



Original Article

# Roles of Crop Boom (Orange) in Biodiversity Conservation in the Northern Limestone Mountain Region of Vietnam

Ngo Ngoc Dung, Le Trong Toan\*, Tran Chi Trung,  
Nguyen Thi Vinh, Le Thi Van Hue

*VNU Central Institute for Natural Resources and Environmental Studies,  
19 Le Thanh Tong, Hoan Kiem, Hanoi, Vietnam*

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**Abstract:** This study examines the roles of crop boom (orange) in biodiversity conservation in Cham Chu Nature Reserve, Tuyen Quang province in the Northern Limestone Mountain Region of Vietnam. The results indicated that the local policy on orange development in Tuyen Quang since 2000 has made positive contributions to both local livelihood improvements and biodiversity conservation. On average, household income has significantly increased (VND 161 million Vietnam/household/year), of which income from sale of oranges made up 62% of the total household income. Poverty rate has been reduced by half during the last 10 years. Therefore, the dependence of the local livelihoods on the harvesting of forest resources has remarkably decreased, accounting for only 1% of the total household income. Data analysis indicates that the trend of increasing orange area (from 7% in 1986 to 27% in 2017) is related to the increasing forest cover in Cham Chu Nature Reserve (60.4 % of 1986 to 63.8% in 2017) and the decreasing trend of forested areas under human impact (11.3% in 2007 to 3.7% in 2017). Notably, the number of cases of violation of the Law on Forest Protection and Development has significantly decreased (from 66 in 2013 to 13 cases in 2017) in the study area. The case of Phu Luu shows that commodity agricultural development has had a positive impact on biodiversity conservation at the local level. Recommendations are provided at the end of the paper as how to strengthen the linkages between commodity agriculture and biodiversity conservation in the limestone mountains of Northern Vietnam so that growth of rural incomes, poverty reduction, and biodiversity conservation can all take place.

**Keywords:** Crop boom, orange, livelihoods, forest, wellbeing, Tay people, Northern limestone mountain region of Vietnam.

\* Corresponding author.

*E-mail address:* [toanrcres@vnu.edu.vn](mailto:toanrcres@vnu.edu.vn)

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## 1. Introduction

The limestone mountain region of Vietnam occupies 20% of its territory and is mainly in the Northern provinces [1]. Due to typical natural, topographical and climate conditions, the limestone region supports a larger number of endemic fauna and flora species [2]. The Critical Ecosystem Partnership Fund (CEPF) considered Sino-Vietnamese Limestone of Vietnam as one of the global biodiversity hotspots and priority corridors for biodiversity conservation in Indo-Burma [3].

Tuyen Quang province, one of the provinces in the limestone region, is located in the middle of the North East and North West of Vietnam. The limestone mountains make up 49.92% of the total area of Tuyen Quang [1]. It is home to a number of ethnic minority groups of people, including Kinh, Tay, Nung, Thai, Dzao and Mong whose livelihoods and culture have been closely related to natural resources. The main livelihoods of the communities living in the limestone region of Vietnam are orange plantation, wet rice cultivation, fish raising, and forest plantation such as *Acacia*, and harvest of natural resources.

There exist many threats and pressures on biodiversity conservation in the limestone mountain region of Tuyen Quang province as well as the entire Northern Vietnam. The high poverty rate and limited cultivation land, illegal hunting and logging, and limestone quarrying are among the causes of biodiversity loss in the region [1, 4]. About 15% of total population of Tuyen Quang province, mostly from Tay and Mong groups, have lived under poverty line [5]. The limited cultivation land and options for expanding cultivation land have posed significant threats to biodiversity conservation in the province. In 2018, there were 529 cases violating the Forest Protection and Development Law, including illegal logging, hunting rare and endangered species and exploitation of non-timber forest products [5]. The situation of illegal trade of turtles from Tuyen Quang, Bac

Kan and Quang Ninh provinces to China has become more serious [6]. A study on Tokin snub-nosed monkey (*Rhinopithecus avunculus*), one of 4 endemic primate species of Vietnam and one of the world's 25 most endangered primates, distributed mainly in the limestone mountain region in Bac Kan, Ha Giang and Tuyen Quang provinces highlighted that the number of population of this species is reduced due to hunting, loss of its habitats, but there is possibility to recover if they are well protected [7].

Studies on agricultural production commodity development in South East Asia have mostly focused on the crops such as rubber, coffee, and cassava and related issues such as gender inequality, land tenures, social relations, forest covers, and land uses. The authors showed that the expansion of rubber plantations has a significant impact on forests and biodiversity in Vietnam and Southeast Asia. For example, to 80% of the rubber area in the Central Highlands was developed on forest land [8] or about 610 km<sup>2</sup> of protected areas in Southeast Asia has been converted to rubber plantations during 2005-2010 [9].

