PROJECT ON PROMOTING BIOMASS ENERGY FOR ASEAN REGIONAL AGRICULTURAL AND RURAL DEVELOPMENT COMMUNITIES

REPORT

MODEL OF BUILDING A MODEL FOR LIVESTOCK WASTE MANAGEMENT, USING RENEWABLE BIO-ENERGY FROM THE BIOGAS SYSTEM IN TEA PRODUCTION AND PROCESSING IN ANH SON - NGHE AN

Implementing Agency: Vietnam Academy of Agriculture Sciences

Ha Noi, 2021

I. General Information:

1. Model name: Building a model for livestock waste management, using renewable bio-energy from the biogas system in tea production and processing in Anh Son - Nghe An.

- Location of project implementation: People's Committee of Hung Son commune, Anh Son district, Nghe An

Name of the sponsor, co-sponsor: Japan ASEAN +

Responsible agency: Vietnam Academy of Agricultural Sciences

- Execution time:
- Funding: 80,000 USD.

II. General introduction

Anh Son is a mountainous district in the western part of Nghe An province, Vietnam. This is a district that UNESCO included in the list of places in the West Nghe An Biosphere Reserve. The district is located along the banks of the Lam River and National Highway 7, the East borders Do Luong district, the North borders the mountainous district of Tan Ky and the highland district Quy Hop, the West borders the highland district Con Cuong and Laos. , the South borders the mountainous district of Thanh Chuong and 100 km northwest of Vinh city. The district has a convenient transportation system for goods transportation and exchange. These are favorable conditions to strongly develop trade, services, and tourism.

Anh Son is a district whose agricultural economy is relatively developed compared to other districts in Nghe An province. The life of the people here is gradually improving thanks to the orientation of developing agricultural and livestock production models by promoting the rich natural potential of the locality.

For animal husbandry, the authority of Anh Son district, Nghe An province has issued many Resolutions, which prioritizes resources to support livestock development associated with environmental protection. Technical advances have been applied in animal husbandry to improve livestock productivity and quality and improve the quality of the ecological environment.

In the field of cultivation, besides traditional crops such as rice, corn, vegetables ... the Anh Son district is taking advantage of a perennial tea production area to gradually improve the economic value of tea plants. through investment in the production of high-quality and high-quality tea varieties such as matcha tea and hook tea.

According to statistics, Anh Son is one of the key tea-growing districts of Nghe An province with an area of over 2,500 hectares, of which 1,700 hectares

were harvested, concentrated in communes: Hung Son, Cam Son, Dinh Son, Long Son, Phuc Son. The annual output of fresh bud tea reaches 17-20 thousand tons. Currently, in the tea processing process in Anh Son, Nghe An, farmers often use energy for the drying process and the heating material for the drying process, why tea is DO oil, coal, and firewood. The use of fossil fuels, wood (mainly exploited from the Western Nghe An Biosphere Reserve) if not properly managed will be a potential danger to national energy security. in general and adversely affecting West Nghe An Biosphere Reserve.

In Anh Son, biogas technology is also encouraged to apply in livestock waste management and has brought many benefits to livestock households such as: treating livestock waste, improving the livestock environment, Create a clean source of biofuel, the residue after biogas can be used as an organic fertilizer source for crops. The fact shows that people only use this renewable energy source for cooking and lighting, but using this energy source for tea drying will have a very positive meaning in limiting Using fossil energy sources, limiting the use of firewood, limiting deforestation to protect the Western Nghe An Biosphere Reserve, on the other hand, will create better tea products due to temperature control. during the drying process.

The goal of the project:

- Building a model using bioenergy from biogas plants for tea drying in Anh Son - Nghe An
- Treating and reusing the residue after biogas as a clean organic fertilizer source for tea plants in Anh Son - Nghe An.

III. Project implementation results:

3.1. Collecting data, investigating, surveying, and evaluating the possibility of using renewable energy sources from the biogas system to replace traditional materials in tea processing in Anh Son - Nghe An.

Anh Son district was established in April 1963, separating Anh Son district according to Decision No. 32 / QD-TTg of April 19, 1963. Anh Son district has a quite convenient transportation system for goods transportation and exchange. These are favorable conditions to strongly develop trade, services, and tourism.

This is a district with a developed agricultural economy. For many years, Anh Son was dubbed the "King Ngo" of Nghe An, the leading products in the province. Besides, the district also develops concentrated raw material areas such as tea, sugarcane, paper material trees ... Over the past years, Anh Son has deployed many economic models for people: Model of safe vegetable production in the commune. Phuc Son with a production area of about 1 ha, the implementation time

of the model is 45 days, earning 183.6 million VND minus expenses, interest income 151.1 million; The model of biomass maize production to provide food for TH dairy cows and raise commercial beef cattle in Tam Son commune with the 3-month harvest period gives an income of 38.2 million VND minus expenses and profit of 27.6 million copper; Improved rice intensification (SRI) model in Vinh Son commune, contributing to raising awareness of rice farmers in applying sustainable rice intensification techniques, limiting the impact of pesticides. materials, reducing input costs, lowering product costs, contributing to increasing rice yield, increasing economic efficiency.

Currently, Anh Son is implementing the policy of restructuring the agricultural sector in the direction of promoting local advantages, improving the area of production of specialized raw materials associated with industrial processing; promote the application of scientific and technological advances.

As a mountainous district, however, Anh Son is a fairly developed district in agriculture and husbandry, annual rice output is over 30,000 tons, maize is nearly 40,000 tons, and pig breeding is 57,600 heads, mainly concentrated in 21 large livestock farms and hundreds of large and small farms in the area. Estimated annual crop and livestock by-products in Anh Son are shown in Table 1:

Table 1: The estimated annual amount of agricultural by-products in Anh Son

Item	**Planting area/head of livestock**	**Estimated amount of crop residue/livestock waste/year**
Rice	6.268 ha	31.340 tons
Corn	7.480 ha	37.400 tons
Pig	57.600 heads	52.560 tons

The data in Table 1 shows that the annual amount of by-products discharged after cultivation and husbandry in Anh Son district is quite large. Survey results show that the majority of farmers' crop by-products are used for cooking or burning in the field. For livestock, because Anh Son has gradually encouraged concentrated livestock, the amount of livestock waste mainly concentrated on farms, the survey results showed that on most of the livestock farms (mainly livestock pig) there is no suitable solution to effectively reuse livestock waste.

