

Dong for Dung

“The economic impact of using bioslurry for tea production on a household level in Thai Nguyen Province, Vietnam.”

Steven von Eije, 2007



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Over 100 farmers welcomed me into their house and openly answered all the questions. I would like to thank them for their hospitality and willingness to take time to answer our questions.

The University of Groningen allowed me to do this research which is not strictly related to the field of International Business and Management. They provided me with part of the funding for the ticket.

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Last but not least I would like to thank my parents, family and friends for their love and support while I was in Vietnam.

MANAGEMENT SUMMARY

In this thesis it will be assessed to find out what the economic effect on a household level of using bioslurry for tea production. In total 100 farmers have been asked about current and historical data about the quantity of tea per sao, the price obtained per kilogram of processed tea and the expenditures on both pesticides and chemical fertilizer.

After analyzing the data it was found out that using bioslurry results in a higher quantity of tea production per sao throughout the whole year.

After factoring in the inflation effect the tea cultivated with bioslurry still obtained a higher price per kilogram of processed tea. The difference in the summer period however was not statistically significant.

Farmers saved money on chemical fertilizer and pesticides. Total average savings amounted to 2 631 986 VND in total, 2 100 277 VND was saved on chemical fertilizer and 531 619 VND was saved on pesticides.

The incremental yield and incremental price together resulted in an income generating effect of 3 751 509VND. The income saving and generating effect together result in a total economic impact of 6 383 495VND per year on a household level. Interestingly the income effect is larger than the total average investment costs of the biogas installation. After this research it has become clear that from an income impact point of view, the bioslurry is the main product of the biogas installation instead of merely the by product.

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ABBREVIATIONS

BgM	: Biogas Manure
BPAL	: Biogas Practice Area Leader
BPD	: Biogas Project Division
CDM	: Clean Development Mechanism
CPI	: Consumer Price Index
CTA	: Chief Technical Advisor
DARD	: Department for Agricultural and Rural Development
GHG	: Green House Gasses
LPD	: Livestock Production Department
MARD	: Ministry of Agricultural and Rural Development
REDP	: Rural Energy Development Program
SNV	: The Netherlands Development Organization
TOR's	: Terms of Reference

INTRODUCTION

Research Goal

With this research it is attempted to prove the relationship of using bioslurry for tea production and household income. Extra income may result from an increased yield for the tea, it is also possible that the tea that is produced obtains a higher sales price in the market. Besides this, using bioslurry for tea may help reduce expenditures. Expenses on chemical fertilizer and pesticides may result from using bioslurry.

Set Up of the Introduction

In this chapter all necessary information to put this research in the right context will be presented. It is started with a very brief explanation on the concepts biogas and bioslurry.

This is followed by some major challenges the world faces today, that the biogas program may help to solve.

Then some background information is presented about Vietnam, the country in which the research took place.

The introduction is continued by the research request of the Netherlands Development Organization (SNV), this organization provides two technical advisors to the Biogas Project Division (BPD). Then a short description is given of SNV, and the BPD.

Then it is explained how the author arrived at the choice of the main subject by looking at the sustainable livelihoods approach. It was decided to focus on the livelihood asset capital and the livelihood outcome more income.

For this reason first the situation of poverty in Vietnam is discussed, and then the main research questions are presented.

Next the purpose of this research is explained, followed by a short introduction of the structure of the rest of the thesis in front of you.

Biogas

“Biogas typically refers to a (biofuel) gas produced by the anaerobic digestion or fermentation of organic matter including manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock, under anaerobic conditions. Biogas is comprised primarily of methane and carbon dioxide.¹”

Bioslurry

Bioslurry is the byproduct of biogas installations. The way the biogas installations work is presented in the literature review. The digested manure (combined with water) is collected in the outlet tank. This can be used for agricultural production and is believed to have a strong fertilizing effect.

¹ <http://en.wikipedia.org/wiki/Biogas>

Millennium Development Goals (MDG's)

On September 18th of the year 2000 the general assembly of the United Nations adopted the United Nations Millennium Declaration². In this declaration they adopted eight global goals which should be realized by 2015.

Among these goals are: to eradicate extreme hunger and poverty, to empower women and promote gender equality, to reduce child mortality, combat HIV/aids, malaria and other diseases and to ensure environmental sustainability. These are five of the eight goals set out by the general assembly that the Biogas Project Division (BPD) might help achieve, having different impacts on different goals. How this might be done is addressed in the literature review.

Upcoming Importance of (Renewable) Energy

In recent years energy has become a more and more important subject. With a constantly growing world population and current trends in technological progress and innovation the demand for energy in 2100 will be five times greater than it is now³. With this increasing consumption of energy and the depletion of fossil fuels the importance of renewable energy sources is becoming larger and larger.

Negative Effects of Agriculture on the Environment

56,8% of Vietnam's workforce finds it's occupation in agriculture⁴. Agriculture also has some negative effects on the environment. One of the harmful effects to the environment is the emission of methane gas. The amount of emission is dependent on the way in which manure is managed. There is a difference between aerobic and anaerobic fermentation, the anaerobic emission takes place when the manure is dumped in a lagoon, but more importantly in Vietnam, when the manure is used for rice production. The rice fields have a constant layer of water that covers the rice. The fertilization with manure causes a high amount of methane emission. When the manure is left in the stables or put on the land the emission is aerobic, and therefore a lot smaller. Considering that rice is still the main agricultural product in Vietnam the pollution from rice production is expected to be quite large.

Besides methane emission from husbandry there is another harmful effect on the environment related to agriculture. The use of chemical fertilizer and pesticides. In Vietnam the agricultural production occurs on a very small scale due to the fact that households only own very small plots of land to use for agricultural production. To increase the yield from these small plots of land Vietnamese farmers tend to use a lot of chemical fertilizer and pesticides. This overuse of chemical fertilizers and pesticides causes groundwater pollution. Besides this after too many years of overusing chemical fertilizer and pesticides the land will become infertile.

² <http://www.un.org/millennium/declaration/ares552e.pdf>

³ <http://www.wrenuk.co.uk/>

⁴ <https://www.cia.gov/library/publications/the-world-factbook/print/vm.html>



Vietnam

The Socialist Republic of Vietnam has a little over 82 million citizens. Agriculture is still the primary means of occupation in Vietnam. Rice is the main agricultural product in Vietnam. Coffee, tea, cotton, sugarcane and rubber are among the main cash crops.

At this moment there is enough wood in Vietnam but due to migration, and commercial forestry the deforestation is slowly becoming a more serious problem.

⁵Vietnam has an extensive history of wartime, over the years they have fought the Chinese, Khmer, Chams and Mongols. After this there was a period of French colonialism. The last war was the American war. Despite a war drenched history the Vietnamese still have a very positive outlook on life. They seem to rather look at the future than at the past.

⁶Substantial economic progress was achieved from 1986 to 1997 in moving forward from an extremely low level of development and significantly reducing poverty. Growth averaged around 9% per year from 1993 to 1997. The 1997 Asian financial crisis highlighted the problems in the Vietnamese economy and temporarily allowed opponents of reform to slow progress toward a market-oriented economy. GDP growth averaged 6.8%

per year from 1997 to 2004 even against the background of the Asian financial crisis and a global recession, and growth hit 8% in 2005 and 7.8% in 2006.”

Vietnam joined the WTO in January 2007 which in the long term is expected to help economic development. For the short term it might have a large negative effect for farmers, who have in general a very limited amount of land which causes large inefficiency disadvantages. The elimination of trade restrictions is likely to make their products too expensive.

⁷Agriculture's share of economic output has continued to shrink, from about 25% in 2000 to 20% in 2006. Deep poverty, defined as a percent of the population living under \$1 per day, has declined significantly and is now smaller than that of China, India, and the Philippines. Vietnam is working to create jobs to meet the challenge of a labor force that is growing by more than one million people every year. Vietnamese authorities have tightened

⁵ Lonely Planet Vietnam

⁶ <https://www.cia.gov/library/publications/the-world-factbook/print/vm.html>

⁷ <https://www.cia.gov/library/publications/the-world-factbook/print/vm.html>

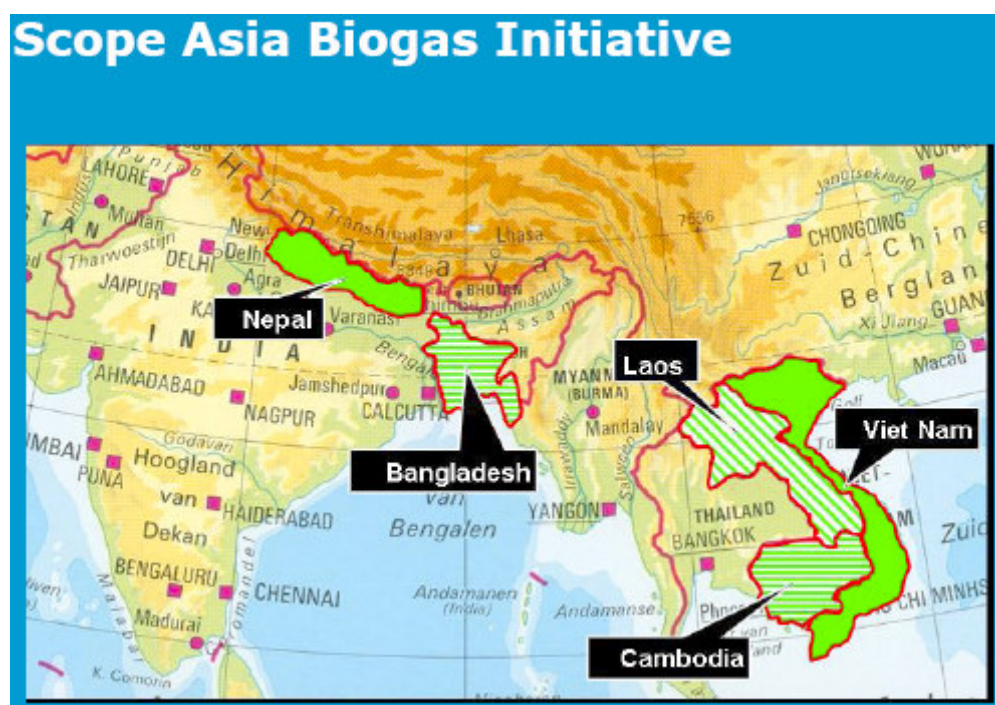
monetary and fiscal policies to stem high inflation. Hanoi is targeting an economic growth rate of 7.5-8% during the next five years.”

Research Request

The organization SNV invited the author to do this research project for the Biogas Project Division.

The BPD has a large importance for Vietnam, as mentioned above it may help to achieve a large part of the MDG's. Also it helps provide renewable energy to around 28000 rural households which covers a large part of their energy consumption. Finally biogas installations may help battle some of the negative effects of agriculture, how this is done will also be described further in the literature review.

The author joined the BPD for 5 months in order to do this research. Below a map of the scope of the Asia Biogas initiative is presented. After that a little more background information about the BPD is given, followed by a very short description of what the organization SNV is trying to achieve.



source: http://www.markets4poor.org/m4p/dmdocuments/snv_biogas_eng.pdf

Biogas Project Division

“The “Support Project to the Biogas Program for the Animal Husbandry Sector in some Provinces of Vietnam” is a cooperation between the Government of Vietnam and the Government of the Netherlands.

Starting in January 2003, the project aims to develop a commercially viable and market oriented biogas industry and to make a contribution to avoid the use of fossil fuels and biomass resource depletion. The Livestock Production Department (formerly named Department of Agriculture), the Ministry of Agriculture and Rural Development and the Netherlands Development Organization (SNV) are assigned to implement the project activities.

The project phase I (2003 – 2005)

With a 2.4 million Euro non-refundable grant from the Netherlands, the project has successfully completed the support of the construction of 18.000 biogas plants in 12 provinces of 8 ecological regions nationwide. The project has brought about benefits for the population such as providing clean energy for daily life and biogas slurry for cultivation and animal husbandry. The project also makes a contribution to reduce the use of chemical fertilizer, environmental pollution and greenhouse gas emissions.

Based on the remarkable achievement of phase I of the project and with a large potential market for biogas technology in Vietnam, MARD and SNV have agreed to upscale the project in the second phase.

The project 2006 is a bridging phase concerned with the preparation for phase II (2007 – 2010) and to smooth the transfer from the first phase. 9.455 biogas plants will be built in 24 provinces and cities nationwide in the year 2006.

In the second phase (2007 – 2010), the project will be upscaled and 140.000 biogas plants will be built. The total estimated budget for this phase is 44.8 million Euro, of which 3.1 million Euro is a grant from the Netherlands and 0.6 million Euro is paid by SNV for technical assistance. Project provinces make financial contributions for the construction of biogas plants. The households themselves are the main investors.”

(Source: <http://www.biogas.org.vn/english/aboutus.asp>)

On april 11th 2007 the BPD has been recognized as an important project in Vietnam but also as an important project worldwide. They have been awarded the Global Energy Award, which is sometimes referred to as the environmental Oscar.

“⁸Aside from the contribution the biogas programme makes to reducing global warming, the jury particularly praised the programme for its sector-based dissemination approach. Involving both public and private actors in the promotion and construction of domestic biogas, the programme reached over 27,000 farming households in rural Vietnam in a commercially viable manner.”

SNV

“SNV is a Netherlands-based, international development organization that provides advisory services to nearly 1,800 local organizations in over 30 developing countries to support their fight against poverty.

Poverty results from unequal access to resources and power, between different social and cultural groups and between men and women. SNV believes the basic purpose of development is to enlarge people's choices; to create an enabling environment for people to enjoy long, healthy and creative lives.

The fight against poverty needs strong organizations that serve the interests of the poor and are able to change the structures that sustain poverty. SNV works with organizations that operate at district and provincial level and function as linking pins between national policies and frameworks and the people living in towns and communities. Its clients include private, governmental and civil society organizations.

These organizations are served by locally present teams of national and international experts. Our added value is that our experts combine their thematic expertise with skills in organizational development, partnership building and institutional strengthening.”

(source: <http://www.snvworld.org/public>)

⁸ <http://www.biogas.org.vn/english/news.asp#tiendonghiemthu>

Formulation of the Main Research Questions

Prior to leaving to Vietnam some communication through email and teleconferences took place. The author of this research was informed that a conference was to take place on the use of bioslurry. The technical advisors from the BPD felt that there was too little information on the use and benefits of bioslurry, especially in Vietnam. They were not quite clear yet what should exactly be the research assignment but their reason to invite me to join their organization for five months was that they wanted more information about this subject.

Bioslurry is believed to have the capability to increase agricultural yields and reduce the need for using chemical fertilizers and pesticides, but until then relatively little academic research had been done. The Junior Technical advisor (JTA) from the BPD advised to use the sustainable livelihood approach as the starting point for this research project.

