

## **Assessing the Environmental Status and Proposing Measures to Improve Environmental Protection Effectiveness In Mushroom Growing Areas of Dinh Quan District – Dong Nai Province**

*Nguyen Vinh Quy, Duy Thuong*

- Faculty of Environment and Natural Resources, Nong Lam University –HCMC – Vietnam; Tran Bao
- Department of Natural Resources & Environment – Dinh Quan district – Dong Nai province:  
Corresponding Author: Nguyen Vinh Quy

---

**Abstract:** Currently, Viet Nam is one of the developing countries which have fastest economic growth rate in the world. Contribution to the mariculous development, there is agriculture in general, and mushroom cultivation in part. However, along with the development of the mushroom cultivation, there are some environmental problems generated and the status in the Dinh Quan district, Dong Nai province is not exceptional. In order to understanding the environmental actualities in the mushroom area of the Dinh Quan district and hence proposing appropriate measures to improve environmental protection effectiveness in the region, there need to have a systematic and scientific research addressing the issues, and this is the main reasons for implementation of the research. During the research implementation, various methods such as: collection of data and information; people's survey; taking samples of water, air and soil for analysing; etc, have been applied. The results gained from the research implementation showed that: environment in the area is still not polluted, but it has signs of pollution; awareness of the mushroom growers on the environment and the relationship between the environmental quality and human health is quite low, hence the mushroom growers do not pay much attention to the surrounding environment; and the efficiency of the environmental protection in the area is not high as it is expected although environmental management in Dinh Quan district has been concerned and there is the coordination between the state management agencies and local authorities. The research has also proposed some measures and applicatind these measures could improve the efficiency of environmental protection activity in the studied region.

**Keywords:** Mushroom cultivation, sawdust, substrate, Dinh Quan district, pollution, improvement

---

Date of Submission: 05-03-2018

Date of acceptance: 26-03-2018

---

### **I. Introduction**

The Dinh Quan distric is one of the mountainous districts of Dong Nai province and contributes a lot to the socio-economic development of the Dong Nai province. In the district, agricultural production plays a key role in the local economy. With the goal of sustainable agricultural development, the district has applied many tools and mechanisms in agricultural production such as: applying advanced science and technology; studying and choosing different types of agricultural production which is suitable for the condition of the region; and selecting and using types of plant suitable to the local natural conditions. Among the agricultural production of the district, mushroom growing for the purpose of food and foodstuffs is considered one of the most economically and environmentally advantageous crops because mushroom growing not only provides various types of products to people but also uses agricultural waste as a source of raw materials for production.

The mushroom production in the Dinh Quan district is small and dispersed, majority of the production are households and individuals that reside in the region. The mushroom production units are not concentrated in one place and scatteredly distributed in all over the communes of the district such as Suoi Nho, Thanh Son, Gia Canh, Phu Tan. The largest mushroom growing area, with the participation of hundreds of households and individuals, is concentrated in Suoi Nho Commune which is formed a mushroom growing area called craft mushroom cultivation village of the Dinh Quan district. It cannot be denied that the craft mushroom cultivation village has brought about many economic and social effects for the locality, but in the production process the village has also caused some problems affecting the surrounding environment. Therefore, it is necessary to have a scientific and systematic study on status of mushroom growing in the region as well as the environmental issues generated from that activity, thenceforward proposing measures to improve environmental protection effectiveness in the craft mushroom growing village, and it is the main reason for the research "Assessing the environmental status and proposing measures to improve environmental protection effectiveness in mushroom growing areas of Dinh Quan district – Dong Nai province" has been implemented.

## II. Literature Review

### a. Overview of fungi and mushroom cultivation

#### i. Concepts of fungi and mushroom

In Vietnam, the word “fungi/mushrooms” have been widely and changeably used by people not only in spoken but also in writing language when they refer to the group of organisms which may be in the form of yeast, molds or small plants, animals,..Therefore, it leads to, in some cases, misunderstanding in communication, even in some formal documents. In order to more clearly understanding about ‘fungi’ and ‘mushroom’ it needs to address to concepts of fungi and mushroom.

According to Wikipedia, (2018), fungus is any member of the group of *eukaryotic* organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms. A mushroom, or toadstool, is the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground on soil or on its foodsource, the word ‘Mushroom’ also describes a variety of other gilled fungi, with or without stems. However, for the purposes of this study, the concept of mushroom or the word "mushroom" refers to the cultivated white button mushroom or those fungi that have a stem, a cap, and gills on the underside of the cap.