The data collected above shows that the annual amount of agricultural and livestock by-products in Anh Son is relatively large, comparing the calorific value

with some other materials shows that if used effectively, this is The source of alternative book energy to fossil fuels is increasingly exhausted.

Table 2. Calorific values of some common fuels (reference):

NO	Coal type	Calorific value
1	Low bituminous coal grade A	24490 – 26823 kJ/kg (6.400 Kcal/kg)
2	Low bituminous coal grade B	22158 – 24490 kJ/kg (5850 Kcal/kg)
3	Low bituminous coal grade C	19358 – 22158 kJ/kg (5293 Kcal/kg)
4	Lignite grade A	14693 - 19358 kJ/kg (4.624 Kcal/kg)
5	Lignite grade B	14693 kJ/kg (3.510 Kcal/kg)
6	Heavy oil (FO oil)	41131 - 43138 kJ/kg (10.030 Kcal/kg)
7	Diesel Oil (DO oil)	43138 kJ/kg (10.030 Kcal/kg)
8	Liquefied gas LPG	39927 - 54900 kJ/kg (13.115 Kcal/kg)
9	Natural gas	55979 kJ/kg (hay 37118 kJ/m3 at 1atm and 20°C) (13.372 Kcal/kg)
10	Rice husk firewood	11720 kJ/kg (2.800 Kcal/kg)
11	Firewood pressed sawdust	17580 (4.200 Kcal/kg)
12	Biogas	17580 (4.200 Kcal/kg)
13	Straw	~3500 Kcal/kg

Table 3: The Estimated raw materials for drying 1kg of tea

Type of material	Estimated of the raw materials for drying 1kg of tea	Raw material price (VND)	Drying cost per 1 kg of tea (VND)
Coal	0,7kg	5.000	3.500
Straw	6 kg		
Wood	4 kg	2.500	10.000
Biogas	0,5m^3	15.00-2.000	7.500-10.000
DO oil	0,32 liter	19.000	6.008

- Current status of construction and operation technique of biogas plants in Hung Son:

A project on livestock waste management and model building using bioenergy from a biogas plant for tea drying was built in Hung Son, Anh Son district, Nghe An province. Hung Son commune has 970 households with about

4,000 people, agricultural production includes 540 hectares of tea; Household breeding is dominated by the majority with an average number of heads of 5-6 animals/household, the commune has an industrial-scale livestock farm with 6,000 pigs. Survey results show that in Hung Son, the application of biogas plants for livestock waste treatment has not been strongly developed, the number of works is very few and mainly by farming households. Research and invest in construction from the 2000s onwards (22 households with biogas / 970 households; the rate of 2.2%).

3.1.1. Survey results from managers

In Hung Son commune, Anh Son district, Nghe An province, the project interviewed 5 staff who were involved in the management, guidance, and operation of biogas systems (biogas systems) in some districts and participate in implementing projects on biogas. The grassroots managers are currently working at the People's Committee of Hung Son commune, the results of the survey are highlighted in the following issues:

- The survey results of the cost of building the biogas plant in the locality show that all households using the biogas works use their family's funds to build, and have not received support from the group. function. The biogas works are built mainly as Composite and KT1
- Investigating the factors affecting the development of biogas in the locality, the results showed that the majority of respondents said that due to the lack of capital, the breeding scale was small and it was necessary to have the support of levels and organizations to develop local biogas plants.
- For the livestock households that have not used biogas, the opinions suggest that they all need to install biogas plants due to the benefits that biogas brings, particularly in saving costs of fuel and sanitation. Improved environment, alternative energy, utilizing waste as fertilizer, saving time, stove free from smoke, convenient cooking, and reducing firewood collection
- Surveying on the contents that need to be done to develop biogas in the locality, opinions suggest that it is necessary to constantly remind and supervise livestock households that pollute the environment, followed by enhancing propaganda. the effect of biogas on the loudspeaker of the commune and reward and encourage households to use their biogas, finally ask for support from the district and province.

1.2. Survey results from biogas users

General information about the survey

In Hung Son commune, Anh Son district, Nghe An province, the project surveyed 20 households that had built biogas tunnels. The survey results are prominent in some of the following contents:

- Survey results on different types of biogas tunnels in the area show that there are 2 types of biogas tunnels in the survey framework, namely KT1 and Composite. In particular, composite tunnels are more popular with a rate of 65%. The size of the tunnels ranges from 7-18 m^3, construction time from 2003 to 2009
- The results of the survey on the level of people's satisfaction with the use of biogas tunnels showed that the cleanliness and convenience of cooking were approved by 19/20 people and accounted for the highest rate of 95%, followed by The criteria for improving pollution of housing and animal husbandry are accepted by 18/20 people, accounting for 90%, only 14/20 people agreeing to use waste for fertilizer replacement, accounting for the lowest rate. 70%. The above survey results show that most of the people using biogas in the survey framework are satisfied with using biogas, which will clean the environment and facilitate cooking. Biogas sludge is a good source of fertilizer and has not received much attention from people.
- All interviewed households have never attended any biogas training.
- The survey results on biogas use purposes show that out of 20 households, all interviewed households use biogas for cooking purposes; Besides, they use them for lighting (4/20 households make up 20%) and generate electricity (3/20 households make up 15%).
- Survey results show that out of 20 biogas households, all the biogas users do not have problems with the phenomenon of gas stoppage, good gas quality, biogas is enough for the family. Leftover households dispose of excess gas by burning it
- Surveying whether to use biogas or not, the results show that the majority of households use biogas (19/20) with the main purpose of fertilizing fields and fish ponds.
- Surveying the impact of biogas plants on the surrounding environment, the survey results show that among 20 households using biogas plants, all think that the biogas plants contribute significantly to reducing odors. reduce pollution and insects such as flies, mosquitoes, ants, ...
- Surveying the aspirations to expand the breeding scale of the households using biogas plants, the results showed that 10/20 (50%) of the households wanted to expand the breeding scale; the rest are not in demand due to the unlimited land area, not enough for expansion.

3.1.3. Survey results from tea growing households

In Hung Son commune, Anh Son district, Nghe An province, the project surveyed 20 households that planted tea. The survey results show that the area of tea growing households in the locality ranges from 0.5 to 5 hectares, of which mainly tea is for business, tea age is from 8 to 16 years; Some households also have construction tea, but the area is very small

The results of the survey on the number of fertilizers used in tea cultivation, the results show that each hectare of tea needs chemical fertilizers at a cost of about 15 million, organic fertilizers at a cost of about 5 million, plant protection drugs with cost about 2 million and labor is about 24 million.