Sustainable Livelihood Approach

The definition of sustainable livelihoods from Carney et al., adapted from Chambers and Conway is:

‘A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the long and short term.’

Sustainable livelihood approach framework

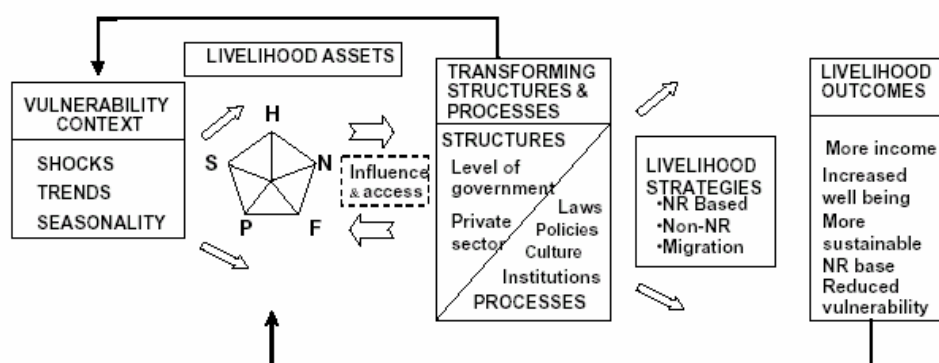


figure. source: <http://www.itcltd.com/docs/sl-bw.pdf>

In order to link the research to my field of study (International business and management), it was decided to focus on only one of the livelihood assets; financial capital and on one of the livelihood outcomes, more income.

The biogas installation is believed to help achieve different livelihood outcomes and obtain different livelihood assets as well. Because of limited availability of time the main part of this research will focus on the financial aspects of the biogas installation. In the literature review it is attempted to provide the reader with the other benefits of the biogas installation as well, but this will not be empirically researched. The focus will therefore be on the financial effects. The reason for this is that one of the main goals of SNV, as mentioned above, is to reduce poverty.

In order to get more insight in the situation of poverty in Vietnam, this is discussed first.

Poverty in Vietnam

⁹“Vietnam’s achievements in terms of poverty reduction are one of the greatest success stories in economic development. A decade ago, 58% of the population had an expenditure level that was insufficient to support a healthy life (with the definition of a “healthy” based on a minimum caloric intake per day plus a set of basic non-food needs). Five years later, the proportion of the population below this particular poverty line had fallen to 37 percent. And it further declined to 29 percent by 2002. Thus almost a third of the total population, the equivalent of more than 20 million people, were lifted out of poverty in less than ten years. The precise figures would probably vary if other criteria were used to define and measure poverty, but the accomplishment would certainly remain.

While rapid economic growth accounts for an important part of the reduction in poverty over the last decade, one of the salient characteristics of Vietnam’s growth pattern is its strong pro-poor nature. As the size of the economy roughly doubled between 1992 and 2002, the fraction of the populations living in poverty declined by half. In annual terms, a growth rate of output per capita of roughly 5.9 percent was associated with a reduction in poverty by about 7 percent too, implying an “elasticity” of poverty reduction to economic growth higher than one. Such a high elasticity reflects the commitment of the Government of Vietnam to equality and social inclusion, reiterated throughout its blueprint for development, the Comprehensive Poverty Reduction and Growth Strategy, or CPRGA (Socialist republic of Vietnam, 2002)”

“¹⁰Poverty in Vietnam is mainly a rural phenomenon. Vietnam's poorest typically engage in agriculture, are poorly educated and live in remote, inaccessible locations with few services. Ninety percent of the poor get most their income from agriculture and 45 percent of the rural population are poor and highly vulnerable to environmental and economic shocks.

Even though the poor are enjoying the benefits of the economic growth there are large differences in divisions of wealth in Vietnam between rural and urban areas.” Since the biogas installations are used by farmers this may aid in reducing poverty in rural areas if the results of this research turn out to be positive.

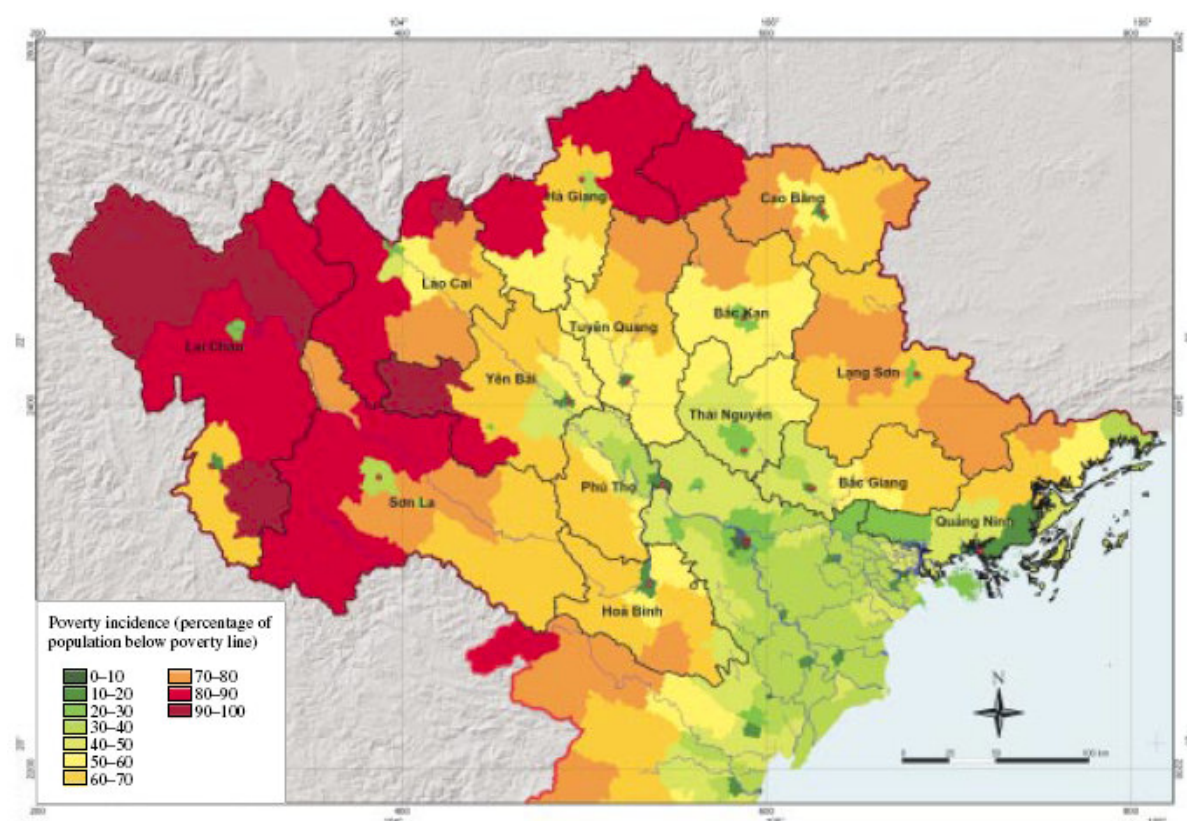
“¹¹Urban households spend about 78% more than rural ones. Vietnam may therefore face large urbanization pressures in the coming years. Confronted with the possibility to substantially improve their well-being, many rural households will choose to migrate to the cities. Administrative barriers, no matter how severe, may not be sufficient to dissuade them. A rapid movement of well-being in rural areas may be the only way to slow down a migration wave in the making.”

⁹ Vietnam Development Report 2004 ‘Poverty’

¹⁰ <http://www.usaid.gov/country/country.cfm?CountryId=33>

¹¹ Vietnam Development Report 2004 ‘Poverty’

Figure 4.6 Estimates of the incidence of poverty at the district level



Poverty map from the northern uplands Source: Analysis of the 1999 Population and Housing Census and the 1998 VLSS. In Minot et al.

Reducing poverty can be done in many ways, but to make this poverty reduction sustainable, the income improvement needs to be structural. The biogas installation appears to help realize this goal, because it, as will be described further in the literature review, helps to reduce households expenses on energy, fertilizer and pesticides, but in case slurry helps to improve the quantity and quality of production, the biogas installation also serves as an aid in income generation.

In order to find out if this is the case, this research will try to assess the income saving and generating capabilities of bioslurry.

It was decided to focus on tea producers only. There were two reasons it was decided to focus on tea producers.

Firstly tea producers were believed to have accurate data on the yield of tea per area of land, and on the price they obtained for their tea.

Secondly one of the two main tea regions in Vietnam (Thai Nguyen) was relatively close to the headquarters of the BPD (approximately 75 km).

Main Research Questions

MQ1: What is the scope of bioslurry use of biogas-households in Thai Nguyen?

MQ2: What is the effect of bioslurry use on tea production in Thai Nguyen?

MQ3: What is the effect of bioslurry on household income for tea producers in Thai Nguyen?

Purpose of the Research

The awareness and use of bioslurry, as became clear from the biogas user survey 2005 (Nguyen) is still very low among owners of biogas installations. Awareness about benefits of slurry in planting, using slurry for husbandry and raising aquatic products is respectively, 78%, 40% and 27%. The actual use of slurry is even lower; 40% for planting, 1% in husbandry and 14% in raising aquatic products.

More research needs to be done into the effects of bioslurry. Once the benefits of slurry become known to the biogas using households, maybe they will start using the bioslurry more. Besides this, awareness among non biogas households of the benefits of slurry may help as a marketing instrument for biogas installations. The promotion of bioslurry use among biogas users is one of the main objectives of the BPD.

Another purpose of this research is to find out whether biogas or bioslurry is the most valuable product for the tea producers with a biogas installation.

Structure of this Thesis

This research will be started with desk research in which available literature will be reviewed. This is done in order to find out what has been researched about bioslurry so far and to identify possible gaps in information between what is known about bioslurry use and the impact on households income. After the desk research the hypotheses are formulated.

Since the author, before starting the research was not very knowledgeable about biogas and bioslurry much literature will be reviewed and also slightly more information might be presented than strictly information that is linked to the above research questions. This is done to make this piece more accessible to readers without a biogas background in order to make more people aware of what biogas installations are and what the benefits are.

The BPD recently got some media attention because they were awarded the global energy award, despite this many people are still unaware of this relatively simple technology with a large amount of benefits to its users and the environment. Therefore some additional information is presented about the biogas installations and the benefits.

Throughout this thesis interesting remarks by the people that were interviewed during the quantitative part of this research will be presented in small textboxes at the bottom of the page.

The structure of the literature review is as follows.

- What is biogas?
- What are the benefits of biogas installations?
- Bioslurry
- Bioslurry use in Vietnam
- What has been found out about the effects of using bioslurry for agricultural production in currently available literature?
- Bioslurry use in tea production.
- Formulation of the hypotheses.
- Can bioslurry be used for other purposes than fertilization as well?

The literature review will be followed by the research design. Here it will be explained how the hypotheses are tested and how these hypotheses will answer the main research question.

The research design is followed by a results section. The results will be presented and the hypotheses are tested. This is followed by a conclusion, discussion, limitation and finally the references of literature that has been used for this research.

LITERATURE REVIEW

Biogas

“Biogas is a gaseous mixture generated during the digestion process of organic matter such as human and animal excrements, water hyacinth, rice straw or leaves under the anaerobic conditions in absence of oxygen. In nature, biogas is generated at the bottom of stagnated ponds, lakes, swamps or in the digestive system of animals.

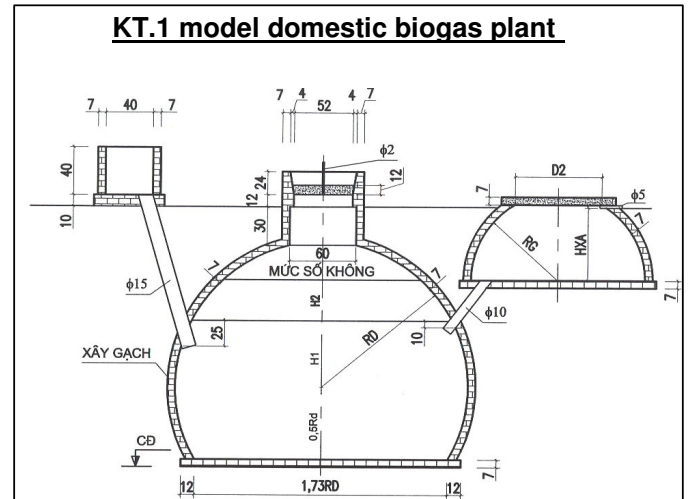
Biogas is composed of methane (CH₄) – 60%, carbon dioxide (CO₂) – 40% and some other gases. Methane is a combustible gas, burning with an odorless blue flame, which can be used for cooking, lighting and other applications.

Digesters Installed Under BPD's Project

This literature review is started with the technical drawings of the biogas installations that are installed under the BPD's project.

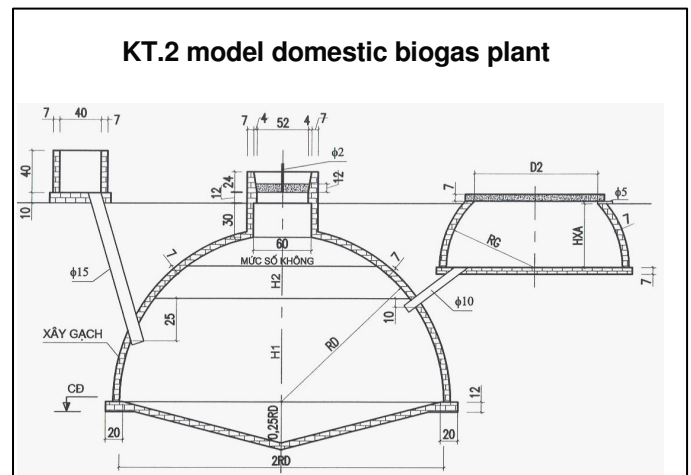
KT. 1 Model

The KT.1 model (1990) is developed on the basis of the NL.6 fixed dome biogas plant model of the Institute of Energy. NL.6 model is the result of a State research project conducted in 1984 and accepted in 1990.



KT.2 Model

TheKT.2 model is a further development of the TG-BP model designed by a Thai-German project in Thailand and has been disseminated in the South of Vietnam by the Can Tho University.



Operation of Fixed Dome Biogas Plant

The information below is adapted from one of BPD's informative brochures about the operation of a biogas plant.

Stage 1: Gas accumulation stage

In the initial state of the operation cycle, the surface of the slurry in the digester and the surface of the slurry having contact with the atmosphere at the inlet and outlet are equal and at the “zero level”. At this moment, the biogas pressure in the digester is equal to 0 ($P=0$)

The generated gas accumulating in the upper part of the digestion tank will push the slurry up into the compensation tank and the inlet pipe. Hence the surface of the slurry in the

digester lowers while the surface of the slurry in the compensation tank is rising. The height difference between these two levels generates the gas pressure. The more gas is generated, the higher the pressure.

