Green Economic Development for Sustainable Poverty Reduction in Northern Mountainous Area of Vietnam: A Case Study of Son Dong District, Bac Giang Province

Anh Tai Do, Bich Hong Nguyen, Trung Kien Dang, and Thi Thuy Linh Tran

Abstract The project was conducted in Son Dong district, Bac Giang province, a mountainous area in Northern Vietnam with a large share of population of ethnic minorities or in low-income class. It aims to create a theoretical model of green economic development to reduce poverty sustainably in the mountainous area. With the main goal being to reduce greenhouse gas emissions, the model has shown the potential for green development due to a significant reduction in emissions. At the same time, the green business shows a stable income from an economic perspective or, in other words, green economic development associated with sustainable poverty reduction. Based on the findings, a number of solutions have been suggested to promote green economics. In detail, the solutions focus on three main groups that are policy, economic model change and the exploitation of natural resources.

1 Introduction

The current growth in the mountainous areas of Vietnam is mainly based on the exploitation of natural resources such as forest and land with low economic efficiency. This problem has been creating great pressure on the local environment and future development. In order to overcome climate change and degradation of environmental resources, to meet the requirements of sustainable development, many countries around the world as well as Vietnam are approaching green economic development by specific programs. We have joined the United Nations Agenda 21 with the important goal of achieving economic development associated with the sustainable use of resources. Effective use of scarce and dwindling natural resources is an urgent requirement for Vietnam, which is the reason for moving toward a green economy.

Along with climate change and environmental degradation, poverty is also one of the dilemmas that countries pay attention to and look for solutions. Over the

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A. T. Nguyen et al. (eds.), *Contemporary Economic Issues in Asian Countries: Proceeding of CEIAC 2022, Volume 2*, https://doi.org/10.1007/978-981-99-0490-7_40

Table 1 Poverty data by region and area in Vietnam[1]

Area	2004	2006	2008	2010	2011	2012	2016	2019	2020
Country	18.1	15.5	13.4	14.2	12.6	11.1	9.9	5.3	4.8
By region									
City	8.6	7.7	6.7	6.9	5.1	3.9	3.9	2.7	3.2
Rural	21.2	18	16.1	17.4	15.9	14.4	12.7	6.7	5.6
By area									
Red river delta	12.7	10	8.6	8.3	7.1	6.1	1.5	0.6	0.3
Northern Midlands and mountainous	29.4	27.5	25.1	29.4	26.7	24.2	17.4	10.7	7.4
North Central	25.3	22.2	19.2	20.4	18.5	16.7	7.5	3.8	3.3
Highlands (Tây Nguyên)	29.2	24	21	22.2	20.3	18.6	20.6	12.4	8.9
South East area	4.6	3.1	2.5	2.3	1.7	1.4	4.9	3.8	6.2
Mekong Delta	15.3	13	11.4	12.6	11.6	10.6	19.5	9.3	8.1

Unit % of poor households

years, poverty reduction has become a central task and national target of Vietnam. This made us remarkable achievements in the 1990s, in which our poverty reduction objective finished ahead of its schedule in this period (from 58% of the poor in 1993 down to 37% in 1998 and 29% in 2002). However, we have to admit that even after many poverty reduction programs that have been invested by the State, up to now we still have a number of poor areas, in which it is mainly concentrated in mountainous, remote and low developed areas, where mainly ethnic minorities are living. Since 2008, the Party and State have continued to launch a program to support the rapid and sustainable poverty reduction for poor districts as defined in Decree 30/A/2008/ND-CP. The efforts of the Vietnamese government and people have brought encouraging results in poverty reduction with the poverty rate decreasing dramatically in recent years (Table 1).

One of the solutions that is clearly mentioned by the authorities is green economic development. This is an effective and long-term solution for the rapid and sustainable poverty reduction program that Vietnam is investing in. However, the reality shows that the combination of green economy development and poverty reduction programs is still pretty weak. This requires the attention of research on green economic development associated with sustainable poverty reduction in link with the economic development strategy, environmental and natural resources protection as well as any other social target that may apply in the Northern mountainous region of Vietnam.