In 1 year, the production households harvested 6 times and each time about 4-5 tons of fresh tea. The total output is from 24-30 tons/year.

The survey wishes to expand the tea growing area of households, the results show that 12/20 households wish to expand their tea growing area, accounting for 60%; the rest do not want to expand because they think that the investment is too large, the weather is not favorable, causing many pests and diseases, affecting tea yield and quality.

Out of the 20 surveyed households, 8 households process tea. Investigating tea processing methods of households, the results showed that most of the households processed according to the specialized method (7/8 households, accounting for 87.5%) with improved tea copying machines.

For each ton of dry tea after processing, the amount of fresh tea needed varies from 3.5 to 6 tons depending on each batch of tea harvested.

Surveying tea prices of producing households, most of the respondents said that tea prices are relatively stable, only a few comments that prices are still changing according to seasons.

3.1.4 Overall assessment of the effectiveness of the Biogas system for households to use

+ Economic efficiency of Biogas systems:

Through surveys in livestock households, before building biogas plants, they all have to use fuel sources such as coal, wood, straw for cooking and drying tea; For livestock raising households with a large number of cattle, they are forced to buy fuel and the budget they have to spend is not small. When building and putting into use biogas plants with alternative biogas sources, most livestock households do not have to use this fuel source anymore. The gas source from the biogas gives a steady fire, generates high heat, and helps to cook quickly. Most households using biogas in the past have used other energy sources such as industrial gas, firewood. After the construction and installation of biogas, it is almost not necessary to use

industrial gas, minimizing the use of firewood. According to calculations of households, the monthly reduction of the amount of money to buy fuel (gas) is from 130,000 to 240,000 VND depending on the time when gas prices go up and down.

+ Evaluate the ecological environmental impact of Biogas systems:

When biogas plants are applied to treat livestock wastes, it has a positive impact on the ecological environment, in particular: reducing the generation of waste from livestock, reducing diseases for Breeders and people living in the breeding area, reduce wastewater discharge into the surrounding environment, the landscape is more beautiful, the water quality of surface water, groundwater in the surrounding areas is also better.

Using biogas in hygienic cooking: does not sting the eyes, harm the lungs, cooking utensils, as well as the kitchen department, are clean and free of smoke.

Wastewater after decomposition in biogas technology will reduce odors, do not see flies cling to destroy pathogens, especially parasites and other infectious diseases.

+ Strengths of biogas:

+ The biogas tunnel construction and operation technique is simple, suitable for regions with different natural and ecological conditions. Applying biogas in livestock waste treatment will minimize greenhouse gas emissions due to waste generated in the breeding process.

+ Biogas's product is biogas - a non-traditional fuel source in Vietnam: meeting cooking and lighting needs, making cooking easier, cleaner, and at the same time-saving time.

+ Biogas/biogas technology is one of the solutions for the sustainable management of livestock wastes as well as domestic wastes in rural areas. Create clean renewable energy sources - limit deforestation, use fossil materials.

+ Minimize biological agents that cause disease and disease transmission in livestock waste.

+ Wastewater after biogas can be used as a food source of aquatic animals, algae, duckweed as food for livestock and poultry.

+ Wastewater after biogas is a fertilizer source with good nutritional value for plants.

+ Weakness of biogas:

So far, Anh Son district in general and Hung Son commune, in particular, have not had any projects on biogas development of the State and international organizations to be implemented here. Biogas construction is developed on the voluntary spirit of the people.

+ Biogas is mainly used for lighting and cooking, has not been exploited for more efficient purposes.

Opportunities:

* Fossil fuels are increasingly exhausted, the development of inexpensive renewable raw materials has always received the attention of the Government of Vietnam, international organizations, and NGOs operating in Vietnam.

* Farmers' awareness of environmental sanitation is increasing day by day.

3.2. Design and manufacture of tea drying equipment using gas from biogas systems

3.2.1. Current technical status of tea drying in Hung Son commune, Anh Son district, Nghe An province.

Surveying at some tea-making families in Hung Son - Anh Son, we found that most of the tea-making stages of the people were supported by machines and equipment. In the process of star-killing tea yeast, mainly used by local people are the tea-drying staves which are operated by a drive motor, (the rotating roll of the tea star) and burned with firewood. According to the project research survey shows that people have to spend 3-5 labor per ton of tea material. The execution time for the production usually lasts from 10 am to 10 pm to complete all stages for 1 ton of tea material.

About the quality of tea, star tea with firewood has the following characteristics:

• Uneven quality depends entirely on the operator and operator

• Tea into drinking water often contains dust from coal and ash during the drying process.

• Finished tea is often overheated due to the inability to adjust the temperature according to the technology

• The taste of the finished tea when drinking is often smoky

• The finished tea has a slightly bitter taste due to the degradation caused by the drying process.

• If using firewood, the fuel cost per kg of tea is about 6,000-8,000 VND / kg and must use 3-4 mortars to dry tea. In tea areas, the source of firewood often meets difficulties in the production process, requires a lot of storage, requires many warehouses for firewood. Besides, the amount of firewood being stored affects the food safety and hygiene for tea, causing mold and impurities in the finished tea if kept close.

3.2.2. Design and manufacture of tea drying equipment

Introduction of drum drying technique:

Rotary drum drying is widely used in many fields, however, tea was only included in the research and experimentation from this project. Differences in different fields, different locations will have to apply different technology. Anh Son tea area is characterized by a mixture of concentrated husbandry and tea cultivation, so the amount of excess biogas from the breeding process is very much. The application of drum drying technique using biogas in stars - tea drying has brought people the following benefits:

- About drying productivity:

With a rotary barrel biogas star drying device, it can replace 03 manual star mortars, with the working productivity from 1.5-2 tons of raw tea/day and the number of operating workers reduced to 1-2 people. produce 1 ton of tea material. And the operator's job no longer has to grapple with the teapots. However, the capacity of machinery and equipment is not as large as in factories but suitable with the production capabilities and conditions of households. Since the application of modern equipment to tea processing, each family has reduced from 3 to 5 workers, cleaner products, eye-catching packaging, safe preservation, and consumer confidence.

- About product quality:

Because the rotary barrel drying technique can control temperature, speed, time, so:

• Tea quality is uniform, an operation is simple, requires no manpower, and requires skills and experience.