When the slurry in the compensation tank reaches the highest level, called the “overflow level”, part of the digested slurry is automatically discharged through the overflow. Hence the gas pressure reaches the maximum value ($P=P_{max}$).

Stage 2: Gas Consumption Stage

When the gas is used, the slurry from the compensation tank flows back into the digester. The level of the slurry in the compensation tank lowers down; while the level of the slurry in the digester rises. The difference between these two levels decreases, hence the gas pressure gradually decreases.

When both levels are at equal height then the biogas plant returns to the initial state of the operation cycle ($P=0$) and the gas flow stops.”

(source: Biogas Project Division 2005)

Possible Applications of Biogas

‘Besides cooking and lighting, biogas can also be used for power generation, processing agro-products, preservation of grains, keeping fruits and vegetables fresh, at low cost with a good result and remarkable economic benefits.’ (Zhang, 2006)

‘Biogas can be used in diesel engines to substitute diesel oil up to 80%. Recently small capacity biogas engines are being developed in India.’ (Gupta 2006)

‘Biogas can also be used for processing tea’¹²

¹³ Biogas can be converted into energy with a machine. The costs of this machine limit it’s large dissemination for these machines.

¹² Information obtained from an interview with SNV’s Program Coordinator North

¹³ Author’s note

Benefits of Biogas installations

Gas production

The main product of the biogas installations is biogas. In Vietnam the households have a total amount of substituted heat per day of 33,730.32kcal which is equivalent to 10 kg of fuelwood per day or 7.6 kg of bee net coal per day, savings resulting from this substituted heat are on average 4000VND per day, resulting in a yearly savings of 1,460,000 VND per year (Nguyen 2005).

The BPD in Vietnam has helped in providing 28000 households with renewable energy which covers a large part of their household energy consumption.

Time savings

In the Biogas User Survey 2005 it was also found that households save much time in collecting cooking fuel, in total 12 man days per year were saved per household. In Nepal the time saved was even higher, there the households saved on average 3 hours per day, the time savings resulted from reduced time in gathering fuelwood, cooking and cleaning the cooking utensils (Bajgain 2005).

Improved manure management

When households own a biogas installation this improves the way in which manure can be managed. Often the stables are directly connected to the biogas installation. This allows the farmers to simply use a hose to clean the stables, the manure and water then automatically flows into the digester.

It was found that this way of manure management allowed farmers to increase the scale of animal husbandry, before the manure management created a barrier for this, besides that, this improved manure management has reduced the smell and presence of mosquito's (Nguyen 2005).

Improved gender development

The previously mentioned time savings result in additional free time, especially for women, since they are usually responsible for collecting the firewood, cooking and cleaning. The women usually chose to spend this additional time for looking after their families (Nguyen 2005).

Besides this collecting the firewood is often a dangerous task since wood is not always available on one's own land or on other public land. Also women are the main beneficiaries of the improved health situation since they are they ones that are usually in charge of the cooking.

Health

The health situation is usually improved after obtaining a biogas installation. The kitchen's become cleaner because cooking on methane gas produces a lot less smoke in the kitchen compared to cooking on firewood. 'This hygienic improvement leads to less eye ailments and respiratory infections,

Improved health due to cleaner kitchen (less smoke), and therefore less eye ailments and respiratory infections, the latter is the most important cause of child mortality in Nepal. Improved animal manure management improves hygienic conditions, this reduces the chances for the spread of infectious and other diseases. Indirectly this has lead to reduced health expenditures. Also the attachment of toilets to the biogas installations have improved hygienic conditions.' (Bajgain 2005)

Below are some pictures of the situation in the kitchen before and after owning a biogas installation that were taken during this research.



The situation in the kitchen before and after using biogas for cooking.

Education

‘The time savings from biogas installations have enabled female children to go to school, also the light provided by gas lamps enables the children to study also in the evening.’ (Bajgain 2005)

Mr. Nguyen Tien Thue:

“In our village we don’t have electricity from 19:00 – 21:00. We are happy with the biogas lamp because now we have light even though there is no electricity”

Impacts on poverty

Biogas installations help save income because less money is spent on energy. In this research it will also be assessed what the savings are due to bioslurry use on the expenditures of chemical fertilizer and pesticides. Besides that it will be assessed whether or not the households are able to obtain extra revenues due to increased agricultural yield and a higher price for their products.

It should be noted here that this program usually does not reach the poorest families. The investment, for local standards, in the biogas installation is usually quite high. Besides that the household needs to own livestock to operate the biogas installation. In order to accommodate the livestock also a stable is needed. From an interview with a farmer it became clear that it costs about 15 million VND to be able to operate a biogas plant. An investment of around 5 million VND is necessary for all three necessary components, the stable, livestock and biogas installation. This represents a total investment cost of around 750 euro's, 50 euro's is provided by the BPD in the form of subsidy.

Environmental benefits

On a household level as mentioned before the biogas installations help to improve the indoor air quality, also the better manure management has improved hygienic conditions.

'On a national level biogas installations help reduce the amount of deforestation. This in turn has important implications for watershed management and soil erosion. In addition if slurry is used the soil is not depleted from important nutrients, which also helps prevent deforestation because no extra farm land need to be created due to unproductive soil. The biogas installation (per household) saves around 2 tonnes of wood per year, 32 litres of kerosene, and 1.7 tonnes of Bio-Fertilizer each year.' (Bajgain 2005)

Besides this the bioslurry can be used for agricultural production. This organic fertilizer can help to reduce the amount of chemical fertilizer needed for agricultural production. This directly reduces the pollution due to chemical fertilizer use.

On a global level the biogas installations help to reduce the amount of emissions of CO₂ and CH₄. Manure does no longer freely emit methane gasses since they are captured in the biogas installation and then used for productive purposes.

Aspiring biogas plant owner:

"I have recently registered for a biogas-plant. The main reason to buy it is that we have many electricity breakdowns. Once I have the biogas plant I can use the biogas lamp."

Aiding in Achieving the MDG's

In the introduction it was shortly mentioned that the BPD may help achieve five of the eight millennium development goals.

Eradicate extreme hunger and poverty

As mentioned before the biogas installations may help to increase income through both income savings and income creation. At this point unfortunately the BPD has not yet been able to reach the poorest families due to the fact that the poorest families usually do not have the required livestock to operate the biogas installation.

To empower women and create gender equality

The fact that women save time helps them to empower them. They now have more time available to do other things that they find important. Also their health situation is improved due to cleaner kitchens.

To reduce child mortality

Improved situation of sanitation in the kitchen also helps to reduce child mortality, often young children are in the kitchen with the mothers, this allows them to look after the children and to do the cooking at the same time. The smoke from firewood is very harmful to the young children's lungs. The decrease in smoke from fossil fuels directly helps to reduce the amount of child mortality.

Combat HIV/Aids, malaria and other diseases

Because the manure is now stored in the biogas installation there is no manure laying around. This attracts less flies and mosquito's. Improved sanitation around the house helps prevent diseases.

Ensure environmental sustainability

It is expected that when slurry is used, there will be less need to use chemical fertilizer. This helps to prevent groundwater pollution. Also when organic fertilizer is used instead of chemical fertilizer the soil conditions improve, this enables a sustainable use of their land.

Bioslurry

This research will focus on the use, benefits and economic revenue of bioslurry.

To get a good overview of the benefits of bioslurry first an overview is given of the general benefits of Bioslurry. This is followed by an overview of negative side effects of inorganic fertilizers, and therefore additional advantages to using bio-slurry, since bioslurry does not generate these negative side effects.

General benefits of Biogas Manure (Anonymous 2005)

- It has no bad smell
- Insects do not grow in it
- Water holding capacity of the soil is enhanced ensuring plant growth
- Retains and enhances nutrient uptake for better nourishment of plant.
- Enhances the aeration of soil for root penetration resulting in better growth
- The viability of weed seeds is lost
- Readily available

Disadvantages of using inorganic fertilizer (Anonymous 2005)

The inorganic chemical fertilizers are harmful in the long run as they do not provide balanced diet to plants, severely affecting the physical chemical and microbial properties of the soil.

The impact of extensive use of inorganic fertilizer:

- Destroys soil micro flora, especially the nitrogen-fixing bacteria.
- Causes pollution of fresh water reserves
- Reduces soil porosity, aggregation and ultimately to infertility
- Erodes topsoil due to wind because of missing organic matter in the soil.
- Is not cost effective on long term basis.

Bajgain (2005) argues that bioslurry is an equally important output like gas that has high nutrient content essential to agriculture production systems. Besides providing much needed nutrients, growth hormones and enzymes, the application of slurry in soils also improves physico-chemical and biological properties of soils.

¹⁴“It was found that the slurry from anaerobic fermentation of a biogas digester improves the physical and chemical properties of the soil. Since there are no more parasites and pathogens in the slurry, it is highly recommended for use in farming. The economic value of the slurry shows that investment can be gained back in three to four year's time if slurry is properly used.”

Gupta identified the advantages of using the biogas system instead of making use of traditional composting. As can be seen in the table below it seems more efficient to use the biogas system and use the bioslurry then to make compost out of the manure

¹⁴ <http://www.palangthai.org/en/bsep/docs/BiogasTrainingOctNov2003.pdf>

	1000 kg of wet cattle dung	
	Compost pit	Biogas system
(a) Organic matter loss by decomposition	500 kg	270 kg
(b) Nitrogen loss by decomposition	1.25 kg	Nil
(c) Final manure quantity Quality – Nitrogen% on dry basis	500 kg 1.0%	730 kg 1.5%
(d) Additional advantage	-	2,000 cu.ft. of gas

Table adapted from (Gupta 2006)

Gupta (2006) also made a swot analysis of bioslurry. The swot analysis of bioslurry can be found below. Even though the SWOT analysis was made for bioslurry in India, the SWOT analysis for Vietnam would be approximately the same.

SWOT Analysis of Bioslurry

Strengths

- Bio-slurry contains humus and almost all essential plant nutrients, where as chemical fertilizers do not supply humus and provide single or at best a few nutrients. Regular application of bio-slurry could reduce or eliminate the occurrence of deficiency symptoms of micro-nutrients.
- Supplying plant nutrients through bio-slurry is cheap as compared to chemical fertilizers.
- Bio-slurry can substitute about 25 to 50 per cent of the recommended N-fertilizer dose; thereby it reduces the cost of cultivation.
- Production of bio-slurry manure is a decentralized activity and does not cause air pollution where as production of chemical fertilizers cause air pollution and health hazards.
- Since weed seeds are destroyed during anaerobic digestion of cattle dung, bio-slurry remains free from weed seeds, provided it is used in wet form.
- Load of pathogens in bio-slurry is drastically lesser then cattle dung and also farmyard manure.
- Bio-slurry does not allow breeding of flies and mosquitoes.
- Bio-slurry does not have odor.
- Like farmyard manure, bio-slurry can be used in reducing the pesticides toxicity in soils. Handling of bio-slurry generates additional employment opportunity in rural areas.

Weaknesses

- Like any manure, bio-slurry contains very low quantity of N, P and K nutrients and it alone can not meet the total requirements of crops and sustain high crop yields.
- Loss of nitrogen takes place quickly when bio-slurry is sun dried. However, use of bio-slurry in liquid form requires large space for storage near the biogas plant and involves transportation to the fields, which is costly and cumbersome.

- Suitable machines, such as applicators, spreaders, etc. have not been developed so far for use of small farmers.¹⁵
- It costs to properly handling bio-slurry and majority of the farmers are not willing to invest in this equipment.
- The initial investment in the biogas installation is relatively high for local standards.
- Farmers, who have seen 200-300% increase in crop yields due to the use of hybrid seeds, chemical fertilizers, etc., are not able to appreciate the marginal increase in yields due to the use of bio-slurry.

Opportunities

- The government has recently started promoting organic farming. Some State Governments have declared their states to be the organic states and are helping farmers to grow organic produce such as tea, coffee, spices, etc. and get them certified for export. This would certainly provide a new and better opportunity for using bio-slurry in organic farming.
- More areas are being covered under cross-bred milk cattle and operation flood, i.e., marketing of milk, schemes. Therefore, the potential of setting up biogas plants is increasing. Such areas need fodder, which could be grown by using bio-slurry.
- Soil Health Cards of villages are being prepared on war footing to promote the use of fertilizers and manures based on soil test data and requirements of crops rotations. This would encourage proper use of bio-slurry as well.
- Ever increasing prices of liquefied petroleum gas and kerosene compel cattle owners to adopt biogas technology, which in turn provides opportunity for using bio-slurry

Threats

- Fodder availability is becoming scarce due to competing land usages and growth in cattle population is expected to decrease. This would affect adversely the availability of cattle dung for bio-slurry operation.
- Increasing mechanization of agriculture over time would discourage farmers to maintain cattle for agricultural operations and thereby the availability of dung would be a limiting the production of bio-slurry.
- Preparing vermin-compost of cattle dung mixed agro-wastes is simple and its quantity and quality is better than biogas slurry.

¹⁵ It is possible to use a pump and hose to apply the slurry to the field. Two inhibiting factors here are the price of the pump and the distance to the land.

Bioslurry use for Agricultural Production Outside of Vietnam

In September 2006 an international conference was held about bioslurry. Researchers from different countries were asked to do research into the effects of using bioslurry. Some of the most important findings are presented below. The assumption here is that when bioslurry has a positive influence on agricultural products other than tea that this effect could also be applicable for tea.

Bangladesh

“Mineral fertilizers alone cannot correct all the deficient nutrients in the soils. Due to high oil prices in the international market and shrinking of natural resources, the prices of imported fertilizers will continue to increase in the coming years.

Bioslurry can play a vital role in restoring fertility as well as organic matter status of the soils. Bioslurry organic fertilizer is environmentally friendly, 100% organic, has no toxic or harmful effects and can easily reduce the use of chemical fertilizers up to 50%. Nutrients from organic sources are more efficient than those from chemical sources. Field trials conducted in Bangladesh have shown the beneficial effects of bioslurry organic fertilizers in increasing the yields of cabbage, brinjal, tomato, onion, potato and papaya.” (Islam 2006)

Nepal

“ It has been proved through laboratory tests and practical implication that organic digested material acts as better soil conditioner than the undigested one. The evidence beside this fact is that the biochemical processes in anaerobic condition inside the biogas plant makes the nitrogen more readily accessible to the plants. Besides, no loss of nitrogen takes place in the digester which would otherwise take place during composting or simple storage. Field trials performed in Nepal by Soil Science and Agricultural Chemistry Division, NARC, DOA, reported that bio-slurry use increased the yield of various crops by big difference, the Nitrogen content in digested slurry is 1.6% as compared to 0.8% and 1% in FYM. And composted manure respectively. Similarly, the phosphorous content is more than double of that in FYM and compost and the potassium content is 1% as compared to 0.7% in FYM. Biogas User’s survey 2003/2004 has also reported an increase in paddy, maize and potato production in by 58%, 70% and 44% respectively due to bio-slurry application.” (Karki 2006)

In Nepal several experiments have been carried out on the effect on agricultural production with different forms of slurry use (Karki 2006). This has been tested on maize and cabbage. For maize an increase in yield was recorded when bioslurry in liquid form was used, in comparison to the recommended dose of chemical fertilizer. When slurry compost was used in combination with chemical fertilizer the increase in yield was the highest.