Son Dong is a mountainous district of Bac Giang province with diverse terrain with many hills and mountains. It is rich in natural resources such as forests (61% of coverage) and minerals (copper ore, tin ore, coal, etc.). The resource can be exploited for local economic development but still this is one of the 62 poor districts of the

[1] *Source: General Statistics Office, Vietnamese government.*

country; the district has approximately 74 thousand people, of which more than 47.2% are ethnic minorities. It can be said that Son Dong is a typical mountainous district of Bac Giang province and the northern mountainous region of Vietnam. Over the years, there have been many investment programs for socio-economic development for poor districts in general and for Son Dong in particular. These programs mainly focus on economic development for locals. However, if only focusing on the economy without paying attention to the sustainable use of resources, it will be difficult to achieve the goal of reducing sustainable poverty for the people in those areas. Moreover, it is easy to lead to excessive exploitation and use of natural resources for the purpose of escaping current poverty.

According to the concept of green economic development, this is the approach sustainable from both economical and environmental perspective, while a non-green economy is only aiming for economic goals but ignoring the environmental aspect. Currently, the world is facing climate change and its negative impacts on human life, so the more we see the need for change, the more we refuse to accept an economy that affects our own living environment.

Another important thing is the purpose of increasing the access to basic services and improving infrastructure for people. A green economy is considered as one of the ways to reduce poverty and improve overall quality of life. According to experts, green economics can provide energy resources capable of supporting the 1.4 billion people who currently lack electricity and the more than 700 million others who currently lack access to modern energy services. Renewable energy technologies, such as solar energy, wind energy, together with energy-supportive policies promise to significantly contribute to improving the lives and health of low-income populations, especially for those who currently do not have access to energy (Vietnam Environment Administration, 2012).

Even the green economy is not entirely aimed at and associated with poverty reduction; its development from one side is an economic goal and at the same time aims for stability and for protecting the living environment for people, which makes it sustainable. Hence, the poverty reduction which is the result of a sustainable economy and has high public acceptance will make that poverty reduction more stable in the long term.

Among the current multidimensional poverty criteria, there are criteria that are directly or indirectly related to the environment such as sanitation and human health conditions (Ministry of Labour, War Invalids and Social Affairs of Vietnam, 2015). Therefore, green economic development helps to reduce poverty in a more sustainable and stable manner, hence reducing the gap between rich and poor.

An important component of a green economy strategy is to improve resource management. Green economies must improve resource productivity and reduce resource use. Such a transition can be achieved through concerted actions by policymakers to establish a regulatory framework that increases resource efficiency (Monika et al., 2012).

A green economy is defined as an economy that is sustainable and good for society with no carbon emissions, which meets human needs for a planetary ecosystem where all energy is derived from renewable resources and is replenished naturally.

A rigorous green economy applies the three-pronged concept of people, planet and profit across all activities at the microeconomic level and throughout the economy at the macro level. In contrast to a green economy, a traditional "black" energy economy is based on strong use of carbon as fossil fuels coal and oil. By definition, a low-carbon economy is distinct from a green economy because it still produces carbon emissions (Green Economy Group, 2013).

According to experts, the "green economy" strategy has become a turning point for the process of global economic recovery and is also a new driving force for promoting sustainable global economic development. According to the United Nations, the "clean economy" policy is a necessary development path for the global economy in the future (UNEP, 2011).

The successful transition to a green economy is a global task. It is not only about green technologies, but it also has to answer the question of how to break the link between resource consumption and economic growth. Transforming into a green economy means entering a new era and the most important thing is a change in perspective.

Focusing on analyzing indicators of green economic development, by using two groups of indicators to compare the ecosystem and the economic system, Chen and Hsieh (2010) have shown that in Taiwan development has only focused on the economy and lack of concern about the environment. According to their findings, in economic terms, the comparison between imported inputs and the decline of non-renewable resources will show that the country is only interested in economic development and ignores environmental protection.