Depending on the characteristics and purpose of each type of the mushroom, it can be divided into 03 types as: food mushrooms - the non-toxic mushrooms with high nutritional value and used by humans for food and foodstuff; medicinal mushrooms – the mushroom that have both nutritional and therapeutic characteristics; and toxic mushrooms – the mushroom contains many toxins that can harm the health of humans and organisms

#### ii. Mushroom cultivation

The role and value of mushroom has been known for thousands of years. In prehistoric times, people have studied the characteristics of mushrooms and use it as food and medicine in daily life. At first, mushrooms are used by humans through direct collection method in nature. However, this manual collection does not meet the needs of the society. Therefore, in order to satisfy people’s increasingly demands, mushroom cultivation is being generated and developed.

Mushroom cultivation first appeared in Eastern countries such as China, Japan, Thailand, ... and then expanded to countries in the West. Despite mushroom has been used by Vietnamese people long time ago, and it has also been traditionally and individually cultivated in the past centuries. However, mushroom cultivation in Vietnam was officially started and developed from the 70s of the 20th century with the following development stages as: in 1984, establishing and developing edible mushroom industry which has operated under the management of Ha Noi University; in 1985, with the help of Food and Agriculture Organization (FAO) by financing, the People's Committee of Hanoi decided to set up the seed production center of Tuong Mai – Hanoi; and in 1986, FAO funded Ho Chi Minh City People's Committee to establish Ho Chi Minh City Mushroom Enterprise. Along with the period, there were also other units such as Thanh Binh Mushroom Company (Thai Binh Province); Mushroom Enterprise (belonging to Vegetexco Vegetable Corporation); Mushroom Production and Processing Joint Venture Company in the South Meko Company in Can Tho, Da Lat ...), been established and started to operate. Since 1990, mushroom production has been seen as a highly productive sector that has attracted many people. The main species of mushrooms that are produced in the southern farms are oysters and straw mushrooms, while in the north they are such as agaric mushrooms, cat’s ear mushrooms and lingzhi mushrooms. Over the past years, annual production, in general, has reached about 1,500 tons of fresh mushrooms. The main mushroom production areas in Vietnam are Nam Dinh, Ninh Binh, Thai Binh, Hung Yen, Ha Nam. the Red River Delta, Dong Thap, Soc Trang, Tay Ninh and Dong Nai. And Long Khanh district of Dong Nai province is main area of cultivating and producing the mushrooms.

### b. Environmental issues generated from mushroom cultivation

In the process of mushroom cultivation, many agricultural wastes such as sawdust, straw, and so on, have been utilised as input materials, it not only reduces the cost of raw material inputs, but also limits the amount of harmful emissions to the environment if these wastes need to handle. The fact show that mushroom cultivation is one of the solutions that do not waste materials and also reduces the pollution of the air, the impact on human health, etc. However, in the process of growing mushrooms, there are also some problems affecting the surrounding environment. The environmental problems generated mushroom cultivation may be: in the areas where regular and continuous mushroom growing takes place, some pollutants may be generated, increasing the concentration of substances in the air, such as CO<sub>2</sub>, CO, as well as fungal dust, these pollutants could affect the environment and the health of the people in the production area; in the area of intensive mushroom cultivation, some harmful spores may be generated, it could enter human lungs through inhalation and affect would affect respiration, causing diseases such as respiratory failure or inflammation; and during mushroom cultivation, a large volume of plastics, which are used as bags for various materials, have been released into the environment and handling these wastes is very difficult and expensive.

### III. Contents And Methods of The Research

#### a. Research contents

The main objective of the research is to assessing the environmental status of the mushroom growing areas in Dinh Quan district, Dong Nai province, and proposing measures to improve the environmental protection effectiveness of the studied region. In order to gain the given objectives, the research focuses on the following contents: studying and assessing the actuality of mushroom growing activities in the Dinh Quan district; assessing the current status of the environment in the growing mushroom areas of the region; assessing activities and effectiveness of environmental management in the studied area; and thence proposing measures to improve environmental protection effectiveness.