For the experiment with cabbage also the highest incremental yield was recorded when composted slurry and chemical fertilizer were used together. Here again the liquid slurry also recorded a higher incremental yield in comparison to chemical fertilizer use.

The yield differences appear to be different depending on what crops are cultivated. The composted slurry seems to have the highest beneficial effect. This method is more labor intensive than using liquid slurry, but the application is in general easier in comparison to liquid slurry.

Bioslurry use in Vietnam

In the biogas user survey 2005 (Nguyen 2005) it was found that 78% of the households in the sample were aware of the benefits of using bioslurry for agricultural production. However, only 40% of the households actually used the bioslurry for agricultural production. This research may aid in increasing the awareness about the benefits of using bioslurry for agricultural production and therefore increase the percentage of households that use bioslurry.

In Vietnam several experiments have been done on the difference in production between the local practices of fertilization and pest application and the recommended way, supplemented by bio-fertilizer (also known as slurry compost). These experiments have been done for paddy rice, cabbage and tomato (Pham 2006).

Paddy rice

The yield for paddy rice increased with 678 kg per hectare, savings on chemical fertilizer and pesticides amounted to 70\$ per hectare.

Cabbage

For cabbage an additional yield of 55,3% was realized, besides this the experimental group had less occurrence of pathogens. Savings on chemical fertilizer and pesticides were 163\$ and 18\$ per hectare.

Tomato

The yield of tomatoes was also considerably higher when bio fertilizer was used in combination with chemical fertilizer. The experimental group produced 60,91 tons of tomatoes compared to 47,39 tons per hectare for the control group.

The savings on chemical fertilizer were 44\$ per hectare and 14\$ per hectare was saved on pesticides.

Besides bigger yields for all three products and monetary savings on chemical fertilizer and pesticides the products will be healthier due to less use of chemical fertilizer and pesticides.

Restrictions to Widespread Use of Bioslurry in Vietnam

- “Bio-slurry is mainly in liquid form making it difficult to transport to the field, especially in Vietnam, where the slurry pit is usually far away from the fields.
- Awareness of farmers/users: Despite the fact that a lot of commune promotion workshops have been carried out, the awareness of biogas users is still limited.
- Lack of labor: Some households prefer using chemical fertilizers because using bio-slurry or composting bio-fertilizers takes time and therefore opportunity costs for the labor force.

Traditional habits in farming activity: there are some restriction when introducing the composting method in southern provinces where people do not have the habit of making compost fertilizer from on-farm residues and using bio-slurry.”(BPD 2006)

Additional Purposes for Bioslurry

As was described above many researchers have already proved the beneficial effects of using bioslurry for agricultural production. Now available literature is reviewed on different purposes for using the bioslurry. This will not be empirically researched but they should at least be mentioned here.

In Vietnam bioslurry has been used for feeding fish, and pigs (BPD, 2006).

Fish food

When the food of mature fish was supplemented with bioslurry 40% was saved on the food of fish costs, and eliminated head floating phenomena which are very common when fresh dung was used to feed the fish. The revenue of increased productivity was raised with 12%.

In another experiment, when bioslurry was used for nursery fish 67% was saved on the cost of fish food.

Pig food

In another experiment in Daklak province in Vietnam, pigs were fed with bioslurry. Profits increased with 9-11 euro/pighead/feeding cycle. Costs were saved on foundation food and digestive diseases were eliminated.

Zhang (2006) also identified to use bioslurry as food for pigs and fish. He also mentioned the following two possibilities for using bioslurry:

Edible fungi culture

“When bioslurry is used for cultivating mushrooms, the time to harvest shortens, quality goes up and the quantity per square meter also improves.”

Soaking seeds

Bioslurry Use in Tea Production

It is now clear that the use of bioslurry can have beneficial effects on agricultural production. It is assumed that the positive effect of using bioslurry as described above may also be applicable to tea production. As was mentioned in the literature review this research will focus on the use of bioslurry for tea production. Now available literature about slurry use for tea production is reviewed.

China

A previous experiment with bioslurry for tea production has been conducted in China (Zhang 2006). For the experimental group 30000kg of dry bio-sludge per hectare was used. For the control group 750kg of compound fertilizer and 375kg of urea was used per hectare. The results differed per season. In Spring the tea production with chemical fertilizer was higher than when bio sludge was used, for the other seasons bio sludge had a higher yield compared to the chemical fertilizer. Overall the bio sludge sector had a higher yield per hectare per year of 1,55 kg.

A beneficial side effects of using bio sludge instead of chemical fertilizer is the fact that the tea seemed to be of a higher quality.

A higher sales price of 2 yuan/kg of tea was recorded in spring. The total income increase due to this was 5,400 yuan on a yearly basis. Besides extra income due to revenues of the tea also money was saved on the costs of chemical fertilizer, in total 1522.50 yuan was saved.

Zhang also mentions an important limitation to bioslurry use. The dosage of bioslurry, when used as a base fertilizer is 15000 kg – 45000 kg in order to be effective. Compared to chemical fertilizer the dosage is too high, which in turn, inhibits its application.

Vietnam

In Vietnam also one experiment was conducted on the effect of using bioslurry for tea (Luu Dinh). This experiment was conducted in Dong Hy District (Thai Nguyen). An experimental and control plot was used. The experimental plot received bioslurry as means of fertilization and the control plot received chemical fertilizer.

The experimental plot produced on average 3,33 kg more tea than the control plot, resulting in 0,8 kg more per sao. The costs of input materials for the control plot was 78,400VND higher per sao of land. The gross income for 1 sao of land for the experimental plot was also 30,000 VND higher in comparison to the control plot. The income generating and income saving effect from using bioslurry for tea instead of chemical fertilizer together amounted to 108,400 VND.

Some caution has to be taken when interpreting these results. It is likely that previous fertilization with chemical fertilizer of the experimental plot may have altered the results. Besides this it is not likely that tea producers will totally replace chemical fertilizer with bioslurry, it's more likely that bioslurry is used to supplement chemical fertilizer.

In this research it will be assessed whether or not bioslurry can help generate additional income for tea producers.

The Vietnamese version of this report was obtained from the BPD's extension worker. Even though this experiment was quite similar to the research in front of you the BPD still wanted more information on this subject. Unfortunately the translation of the report didn't occur until after the data collection process for this research. The results of both researches are compared to each other in the results section. The previously conducted experiment has its own strengths and weaknesses. Using an experimental and control plot seems to be a valid method, but the results may have been altered due to previous fertilization of the experimental plot.

Advantages of this research compared to the research mentioned above is that the sample is much larger, and therefore the chance of other factors than bioslurry influencing the yield and price per kilogram is much smaller. Besides that it gives a more accurate representation of the reality in Thai Nguyen because bioslurry is used in combination with chemical fertilizer. In this research the previous and current expenditures on both chemical fertilizer and pesticides are recorded. This gives a more accurate representation of actual savings on chemical fertilizer and pesticides than to not use them at all and call this the income saving effect.

The main disadvantage to this research is that current and historical data had to be used. Prices may have changed over the years, also the plant has a different production rate at different ages. How this is accounted for is explained in the research design.

In the introduction the main research questions were presented, these had been decided on after a discussion with the advisors from the BPD. The author was also asked to include a question about the scope of bioslurry use. The idea here is that when the slurry is not used it cannot have an effect on either tea production or household income. Therefore main research question 1 is included. No sub-questions are formulated to answer this main research question.

Research Questions, Sub-questions and Hypotheses

MQ1; What is the scope of bioslurry use of biogas-households in Thai Nguyen?

No sub-questions are formulated for this main research question. Households are asked if the slurry is used, how many times per month it is used, in what form and whether they feel they have enough slurry or if they wished to have more. The reason to include this question is that if the slurry is not used it cannot have an effect on the yield and price of tea and therefore it can also not have an effect on household income.

MQ2: What is the effect of bioslurry use on tea production in Thai Nguyen?

SQ1; What is the effect of bioslurry use on the quantity of tea production?

Hyp1;

Ho: There is no difference in productivity before and after using bioslurry for tea production.

Ha: There is a significant difference between productivity before and after using bioslurry.

SQ2; What is the effect of bioslurry use on the market price of tea?

Hyp2;

Ho: There is no significant difference in price before and after using the bioslurry.

Ha: There is a significant difference in price before and after using the bioslurry.

MQ3: What is the effect of bioslurry on household income for tea producers in Thai Nguyen?

In order to answer this research question two sub-questions have to be answered. Expected increase in income can result from two factors.

If less chemical fertilizer and or pesticides are used bioslurry can have an income saving effect for biogas households producing tea.

If the tea producers have an increased revenue due to a higher quantity and or a higher sales price, the use of bioslurry for tea production may have an income generating effect.

SQ3; Does using bioslurry for tea production have an income saving effect?

To answer this sub-question two hypothesis are formulated

Hyp3;

Ho: There is no significant difference in expenditures on chemical fertilizer after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on chemical fertilizers after households started using the bioslurry for tea production.

Luu Dinh proved that supplementing chemical fertilizers with bioslurry can help reduce the amount of pests. If this is the case this can also increase the income saving effect of bioslurry. This leads to the following hypothesis.

Hyp4;

Ho: There is no significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

SQ4; Does using bioslurry for tea production have an income generating effect?
The answer to this sub-question is derived from SQ1 and SQ2.

Hyp5;

Ho: There is no significant difference in income from tea production after the households started using the bioslurry.

Ha: There is a significant difference in income from tea production after the households started using the bioslurry.

RESEARCH DESIGN

In the literature review it was identified which are the questions of interest for this research. The main research questions, sub-questions and hypotheses are reproduced and grouped together below.

Main Research Questions

MQ1: What is the scope of bioslurry use of biogas-households in Thai Nguyen?

MQ2: What is the effect of bioslurry use on tea production in Thai Nguyen?

MQ3: What is the effect of bioslurry on household income for tea producers in Thai Nguyen?

Sub-Questions

SQ1; What is the effect of bioslurry use on the quantity of tea production?

SQ2; What is the effect of bioslurry use on the market price of tea?

SQ3; Does using bioslurry for tea production have an income saving effect?

SQ4; Does using bioslurry for tea production have an income generating effect?

Hypotheses

Hyp1;

Ho: There is no difference in productivity before and after using bioslurry for tea production.

Ha: There is a significant difference between productivity before and after using bioslurry.

Hyp2;

Ho: There is no significant difference in price before and after using the bioslurry.

Ha: There is a significant difference in price before and after using the bioslurry.

Hyp3;

Ho: There is no significant difference in expenditures on chemical fertilizer after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on chemical fertilizers after households started using the bioslurry for tea production.

Hyp4;

Ho: There is no significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

Hyp5;

Ho: There is no significant difference in income from tea production after the households started using the bioslurry.

Ha: There is a significant difference in income from tea production after the households started using the bioslurry.

Contribution of Sub-Questions to Main Research Question

SQ1 is used to assess whether or not there is a causal relationship between the use of bioslurry and the amount of tea that is produced per hectare. If the use of bio-slurry increases the yield of tea per hectare this could have a large financial effect on the tea producers in Thai Nguyen, they will reap larger benefits from their work.

SQ2 follows from sub-question 1. It is also possible that the use of slurry increases the quality of the tea. Quality of tea, in this research, will be assessed by the price that is obtained per kilogram of tea. If the quality, and market price improve, this has a beneficial financial effect on the tea producers in Thai Nguyen as well.

SQ3/SQ4 measure the economic effects of biogas installations. These are probably the most important to the tea producer. The purchase of a biogas installation demands a relatively high investment for local standards. If a biogas installation would not bring economical benefits to the farmer that outweigh the burden of the investment costs, most likely, no biogas installations would be sold.

Rationale Behind Country, Case and Place

Vietnam is a country where relatively little academic research has been done into the effect of bioslurry. It is a very interesting country to do research because a very large part of the population is involved in agriculture, nearly 80% (Pham 2006). Also this country has a large number of biogas installations. According to BPD's coordinator there are a total of 100,000 biogas installations spread across Vietnam. The BPD is responsible for around 28,000 of them as of January 2007. The biogas installations have a very large relevance in Vietnam, they improve the lives of rural households. Therefore Vietnam is a great location to do this research.

Tea producers are chosen because they are assumed to have very accurate records of how much tea is produced per sao (¹⁶Sao = unit of land measurement of 360 m², equal to 0.035 hectares (or 1hectare = 28 sao)). Also they are assumed to have very accurate records of the price they obtained per kilogram of tea. Because this research, besides assessing the impact on income, tries to assess the influence of slurry on quantity and quality of tea production, it was chosen to focus on tea producers

Thai Nguyen is one of the 64 provinces in Vietnam. The reason for doing the research here is that there are a lot of tea producers in Thai Nguyen. The second reason is a logistical one, Thai Nguyen is located around 80 kilometers from Hanoi, and therefore it will be relatively easy to travel back and forth between Hanoi and Thai Nguyen. The fact that the research will only take place in Thai Nguyen is a limitation to this research. However besides the logistical advantage, also money and time have to be taken into account. Ideally an a-select, stratified statistically significant sample would have been taken from the entire population of biogas households in Vietnam, but for the above mentioned reasons this is not possible.

What Methods and Why

A *pilot study* is performed in order to find out whether assumptions made during the formulation of the research plan are correct. During the pilot study the questionnaires are used in order to find out how long it takes to do one interview and to find out if the responses from the respondents are useful. Besides that the intended research approach is tried to see if this is a valid and feasible approach.

¹⁶ <http://www.regional.org.au/au/apen/2001/r/BarrettG.htm>

Quantitative analysis is performed to generate a large amount of data on the use, benefits and economic impact of bioslurry on tea production. Quantitative analysis is used to try make a statistical powerful statement.

Co researcher

The BPD has provided funding for hiring a co-researcher to assist in the gathering of data in the field. In this way the language problems are overcome, also cultural barriers are tackled this way since the co-worker is Vietnamese, and therefore knows about local customs and traditions. The TOR's for the co-researcher are also attached to this report as appendix 1. The co-worker that was hired is Tuan Ha Minh. He is currently a lecturer at Thai Nguyen University. He had previous experience in doing field research in this area. His knowledge of local customs and administrative procedures has facilitated the data gathering process.

Data Collection

The data will be collected by means of a questionnaire. In total 100 households with a biogas installation are interviewed. This will be done together with the co-researcher.