Wang and Qiu (2011) pointed out that the Chinese government needs to build a stimulus system for the green economy through a green financial system and green tax. By promoting emissions trading and the carbon trading system, China can create a market with energy saving and business emission reduction. An environmental assessment system should be set-up for the whole society, together with strengthening business inspection, promoting energy saving and emission reduction in government, schools and other institutions.

However, most of the research often focuses on a general industrial or a national. The studies on a specific region and for the agricultural sector are very few, especially for those countries where the rural area occupies a large area and consumes a lot of resources. Or in some areas, the non-renewable resources are being exploited for industrial development without the concern of long-term impact to the environment.

Economic development is associated with poverty reduction in countries around the world. A question given is, why should we care about agriculture when we plan to develop a green economy. Because this is the business/production sector that uses 70% of water, 34.3% of the land area, while generating 17% of greenhouse gas (GHG), employs 37.3% of labor (Farming First, 2022) in which among 1.4 billion people living in poverty, 1 billion are from rural areas, an area that is under pressure to generate twice the amount of food today by 2050. Thus, the world has paid attention to and is concerned about the relationship between green economic development and poverty reduction for the agricultural and rural areas.

According to UNEP (2011), green economic development can help reduce poverty from different aspects that are related to poverty such as agriculture, forests, fisheries and water management, which are common resources for production. Investing in these factors includes expanding the microfinance program that will benefit the poor not only in terms of job creation but also in ensuring livelihood security from the local ecosystem.

It can be seen that the role of green economic development with poverty reduction is recognized; however, most of them just stops at the theoretical analysis aspect. It lacks research that builds models or evaluates the relationship between green economic development and sustainable poverty reduction in the practical field; thus, this study may fulfill a partial of this gap.

2 Research Conducted Area—Son Dong District, Bac Giang Province

Research has been conducted in Son Dong, a highland district, located in the North-east region of Bac Giang province, 80 km from the center of Bac Giang city, Vietnam.

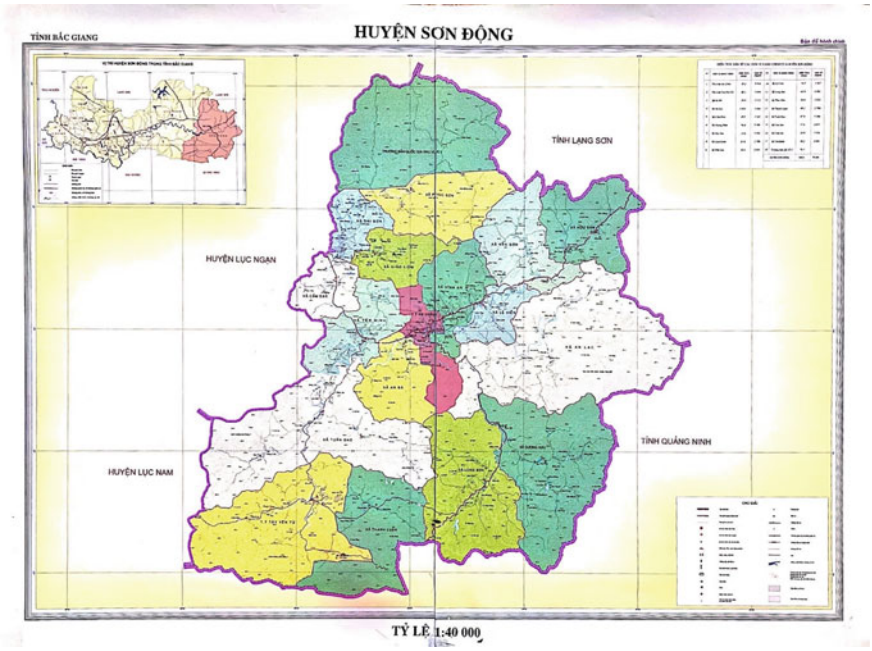

Fig. 1 Administrative map of Son Dong district, Bac Giang province, Vietnam[2]

The location of the district can be found in Fig. 1. The basis for selecting Son Dong district as a study site is this location has met the following criteria:

- Belongs to the mountainous area
- There are ethnic minorities living
- An area with high poverty rate (based on the standard stated in Resolution No. 30A/2008/NQ – CP of Vietnamese government)
- A place with abundant natural conditions, a high rate of forest cover, lots of hilly land and potential for development.
- Accessible and supported by local authorities and people to participate in the study.