Studies have shown that the expansion of rubber plantations has a significant impact on forests and biodiversity in Vietnam and Southeast Asia. For example, up to 80% of the rubber area in the Central Highlands is developed on forest land [8] or about 610 km<sup>2</sup> of conservation land in Southeast Asia has been converted to rubber plantation in the period 2005-2010 [9].

In addition, the development of rubber trees by companies and state policies also significantly changed land ownership in the Northwest [10]. Cassava development in recent years has brought many benefits for the rich and upper-middle households while bringing many risks to the poor households as well as increasing the gap between the rich and the poor [11]. However, no studies have focused on how the development of commodity agriculture (fruit trees such as Oranges, Lemons) has an impact on forest protection and biodiversity conservation.

This study examines the impact of the development of orange trees on forest protection and biodiversity conservation in the limestone mountains of Northern Vietnam through a case study of Nam Luong village, Phu Luu commune, Ham Yen district, Tuyen Quang province in the buffer zone of Cham Chu reserve.

## 2. Research Methods

### 2.1. Study Site, Research Object and Research Duration

Phu Luu is a commune in the bufferzone of Cham Chu Nature Reserve (Figure 1). The commune has 12 villages which are located in the core zone and bufferzone of the nature reserve. More than 83% of the commune's population is the Tay ethnic group. Nam Luong village was selected as the study site. The village had 200 Tay ethnic households and the poverty rate of Nam Luong village in 2018 was 15%. Orange tree has been developing since 1992 in Phu Luu commune and is one of the current main economic activities of the commune. Phu Luu commune has the largest area of orange plantation in Ham Yen district (2,500 ha) and the annual output was about 35,000 tonnes by the time the field survey was being conducted.

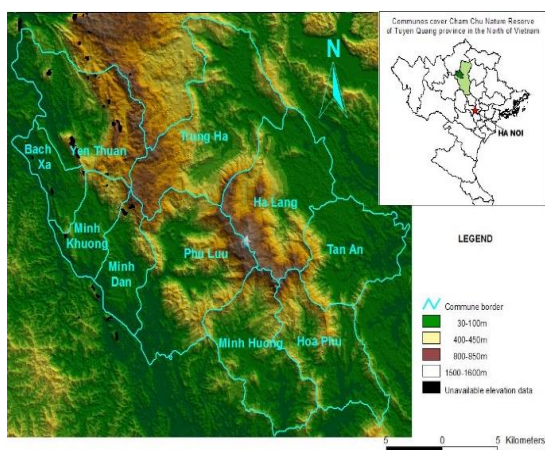


Figure 1. Communes including Phu Luu located in Cham Chu Nature Reserve, Tuyen Quang province in the North of Vietnam.

### 2.2. Research Approach

Vietnam is one of the 10 countries with the highest biodiversity in the world with about 10% of animals and plants [12, 13]. Biodiversity is the prosperity of life on earth, including plants, animals, and microorganisms, genes contained in species and extremely complex ecosystems that coexist in an environment. Biodiversity, ecosystems, ecosystem services and the quality of life of people are closely related. More specifically, biodiversity provides a wide range of goods and services to people (See Figure 2). In contrast, ecological conditions and biodiversity are also influenced by human and economic activities.

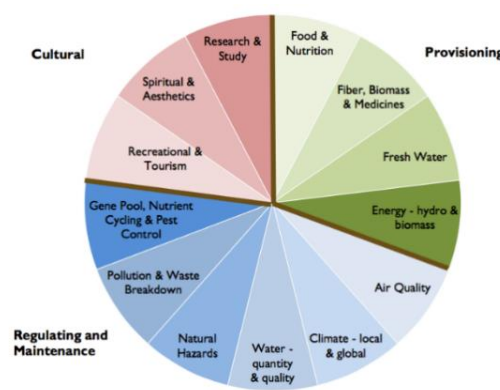


Figure 2. Examples of ecosystem services [14].