• The finished tea drink is free of coal dust and ash during the drying process, the water is clear and has no strange smell.

• Finished tea with equal color, no color difference between batches.

• The taste of the finished tea when drinking is typical of tea, not bitter after drinking, and has a good taste.

+ Design and manufacture indirect drying system:

Drying is the process of separating water from the material to help the material avoid damage during storage. Under the industrial age, drying is considered a technological process that is widely used in many industries and agriculture.

The separation of water and steam from the material is not just normal drying but is a technologically carefully calculated process to deliver a high-quality product after drying. At the same time, it should be a process with little energy consumption and low running cost. In the tea drying system, the drying agent is the air heated by a heat transfer tube, which is heated by biogas which is collected and compressed by a compression pump before burning. The gas is controlled inlet temperature to the drying chamber by the pump system. Then bring to the drying area to provide

convection heat to the drying object. Due to the high temperature, the relative humidity of the drying agent is low. Some of the heat in the hot air heats the drying material, making it easier for the water molecules of the root drying material to escape and into the stream of the drying agent. When discharging this moisture, it is sucked out into the environment. Thus the moisture from the material is separated and released into the environment. The process of making the material dries out over time.

Using this system one can perform with a large capacity, fast evaporation rate, short drying time, relatively good product quality (due to not too high temperature), inexpensive equipment, Simple and special onions that can use many different energy sources. Hence this is a method with good economic efficiency. (Details of the design are shown in Appendix 1)

+ Principle of design of rotary barrel dryer:

Roasted tea drier is usually at 250-3500C. The body of the furnace has a flame spray, put the dryer through the center of the oven, put the tea in the drying chamber, and then start. The motor pulls the speed down to the transmission sprocket to pull the drying barrel and has a lever to keep the barrel rotating when the drying is finished, the mixing chamber rotates 30-50 v / min.

Roasting of tea in the barrel uses heat by biogas or using heat with gas

Requirements for drying equipment:

• Productivity 20 kg/batch.

• Heat by burning biogas

• Tea after drying must be of high quality: evenly dry, not scorched, and do not change much of the chemical composition of the product.

• The dryer must work well, be safe for the user, easy to assemble and repair, with high productivity and longevity.

• Easy to operate without skilled workers.

• Production cost is also relatively low, suitable for machinery and equipment in our country.

With the requirements set out above, the design plan of a rotary barrel-type tea dryer will be selected.

The design plan is as follows:

The product is loaded in and out of the drum from the front door

• The rotating barrel is made of steel that holds heat and is not locally distributed

• While heat is applied the product requires continuous mixing in the tank to avoid scorching and uneven drying. This whole process will be monitored by temperature

sensors and operators to ensure the quality of tea after drying. The rotating system should be operated by an electric motor with the required speed control

• The material removal unit, the rotating barrel needs to be connected to the bracing system, capable of removing materials from the barrel as quickly as possible. Therefore, it is required that the vane unit sucks and removes the material in front of the inlet and the barrel rotation reverser to push the product out.

• Heating parts: required to use burned with biogas and gas (when needed). For biogas, it is necessary to have a booster and a toxic gas filter, a corrosive gas for the gas stove.

• Gas controller is attached to the temperature sensor system and the gas jacks to control according to the technology parameters

3.3. Building a model:

+ Building 03 models of tea drying on farm scale using the tea drying system using gas from the biogas system, capacity of 20kg /times

+ Building 03 models of applying microbiological technology to treat waste after biogas as bio-organic fertilizer

+ Building 03 application models of bio-organic fertilizers processed from biogas residues for tea plants

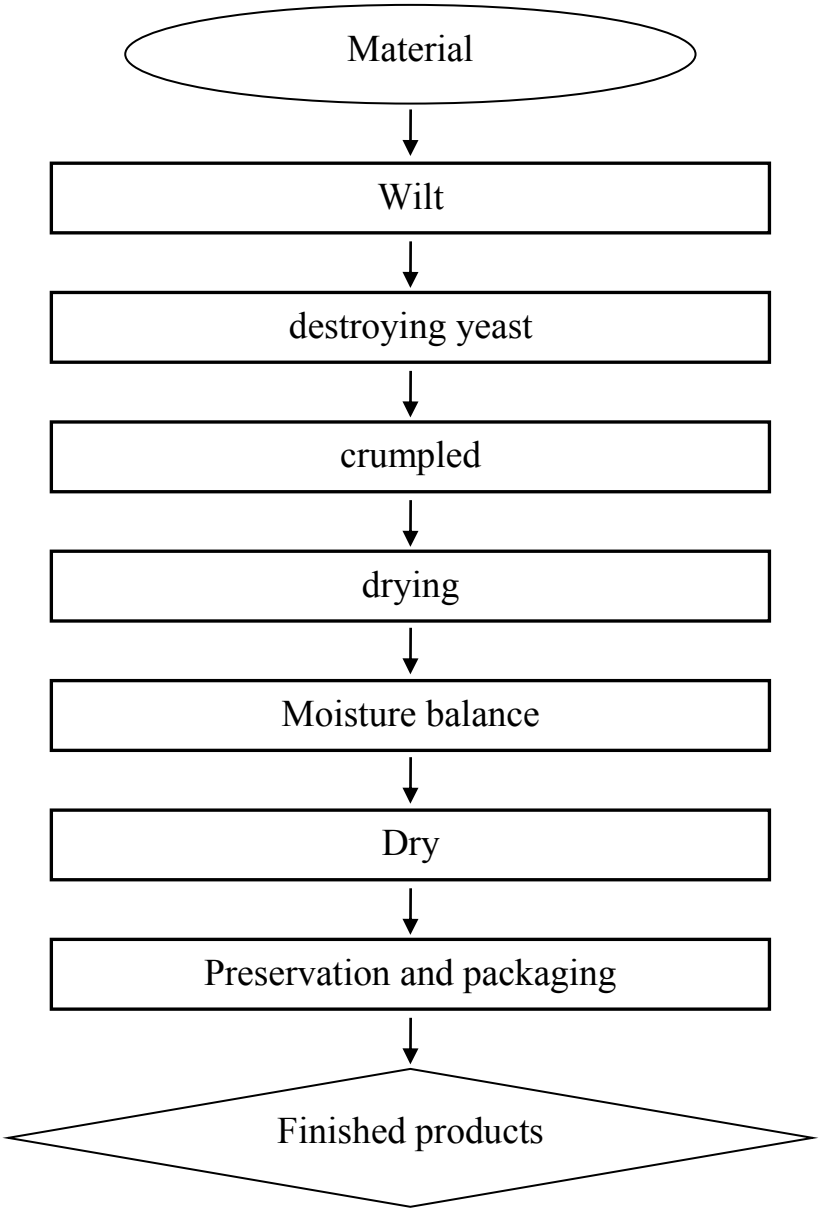
+ *Evaluate the model's economic, social and environmental efficiency*

3.3.1. Building a tea drying model on farm-scale with a tea drying system using gas obtained from the biogas system, capacity of 20kg / times..