#### b. Research methods

During the research implementation, a number of various methods have been used, the methods using in the research process include: method of collecting secondary information; collecting and analysing samples of soil, groundwater and air samples in the studied area; participatory public assessment; and comparing the quality of environmental components in the studied area based on the current environmental regulations of Viet Nam. The number of stakeholders selected to conduct survey have been calculated by the the formula of Yamane (1973), as follows:  $n = N * (1 + Ne^2)^{-1}$ . As total number of households residing and growing mushroom in the studied area in turn is about 3,362 and 250, the level of error selected, respectively 10% and 5% for each objectives surveyed. So, the number of households growing mushroom selected for the survey would be 153 ( $n = 153$ ) and about 97 ( $n = 97$ ) households representative of no growing mushroom group were survyed. There have 05 ground water samples and 05 air samples been selected by randoon simple and random stratified sampling, and 03 soil samples have been taken to analyse pollution parameters. In order to assess the reduction of greenhouse gases (GHG) due to utilising strawdust as input materials in mushroom growing process, the authors have used the formula:  $E_i = Q_{st} \times EF_i \times F_{CO}$ , where:  $E_i$  is the volume of i-emission released into the environment (ton);  $Q_{st}$  is quantity of strawdust or sawdust used (ton);  $EF_i$  is emission coefficient of i-exhaust gas (ton/TJ); and  $F_{CO}$  is conversion rate of i- exhaust gas (%).

The equipments and materials which have been used in the research implementation are: motorcycles used for transportation; bags, buckets and 2 liters plastic cans, rulers and balance, these are used to measure samples collected during the study; maps and GPS are used to identify routes and location of households that need to be surveyed in the studied area.

### IV. Results and Discussion

#### a. The current status of mushroom production in Dinh Quan district

##### i. Generalisation of mushroom production subjects in the studied region

The mushroom production, including both growing and processing, in Dinh Quan district is small scale, mainly production households or individuals. The households and individuals usually use the land area for both living and producing mushrooms. Area of mushroom production of households varies on average from 1,000 m<sup>2</sup> to 2,000 m<sup>2</sup>, in some cases it could be about 5,000 m<sup>2</sup>- 10,000 m<sup>2</sup>. The mushroom production facilities or farms are not concentrated in one area and scattered all over the commune. Especially, some production establishments are located in residential areas of high desity, and it is one of the envrimental and social-economic issues impeding the local development. According to the data gained from the research implementation, there are about 250 households growing mushrooms with 1,600 mushroom farms, of which 241 growing mushroom households concentrate in Suoi Nho commune and distributing in 7 hamlets of the commune, and the rest scatterly distribute in other communes in the district. Detailed information on the number of households, mushroom farms in the hamlets of the Suoi Nho commune is presented in table 4.1

Table 4.1: Numbers of growing mushroom households and mushroom farms in the hamlets of the studied area

No.	Name of hamlets	Number of households	Number of farms
01	Hamlet - 1	35	223
02	Hamlet - 2	12	80
03	Hamlet - 3	120	704
04	Hamlet - 4	38	264
05	Hamlet - 5	16	152
06	Hamlet - 6	5	57
07	Market Hamlet	15	120
<b>Total</b>		<b>241</b>	<b>1.600</b>

From the data presented in the table 4.1 above, it can be seen that number of households and farms related to mushroom production concentrate mainly in the hamlet 1, hamlet 3 and hamlet 4 and the biggest number is in hamlet 3; the lowest number of mushroom production housholds and mushroom farms is in hamlet 6.

**ii. Materials and mushroom production process in the studied area**

The materials using in mushroom cultivation in the studied mainly are rubber timber sawdust, fungal inoculum (spawn), lime, fertilisers, pesticides, herbicides, plastic bags and wires, and pressure – cookers. All of the materials and equipments using in the mushroom production process have been got in the Long Khanh town of Dong Nai province. The mushroom production in Dinh Quan district is still by the handicraft production method, the households are not interested in investing in material facilities and techniques for the production.

**b. Environmental status in the mushroom growing areas of the Dinh Quan district**

**i. Status of the water environment**

Although mushroom cultivation does not require the use of much water and in put materials like other crops, it is, however, a very important factor contributing to spore mold growth is potential of hydrogen (pH). Suitable environment for growth of spore molds is neutral medium (pH = 7), with the medium environment, fungus would well grows and absorbs nutrients through water. Thus, the assessment of water quality in the mushroom growing area will be the basis for evaluating the effectiveness of mushroom production as well as the quality of the environment in and around the production area. In order to assess quality of groundwater in the studied area, the research has taken 06 ground water samples from the wells in 06 hamlets of the studied region and the results of analysing characteristics of the water are presented in the table 4.2 below.