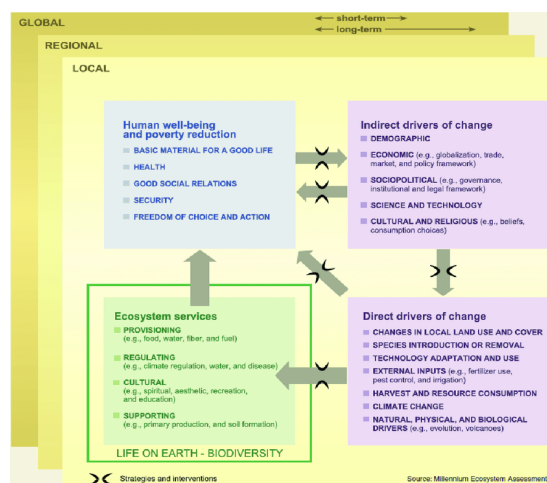


Figure 3. Biodiversity, Ecosystem Services, Human Well-being, and Drivers of Change [15].

The link between biodiversity and human well-being is described in detail in Figure 3. MEA (Millennium Ecosystem Assessment) shows that human prosperity is guaranteed through 5 key components [15]. These include basic physical needs, health, good social relations, protection and freedom of choice and operation. Human well-being is the result of many factors that are directly or indirectly related to ecosystem services and biodiversity.

On the other hand, since the late 1980s, biological resources in Vietnam have tended to become increasingly degraded, especially biological losses due to reduced forest cover from more than 43% in 1943 to below 23% in 1993 [16]. Biodiversity degradation comes from a variety of causes [17]. Agriculture is one of the main causes of direct biodiversity loss in Vietnam, but has not been thoroughly researched recently. Many of the current practices and approaches aimed at achieving high productivity have led to the simplification of the components of the agricultural system, reducing biodiversity and causing ecological instability. These include monoculture; eliminating inheritance or crop rotation; using many hybrids with high yield; oblivious to traditional varieties; more use of fertilizers and pesticides than mechanical or biological methods [16]. Although biodiversity is considered to be one of the indispensable goals in sustainable development programs [18], the relationship between biodiversity and human well-being has not been systematically studied [19]. Vietnam and especially in the limestone mountains of Northern Vietnam is not an exception. It is worth noting that studies evaluating the socio-economic efficiency combined with considering the impact of growing fruit trees on the environment in Vietnam are few and limited. Therefore, in order to better understand the economic efficiency and its impact on the ecosystem from fruit tree planting, this study focuses on assessing the impact of orange plantation on income and biodiversity conservation in the limestone areas of northern Vietnam through a case study in Nam Luong village, Phu Luu commune, Ham

Yen district, Tuyen Quang province located in the buffer zone of Cham Chu conservation area.

This study employed the Millennium Ecosystem Assessment Conceptual Framework of Interactions between Biodiversity, Ecosystem Services, Human Well-being, and Drivers of Change (Figure 3) to better understand the relationship between crop boom, ecosystem services, and human well-being in the region.

### 2.3. Data Collection Methods

#### *Secondary data collection*

Desk study was carried out. Those documents include articles, reports, decrees and policies related to economic development, community livelihoods, indigenous knowledge related to resource exploitation and use, and books on biodiversity conservation, policies on the management of natural resources, forest protection, environmental protection, community health in order to better understand the history of socio-economic development and agricultural commodity markets as well as their impact on the management and protection of domestic and international biodiversity resources.

#### *Field research*

The research team conducted fieldwork in Tuyen Quang Province, Cham Chu Nature Reserve, Ham Yen District and Phu Luu Commune from January to June 2019.

#### *Key informant interviews*

The research team interviewed key informants from provincial, district and commune levels. Key informants included officials from the Provincial Department of Agriculture and Rural Development, Department of Natural Resources and Environment, Forest Protection Sub-Department, Forest Protection and Development Fund; District Offices of Natural Resources and Environment; Agriculture and Rural Development; At the commune and village level Chairman of the Commune People's Committee, the Head of the Commune Women's Union, the Head of the Village, the Secretary of

the Village Party Cell and the Head of the Village Women's Union.

The interviews aimed to understand the socio-economic development, poverty reduction policies, natural resources and environment management policies, and the market for agricultural products. In the commune, the research team conducted the following interviews:

#### *Discussion groups*

Group discussions were conducted at the Village Cultural House with the participation of 12 people in the village with a full range of male, female, elderly and young people and involved in various occupations.

The main topic for discussion were:

- Key milestones leading to socio-economic changes of the village;
- Criteria for wealth ranking;
- Changes in ecosystem services and natural resources;

- Forest management and protection policy;
- What needs to be done to better manage, protect forests and conserve biodiversity.

#### *Household interviews*

Questionnaires were developed to collect data with regards to: i) Household demography: age, education level, household composition; ii) Income and expenditures; and iii) Issues related to natural resource exploitation, forest protection and biodiversity (Tables 1 and 2).