Based on the results of a detailed survey on tea processing facilities' infrastructure, processing technology and drying techniques, and the preferences of the processor and infrastructure in accordance with the applicable conditions. As a result of the project, the project team has built 03 models of tea drying on a farm household scale using the tea drying system using gas from the biogas system, capacity 20kg / Times, at households:

1. Mr Vo Van Dong, Hamlet 3, Hung Son Commune, Anh Son District, Nghe An Province
2. Mr. Hoang Xuan Truong, Hamlet 4, Hung Son Commune, Anh Son District, Nghe An Province
3. Ms. Tran Thi Huong, Hamlet 4, Hung Son Commune, Anh Son District, Nghe An Province

The team builds up a model of installation and test operation of 03 tea drying equipment, including: 01 rotary drying equipment and 02 tea flavor drying systems, project equipment using recovered gas from biogas plants.



Explanation of technological process

- Material

Materials are harvested according to the standards of “1 tom 2 la” spread and “1 tom 3 la” sprouts then wilting naturally on the floor with a clean canvas with a density of about 5 kg / m2, wilting time from 4 to 4. 6 hours under natural conditions. Tea is spread evenly, porous, covering the mesh surface with a thickness of 20 - 25cm.

When spreading the amount of tea at the top of the pots thicker than the inside, then turn on the fan to blow air through the tea layer with an axial fan mounted at one end of the tea cooler for 15 minutes, when the surface of the leaves is dry. over

During the wilting process, stir the tea once every 2 hours, turn it upside down for the first time, the next time to roll it up, increasing the level of withering evenly. - After tea is plasticized, the remaining moisture is from 74-76%, tea leaves turn yellow green, the process of wilting ends.

- Destroying yeast

The temperature of killing yeast is applied in the range of 280-300oC, the killing time of yeast is 4-6 minutes, the appropriate moisture content of tea after killing the yeast is 59-63%, the tea after killing the yeast is cooled by a fan. This is the process of using the project's drying equipment (rotary barrel drying uses 50% of the gas recovered from the biogas reactor) instead of the yeast-killing device using firewood.

- Crumple tea

Crushing to crush the cells of the leaves makes the tea fluid drain out of the surface so that after drying it will make the tea wings more shiny and after mixing the water, the tea shifts into the brewed water more easily.

Crumpling machine: crusher can be used

- Preheating

Tea coming out of the crusher is pre-dried with the project's drying equipment 100% of the gas recovered from the biogas reactor, the drying temperature maintained at 95-100oC, tea humidity after preliminary drying: 30-35%

Tea after pre-drying is spread on a clean floor to balance moisture for 30-40 minutes.

- Drying (indirect drying)

Tea is dried at a temperature of 70-800C until the remaining tea moisture is 3-3.5%, the drying process uses the indirect drying equipment of the project instead of an electric drying system.

- Bagging and storage

After drying tea is stored in dry, cool, and sealed conditions. Tea is cooled and preserved with tin-coated PE bags or laminated PE bags, then stored in PP bags.

Before being packaged, it should be checked for quality and re-dried.

Table 4. The efficiency of rotary drum dryers and indirect drying equipment:

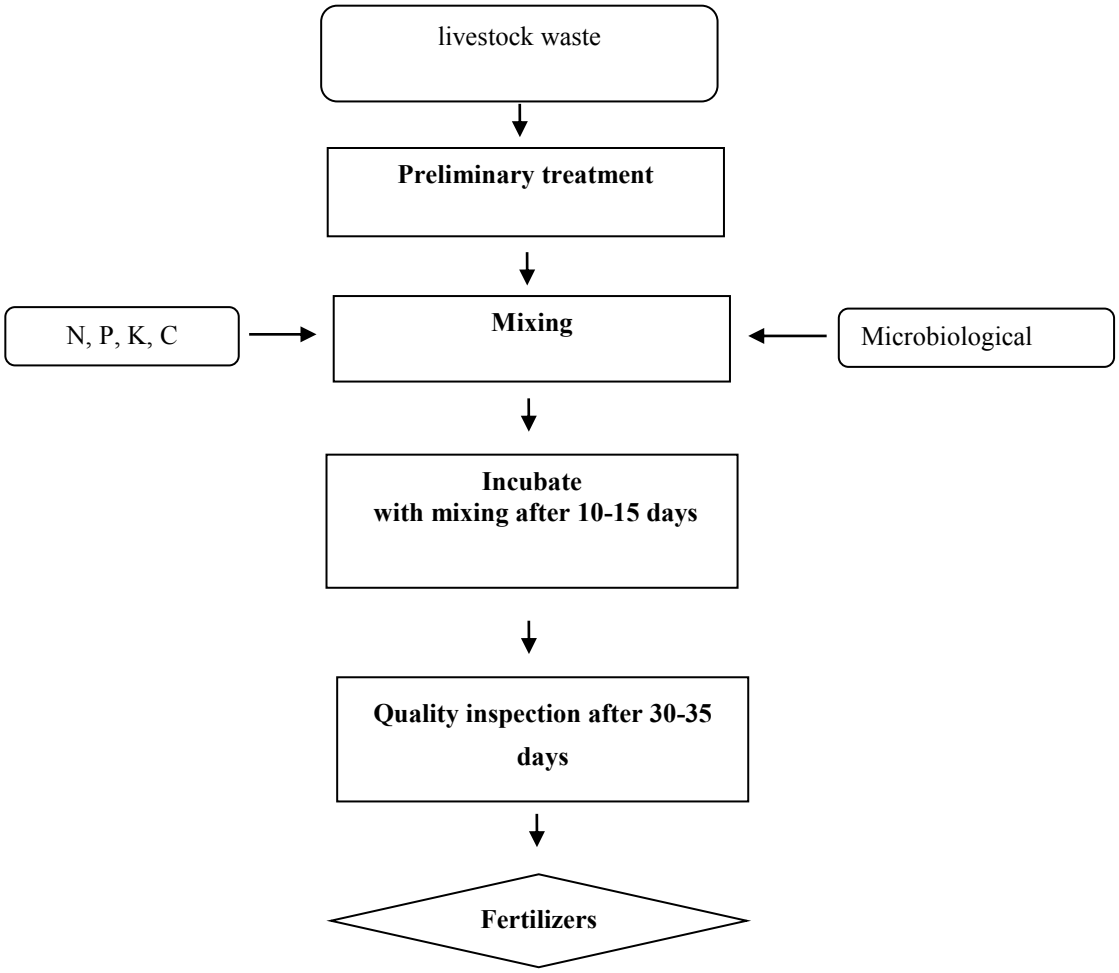
Target	**Unit**	**Biogas model**	**Others**
1. Fresh bud tea processing			
Fresh bud tea processing 2018	Kg		152.455
Fresh bud tea processing 2019	kg	93.650	82.000
2. Dry tea processing output			