Access to the Units of Analysis

Thai Nguyen is one of the 64 provinces in Vietnam. In Vietnam the provinces are divided into districts and the districts into communes.¹⁷ The best way to approach doing research in Vietnam is to take the official way of asking for permission to enter communes to do research. An official letter is written (first in English and later translated into Vietnamese), this letter needs to contain the purpose and subject of the study, it was also advised to attach the research plan to the letter, with the names of communes intended to visit on which day. This letter needs to be signed by SNV in Hanoi and can then be sent to the Provincial People's Committee (PPC). The PPC will then decide whether to grant the request or not.

After obtaining this permission letter it is necessary to obtain a letter of recommendation from the organization one is working for. In this case the Provincial Biogas Project Division. After obtaining these documents all the formal requirements have been fulfilled to start the actual data collection at the household level.

Compensation

The households are compensated for their time and efforts. Each household will receive 10 000 VND, this is equal to 50 euro cents. The households were told about the compensation after the interviews.

Also the guides were paid for their services. Guides were either extension workers, village heads or in one case a biogas mason. They were paid a maximum amount of 50 000 per day. This was decided after the pilot study because it seemed to help boost their enthusiasm which facilitated the access to the households.

¹⁷ This information was gathered during an interview with one of SNV's Market Access for the Poor's advisors.

Results from the Pilot Study

For logistical reasons Thai Nguyen City district was chosen to do the pilot study. The data was gathered in two communes; Phuc Xuan and Phuc Triu.

Initially it was intended to use both an experimental and a control group. The experimental group consisted of households with a biogas installation and the control group consisted out of households without a biogas installation. In total 11 households from both groups have been interviewed.

The questionnaires, as attached in the appendix 2 where used for the pilot study. Below are the conclusions of the pilot study per group.

Experimental Group

The main finding for the experimental group, and the one with the largest implications was the fact that one interview took around 2 hours. It was found that after around forty five minutes, and worse after one hour the attention, interest and enthusiasm of the farmers quickly faded away. After a discussion with both the co-worker that assists in the interviews and the supervisor from SNV it was decided to take out a large part of the questions. The initial target was to assess income savings for all biogas related issues and also some livelihood assets and outcomes where intended to be measured. After the pilot study it was decided to use secondary data for some aspects.

Possible fertilizer and pesticide savings were planned to be intensively measured, after the pilot study it was decided to only ask two questions for both factors. How much did you use for tea production before the installation of the biogas plant and how much do you use now?

Also other agricultural products than tea where intended to be measured, this took a lot of time and slurry was not always used for all the products, this made the analysis uncontrollably complicated and in the opinion of the researcher did not add enough value to the total research. Other agricultural products are left out of the analysis after the pilot study.

Besides possible fertilizer and pesticides savings also savings on energy costs where intended to be measured. This took up too much time and did not yield very clear results. In general some money was saved on wood usage. A complicating factor was that not all of the wood was bought in the market for a uniform price, some people gathered part of the wood. This gathering process costs time, but it is difficult to give this a monetary value, besides that people did not exactly know how much time was spend on these activities.

Often households did spent more money on electricity, not all households use the biogas lamp, and often other electrical appliances had been bought. More energy was for example used for pumping the slurry to the land, and for the processing of tea.

Before the pilot study also livelihood outcomes other than monetary factors where supposed to be measured. These consisted out of time savings, health care expenditures and the use of additional income.

The time savings proved to be difficult to answer for the households, and the exact same question had been asked in the biogas user survey.

The health care expenditures where largely dependent on factors that where none biogas related. A positive health effect is expected due to the biogas installation, however, by asking for the monetary expenses this effect can not be proven. Most people have health insurance, some reported that even if they feel they should get medical attention do not go to the hospital, they say it is too expensive and takes too much time. Instead they buy medicines locally, this is often covered by insurance. Because of the above reasons it was decided to leave it out of the analysis. Additional research could be done into this, but it should be done by a researcher with a medical background, and in a different way than questionnaires.

The use of additional income yielded some interesting results, however among the first interviews most of the answers remained the same, besides this the author assumes that most answers were only socially acceptable answers, one man however honestly admitted that he now is able to drink a bit more rice wine. For the remainder of the interviews this is not analyzed. The households are still asked if they feel they have more income due to the biogas installation, often they think it is a stupid question and say yes. To be academically correct it was chosen to leave this question in.

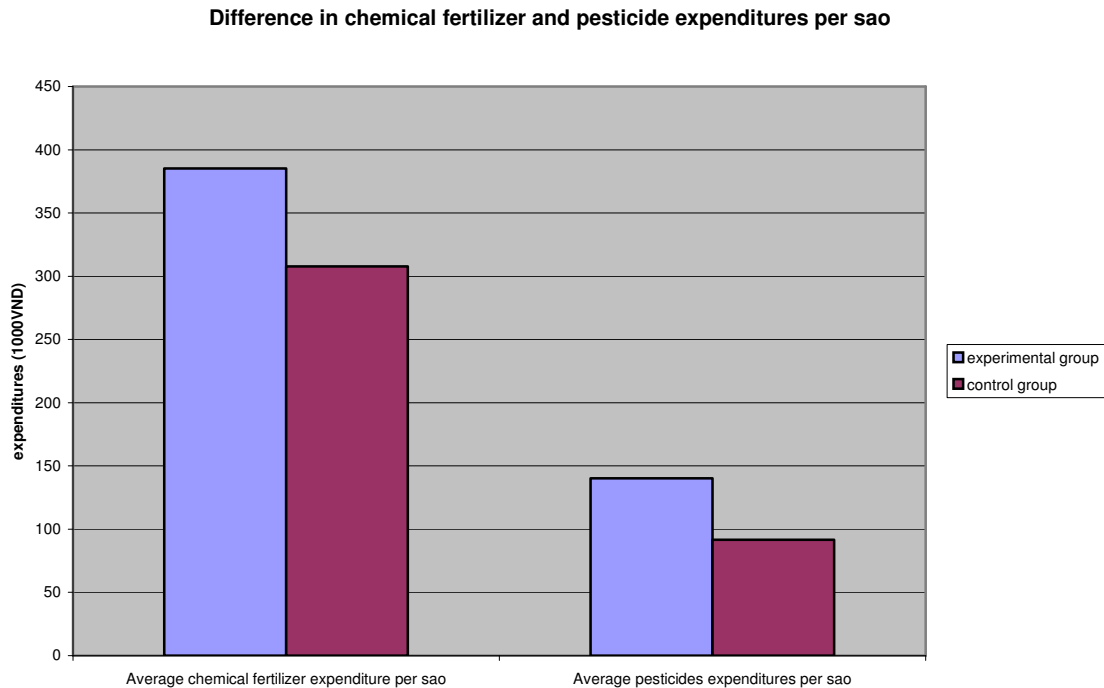
Another factor that had not been initially taken into account was the fact that some people may produce the same variety of tea, but the tea has a different age. For this reason we had to add some extra space in the questionnaires to fill in the difference for different kinds of tea. This was only a format issue but otherwise no valid comparison could have been made, due to different productivity rates throughout the life of the tea plant.

Control Group

After the pilot study it has been decided to stop using the control group. The initial plan was to use a control group and ask them the same questions as the experimental group. There was one theoretical flaw behind this reasoning. This can be best illustrated by one farmer who made approximately the following remark when asked about his opinion for the demand for biogas installations. "There is no actual demand for biogas installations, everyone who can afford one has one because it's a great product." In other words the difference in wealth between the biogas households and non biogas households was too large.

The intention of using a control group was to make a comparison between similar groups to assess the difference in tea production due to slurry use and the monetary savings due to the biogas installation in general. Because the difference in wealth was too large no such comparison could be made. Non biogas households reported that they would use more fertilizer if they could afford it, this obviously distorts the comparison when the purpose is to analyze yield and quality of tea production, the results would be largely in favor of the biogas using households since they are able to afford more fertilizer which is also complemented by bioslurry use.

This is also illustrated in the graphs below, as can be seen the control group uses less chemical fertilizer and pesticides per sao in comparison to the experimental group, even though the biogas households use additional organic fertilizer.



For energy expenditures the comparison would also have been useless. Quite likely the poorer households would use more energy if they had more money. Possibly they would buy more electrical appliances which would cause them to use more electricity. The same is true for other sources of energy. If the household cannot afford it they will not use it. The energy saving ability of the biogas installation would not have been accurately been measured if the control group was used.

The other reason not to use the control group was to be able to do some more interviews with biogas using households. This will increase the statistical significance of the data.

Research Approach

As was mentioned above the initial plan of using an experimental group and a control group was not a valid approach because the difference in wealth. After this had become clear it was decided to still use questionnaires but to include only households with a biogas installation in the sample. Households in the sample are asked about current and historical data about the topics of interest. The questionnaires that were revised after doing the pilot study are attached as appendix 3.

It was decided to only measure bioslurry related income effects instead of measuring all income effects related to biogas installations.

In total 100 households with a biogas installation that produce tea are interviewed. How each sub-question is answered is described below.

Method of Answering MQ1 and the Sub-Questions

MQ1; What is the Scope of Bioslurry Use of Biogas-Households in Thai Nguyen?

For the first sub-question information needs to be gathered about the theoretical possible use of bioslurry and information needs to be gathered about the actual use of bioslurry. To assess the theoretical possible use of bioslurry some desk research had to be done. Previous research into the use of bioslurry was reviewed. Information about the use of bioslurry can be found in the literature review.

Besides the literature review some experts were interviewed. The former Chief Technical Advisor (CTA) from the BPD and the Biogas Practice Area Leader (BPAL) were interviewed.

Data about the actual scope of bioslurry use was collected from all the households. The households were asked about the following factors related to bioslurry use:

- Is slurry used for tea production
- How many times per month do you apply it
- In what form is the slurry applied
- How is the slurry transported and applied to the land
- How much slurry do you have (not enough, enough, excess)
- In case of excess slurry, what is done with it?

The scope of the bioslurry use is analyzed by comparing the theoretical possible use to the actual use of bioslurry by tea producers in the sample.

SQ1; What is the effect of bioslurry use on the quantity of tea production?

Biogas installations produce bioslurry. This slurry can be used as a potent fertilizer. It is assumed that good fertilizer increases the volume of tea production.

The second assumption is that Thai Nguyen tea producers (both with and without a biogas installation) have accurate information about the quantity of tea that is produced.

The information that needs to be gathered is the amount of tea produced per sao in kilograms (sao is the Vietnamese measurement unit of land). Therefore they are asked the number of saos they use to produce tea, the number of harvests both in summer and winter and the amount of processed tea produced per harvest per sao.

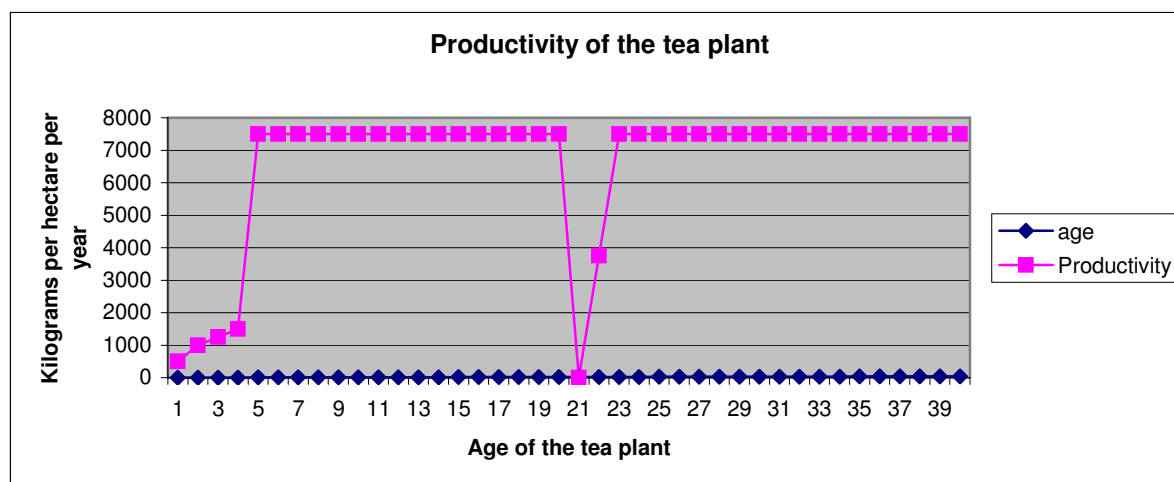
Also information about the age of tea plants, the sort of tea, method of cultivation and the method of harvesting needs to be obtained.

The households are selected in cooperation with the local extension officers when available. If this was not possible other people were asked, like biogas masons or village heads.

The data is collected by means of a questionnaire. The households are asked about the current production per sao and the production per sao before they had a biogas installation.

When the current production is significantly higher per sao/harvest this proves that bioslurry use has a beneficial effect on the quantity of tea production.

One problem for the analysis is that the tea plant has different growth rates at different ages. From the interview with Mr. Chung from Thai Nguyen university we gathered that the productivity curve of the tea plant is as shown in the graph below. This is the amount of processed tea that is produced per hectare per year. The Vietnamese land measurement unit is not hectares but sao's. This graph is based on hectares, in order to get the productivity per sao the number has to be divided by 28. The shape of the graph and the trading period is the same however.



As can be seen from the above graph the results will be positively affected because the purchase of the biogas plant is always in the past. Even though the cycle of the tea plant repeats itself in the beginning of the life of the tea plant the production increases in the first four years. After pruning (normally around 20 years after planting the tea, the cycle starts over again. In the first year after pruning it will not produce, the year after it produces at 50 percent of the maximum capacity to return to growing at maximum capacity the year after.

Depending on the way the tea is cultivated the total productive lifetime of the plant varies between 40 and 80 years. When chemical fertilizer is overused the productive lifetime will not be over 40 years. This is the common situation in Thai Nguyen. For the slurry farmers the lifetime of the plant may be longer because they use less chemical fertilizer, this is complemented by the bioslurry (organic fertilizer).

For the analysis of difference in quantity not all data on quantity can be used. The objective here is to show a causal relationship between the use of slurry and the quantity of tea production. For this reason only data will be included from households of which their tea was in the trading period, both in the current time and at the moment they started using the bioslurry. The rest of the data will be excluded for this analysis.

Within the trading period the yield remains equal. The difference in yield can therefore be attributed to bioslurry use.

The following hypothesis is tested for this sub-question:

Ho: There is no difference in productivity before and after using bioslurry for tea production.

Ha: There is a significant difference between productivity before and after using bioslurry.

The mean of the current productivity per sao is compared to the historical productivity per sao. The software package Stata will be used to test whether the increase or decrease in productivity is statistically significant. This is tested with a confidence interval of 95%.

SQ2; What is the Effect of Bioslurry use on the Market Price of Tea?

Besides a possible higher production of tea it is also possible that bioslurry helps produce tea of a higher quality. The quality of tea is determined by the price that is obtained for the tea; the market price. The assumption is that people are willing to pay more for tea of a higher quality and that quality is recognized by tea buyers (consumers and exporters). Different kinds of tea will be taken into account, some kinds of tea are more expensive than others.