Random selection of households based on the list of all households in the village was carried out to select household for interviews. 51 out of 200 households from Tay ethnic group in Nam Luong village, Phu Luu commune, Ham Yen district, Tuyen Quang province were selected and interviewed. In case a selected household was not be able to participate in interview random selection of another household would be selected from the remaining unselected households.

Table 1. Information of the interviewed households

| Criteria            | Interviewee is household head |      | Gender |        | Household ranks |        |            |      |        |
|---------------------|-------------------------------|------|--------|--------|-----------------|--------|------------|------|--------|
|                     | Yes                           | No   | Male   | Female | Poor            | Middle | Better-off | Rich | Unknow |
| Number of household | 28                            | 23   | 37     | 14     | 10              | 30     | 9          | 1    | 1      |
| Percentage (%)      | 54.9                          | 45.1 | 72.5   | 27.5   | 19.6            | 58.8   | 17.6       | 2    | 2      |

Table 2. Key milestones of socio-economic development and natural resources of Phu Luu commune

| Year                 | Key activities  |
|----------------------|---|
| Before 2000          | The local people and state forest enterprises exploited timber to provide to people in the lowland (1970-1980);<br>Main livelihoods were swidden cultivation of rice, corn, cassava, timber logging and hunting.  |
| From 2000 to present | Orange plantation development and sold to the local middle men and Hanoi capital (2000);<br>Road to and from the village and the people's committee of the commune were expanded and upgraded. These provided favour condition to orange plantation and trade;<br>Price of orange was highly increased (2011-2016). However, it was decreased and the cost was high (2017-2018);<br>The main income sources in order from high to low since 2018 to date: Orange, Lemon, Pamelos, Livestock, Paddy, Services. |

(Source: Field research, 2019).

### 3. Research Results

#### 3.1. History of Socio-economic Development of Phu Luu Commune, Ham Yen District, Tuyen Quang Province

The results of focus group discussions regarding key milestones of socio-economic development, natural resource management of the commune were briefly presented in Table 2.

From 1970 to 1980: This was the transition period as the cooperatives were transferred into the market economy regime. All possessions and materials under this centralized planned economy planning regime were owned by the communities and under the management of the government. Nam Luong village's community mainly engaged in agriculture activity in this period. Natural resources were considered as national assets and all produced products were managed by the government in order to support Vietnam's wars as well as national improvements.

According to the elders in Nam Luong village, the government allowed a state forest enterprise to exploit timber at this village from 1970 s. As a tradition of Tay ethnic group, communities in this area used to exploit timber to build houses on stilts and use wood as household facilities. Numerous wooden houses are remained recently, which show significant evidence of free forest exploitation in the previous years. Forest exploitation occurred within a period of twenty-year and the accessibility for both forest company and communities were then banned in 1996.

From 1980 to 1990: Viet Nam Agricultural economy in general and Phu Luu in particular showed a remarkable step for breaking centralized mechanisms, bureaucracy in agricultural production. Important changes were clearly made at this stage, such as terms of ownership, management, and distribution relations bringing practical benefits to the farmer and stimulate production development. In the early 1980s, quality and productivity of agriculture were promoted significantly under Resolution No.100, which carried out a

dynamic rural market economy as well as a much larger volume of agricultural products as compared to previous years. Subsequently, Resolution No. 10 that was promulgated in April 1988 marked a great change in the agricultural economy. The major purpose was to increase the production and quality of agricultural products and ensure food security. Due to the crop rotation, agriculture soil was gradually degraded, leading to a decrease in productivity.

In Phu Luu Commune 1984, the Ham Yen District People's Committee decided to allow communities to cultivate crops in the areas that the forest company had exploited to increase more income sources. Such areas were cultivated with upland sticky rice and paddy. Although the yield was not high, it was sufficient to provide food source for local people.

The life of the Tay people in this commune had gradually improved, which demonstrated the efficiency of Government's Doi Moi policy in 1986. The greater rice productivities were obtained because local people started to apply science and technology to intensive cultivation, use fertilizers, pesticides, and plant new rice varieties such as Thai Binh, Huong Thom, etc. Other crops were also planted such as maize, cassava to serve for livestock farm and improve their livelihood.

From 1990 to 2000: Although living standards had been partly improved, poverty was still and most people did not even have adequate food for survival. This period was also the time for people to exploit forest products to solve the food shortage and expand the production area. Therefore, the exploitation and hunting in this period were always at a high level. In 1996, when the forest management policies were launched and tightened, people had no other options and must shift to cultivate perennial plants and *Sanh* orange was selected as their best option.