Dry tea processing output 2018	kg		18.094
Dry tea processing output 2019	kg	19.510	15.084
3. The selling price of dried tea for processing			
The selling price of dried tea for processing 2018	đ/kg		42.000
The selling price of dried tea for processing 2019	đ/kg	73.000	57.000
4. Revenue from processed tea			
Revenue from processed tea 2018	đồng		733.981.250
Revenue from processed tea 2019	đồng	1.304.052.083	817.565.625
5. Tea production costs			
5.1. Tea production costs 2018			***865.400.000***
wage	đồng		615.000.000
Cost of materials	đồng		200.000.000
energy costs	đồng		54.000.000
5.2. Tea production costs 2019		***479.208.000***	***871.098.000***
wage	đồng	295.020.000	512.692.000
Cost of materials	đồng	178.708.300	204.154.000
energy costs	đồng	5.500.000	45.252.000
12. The added value of the whole model			
12.1. The added value of the whole model 2018	đồng		131.418.75
12.2. The added value of the whole model 2019	đồng	824.844.083	153.532.375

3.3.2. Building 03 models of applying microbiological technology to treat waste after biogas as bio-organic fertilizer:

Survey results show that although husbandry in Hung Son is developed but fragmented, the whole commune has 01 centralized breeding farm with 6,000 heads of pigs. The survey results also show that most of the post-livestock waste is used directly for farming without any treatment, which leads to a potential danger to public health and the ecological environment.

To solve this problem, the project team has developed a plan to treat animal manure by composting method to create a safe bio-organic fertilizer with an ecological environment..



Figuge 1: Diagram of treating livestock waste into bio-organic fertilizer

List of the model of livestock waste treatment:

Mr. Vo Van Dong: Village 5, Hung Son Commune, Anh Son District, Nghe An Province (treatment volume of more than 20 tons of pig manure)

Mr. Vo The Dung: Village 5, Hung Son Commune, Anh Son District, Nghe An Province (treatment volume of more than 20 tons of pig manure)

Mrs. Phuc Thi Minh: Village 4, Hung Son Commune, Anh Son District, Nghe An Province (treatment volume of more than 10 tons of pig manure)

<u>The procedure is as follows:</u>

- Preparation of raw materials: The main raw materials for processing bio-fertilizers are fresh pig manure collected from the barn, accompanied by nitrogen fertilizer, phosphate fertilizer, nitrogenous fertilizer, powdered lime, molasses or sand sugar and bio-yeast..

- Prepare tools and labor tools: Prepare the following tools to do this job, including: 500 liter tank, water pump, water pipe (long enough to carry water from the water source to the processing place); old bags and tarpaulins; and labor tools

such as hoes, shovels, rakes and watering tools. In particular, the treatment needs 2 workers to divide 2 times to complete the job:

+ Stage 1: It takes 2 workers to finish the compost pile

+ Stage 2: After the first Stage about 15 days, it takes 2 workers to reverse the pile

- Steps by steps

+ *Step 1* :

The microbiological fluid used to treat 1 organic material is processed according to the following formula:

Material	**Unit**	**Net weight**
Microbiological products	kg	0,2
Urea or $(NH_4)_2SO_4$	kg	0,5
KCl	kg	0,5
Molasses *	kg	5,0÷7,0
Water	Liter	10÷15

In the absence of molasses, 1 kg of sugar can be used instead.

The microbiological solution is processed in the following way: Mix the ingredients above into the container and in the following order: add molasses, urea, potassium to the water, mix to dissolve the urea and potassium, then process. to mix microorganism products

+ *Step 2*: Fermentation

The main material for composting is the initial moisture content of pig manure. This additional organic material should be processed to be same size (the smaller the better). Mixing ratio is about 20-30%, in the mixing process, add powdered lime to adjust pH.

The formula for mixing:

Material	**Unit**	**Net weight**
Pig manure	kg	1000
Phosphate	kg	5,0
Molasses	kg	5,0

Use water can to evenly spray the microorganisms prepared in step 1 on organic materials prepared as above, then use hand tools such as hoes, shovels, mix well, use bags, old canvas or sheets. nylon covers the entire pile to keep moisture and temperature for the pile

+*Step 3*: Tracking

During monitoring, attention should be paid to the deflection of the pile, the temperature, the odor, the humidity, and the color. Especially during the period

from day 15 to day 18, it is necessary to check the compost pile regularly to reverse the compost pile.

+ *Step 4:* Checking after fermentation

About 15 days after incubation, we conduct an inspection of the pile, use a hoe to dig a deep hole into the center of the pile and notice that the pile is white on the surface of the material and the temperature of the pile can be up to 60. -700C has the effect of decomposing materials and destroying pathogens. At the same time, the compost pile is also lack of moisture (dry), so it is necessary to water more so that the water can evenly wet the pile. After that, gather the piles and cover them.

+ *Step 5:* Mixing

After checking for 15-20 days of incubation, remove the entire bag, canvas, plastic cover and proceed to mix the entire pile, mix and water enough to completely absorb the material.

Once mixed, it is recommended to collect, load and step the ingredients into piles with a minimum height of 1 meter and cover them with plastic bags, tarpaulins and sheets like the first time.

+ *Step 6:* Final check

When the total fermentation days are 45 - 50 days, check the compost pile to find that the ingredients are soft and crushed, the pile is no longer hot, it can be used to fertilize plants.