Also the use of pesticides is believed to influence the price obtained for tea. If pesticides are used the market price of tea is expected to go down. Bioslurry is believed to help reduce the need for pesticides and therefore could also improve the market price in this way.

For this question information about the average price per kilogram of processed tea needs to be gathered. Households are asked about the current price per kilogram of processed tea and the price per kilogram right before they started to use the bioslurry.

The problem with the average prices is that inflation will create an artificially high price in favor of the bioslurry tea from the current time. This will be corrected with Vietnam's monthly consumer price index.

The data collection took place in December 2006 and January 2007. For the inflation correction January 1st 2007 is used. Even though the data are collected a little before and a little after this date.

E.G. if the slurry is used for 2 months the biogas installation is owned for three months. This means the prices are revalued according to the price index, Dec. 06 divided by Sept. 06.

A paired comparison will be made between prices before slurry use and prices after slurry use. Only if observations from both before slurry use and current prices are available the data is included in the analysis.

The following hypothesis is tested for this sub-question:

Hyp2;

Ho: There is no significant difference in price before and after using the bioslurry.

Ha: There is a significant difference in price before and after using the bioslurry.

Again, if bioslurry using households on average obtain a significantly higher price per kilogram of tea this proves that using bioslurry has a beneficial effect on the price that is obtained per kilogram of tea. The inflation corrected prices are compared to the prices before the household started to use bioslurry.

Again Stata will be used to test whether or not the differences are statistically significant. This is tested with a 95% confidence interval.

Sub-questions number two and three together answer main research question number one.

SQ3; Does using bioslurry for tea production have an income saving effect?

Due to using bioslurry money could be saved on chemical fertilizer and pesticides. Households will be asked about yearly current and previous expenditures on both chemical fertilizer and pesticides. The expenditures before the biogas installation will be adjusted for inflation with Vietnams CPI.

The following hypotheses are tested for this sub-question.

Hyp3;

Ho: There is no significant difference in expenditures on chemical fertilizer after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on chemical fertilizers after households started using the bioslurry for tea production.

Hyp4;

Ho: There is no significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

If both hypotheses are rejected this means that bioslurry has an income saving effect. It is also possible that households only save on either pesticides or chemical fertilizer, or that expenditures increased after they started using the bioslurry. When combined expenditures have decreased this means that bioslurry has an income saving effect.

SQ4; Does using bioslurry for tea production have an income generating effect?

If bioslurry helps achieve a higher production per sao this will help generate additional income for tea producers. The yearly additional yield in kilograms of processed tea will be multiplied by the average price obtained per kilogram of processed tea.

If bioslurry helps achieve a higher price this also generates additional income. The price difference will be multiplied with the total production in kilograms of processed tea.

The households were not asked about number of harvests and sao's for tea production before the purchase of the biogas installation. These numbers are assumed to have remained equal during the ownership of the biogas installation.

The hypothesis that is tested for this sub-question is the following:

Hyp5;

Ho: There is no significant difference in income from tea production after the households started using the bioslurry.

Ha: There is a significant difference in income from tea production after the households started using the bioslurry.

The income saving and creating effect are added together to make a statement about how bioslurry use contributes to the households' total expendable income and therefore answer main research question number two.

RESULTS

In this research it is attempted to show a causal relationship between the use of slurry and the quantity and quality of the tea.

The main variety of tea that is grown by the farmers in the sample is the Trung Du variety. Other varieties are also grown, it seems that the tea producers in Thai Nguyen are slowly starting to replace the Trung Du variety with more profitable new varieties. The distribution of different varieties grown by the households in the sample is shown below.

	Trung Du	LDP1	LDP2	777	Kim Tuyen	Bat Tien	others
N	137	50	2	73	5	5	8

The results are based on the Trung Du variety only, because all of the households in the sample produced this variety, therefore most observations on quality and quantity are made for this variety. Other varieties were grown as well, data from these varieties has been recorded but will not be used for the analysis.

The advantage of only analyzing the data for the Trung Du variety is that this variety was in general a bit older. Therefore with most households there was also data available about quantity and quality before they started using the bioslurry. With the other varieties this was often not the case, if there was data the tea often was not yet in the trading period.

For the income analysis this slightly distorts the analysis. It is not expected however that it will be positively influenced, more likely negatively.

Questions to be Answered

MQ1; What is the Scope of Bioslurry Use of Biogas-Households in Thai Nguyen?

MQ2; What is the effect of bioslurry use on tea production in Thai Nguyen?

MQ3; What is the effect of biogas installations on income for tea producers in Thai Nguyen?

The sub-questions

SQ1; What is the effect of bioslurry use on the quantity of tea production?

SQ2; What is the effect of bioslurry use on the market price of tea?

SQ3; Does using bioslurry for tea production have an income saving effect?

SQ4; Does using bioslurry for tea production have an income generating effect?

MQ1; Scope of bioslurry use

All the households in the sample actually used the slurry for tea production. This is not surprising since this was a selection criteria to be selected for the interviews. There were a few households that did have a biogas installation but did not use the slurry for tea production. If this was the case, the household was not interviewed because the purpose of the research is to show the effects of using the bioslurry.

Households with a biogas installation that did not use the slurry for tea production had either just sold all of their animals and therefore had no input materials for the biogas digester and as a result no slurry.

Also some households mentioned that they did use the slurry but not for tea production, sometimes the tea fields were too far away from the house to pump the slurry there. It is possible to buy a stronger kind of pump and a very long hose, but the investment in this was the inhibiting factor. Usually the slurry was then used for other agricultural production than tea.

On average the households applied the slurry 1,87 times per month. The slurry was not always used for all the area of production. This was found out in a later stage of the quantitative data collection. The first 15 households were not asked about this. From this point it has been attempted to gather data on the amount of area that did use the slurry. For the quantity and the prices information was asked about the area that did use the slurry. For the total income analysis this might distort the data slightly but the main purpose of this research is to show the effect of slurry use on tea production, therefore this approach was used.

In total 100% of the households applied the slurry in liquid form. This means exactly the way it comes out of the biogas plant. Some farmers had big mixing tanks in order to store the bioslurry, this was then mixed with water to increase the quantity of slurry. In the pilot study it was found out that many households consider using the slurry as a form of irrigation more than fertilizer.

Some households also use the semi-liquid slurry for tea production. Semi liquid slurry is the thicker variety that builds up if the biogas installation is used for a longer period of time. This material has to be removed sometimes in order to keep the circulation within the biogas installation. Households that had semi-liquid slurry used this in combination with the regular slurry for tea. In total this was 8% of the households, of which one household mixed the semi liquid slurry with phosphate.

Besides the households that applied the semi-liquid slurry directly to the land some households use the semi-liquid slurry in order to make compost, 6% of the households reported using semi-liquid slurry for making compost, one of these households did not use this compost for tea production but for rice production instead. Two households (2%) reported that they used the semi-liquid slurry for tea production as well, but the semi-liquid slurry was dried before applying it to the land.

For the transportation and application of the liquid slurry, all the households use a pump and a hose.



The pump.



Farmer applying the slurry to the tea field.

Mr. NguyenTien Thue:

“Even if I don’t make money from raising pigs I will continue to do so because the bioslurry is very valuable for me.”

The households were asked about the amount of slurry they have. This question was split up in three answers. Either the households had not enough, enough or excess slurry. In case there was excess slurry they were asked what is done with it.

In total 90% of the households reported that they did not have enough slurry for tea production, in other words, if they had more they would use it.

Six households in the sample reported that they had enough slurry for the tea production. Four households had excess slurry. In one case the excess slurry was used for rice production. The three other households gave the slurry away for free to their neighbors.

The above information is an indication that the bioslurry is a valued asset for the farmers, since all the slurry produced is actually used.

Mr. Nguyen Ngoc Chung:

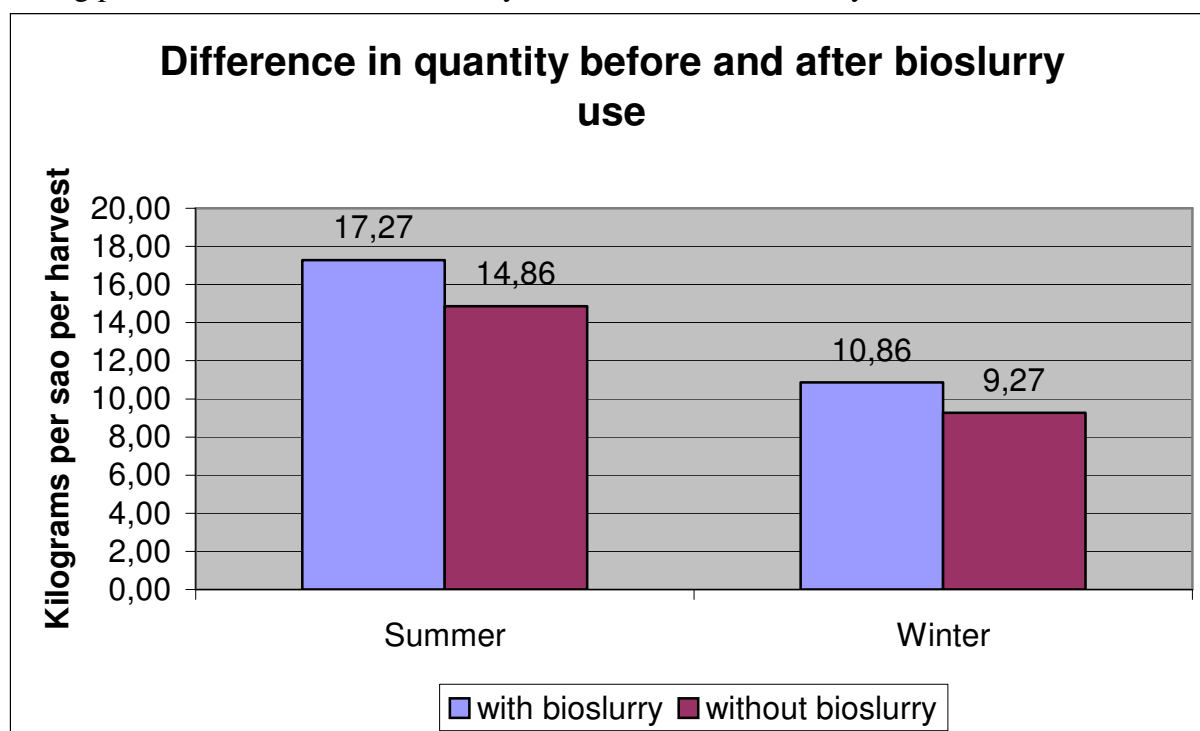
"The purpose of purchasing a biogas installation is mainly for the tea production. Once we have a biogas installation we can use the slurry for tea production."

Mr. Le Viet Thanh

"I know that when I use slurry there is less occurrence of pests, therefore I use the slurry for my most important product, the 777 variety. This is the variety I use in winter in order to make cuttings, (small new tea plants, made from branches cut from the plants). These new plants are sold to other farmers."

SQ1; Increase in quantity of production sao/harvest

As was mentioned in the research design observations are only included if the tea was in the trading period both before and after they started to use the bioslurry.



Some households had the Trung Du variety but with different ages. One household had four different age groups of the Trung Du variety. In total 124 observations were obtained for the summer season (March-September) and 117 for the winter period (October-February).

Ho: There is no difference in productivity before and after using bioslurry for tea production.

Ha: There is a significant difference between productivity before and after using bioslurry.

The hypotheses have been tested with a 95% confidence interval.

The difference in productivity before and after using the slurry in the summer period is 2,41kg of processed tea per sao per harvest with an alpha of 0,000.

The difference in quantity before and after using the slurry is 1,59 kg of processed tea per harvest per sao with an alpha of 0,000.

Therefore both in the summer and in the winter season the alternative hypothesis has to be accepted. There is a significant difference in productivity before and after using the bioslurry.

Mrs. Nguyen Van Dinh:

"There is less pollution since we have the biogas plant, we use the slurry for the tea in pure form, we use it to enrich compost and for the fish pond. When I use chemical fertilizer the tea will die, when I use slurry the tea grows well. The slurry improves the quality of the soil."

Matched pairs t-test on current kilogram's per sao per harvest in comparison to kilogram's per sao per harvest before the biogas installation was owned (only pairs in trading period observations, 2002-2006)

Panel A Summer

Variable	Observations	Mean	t-value	Probability of a mean difference > 0
c1qsincl	89	18.221		
c1bqsi~l	89	15.356		
diff	89	2.865	7.892	0
c2qsincl	32	14.725		
c2bqsi~l	32	13.522		
diff	32	1.203	2.79	0.005
c3qsincl	2	17.000		
c3bqsi~l	2	14.250		
diff	2	2.750	3.667	0.085
c4qsincl	1	15		
c4qwincl	1	15		
diff	1	0	NA	NA
allcqsi~l	124	17.273		
allbqsi~l	124	14.862		
diff	124	2.411	5.422	0.000

Panel B Winter

Variable	Observations	Mean	t-value	Probability of a mean difference > 0
c1qwincl	85	11.478		
c1bqwi~l	85	9.529		
diff	85	1.948	5.432	0
c2qwincl	29	9.172		
c2bqwi~l	29	8.500		
diff	29	0.672	1.302	0.102
c3qwincl	2	9.750		
c3bqwi~l	2	9.000		
diff	2	0.750	3	0.102
c4qwincl	1	10.000		
c4bqwi~l	1	10.000		
diff	1	0.000	NA	NA
c1qwincl	85	11.478		
c1bqwi~l	85	9.529		
diff	85	1.948	5.432	0
allqwincl	117	10.864		
allbqwi~l	117	9.269		
diff	117	1.595	5.422	0.000

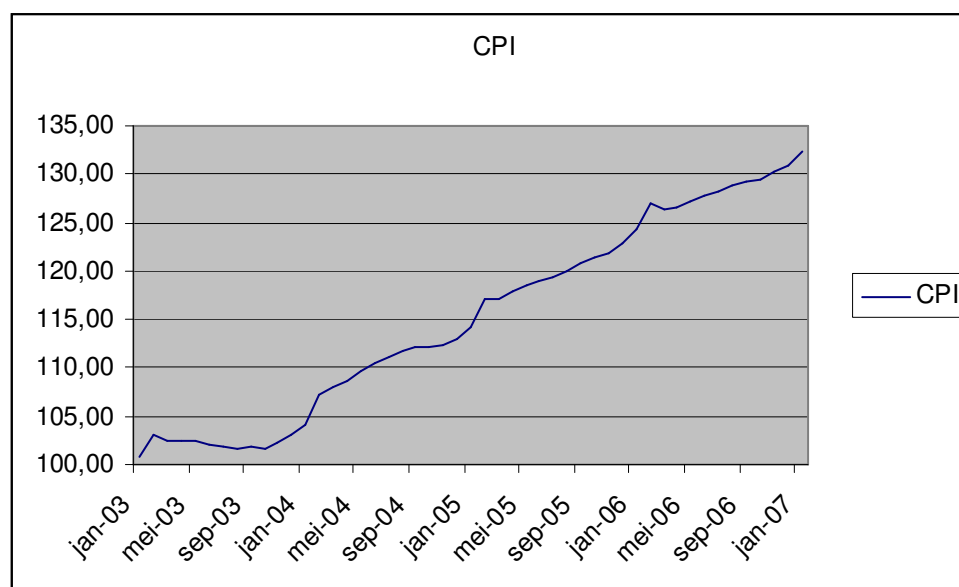
SQ2; Difference in price per kilogram of processed tea with and without slurry

Besides the increase in yield, it is also analyzed if there is an increase in price obtained for the tea after the households started to use the slurry. As mentioned before it is not easy to compare the current and historical data. The price for tea is assumed to have increased over the past few years.