An elder revealed the history of orange trees in Nam Luong village as follows:

Since I was born, I had seen about 20 orange plants cultivated in the gardens of each family. People ate oranges and fling freely seeds outside and those seeds were grown into trees by itself.

In 1968, people studied the layerage methods of the Kinh people and Chinese. By 2006, people started to grow more and more orange plants. Besides Sanh orange variety, they also planted other variety including Vinh oranges, which is originated from Nghe An province. Vinh oranges were planted following the layering method and sold with a higher price than Sanh oranges. However, each house has a small number of planted Vinh oranges. In 2018, Vinh orange price was 8,000 VND/kg while Sanh orange was 5,000 VND/kg. The total area of oranges growing in the commune is about two or three hundred hectares, of which Vinh orange trees account for 20%.

The orange market has developed strongly and became a key agricultural crop for economic development in Ham Yen district since 2000.

From 2000 to date: In the early 2000s, the orange market in Ham Yen was relatively stable and brought more income for people. They gradually shifted to specialize in planting orange trees and being the main agricultural crop for income generation. In 2006, Ham Yen district developed a program which was called "Development of orange trees in the 2006 - 2010 period". This program aimed to advertise the brand of "Sanh orange of Ham Yen district" and introduce Sanh orange of Ham Yen district to domestic and foreign customers. After successfully constructing the Sanh orange brand in 2007, this has become more and more well known. The value and consumption rate of orange products have also greatly increased.

This is considered as "orange boom" period in the studied area. Because of the increasing value of orange trees, several households in Phu Luu commune have broken the law to encroach forest area and expand their orange farm. This phenomenon was called by local people as "Vén Rừng" or "Forest encroachment". This situation has occurred gradually and it is extremely difficult for forest rangers to control, resulting in the loss of a large area of natural forest.

In 2013, due to the implementation of the new Nationwide Rural Development Program, Phu Luu commune was invested to upgrade

roads from the village to the commune level. The roads were continued to expand in 2016 smoothing the transportation system and promote greater services for orange production and trade. The infrastructure had promoted the local economic development, production and quality of oranges in Phu Luu commune. It was also gradually asserted and developed massively. Oranges were most valuable in the period from 2011 to 2016, the value of oranges reached a high-profit level, becoming a brand and occupying a huge share in the consumer market. Sanh oranges have been planted all over Ham Yen district, Phu Luu commune has more than 2,500 ha with 130/200 engaged households. The yield was estimated at 140 quintals/ha and the average orange productivity of 45,000 tons/year. Currently, the average income per capita was 34 million/year, with the highest family income/year of up to 2 billion and the average profit of 200 million/year. Phu Luu has contributed to making the Ham Yen brand of Sanh orange become a "gold brand" and was honored to receive the title of "Vietnam Agricultural Gold Brand 2019" by the General Association of Agriculture and Rural Development. In addition, due to the market and aging orange tree utilization demands in recent years, people have also planted lemon trees in all seasons. Because lemon trees are relatively suitable for local soil conditions and its fast growth rate, Phu Luu commune has grown more than 80 hectares of four-season lemons with the average yield of about 30 tons/ha. The outstanding advantages of lemon tree are suitable for the local soil properties and low hill areas where oranges cannot be grown. The care investment is also simpler and it is harvested after 2 years of cultivation. Compared to other lemon cultivars, the four-season lemon produces fruit all year round and 5 to 6 times a year.

### 3.2. Orange Development and Local Livelihoods

Development of orange has improved the local livelihoods in Phu Luu commune. The

result from 51 households in Nam Luong village showed that the average income was about 161 million VND/household/year in 2018. Orange and Lemon productions accounted for 62% of the total average income of the households (Figure 4).

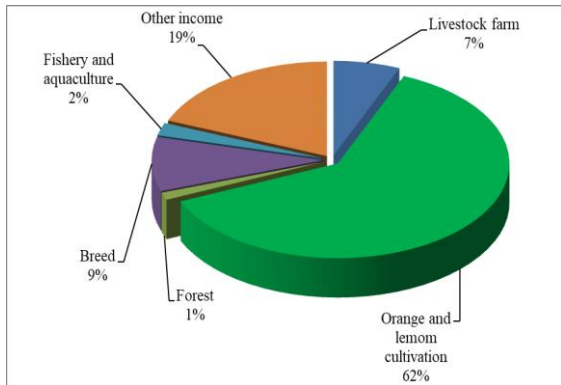


Figure 4. Household income and proportion of income sources in 2018 (Source: Field research, 2019).