+ *Quality evalution*

After completing the steps of handling pig manure, the project team took a sample of the manure after analysis. The quality of finished fertilizers is shown in the following table:

***Table* 5: Fertilizer quality**

TT	Index	Unit	Mr Vo Van Dong	Mr Vo The Dung	Mrs Phuc Thi Minh	QCVN01-189:2019/BNNPTNT)
1	OM	%	27,0	24,6	25,9	≥ 15,0
2	Asen	mg/kg	1,05	0,98	1,02	≤ 10,0
3	Cadimi	mg/kg	0,24	0,20	0,16	≤ 5,0
4	Lead	mg/kg	0,9	0,8	0,9	≤ 200,0
5	Mercury	mg/kg	0,002	0,003	0,002	≤ 2,0
6	*E. coli*	MPN/g	Not detected	Not detected	Not detected	≤ 1,1 x 10^3
7	*Salmonella*	MPN/25g	Not detected	Not detected	Not detected	Not detected

Comment: Nutrient content in organic fertilizers processed from pig manure meets the fertilizer standards according to the National Technical Regulation on fertilizer quality: QCVN01-189:2019/BNNPTNT.

Figuge 2: Composing process

3.3.3. Building 03 application models of bio-organic fertilizers processed from biogas residues for tea plants

a) Location

Models are deployed in locations:

1. Mr Vo Van Dong's Tea garden, village 5, Hung Son Commune, Anh Son District, Nghe An Province

2. Mr Nguyen Canh Tung's Tea garden, village 4 Hung Son Commune, Anh Son District, Nghe An Province

3. Mr Nguyen Xuan Vinh's Tea garden, village 4, Hung Son Commune, Anh Son District, Nghe An Province

b) Results

The effect of using bio-organic fertilizers on tea plants is shown as follows::

Productivity

Results of monitoring tea productivity when using bio-organic fertilizers processed from biogas residues are presented in the following table.:

Table 6. Productivity factor

Material	**Unit**	**Test mode**		**Note**
		Test model	**Original**	
Length leaf* (tôm+3lá)	Cm	12,19	11,75	LSD $_{0.05}$:0,43
	% Original	103,74	100,00	
P1 búp* (tôm+3lá)	Gam	1,60	1,53	LSD $_{0.05}$:0,06
	% Original	104,58	100,00	
Cone leaf density	Cone leaf/m2 canopy /year	519,80	480,20	LSD $_{0.05}$:40,4 CV%:4,6
	% Original	108,25	100,00	
Productivity	tons/ha	3,79	3,01	Productivity increases 25,9%
	% Original	125,91	100,00	

*Ghi chú: * Values are averaging 3 times (months 5,6,8, and 10), each implementation of 30 con track; Cone leaf track: 1 tôm 3 lá*

The data in the table above shows that: the growth indicators in the model using bio-organic fertilizers processed from biogas residues are higher than the control models with the confidence level of 95%; The actual yield obtained in the model using bio-organic fertilizers processed from the post-biogas residue was 3.79 tons / ha / year, 25.9% higher than the control model..

Tea pests and diseases

Pests and diseases have a great influence on the growth, productivity and quality of products; The monitoring process of some common tea pests obtained in Table 7 shows the situation of pests and diseases on the lips using bio-organic fertilizers processed from biogas residue and the control has no significant difference. In fact, in the control model, there were aphids, silk beetles, red spiders and mosquito stink bugs that were slightly heavier, but still at the threshold, no control measures were required..

Table 7. Tea pests and diseases on the model using bio-organic fertilizers processed from biogas residues and controls

Content	leafhopper **(number/plate)**	**Bug (number/leaf)**	blackwidow **(number/leaf)**	stink bug **(%damages)**
April				
Model	0,00	0,00	2,67	0,4
Original	0,00	0,50	3,00	0,6
May				
Model	1,00	1,33	1,00	2,7
Original	1,01	1,33	1,67	3,2
July				
Model	1,01	1,33	1,33	3,0
Original	1,33	1,33	1,67	3,6

Quality of tea products

Basically, there is no difference between the two models of using bio-organic fertilizers processed from biogas residues and the control.

Tea products of the model after 2 seasons of processing, spring and summer, analyzing the residue level of heavy metals, the results obtained are shown in Table 8:

Data in Table 8 shows that when analyzing and evaluating the levels of heavy metal residues in tea products in models such as arsenic, caffeine, lead and mercury in the spring and summer seasons, all heavy metals are above the level. safety allows in production.

Table 8. Residue levels of heavy metals in the product

Model	Season	Index			
		Asen(mg/kg)	Cadimi(mg/kg)	Hg(mg/kg)	Pb(mg/kg)
Original	Spring	0,015	0,003	0,003	0,31
	Summer	0,017	0,003	0,003	0,39
New model	Spring	0,017	0,005	0,002	0,31
	Summer	0,018	0,005	0,002	0,39
Standard		1	1	0,05	2

Figuge 3. The farmer running the test

3.4. Organize technical training, visit and study environmental management models for tea processing establishments

During the mission, up to now, the project team has built a technical training course on the technique of using biogas as fuel for the tea drying system with 30 people and 1 class. training on biogas processing techniques for bio-organic fertilizer with a total of 3 participants and staff from tea processing establishments in Hung Son; and 01 training course: "Technical training on using bio-organic fertilizers processed from biogas residue for tea plants"

The aim is to help trainees to raise awareness in agricultural waste management and treatment, and at the same time improve the efficiency and capacity of waste treatment and reuse waste products for livestock farms. farming, contributing to improving economic efficiency and improving the environment.

Comment: Most of the trainees participating in the training are familiar with the process of treating livestock waste into bio-organic fertilizer. They are aware that the environmental management, treatment and reuse of agricultural by-products are in the right direction, not only minimizing environmental pollution, reducing waste treatment costs but also creating more economic benefits for themselves.