The district's land is quite diverse and rich, distributed in flat and sloping terrain, allowing the development of agro-forestry ecosystems. The exploitation and use of land must be associated with forest development, land protection and environmental protection. Besides, it is necessary to have the intervention of functional units to both ensure economic efficiency on the productive land area, while ensuring the area of watershed forests, in order to bring income, poverty alleviation and sustainable economic development of the district.

According to local authorities, this place has 56.9% of the population belonging to 12 ethnic minorities (data of 2022). The economy of the district is developing slowly. The district's average annual increase in production value is 10%, lower than the provincial average. In the past years, the district has received the attention, support and investment from the State in many forms, economic programs and projects, such as projects 134, 135, 327, etc., or the Poverty Reduction project supported by the World Bank. By the end of 2008, these programs/projects have brought many changes to this area, especially the significant improvement of infrastructure for development of socio-economic and people's life here.

However, up to now, Son Dong district is still among the poorest districts of the country; the poverty rate of Son Dong still accounts for more than 25.8%, while the whole country accounts for only 4.8% (based on the standard of multidimensional poverty line, decree 07/2021/ND-CP by Vietnamese government (2021)). This rate is even higher in highlands area, where the situation of grain starvation before the harvest season still occurs frequently, in which the implementation of the previous socio-economic development and poverty reduction programs in the district still has shortcomings. This problem encouraged the government to issue Resolution No. 30a/2008/NQ - CP (Vietnamese government, 2008) on fast and sustainable poverty reduction for 61 poor districts (now 62 districts) in the whole country, including Son Dong district, Bac Giang province.

[2] *Source: Web portal, Bac Giang province.*

2.1 Total Population and Research Sample

Due to the large area of the district with many different characteristics, the study will take samples according to the hierarchical sampling method.

The population is divided into three tiers, commune level, village level and household level. Each stratum will take representative groups with commune and village levels; the selection of samples is based on representative criteria and the intention of the research team.

The study selected five communes representing different regions of the district, including:

- Cam Dan commune represents the Northwest region of the district where there are favorable traffic conditions due to its proximity to the road connecting with Luc Ngan district and Bac Giang city;
- An Ba commune represents the area near the district center where has the most developed socio-economic conditions in the district;
- An Lac commune represents the Northeast region of the district with large forests cover and high areas of protection forests and special-use forests;
- Long Son commune and Thanh Luan commune represent the southern area of the district with the forest and high mountain area development conditions of the district.

In selected communes, we will select from 3 to 5 villages/hamlets each to look for survey households, on the basis that the villages are evenly distributed in the commune and have many ethnic minorities or poor living people. Finally, in each village, random households will be selected for the survey using a prepared questionnaire.

The number of households of the 5 selected communes is 2500 in total; to ensure the representativeness and accuracy of the collected information, the sample size will be selected according to Slovin's formula as follows:

$$n = N \Big/ \left(1 + Ne^2\right)$$

where

n *the representative sample size*
N *the overall scale*
e *the allowable error (5% as chosen in this study).*

By calculation, the sample size is 256. So the study conducted a survey of 256 households in the district. In addition, in order to collect information about the green economy, the research team has interviewed the commune and district leaders as well as a number of locals in different ages and genders. They are divided into 03 groups (with the number of people from 10 to 15 people/group) for a participatory rural appraisal approach (PRA) with pre-prepared questions to assess the strengths,

weaknesses, challenges and opportunities (SWOT) in green economic development in mountainous districts.

