activities, and training activities is a factor that the project should consider.(making dissemination and persuasion right after harvesting season or when farmer have enough moneys, or in good weather condition; conducting training during off-peak season; should pay attention on those farmer want to increase their livestock scale)

Emphasizing dissemination, technical guidance activities in aiming at increase people awareness on biogas effectiveness and encouraging people in utilization of biogas (using slurry for crop production, raising livestock, biogas for electric generator...).

❖ **Development of biogas demonstration model through R&D**

When developing biogas demonstration model, it is a need to apply the method “state and farmer working together”. When duplicating the model, it needs to draw all possible financial sources to support farmer so that it may encourage and improve the effective use of biogas plant.

The project may need to develop demonstration models on biogas utilization with many forms of biogas uses so that people can learn, study and understand more about their own demand on biogas uses.

❖ **Closely coordinating with authorities at all level**

In order to develop and effectively use of biogas plants, it is a need to have closely coordination activities among stakeholders, clear direction and guide from leaders in technical dissemination, construction technique and utilization./.

REFERENCES

1. Biogas user survey in 2005, 2006 - BDP
2. Biogas User Manuals - BDP
3. Livestock Development Strategy until 2020 - Livestock Department, 2007
4. Environmental Protection and sustainable development for Livestock Sector in Vietnam - Dr. Nguyễn Thiện - Agricultural publishing house, 2006
5. Biogas development Plan in Quang Ninh province- NIAPP, 2007
6. Agriculture and Rural Survey - General Statistical Office, 2002, 2004, 2006
7. Master Plan of Vietnam Land Use - MONRE, 2007
8. Master Plan for Agricultural Development until 2020 - NIAPP, 2005
9. Livestock Development Plans of selected provinces in BUS 2007
10. Agricultural Atlats - NIAPP, 2007
11. MARD, BDP, CCRD, SNV, VACVINA websites on biogas technology
12. Statistical Yearbook 2004, 2005, 2006, 2007- General Statistical Office