The total turnover of all surveyed households from oranges in 2018 was 4,828,535,000 VND accounting for 95% while the turnovers from lemons and tangerines were only 155,100,000 (3%) and 53,200,000 VND (1%), respectively. Thus, oranges are still the principal crop and bring the highest turnover to the communities (Figure 5).

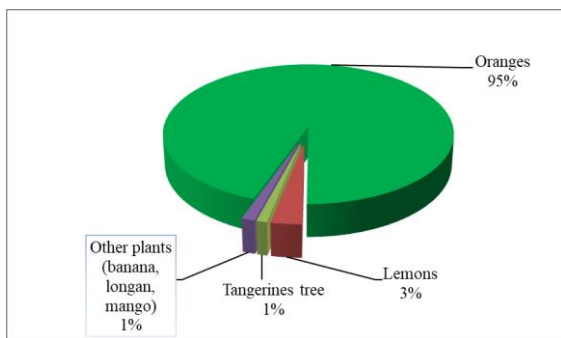


Figure 5. Turnover of fruits in 2018 (%) (Source: Field research, 2019).

Orange development has also made an important contribution to poverty reduction. Data analysis indicated that the poverty rate in

the study area has been reduced by half over the last ten years (See Figure 6).

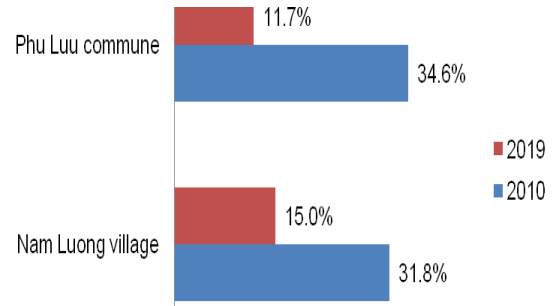


Figure 6. Poverty rate in the study area (Source: Field research, 2019).

### 3.3. Relationships between Agricultural Development, Forest Protection and Biodiversity Conservation

Crop boom and forest protection and biodiversity conservation

The development of orange cultivation from 2000 and lemon from 2014 to date has brought remarkable economic outcomes and reduced Tay community's dependency on forest resources in Phu Luu commune. Income from forest products accounted for only 1% of the average household income in 2018 (Figure 4). Results from key informant interviews and group discussions also show that the crop boom has significantly contributed to forest protection and biodiversity conservation.

A forest ranger of Phu Luu commune also revealed that: "Since orange plantation have been developed, communities have stopped encroaching, destroying, burning and exploiting resources on forest land. The number of violations is clearly decreased because income sources from orange and lemon stabilize and enhance their livelihoods".

Head of Yen Thuan district ranger station managing Cham Chu special-use forest emphasized that: "There are no animal traps in the forest at present and footprints in the forest are no longer seen. The number of



forest violations decreases and the quality of forests increases”.

The results of the group discussion also show that most people no longer go to the forest to harvest timber and collect non-timber forest products such as ginseng, wild tea, bamboo, and wild animals for sale since the 2000 s.

The violation cases tended to decrease sharply. The total number of violations has decreased from 66 in 2013 to 13 cases in 2017 (Figure 7).

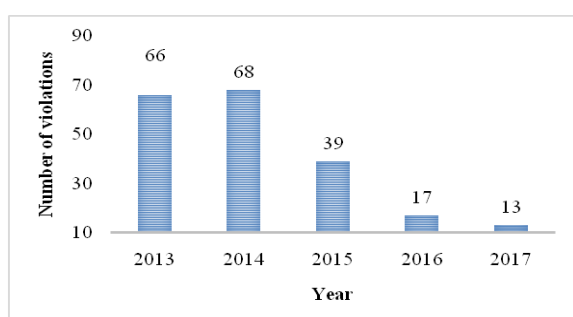


Figure 7. Number of violations of the Forest Protection and Development Laws in Cham Chu Nature Reserve from 2013 to 2017 [19].

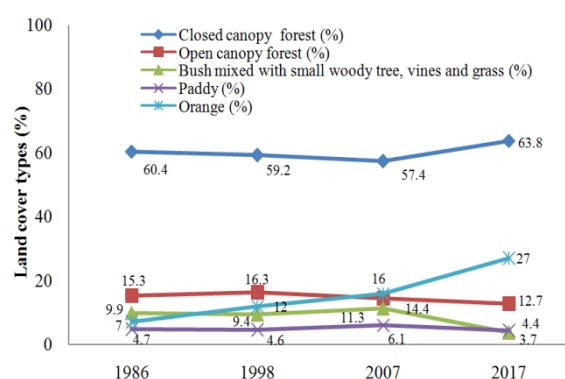


Figure 8. Land cover types of Cham Chu Nature Reserve Area between 1986 and 2017 [20-22].