2.2 The Optimization Problem Model

The linear programming problem will be used to build a theoretical model of green economic development for the locality with appropriately environmental constraints. Using a model of a linear programming problem with objective function variables representing the economic factors that contribute to the green economic indicator, here is the amount of greenhouse gas emissions. The linear function is targeted to reach minimum value.

The theoretical model of the linear programming problem is as follows:

The objective function of the problem: Finding the minimum of a linear function

$$F(x) = \sum_{j=1}^{n} Cjxj$$

Constraints

$$\sum_{j=1}^{n} aijxj = (\leq; \geq)bi(i = \overline{1, m})$$

$$xj \geq 0(j = \overline{1, n})$$

in which:

- C_j The parameters of the variables in the objective function expressed as the level of greenhouse gas emissions.
- a_{ij} Coefficients representing technical values of related constraints such as land, labor, capital, income, etc.
- b_i The right-hand side of the constraints showing the availability of factors to which the requirements of the problem are related, such as local income or production value.

2.3 Analytical Framework

The conditions for green economic development included the general socio-economic conditions, the natural infrastructure and the conditions of each household (which are related to the livelihood resources of the households, issues of thinking, understanding as well as the awareness of people about green economy development).

From that situation, it can help to build a theoretical model showing the potential as well as the meaning of green economic development for the region. Combined with

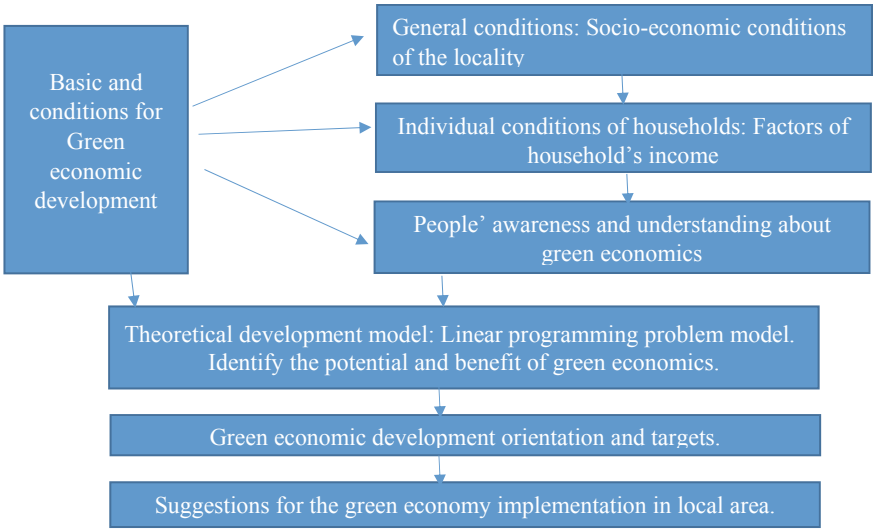

Fig. 2 Research framework diagram[3]

the orientation for Vietnam's green economic development and the local economic development, we build a framework of solutions to develop the green economy in the area in the coming time (Fig. 2).

The general assessment of the resources of households in Son Dong district is through the assessment of resources on a 10-point scale. It is evaluated by locals themselves through surveys. The feedback distribution can be found in Fig. 3 in which social resources among these factors give the highest average value, while financial resources through financial evaluation criteria give the lowest average results. Other resources such as natural and material resources are also underestimated. On the other side, we also may consider there is obviously room for improvement with financial resources, human resources.

3 Building a Model of Green Economic Development in Son Dong District

The concept of green economic development is an economy that creates income but has little impact on the environment. Thus, the construction model needs to ensure that the income received is at least at the current level but minimizes the level of environmental impact. Here environmental impact is a qualitative term so it is necessary to define a specific indicator that can be measurable.