CPI Index, increase compared to the previous month

	2003	2004	2005	2006	2007
January	100,90	101,10	101,10	101,20	101.05
February	102,20	103,00	102,50	102,10	
March	99,40	100,80	100,10	99,50	
April	100,00	100,50	100,60	100,20	
May	99,90	100,90	100,50	100,60	
June	99,70	100,80	100,40	100,40	
July	99,70	100,50	100,40	100,40	
August	99,90	100,60	100,40	100,40	
September	100,10	100,30	100,80	100,30	
October	99,80	100,00	100,40	100,20	
November	100,60	100,20	100,40	100,60	
December	100,80	100,60	100,80	100,50	

Source: <http://www.gso.gov.vn>



Inflation has been quite high in Vietnam over the past four years. The amount of inflation is not necessary equal to the price increase of processed tea. The prices of tea are however expected to have risen over the past four years. Because the measurements of price obtained for one kilogram of processed tea are in the past the measurements have to be corrected for inflation. As can be seen in the chart below, even if the price increase of tea is assumed to be equal to the inflation, the Trung Du tea that is cultivated with bioslurry still obtains a higher price.

Mr. Lun Thi Nhan:

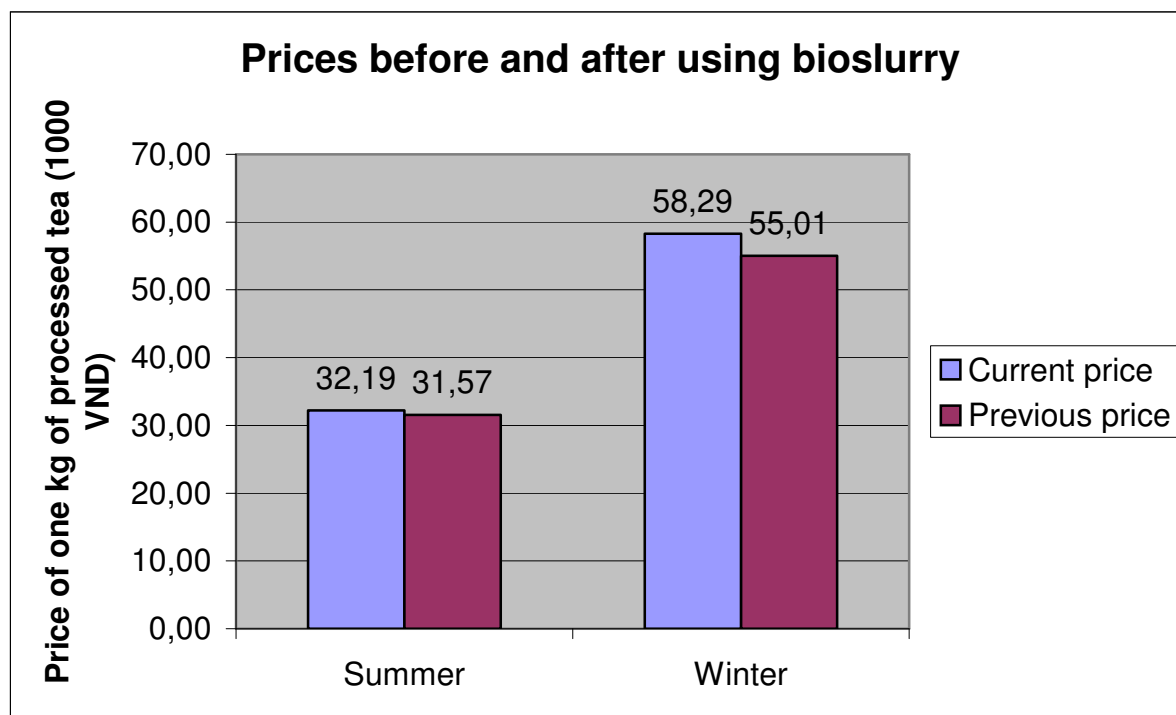
“We have an average increase in the price of tea of about 5000VND per kilogram of processed tea due to the use of bioslurry”

In total 126 observations in summer and 119 observations in winter were made for the price of a kilogram of processed tea.

Ho: There is no significant difference in price before and after using the bioslurry.

Ha: There is a significant difference in price before and after using the bioslurry.

Again the hypotheses are tested with a 95% confidence interval.



For summer the difference is not statistically significant, the difference in price in the summer period was 623 VND per kilogram of processed tea in favor of the slurry tea, with an alpha of 0,079. For the summer period therefore the Ho hypothesis has to be accepted, there is no significant difference in price before and after slurry use.

For the winter period the difference is statistically significant. The difference in price in winter was 3 276 VND per kilogram of processed tea in favor of the slurry tea, with an alpha of 0,001. For the winter period therefore the alternative hypothesis has to be accepted. There is a significant difference in price before and after slurry use.

Mr. Phung Hoc Dat

If I use the bioslurry to fertilize my tea the quality is much higher. Even though Quang Ninh is quite far away, customers come here to buy my tea, because the quality of my tea is so high.

Mrs. Long Thi Huong:

"The tea traders recognize the higher quality of our tea. They are willing to pay a higher price for tea that is produced with bioslurry"

_Matched pairs t-test on current prices in comparison to prices before the biogas installation was owned and corrected for inflation (2002-2006)

Panel A Summer

Variable	Observations	Mean	t-value	Probability of a mean difference > 0
c1cps	92	32.761		
c1bpsin	92	31.873		
diff	92	0.888	1.744	0.042
c2cps	31	31.210		
c2bpsin	31	31.217		
diff	31	-0.008	-0.009	0.503
c3cps	2	28.000		
c3bpsin	2	25.899		
diff	2	2.101	1.075	0.239
c4cps	1	19.000		.
c4bpsin	1	26.067		.
diff	1	-7.067	NA	NA
cacps	126	32.194		
cabpsin	126	31.571		
diff	126	0.623	1.423	0.079

Panel B Winter

Variable	Observations	Mean	t-value	Probability of a mean difference > 0
c1cpw	88	59.318		
c1bpwin	88	55.507		
diff	88	3.811	3.266	0.001
c2cpw	28	56.071		
c2bpwin	28	54.044		
diff	28	2.027	1.092	0.142
c3cpw	2	51.750		
c3bpwin	2	49.536		
diff	2	2.214	0.596	0.329
c4cpw	1	42.500		
c4bpwin	1	49.238		
diff	1	-6.738	NA	NA
cacpw	119	58.286		
cabpwin	119	55.010		
diff	119	3.276	3.375	0.001

SQ3; Does using bioslurry for tea production have an income saving effect?

Besides more tea and a higher sales price for tea bioslurry may also decrease the use of chemical fertilizer and pesticides. All households have been asked about the yearly costs of using chemical fertilizer and pesticides before and after they started to use the bioslurry.

The following hypotheses are tested in order to make a statement about the income saving effect of using bioslurry for tea production.

Ho: There is no significant difference in expenditures on chemical fertilizer after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on chemical fertilizers after households started using the bioslurry for tea production.

Ho: There is no significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

Ha: There is a significant difference in expenditures on pesticides after households started using the bioslurry for tea production.

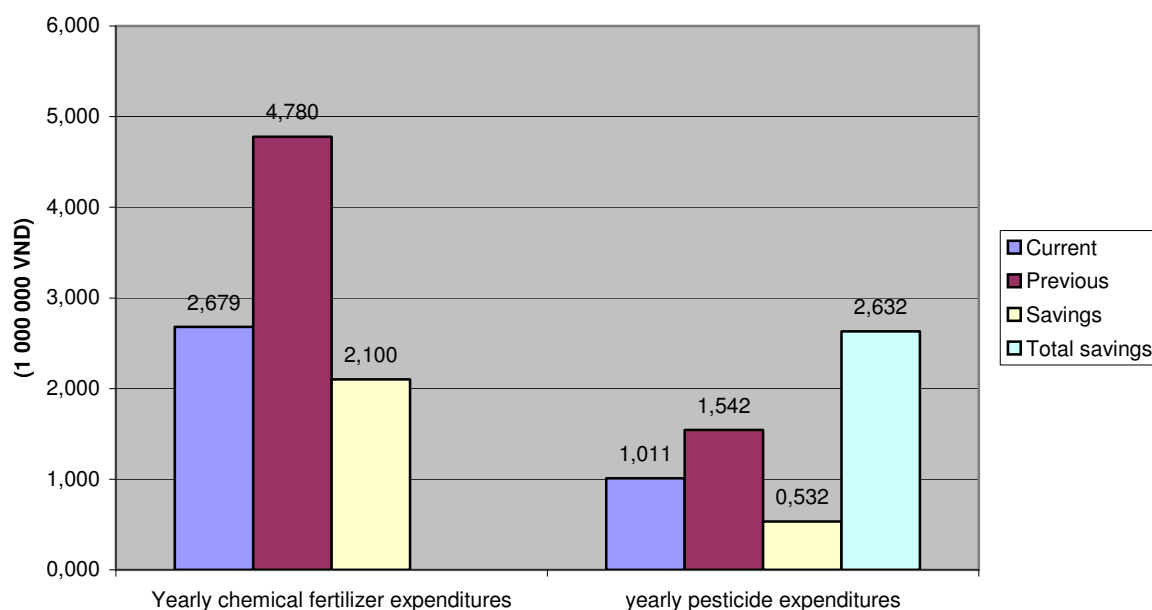
The hypotheses are tested with a 95% confidence interval.

Variable	Observations	Mean	t-value	Probability of a mean difference > 0
Chemical fertilizer				
tftbin	100	4779.737		
tftc	100	2679.46		
diff	100	2100.277	8.421	0.000
Pesticides				
tptbin	100	1542.149		
tptc	100	1010.53		
diff	100	531.619	6.522	0.000
Total savings		2631.896		

Mr. Vu Van Quynh:

“The biogas plant in general, and the bioslurry in particular is very valuable, especially in the rural area; we now save a lot of money on chemical fertilizer. When using bioslurry the tea grows in a more sustainable manner. Chemical fertilizer damages the tea, when used for more than 2 years the productivity will go down. Besides this the chemical fertilizer also negatively affects the quality of the soil.”

Yearly expenditures on chemical fertilizer and pesticides before and after using bioslurry



As can be seen above, for both chemical fertilizer and pesticides the alternative hypothesis has to be accepted. There is a significant difference in yearly expenditures on chemical fertilizer and pesticides before and after using the bioslurry. The households in the sample reported savings after using the bioslurry. The savings on chemical fertilizer are 2 100 277 VND and the savings on pesticides are 531 619 VND. In total this amounts to yearly savings of 2 631 986 VND due to using bioslurry.



Mr. Pham Van Linh:

"I would have bought the biogas plant even without the subsidy. The plant cost about 5 million VND, I save around 2,5 million VND per year due to the biogas installation. I expect my biogas installation to have a lifetime of 20 year, so in total I will save around 45 million VND in total because I bought the biogas installation"

Previous manure management

In the survey the households have not been asked about previous manure management. Two people have been informed about this. The extension officer from the BPD and a lecturer from Thai Nguyen university both mentioned that none of the manure is disposed of if households do not own a biogas installation. All the manure is used, there were no exact numbers on the way in which it was used, usually it would be through either composting or applying it directly to the field. This means that no additional manure is used for the tea, and therefore all the effects above (keeping the limitations of the research in mind) can be attributed to the digestion process that takes place in the biogas digester.

SQ4: Does using bioslurry for tea production have an income generating effect?

For the final income analysis for each household income from tea production is calculated, both before and after using the bioslurry. The number of sao's for Trung Du production and the number of harvests are assumed to have remained the same. For the quantity of tea production only the tea that is in the trading period both before and after slurry use is included in the analysis. This means that the actual income increase may actually be larger.

Then the difference in chemical fertilizer and pesticides expenditures is added to the current income. After the average income increase (or decrease) is calculated for each household the following hypotheses are tested in order to answer sub-question 4.

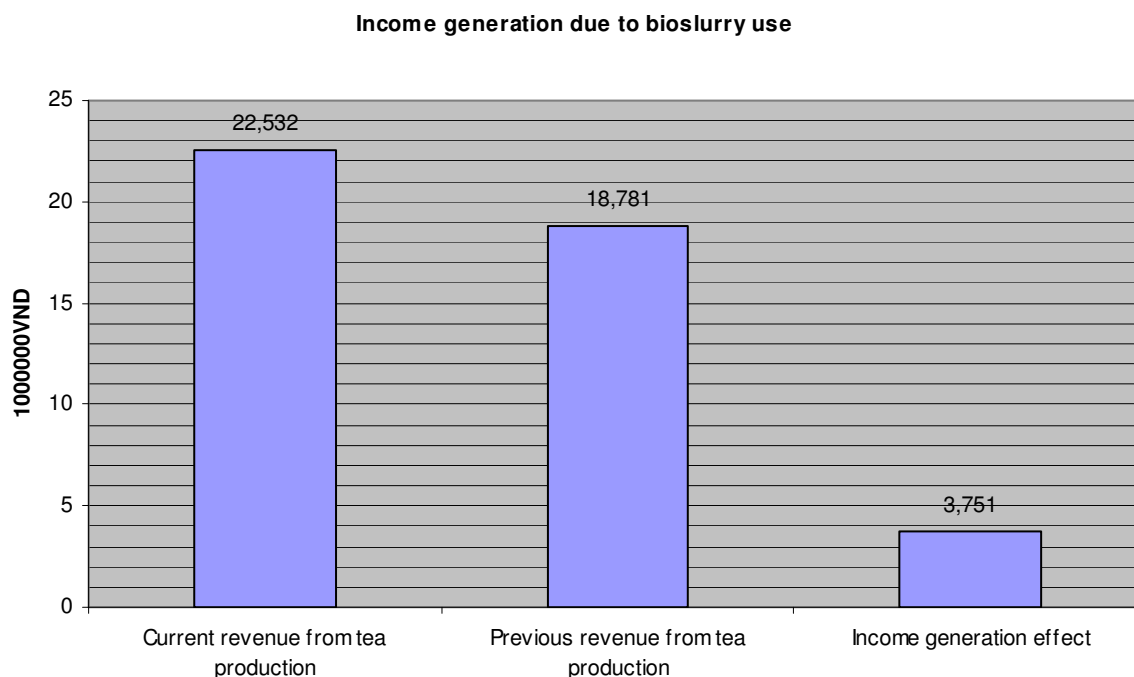
Ho: There is no significant difference in income from tea production after the households started using the bioslurry.