Table 4.2. Results of analysing water quality in mushroom growing area

No.	Parameters	Hamlet 3		Market-Hamlet	Hamlet- 1	Hamlet- 2	Hamlet- 4	Reg. 09-MT 2015/Monre
		S.W-1	S.W-2	S.W-3	S.W-4	S.W-5	S.W-6	
01	pH	6,36	6,86	6,86	6,71	7,33	6,86	5,5 - 8,5
02	Màu (Pt-Co)	5	10	6	8	4	3	-
03	CaCO <sub>3</sub> (mg/l)	86	126	93	56	93,2	84	500
04	TDS (mg/l)	154	257	226	257	167	226	1.500
05	Cl <sup>-</sup> (mg/l)	18,9	10,4	16,8	16,5	22,5	10,3	250
06	F <sup>-</sup> (mg/l)	0,36	0,62	0,21	0,23	0,096	0,29	1
07	NO <sub>3</sub> <sup>-</sup> (mg/l)	2,1	1,84	1,69	3,6	0,64	0,54	15
08	SO <sub>4</sub> <sup>2-</sup> (mg/l)	10,4	11,2	15,7	10,5	34,6	5,8	400
09	Fe (mg/l)	0,36	0,25	0,83	2,6	3,7	2,3	5
10	Pb (mg/l)	ND	ND	ND	ND	ND	ND	0,01
11	Zn (mg/l)	0,05	ND	ND	0,063	ND	0,067	3
12	Mn (mg/l)	0,11	0,11	0,27	0,54	0,56	0,22	0,5
13	Hg (mg/l)	ND	ND	ND	ND	ND	ND	0,001
14	Ecoli (MPN/100ml)	ND	ND	ND	ND	ND	ND	-

ND- Not detected

The results of analysis of parameters in ground water of the mushroom growing area showed that most of the parameters have value not exceeding allowed limit of Viet Nam groundwater regulations. Especially parameters such as Pb, Zn, Hg, Ecoli are not detected or detected with very low value compared to the regulation. This is a sigh showing quality of the groundwater in the mushroom production area is good and still affected by the mushroom production activity. However, quality of groundwater in the hamlets is not the same, in some samples analysed the pH is slightly higher than optimal level requiring for fungus growth.

**ii. Air environment**

In order to assess quality of the air environment in the mushroom growing area of the studied region, the research has performed surveying and taking 05 air samples in the households of 04 hamlets for analysing; the air samples taken are signed A1, A2, A3, A4, and A5; the hamlets in which the air samples taken names after Hamlet 1, Hamlet 2, Hamlet 3 and Market Hamlet (M.hamlet). For the purpose of ensuring effective analysis and evaluation of the environmental quality, the air samples collected were concentrated mainly in the medium-sized mushroom growing households, and at the time of the operation of the boiler; the parameters analysed include: Noise, Dust, CO, NO<sub>2</sub>, SO<sub>2</sub> and THC. Results of analysing air quality of the air samples taken in the studied area are presented in the table 4.3 below.

Table 4.3. Results of analysing air quality in mushroom growing area

Location	Samples	Parameters					
		Noise (dBA)	Dust (mg/m <sup>3</sup> )	CO (mg/m <sup>3</sup> )	NO <sub>2</sub> (mg/m <sup>3</sup> )	SO <sub>2</sub> (mg/m <sup>3</sup> )	THC (mg/m <sup>3</sup> )
1/ Hamlet 3	A 1	46,7 - 50,3	0,280	5,7	0,042	0,067	5,3

2/ Hamlet 3	A 2	43,7 - 50,2	0,261	5,6	0,048	0,079	2,1
3/ M.hamlet	A 3	52,1 - 53,7	0,250	5,5	0,041	0,069	3,1
4/ Hamlet 1	A 4	52,1 - 61,3	0,271	5,8	0,045	0,070	4,9
5/ Hamlet 2	A 5	46,8 - 69,4	0,282	5,7	0,048	0,073	4,7
Reg.26:2010/Monre		6h – 21h: 70 21h – 6h: 55					
Reg. 05:2013/Monre			0,3	30	0,2	0,35	5