[3] *Source: Developed by research group.*

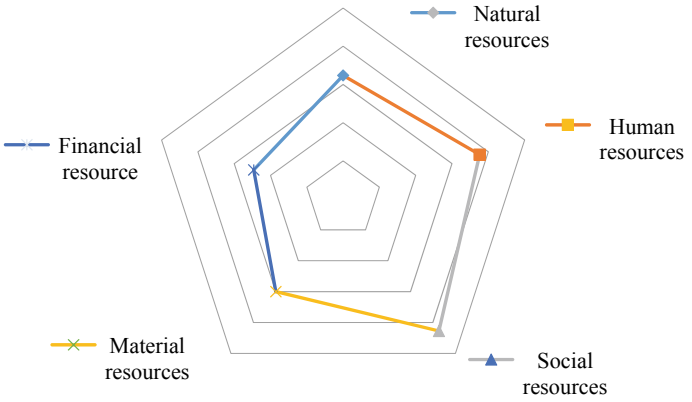

Fig. 3 General assessment of livelihood resources of households in Son Dong district[4]

The important indicator that the world is interested in is the greenhouse gas effect caused by human activities, so the study will also use this indicator as a target to pay attention to. In detail, we target for reducing greenhouse gas effects caused by human agro-forestry production activities.

It is said that the traditional production method has emitted too many greenhouse gases such as CO_2, SO_2, CH_4 to the air. This is the cause of climate change taking place on a global scale, threatening human life and bringing consequences to economic activities. In order to change this situation, the United Nations Environment Programme—UNEP has introduced a new approach to economic development that many countries agree to respond to, which is the development of a "green economy". (*Nguyen,* 2011*).*

Forest and afforestation will have a positive impact on the greenhouse effect through the absorption of CO_2, so here in this study, we considered preserving and maintaining the forest status of Son Dong district, while considering changes in agricultural production activities because this production activity is a source of greenhouse gases such as CO_2, NH_4, N_2O.

3.1 Linear Programming Problem

As said above, the multi-objective problem model, also known as a linear programming problem, is conducted. This problem model can simultaneously meet many goals, in which the most important goal will be expressed in the objective function of the model, and the other goals will be expressed through the model constraints system. The problem model is built for the whole district, based on secondary data provided by the District Statistical Office and based on FAO data.

[4] *Source: Household survey in 2015, conducted by research group.*

In the problem model, the main local agricultural activities are rented to analysis. At the same time, based on the available data, we may choose variables and constraints for the model. The results of the problem model can be used to review and provide suggestions for the transformation of production models toward a green economy in which the problem model chooses the objective function to minimize the level of greenhouse gas emissions created by crops and animals in local agricultural activities.

3.2 Constraints Included

The constraint on total income from agricultural activities: The activities proposed by the model must create an income at least equal to the current total income of households from their agricultural activities. As said, people are very concerned about their family income, so if a decision has a negative impact on household income, it will be difficult for them to agree. Total revenue from agricultural activities will be taken from the revenue report of the whole district.

The constraint on available workforce: This constraint is related to the district's ability to provide human resources for agro-forestry production activities; the requirement for this constraint is to use less than the number of available workers.

Constraints on land: In this constraint, land for agricultural production such as farmland, hilly land and grazing land will be included, in which each type of land will be separated with its own constraint, with the requirement that the land demand does not exceed the possible capacity of the district.

The constraint on minimum food demand is a constraint to meet the food security requirements for the area. It is calculated based on the total food demand (calculated by the number of people in the district). Finally, obvious constraints on the values of variables should be non-negative values.

3.3 The Current Agricultural Production Model of the District

- The production value from cultivation and animal husbandry of the district in 2015 was VND 804.69 billion.
- Crops: Rice with an area of 4559 ha (hectare) with an output of 21,936 tons; corn plant with 1471.7 ha for an output of 6215.6 tons; the average yield of grain food per capita is 389 kg/person/year; sweet potato is for 477 ha and create yield of 84 quintals/ha; 396 ha of cassava with an output of 4365 tons. In addition, there are beans, peanuts and vegetables of all kinds.