The results from household interviews, key informant interviews, and group discussions about the positive roles of the crop boom on forest conservation is also confirmed by the land cover analysis of the area. As shown in Figure 8, in addition to the upward trend of the orange boom in Ham Yen district (from 7% in 1986 to

27% in 2017) [20-21], there has been an increasing trend of closed-canopy forest (60.4% in 1986 to 63.8% in 2017) and decrease trend of bush mixed with small woody tree, vines and grassland (9.9% to 3.7%) [22]. It should be noted that the bush mixed with small woody trees, vines and grassland cover type indicates the human impacts on the forest cover in the nature reserve.

#### Crop boom and ecosystem services

When the group discussions were conducted with households in Nam Luong village, the research team also focused on understanding changes in ecosystem services before and after the development of orange cultivation in the studied area. There were three types of services, including provisioning, regulating and maintenance, and cultural services. As presented in Table 3, before 2000, when orange trees were not developed, local people cleared forest for cultivation land and focused on harvesting mainly the provisioning service, including wood products for home construction, non-timber products such as firewood, forest vegetables, medicinal plants, hunting wild animals (pangolin, monkeys, deer, tigers, bears, wild pigs). This had led to a decline in the number of species. After the orange plantation took place and more recently lemon plantation, the harvesting of forest products has decreased.

Several reasons given by local communities include:

- The number of many plant and animal species has declined;
- Forest closure policy in 1996;
- People have gradually become aware of the roles of forests in maintaining soil fertility, limiting landslides, as well as providing opportunities for tourism and recreation;
- Income from orange and lemon trees has helped people improve their lives significantly, many people became rich thanks to these two main cash crops.

In general, the development of orange and lemon plantations has brought significant economic changes and local biodiversity

conservation. First, it could minimize the dependence of the people on the forest and reduce the exploitation of forest resources as well as the number of violations to the Law on Forest Protection and Development. On the other hand, the high income from oranges and lemons helped people not only overcome poverty but

also enriched themselves on the upland fields where they used to practice swidden cultivation. This is a key factor contributing to better forest protection in the area of Phu Luu commune because people have reduced impact on the forest. As a result, the forest area has been recovered and increased in the nature reserve.

Table 3. Ecological services provided to communities before and after 2000

| Ecological services  | Before 2000   | After 2000  |
|--|---|---|
| <i>Provision service:</i><br>- Firewood;<br>- Forest animals;<br>- Medical plants;<br>- Fish;<br>- Clean water;<br>- Food.<br>...  | Before 1983, clearing forests for cultivation land and timber was allowed;<br>- Firewood, banana body to feed pigs;<br>- Forest vegetables, ginseng, wooden houses, bamboo, medicinal plants to treat diseases such as: hemorrhoids (3 types of medicinal plants), diarrhea, colon, bones and joints, and aphthous stomatitis;<br>- Wild animals: pangolin, monkey, deer, tiger, bear, wild boar, civet, leopard, stream fish, shrimp, rock crab. | From 1996 to date:<br>- Less harvesting of forest resources;<br>- No more ginseng, forest tea, firewood from old orange trees;<br>- Forest animals become extinct due to over hunting (using guns). Fish, shrimps and crabs are few;<br>- People mainly focus on planting oranges, the exploitation activities in the forest are significantly reduced. |
| <i>Regulating and supporting services:</i><br>- Mitigate flood;<br>- Protect water sources;<br>- Pollination;<br>- Disease treatment;<br>- Soil formation;<br>- Nutrient regulation. | - Cooler weather and more water resources;<br>- Forest stimulate the soil's fertility.  | - Forest prevents landslides;<br>- Less water due to the expansion of production land and population development;<br>- Less insects, bees, butterflies. There are more harmful hybrid bees;<br>- Forest induce the soil's fertility.  |
| <i>Culture services:</i><br>- Tourism and entertainment;<br>- Indigenous knowledge;<br>- Education.  | - Did not use.  | - Enter small stream or river to chill and cool the body during hot days;<br>- Environmental education.   |

(Source: Field research, 2019).

#### 4. Discussion and Recommendations

Biodiversity, Ecosystem Services, Human Well-being, and Drivers of Change

By employing the framework on biodiversity, ecosystem services, human wellbeing, and drivers of change, this study clearly identifies the key factors and the trends in biodiversity conservation in the area. Although the government issued the decision on banning forest exploitation in 1996 the forest

cover had been still decreasing and the area of bush vegetation (under human impacts) had been increasing until 2007. The situation was reversed since the provincial policy on developing orange plantations during the 2000s (See Figure 8 above). Therefore, the crop boom (orange and lemon) is the key driver of change in forest protection and biodiversity conservation in the area.