Ha: There is a significant difference in income from tea production after the households started using the bioslurry.

The hypotheses are tested with a 95% confidence interval

Variable	Observations ¹⁸	Mean	t-value	Probability of a mean difference > 0
Income				
totcur~v	96	22532.81		
totpre~v	96	18781.3		
diff	96	3751.509	4.7672	0.000

¹⁸ The number of observations does not equal 100 for two reasons. Two households were excluded because they had a biogas installation for longer than four years (no accurate inflation numbers were available). Two households didn't have any production that was in the trading period both before and after slurry use. Therefore these four households have been left out of this income creation analysis.



Again the alternative hypothesis has to be accepted. There is a significant difference in income after the households started using the bioslurry.

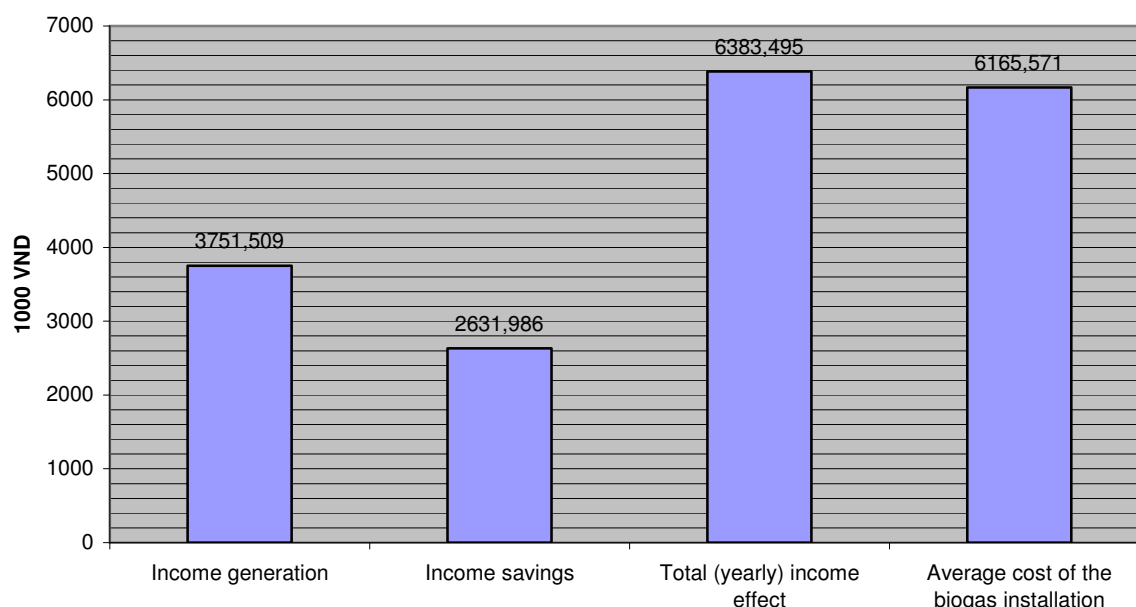
As can be seen above the use of bioslurry for tea production results in an income creating effect. The actual income generating effect may be larger. Only the Trung Du variety is taken into account and only the observations that were in the trading period both before and after slurry use are taken into account. Otherwise there would be a positive bias in favor of the after slurry use observation. The income creation effect presented above is only due to slurry use.

In total the households have an additional income from tea production of 3 751 509VND due to bioslurry use.

Now it is clear that using bioslurry for tea production has both an income saving and income generating effect. The two will be combined together in the graph below to show the financial impact on a household level.

In the same graph this impact will be compared with the average costs of the biogas installation. The average costs of the biogas installation in the sample is calculated with data from the Biogas User Survey 2005. In this survey the average costs per square meter was calculated. In the data collection process the households were also asked about the size of their biogas installation in square meters.

Overview of financial impact of bioslurry use for tea production



As can be seen above the income generation and income savings due to bioslurry use combined are higher than the total investment costs for the biogas installation. In other words, when the bioslurry is used for tea production the biogas plant pays for itself within one year when the bioslurry is properly used.

Bioslurry vs. Biogas

The average savings on cooking fuel, as measured in the Biogas User Survey 2005 amount to 1 460 000 VND/year. This has therefore a lower income saving effect than when bioslurry is used. When the income generating effect for the tea producers is included the difference is much larger.

When the additional income related to bioslurry use is compared to the income savings of the biogas we can see that bioslurry is clearly the main product of the biogas installation if one would only look at monetary factors.

Mr Duong (head of Soi Mit village):

“The price of pigs these days is very low. However, even if the input price(cost of pigbuying piglets, food etc.) equals the output price (sales price of grown pigs) they would still raise pigs because the manure is a valuable product.”

CONCLUSION

In Thai Nguyen almost all of the slurry is used for productive purposes. Using bioslurry in tea production resulted in a higher yield of tea. After using the bioslurry the farmers produced 2,41 kilograms of Trung Du extra in summer and 1,59 kilograms extra in winter compared to before they used the slurry.

The use of slurry also appears to result in a higher price. In summer the average price of 1 kilogram of Trung Du tea was 623 VND higher than before the slurry was used, in the winter period this difference was 3 276 VND higher in favor of the slurry tea.

The savings on chemical fertilizer due to slurry use amounted to 2 100 277VND per year, the savings on pesticides amounted to 531 619 VND per year. Therefore in total the bioslurry has an income saving effect of 2 631 896 VND per year.

As can be seen above, the bioslurry causes an increase in the amount of tea produced, and at the same time generates a higher price per kilogram of tea. This results in an increased income. The total income generating effect of using bioslurry in tea production is 3 751 509VND VND per year.

The income savings and additional income due to bioslurry use amounts to 6 383 495VND per year, this is more than the total investment in the biogas installation, which was on average 6 165 571 VND per installation.

When only looking at monetary factors, it can be concluded that bioslurry is not a mere byproduct of the biogas installation, it is actually the main product, at least for tea producers in Thai Nguyen.

DISCUSSION

The use of bioslurry was believed to have a positive effect on agricultural production and therefore to help save on chemical fertilizer expenditures. In this research it has been proven that bioslurry can indeed help get a higher production, a higher sales price and help to save money on chemical fertilizer and pesticides as well. The combined result is a large positive difference in income for the bioslurry using tea producers in Thai Nguyen.

There are some important limitations to this research however. The data collection has only been done in one of the provinces, Thai Nguyen and only in two districts, TP Thai Nguyen and Dong Hy. It is believed that the farmers here are more wealthy and maybe also higher educated than in different locations. In the sample taken for this research all the farmers used the slurry, this is surely not the case everywhere, when the slurry is not used, it cannot create the positive income effects that were proved in this research.

Also the fact that in this research the focus was on tea may have created a positive bias, tea plants need a lot of nitrogen, bioslurry is very rich in nitrogen, therefore the increase in quantity and quality, and the decrease in fertilizer is likely to be lower for other kinds of agricultural production. More research needs to be done to find out the effects on different agricultural products.

Biogas installations also provide the households with free gas to cook on. This obviously also has an income saving effect. Biogas installations also provide different benefits to the households as mentioned in the literature review. The main reason for buying a biogas installation often appears to be the fact that it reduces bad odor from the manure from the animals. Due to biogas use instead of wood the kitchens are also cleaner, and therefore it has a positive health effect on the women that usually do the cooking. Time savings are also achieved because the wood does no longer have to be collected, and the cooking takes less long.

Besides this biogas installations also have a positive effect on the environment. Methane emissions are reduced because they are collected in the biogas installation and then burned. This effect is larger when manure is used for rice production because then it is put in the water which results in anaerobic fermentation with a higher emission. Also wood that is not burned saves CO₂ emissions. Finally the fact that now less chemical fertilizer is used also has a positive effect on the environment and groundwater.

In the authors opinion the need for subsidies is smaller than in the first phase of the project, because the biogas installation earns itself back in a short time due to income saving and income generating effects. Perhaps it is better to make microcredit available to aspiring biogas owners. Also with the savings of not providing a subsidy anymore would free up money to help the mason companies develop, perhaps it would be possible to subsidize companies that operate in poorer areas, or in areas that are more difficult to reach (for example the mountainous regions).

Even though the farmers in this sample almost all were very knowledgeable about the benefits of using bioslurry this is not likely to be the case everywhere, from another researcher I understood that for example in Son La almost all of the slurry is disposed of instead of used. Biogas households should be made aware of the benefits of using the bioslurry in order to get the maximum profit from owning a biogas installation.

As mentioned in the literature review a previous research was done on the effect of using bioslurry for tea production. When we compare the above result to the information from the previous research the results are relatively similar.

The farmers in the sample had on average 7,6 sao of land for tea production. In the previous research it was calculated that per sao, the farmers that used only bioslurry had an

additional income of 108400VND, these are the savings on chemical fertilizer combined with increased income from tea production per sao per harvest.

When the two are multiplied an additional income of 828826VND would have been realized per harvest. In the sample for this research the farmers had on average 8,67 harvests per year. This would result in an additional income of 7,19 million VND. As can be seen above this is quite a bit higher than the result of the research. Following the methodology used for this research one harvest took place in the 'summer' period and one in the winter period. This may have caused the difference between the results of the two researches.

Also in this research before they started using slurry only it is quite likely that the experimental plot received chemical fertilizers, this may have affected the results as well.

Besides this, the research in front of you has excluded tea that was not yet in the trading period in both periods. Bioslurry is expected to have an influence on the production of tea also when it is not in the trading period, but it is impossible to say what part of the increase would be from bioslurry and what part would be due to the productivity cycle of the plant.

Also most of the households indicated that if they would have more slurry they would use this for tea production. In the previous research slurry was no inhibiting factor. However, both researches show a large increase in household income after they started to use the bioslurry for tea production.

RECOMMENDATIONS

I would recommend the Biogas Project Division to continue its extension efforts and expand them where necessary. In Thai Nguyen the households were quite knowledgeable about how to use the slurry and about its benefits. In other areas where this is not yet the case, the households with a biogas installation should be informed about the use and benefits of slurry. This research could be used to inform the households, especially the ones that produce tea.

The results of this research could also be used as a marketing tool. When households with livestock become informed about the advantages of the biogas installation and the economic benefits of slurry use, they may become more inclined to purchase one themselves.

The author of this research also recommends to stop using subsidies, at least in the way in which they are given at this moment. With the income earning and saving capabilities of the biogas installation subsidies are not necessary. In different regions this may not be the case, but the results of this research show that only bioslurry related income (savings and income generation) in Thai Nguyen help to pay for the investment costs of the biogas installation. Even though in Thai Nguyen not all the households would use this option if available, for less wealthy households micro-finance may be a better solution than giving subsidies.

More research needs to be done into the different levels of poverty throughout Vietnam, some regions may still need to get subsidies in order to ensure smooth and fast dissemination of the biogas installations but in Thai Nguyen the subsidy seemed to be an inhibiting factor for the dissemination. One farmer actually admitted that he was going to buy a biogas plant, but that he would wait a while, this way he could become eligible for the subsidy, even though he honestly admitted he did not really need the subsidy.

If the subsidy would be no longer awarded to all the households this would free up money to look for more creative and effective ways of ensuring smooth and equal dissemination throughout the country.

In this research it was found that at least in winter the bioslurry tea receives a higher price. This could be an indication that the cleaner cultivation of tea leads to a higher sales price. This would be a nice topic for future research.

LIMITATIONS

- Limited amount of stratification, the situation in Thai Nguyen is not necessarily similar to the situation in the rest of the country.
Thai Nguyen is one of the success stories for extension workers, people are aware of the value of bioslurry and therefore use it for agricultural production. It is known that in other provinces the awareness of the benefits of slurry are lower and therefore the financial effects of using bioslurry as found in this research cannot easily be generalized to other provinces in Vietnam
- The research only focused on the effects of bioslurry on tea production. Tea plants need a lot of nitrogen to grow. Because bioslurry has a good nitrogen fixing capability the increase in growth and quality of different agricultural products are likely to be smaller than for the tea.
- Historical data had to be used because the control group seemed to yield unusable data. Even though factors like inflation and different growth rates have been accounted for, other factors may have also influenced the change in price and quantity of tea.
- The research plan and the questionnaires were intended to measure increase in price and weight of the tea, not necessarily for the income analysis, therefore some assumptions had to be made for the total income analysis.
- Only the Trung Du variety could be used for the analysis. The reason for this was that the plants in general were a bit older than the other varieties. If the varieties were too young usually there was not a before and after slurry use measurement for the difference in weight because the young plants were not yet in the trading period.
- Another flaw was that not always all of the area of one variety would receive slurry, sometimes because there wasn't enough slurry. Sometimes the tea was too far away from the slurry pit to transport the slurry with pump and hose. If this was the case the households were asked for the area that did receive slurry, since the main purpose was to find out the influence of the slurry. This may have distorted the total income analysis, however, in this analysis only the Trung Du variety has been taken into account, if the slurry would have been used only for the Trung Du variety the households would have most likely had enough slurry for all the area of Trung Du variety they would have probably had enough slurry to fertilize the entire area of Trung Du. Additional gains from other varieties have not been taken into account for the income analysis.
- No empirical information is available on what was done with the manure before the households had the biogas installation. According to two experts normally all the manure is used. If this is not the case the gains could not necessarily be only attributed to the use of bioslurry, also with normal manure a certain fertilizing effect is achieved.
- No consumers of tea have been interviewed about their opinions of clean or organic tea. The price difference after using the bioslurry (organic fertilizer) conflicts with the opinions of key informants. According to the key informants the market does not recognize the importance of cleaner, or organic tea by a higher price, yet the tea that was cultivated with more organic fertilizer, and less chemical fertilizer, did obtain a higher price from the traders. This incongruence cannot be explained.
- The households were rewarded for their time to do the interview, they were only told about this after the interview, they were given 10 000 VND per household

(approximately 50 eurocent). Because the households were told afterward this is not expected to have altered the answers to the questions.

- In order to arrive at the households permission needed to be obtained through the local authorities. When entering a commune first it was necessary to show all the permission documentation to the local authorities, if everything was okay they were usually very willing to send one of their staff members with us to select the households. The guides where also paid for their services, a maximum of 50 000 VND per day was given to the guides. The payment is not expected to have altered the selection of households. Staff may have been instructed by the local authorities to not take us to certain households, the author did not see any evidence of this.

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