For fruit trees, lychee for 1436 ha with an output of 5657 tons; oranges 41.5 ha, yield 181 tons; longan is 83.2 hectares with a yield of 686 tons; 27.6 hectares of tea yielded 63.5 tons of fresh buds.

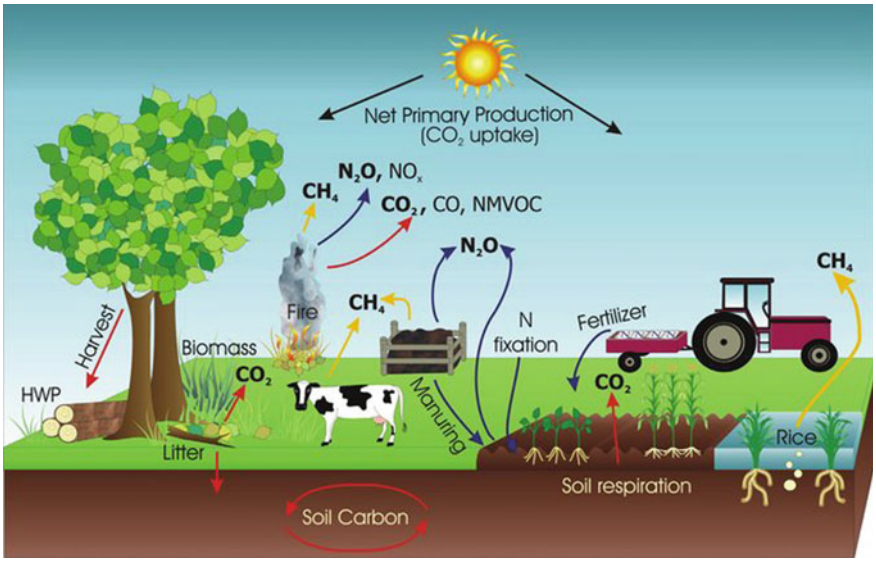

Fig. 4 Sources of greenhouse gas emissions[5]

- Cattle: 10,018 buffaloes, 2704 cows; 70,242 pigs; 2480 goats; poultry for 672 thousand heads.
- Aquaculture: Farming area accounted for 155 ha

The greenhouse gas emission sources/removals and processes in managed ecosystems are clearly shown in the guideline of IPCC, Intergovernmental Panel on Climate Change (Fig. 4).

Based on public information, survey data collected, the study builds a model to investigate the gas emission in local areas. This effect is calculated based on the emissions per animal, per hectare of crops generated with use of chemical fertilizers (except for organic manure since it is already calculated for livestock) and organic waste produced as people burn for fertilizers.

Using the linear programming problems, together with some fixed characteristics of local production, there are several conditions included as tight constraints, such as the area for perennial crops and the area of aquaculture. At the same time, agricultural production value constraint is also calculated at about 25% higher than the current reality to produce more efficient estimation results. Table 2 presented the calculation result of linear programming problem.

The value of greenhouse gas emissions is rechecked and shown in Table 3. Based on the estimated result, the locals should choose cow breeding instead of buffalo farming due to its greater value and lower greenhouse gas emissions; pig farming is also recommended while goat farming is not preferred. Poultry also brings great benefits with little impact on emissions levels. Production of rice and maize to meet

[5] *Source:* IPCC (2006).

Table 2 Multi-objective problem model, Son Dong district[6]

	Buffaloes (unit)	Cow (unit)	Pig (unit)	Goat (unit)	Poultry (unit)	Rice (ha)	Corn (ha)	Grain (ha)	Peanuts (ha)	Sweet potato	Potato	Vegetables	lychee (ha)	Orange (ha)	Aqua culture (ha)	Sign	Right side
HMT: greenhouse gas emissions (kg)	1328	1146	173.6	121	0.24	7750.9	4736	4374	4473.7	3521	3750	6540	3038	3589	2000	→	Min
Labor force	2.4	3	0.036	0.03	0.0036	120	70	70	70	55	60	110	100	100	50	<=	10,861,800
Agricultural production value	26	30	3.8	1.5	0.1	31.1	36	70	88	42.5	36.4	27.04	39.5	43.6	32.1	>=	1,000,691
Cultivated area						1	1	1	1	1	1	1				<=	6989.7
Winter crop land area							1	1	1	1	1	1				<=	958.7
Land area for perennial crops													1	1		=	1440
Land area for rice cultivation						1	1									=	6031
Area of aquaculture															1	=	155.4

(continued)

[6] Source: Research group's calculation.