This study shows that the crop boom (orange and lemon) has turned Tay ethnic communities

that were traditionally dependent on natural resources now becomes independent and less reliant on natural resources. This study also contributes to the field of agrarian change in Vietnam and Southeast Asia as well as the impact of agricultural development policies on nature conservation. In addition, the relationship between commodity agriculture and biodiversity conservation is also clarified. The policy of commodity agriculture development of Tuyen Quang province in the 2000s brought positive effects on socio-economic development and remarkable changes in protecting forest and nature conservation.

The research results also show that only when forests are protected and developed, ecosystem services such as provisioning, regulation and maintenance services, and cultural services as mentioned in this article are provided, thus making a positive contribution to the cultivation of oranges and lemons, contributing to increased income for local people. In other words, only when forests are protected and biodiversity is preserved will the prosperity of the people be maintained. The “conservation of conservation” approach has also often considered communities living near or in national parks and nature reserves as a major threat to biodiversity. Relocation of communities, therefore, out of the “protected” boundary to protect natural resources is often a priority for policies to promote conservation in Vietnam.

However, it has been proven that many resettlement projects for communities in national parks and nature reserves have failed to prevent dependence and impact on natural resources. The research results of this study have shown that not every community living near forests is highly dependent on forest resources and also a threat to biodiversity. The findings also show that the dependence and impact of the Tay community on the natural resources of the Cham Chu Nature Reserve are negligible. Therefore, recognizing the different levels of dependence and impacts of different ethnic communities on natural resources is very important in the development of appropriate

policies or interventions to bring about effective biodiversity conservation.

Research on the value chain of orange trees in Tuyen Quang province shows that the value chain has not really developed because most of the oranges after being harvested are concentrated for consumption in the domestic market and the linkage between various actors in the chain is not deep and effective [23]. In addition, according to data analysis, the majority of the people interviewed proposed technical assistance, market development, and post-harvest technology application. The research results also show that brand and market development for orange products in Phu Luu commune and Ham Yen district has not been promoted, especially not associated with biodiversity conservation benefits and images that orange trees bring.

Therefore, there is a need for more in-depth studies on the benefits that agricultural products, which are in this case orange - provide local communities with both economic and biodiversity conservation benefits. This is a great potential for development. The evidence shows the positive impacts that the development of commodity agriculture brings about local conservation.

Therefore, there is a need for more in-depth studies on the benefits that agricultural products - in the case of Phu Luu is orange that brings local communities both economical well as biodiversity conservation benefits. This is the hard evidence to demonstrate positive effects that the development of commodity agriculture has brought about for conservation at the local level.

Countries around the world and Vietnam tend to promote agricultural brands with environmentally friendly cultivation processes, product traceability as well as biodiversity conservation value. Certification of products, such as coffee and cocoa grown in an environmentally friendly and sustainable manner, has been applied in many countries around the world [24]. Many projects in Vietnam are also linking agricultural brands with biodiversity conservation images to both raise public awareness of conservation and increase

agricultural value. Beekeeping in the mangroves in Xuan Thuy National Park, Nam Dinh is a typical example.

## 5. Conclusion

The case study of Phu Luu points out that the development of commodity agriculture has had a positive impact on forest protection and biodiversity conservation in the community in the buffer zone of Cham Chu Nature Reserve. Orange trees have helped people to increase their income and this is the reason why their dependence on forests is reduced to a minimum. The exploitation of forest resources as well as the number of forest encroachment thus decreased significantly. Forest cover is maintained and biodiversity is preserved.

The research results have shown that not every community living near the forest is highly dependent on forest resources and also a threat to biodiversity. Therefore, to develop appropriate policies or interventions for biodiversity conservation, it is necessary to assess the degree of dependence of different ethnic communities on natural resources.

## 6. Recommendations

Based on the above research results, we have made a number of recommendations to promote the biodiversity conservation associated with the development of commodity agriculture in the northern mountainous areas of Vietnam as follows:

- Biodiversity conservation policies should pay attention to the differences in agricultural products typical of ethnic communities living near forests, protected areas and national parks to produce development policies as well as develop appropriate conservation solutions.

- There should be technical support policies to help local communities develop value chains, develop brands and markets, as well as post-harvest technologies for agricultural products associated with the nature conservation image at the local level.

- Further research on the roles and impacts of different ethnic communities on biodiversity in the karst areas of Vietnam is needed to provide an overall picture of the linkages between economic development and nature conservation.

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