3.5. Funding for project implementation

No	Content	Estimates (VNĐ)	Real cost (VNĐ)
1	*2*	*3*	*4*
Action 1. Collecting data, investigating, surveying, and evaluating the possibility of using renewable energy sources from biogas systems to replace traditional materials in tea processing in Anh Son, Nghe An		**148.432.440**	**148.455.840**
1,1	**Collecting data, assessing the current status of biogas systems in Anh Son, Nghe An**	**22.604.160**	**22.604.160**
	Collect documents on the current status of the use of biogas plants in Anh Son (Dam Trong Anh)	3.196.080	3.196.080
	Collecting documents on current management and use of biogas plants in Anh Son (Nguyen Ngoc Quynh	3.196.080	3.196.080
	Report on analysis and synthesis of documents, studies on the current status of biogas system in Anh Son, Nghe An (Dam Trong Anh)	16.212.000	16.212.000
1,2	**Field survey in households using biogas systems in Anh Son**	124.670.280	124.693.680
	Form the questionnaire (Nguyen Ngoc Quynh)	3.196.080	3.196.080
	Remuneration for interviewees (households)	2.084.400	2.100.000
	Remuneration for interviewees (managers)	1.042.200	1.050.000
	Analysis	57.900.000	57.900.000
	Rent a car to survey	12.274.800	12.274.800
	Salary for surveyors (4 people x 5 days)	31.960.800	31.960.800
	Report on the results of the survey at farmers using biogas plants, assessing the possibility of using energy from the biogas system to replace traditional materials in tea processing in Anh Son (Luong Huu Thanh)	16.212.000	16.212.000
1,3	**Printing, stationery**	1.158.000	1.158.000
Actione 2. Design and manufacture of tea drying equipment using gas from biogas systems		**97.272.000**	**97.272.000**
	Rent to design tea drying system using gas from biogas system, capacity of 20kg / time	**97.272.000**	97.272.000

Actione 3. Building a model		**1.400.670.480**	**1.398.354.480**
3.1	**Building 03 models of tea drying on a farm scale using a tea drying system using gas from the biogas system, with a capacity of 20kg / batch in 3 households in the commune.**	**1.160.918.160**	**1.160.918.160**
	Building a site for the selection of sites to build 3 tea drying models using an energy-based drying system that is gas from the biogas system (Dam Trong Anh)	16.212.000	16.212.000
	Install a tea drying model for farmer households using a tea drying system using gas collected from the biogas system, with a capacity of 20 kg / batch (According to the contract No. 1411 / DAB dated November 14 / 19; liquidated on December 13, 19, Red Invoice No. 0074275 dated December 13, 19)	1.042.200.000	1.042.200.000
	Salary for model implementation staff (3 people x 3 times x 6 days)	86.294.160	86.294.160
	Report (Vu Thuy Nga)	16.212.000	16.212.000
3.2	**Building 03 models of applying microbiological technology to treat waste after biogas as bio-organic fertilizer**	**121.034.160**	**118.718.160**
	Building a site-selection facility to build 3 models of applying microbiological technology to treat waste after biogas as bio-organic fertilizer (Dam Trong Anh):	16.212.000	16.212.000
	Salary for model implementation staff (3 persons x 3 batches x 6)	86.294.160	86.294.160
	Biological products for treatment of waste after biogas	2.316.000	
	Report writing (Nguyen Ngoc Quynh):	16.212.000	16.212.000
3.3	**Building 3 models of using bio-organic fertilizers processed from biogas residue for tea plants in Anh Son**	**118.718.160**	**118.718.160**
	Building a site-selection facility to build 3 models of application of bio-organic fertilizers processed	16.212.000	16.212.000

	from biogas residues (Nguyen Ngoc Quynh)		
	Salaray for model implementation staff (3 persons x 3 batches x 6)	86.294.160	86.294.160
	Report writing and lessons learned (Vu Thuy Nga)	16.212.000	16.212.000
Action 4. Training and propaganda		**185.418.960**	**185.860.560**
4.1	**Technical training on using biogas as fuel for tea drying system**	**35.064.240**	**35.206.440**
	* Training officer		
	Rent a car for trainers	12.274.800	12.274.800
	Training salary (55$ x2 people / class) _Luong Huu Thanh, Vu Thuy Nga	2.547.600	2.547.600
	Salary for trainers (2 people x 3 days)	9.588.240	9.588.240
	* Students (30 people)		
	Water	694.800	694.800
	Documentation and stationery	2.084.400	2.085.000
	meals	3.474.000	3.600.000
	Rent a hall	2.316.000	2.316.000
	Travel assistance	2.084.400	2.100.000
4.2	**Train on techniques of waste treatment after biogas as bio-organic fertilizer**	**35.064.240**	**35.206.440**
	* Training officer		
	Rent a car for trainers	12.274.800	12.274.800
	Salary for trainers (55$x2 people / class)- Nguyen Ngọc Quynh, Dam Trong Anh	2.547.600	2.547.600
	Salary for trainers (2 people x 3 days)	9.588.240	9.588.240
	* Students (30 people)		
	Water	694.800	694.800
	Documentation and stationery	2.084.400	2.085.000
	Meals	3.474.000	3.600.000
	Rent a hall	2.316.000	2.316.000
	Travel assistance	2.084.400	2.100.000
4.3	**Technical training on the use of bio-organic fertilizers processed from biogas residues for tea plants**	**35.064.240**	**35.206.440**

	* Training officer		
	Rent a car for trainers	12.274.800	12.274.800
	Salary for trainers (55$x2 người/lớp) - Nguyễn Ngọc Quỳnh , Đàm Trọng Anh	2.547.600	2.547.600
	Salary for trainers (2 người x 3 ngày)	9.588.240	9.588.240
	* Học viên (30 người)		
	Water	694.800	694.800
	Documentation and stationery	2.084.400	2.085.000
	meals	3.474.000	3.600.000
	Rent a hall	2.316.000	2.316.000
	Travel assistance	2.084.400	2.100.000
4.4	**Model review workshop (1 day)**	**80.226.240**	**80.241.240**
	Workshop package (including meeting room, 02 tea breaks and 01 lunch)	15.285.600	15.300.000
	Chair and technical expert (2 people x 1 day)	3.196.080	3.196.080
	Salary for delegates	9.032.400	9.032.400
	Stationery	2.084.400	2.085.000
	Car rental for the organizers (5 people)	12.274.800	12.274.800
	Salary for the organizers (5 people x 3 days)	23.970.600	23.970.600
	Presentation (3 people x 3 days preparation)	14.382.360	14.382.360
Actione 5. consulting		**4.794.120**	**4.794.120**
	Consulting drying technology - Luong Huu Thanh	4.794.120	4.794.120
6	**Model summary report - Luong Huu Thanh**	**16.212.000**	**16.212.000**
Total (VND)		**1.852.800.000**	**1.850.949.000**