Table 2 (continued)

	Buffaloes (unit)	Cow (unit)	Pig (unit)	Goat (unit)	Poultry (unit)	Rice (ha)	Corn (ha)	Grain (ha)	Peanuts (ha)	Sweet potato	Potato	Vegetables	lychee (ha)	Orange (ha)	Aqua culture (ha)	Sign	Right side
Livestock grazing area	0.08	0.08		0.01												<=	907.6
Maximum number of pigs			1													<=	120,000
Maximum number of poultry					1											<=	1,150,000
Food demand						48	43									>=	250,000

Table 3 Results of the problem after being processed by Excel software[7]

Objective Cell (Min)			
Name	**Original Value**	**Final Value**	
Greenhouse gas emissions	75,117,085.15	75,117,085.15	
Variable Cells			
Name	**Original Value**	**Final Value**	**Integer**
Buffaloes (unit)	0	0	Contin
Cow (unit)	11,345	11,345	Contin
Pig (unit)	76,634.454	76,634.454	Contin
Goat (unit)	0	0	Contin
Poultry (unit)	1,150,000	1,150,000	Contin
Rice (ha)	5072.3	5072.3	Contin
Corn (ha)	958.7	958.7	Contin
Grain (ha)	0	0	Contin
Peanut (ha)	0	0	Contin
Sweet potatoes	0	0	Contin
Potatoes	0	0	Contin
Vegetables of all kinds	0	0	Contin
Lychee (ha)	1440	1440	Contin
Oranges (ha)	0	0	Contin
Aquaculture (ha)	155.4	155.4	Contin

local food needs, in addition to growing litchi, is also recommended rather than for other crops on hilly land.

The objective function value (GHG emissions) is 75,117,085.15 kg.

Compared with the actual value of the activities currently being carried out, it will generate greenhouse gas emissions of 80,513,527 (kg) NH_4, CO_2, N_2O (This number can be estimated from the current agricultural production data in the district). Thus, the optimal model will help reduce the amount of greenhouse gas emissions. Greenhouse gas is: 5,396,442 (kg).

4 Conclusion

The current economic model practiced in Son Dong district in agricultural production is not a green economic model, due to the high level of greenhouse gas emissions, while in the multi-objective problem model, even though many strict constraints have been included, the recommended scenario can create around 10% lower in emission

[7] Source: Research group's calculation.

level. Compared to the actual production, it can be seen from the case of Son Dong district; the green economy will reduce the harm to the environment, but still create the same or even higher amount of production value.

The study has built a theoretical model of green economic development to reduce poverty sustainably in the Northern mountainous area in Vietnam. The main objective of the model is to reduce greenhouse gas emissions, one of the important criteria and expected results of green economic development. The linear model has shown the potential for green development due to a significant reduction in emissions, while ensuring better income from an economic perspective. In other words, green economic development is associated with sustainable poverty reduction.

Green economic development is the right direction to ensure the harmony between human needs and nature, so we need to come up with policies to promote and create a legal basis for green economic development. Green economic activities can be prioritized for development.

However, it can be seen that there are some limitations that exist in this study; thus, it is necessary to continue with further studies for deeper understanding of practical models and then apply them specifically in a locality to be able to learn and replicate in a larger area and region.

Acknowledgements The study is based on the research result of project number B2014-TN08-01 of the Ministry of Science & Technology of Vietnam. The authors would like to thank the community members of the study area for participating in the research, who were most collaborative in completing the questionnaires and in providing discussion opportunities on the results.

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