From the data presented in the table 4.3, it can be seen that most air parameters of the samples analysed are within the limit of Viet Nam ambient environmental regulations; the THC – parameter of some samples analysed is asymptotic or slightly higher compared with the Viet Nam ambient environmental regulation: THC in the sample A1 taken in the hamlet 3 is slightly higher; THC in the samples A4 and A5 taken in the hamlet 1 and 2 are asymptotic to maximum value of the regulation. The investigation also showed that in the production of fungus there are many sources of noise contributed the noise pollution of the production area, the sources could be conversations of mushroom producers, noise from transportation of mushroom growing materials, etc. However, the largest source of the noise is the operation of the sawdust sieve – machine: in average, the sawdust sieve – machine operates about 35 minutes for 01 ton of sawdust.

### iii. Solid waste

Despite the mushroom producers in the studied area use waste from activities of agriculture and forestry as material input in some production process that, in general, lead to reducing volume of solid waste generated in the socio – economic development in the region. However, after the mushroom process is completed, there is a quantity of solid waste also remained which affect the surrounding environment. In fact, mushroom cultivation in the studied area has two main kinds of solid waste: nylon bags, nylon strings and residues of mushroom after harvesting, the households in the area have handled the solid waste by reuse or recycle: for nylon bags, nylon strings, the majority of households handle them by selling them for recycling (98.68%); for the fungal residue, depending on the characteristics of each mushroom that have different treatment methods; and the fertilizer residues on the substrate will be recycled by the households to recycle straw mushrooms, and so on. However, during the collection of solid waste for reuse or selling to waste recyclers, the households place the waste vacancies in the mushroom production area or litter the waste without cover material, the duration of the gathering takes place from 3 to 5 days and this causes the garbage accumulation encroaching on the production land. All of this has affected the surrounding environment and communities living near the mushroom production facilities

### iv. Land environment

During the research implementation there were 04 soil samples taken in 04 hamlets for analysing such parameters as: pH<sub>KCL</sub>, Zn, Cu, Mn, Fe, OC and Diazinon; The analysis results would then be compared with the national technical regulations on the allowable limits of heavy metals and pesticide residues in the soil (Reg. 15-En.:2008/Monre, Reg. 03-En.:2015/Monre). The results of analysing the soil samples are presented in the table 4.4.

Table 4.4: Results of analysing soil sample in mushroom growing area

No	Parameters	Sample symbol and sampling location				Reg.15-En.:2008/Monre	Reg.15-En.:2008/Monre
		S-1/H.1	S-2/m.H	S-3/H.3	S-4/H.2		
01	pH <sub>KCL</sub>	5,18	5,01	4,67	4,69	-	-
02	Zn (mg/Kg)	80,8	82	85,9	87	-	200
03	Cu (mg/Kg)	58,8	72,6	65,8	66,2	-	100
04	Mn (mg/Kg)	1.689	1.104	1.268	1.010	-	-
05	Fe (%)	32,2	30,6	27,6	37,9	-	-
06	OC (%)	1,46	1,98	1,78	1,63	-	-
07	Diazinon mg/Kg)	<0,03	<0,03	<0,03	<0,03	0,05	-

**Notes:** S-1/H.1 – Sample taken in the hamlet 1; S-2/m.H – Sample taken in the market hamlet; S-3/H.3 – Sample taken in the hamlet 3; and S-4 – sample taken in the hamlet 2.  
(-) Not regulated

Based on the data presented in the table 3.6 above, it can be seen that the soil in the growing area of the studied region is still not contaminated and all parameters of the soil samples are not exceeded the limits of the regulation.

### c. Actuality and effectiveness of environmental protection in the areas

#### i. Organizational structure of environmental protection system in the areas of the district

The results of the survey implementing during the research period showed that the organizational structure of the environmental protection system in Dinh Quan district is currently composed of: the Division of Natural Resources and Environment, it is the specialized agency operating under the People's Committee of the Dinh Quan district and has responsibility for managing, guiding, inspecting ... communes and towns in the district on environment and natural resources within their area; the People's Committee of the commune does not have a dedicated environmental unit, but there is one environmental officer helping the people's committee of the commune on environmental protection; and each hamlet of commune has established a group, called 'Self Environmental Management Group/SEMG', which is responsible for managing environment in their hamlet, each SEMG has 5 or 6 members. The organizational structure of environmental management system in Dinh Quan district is shown in figure 4.1 below.

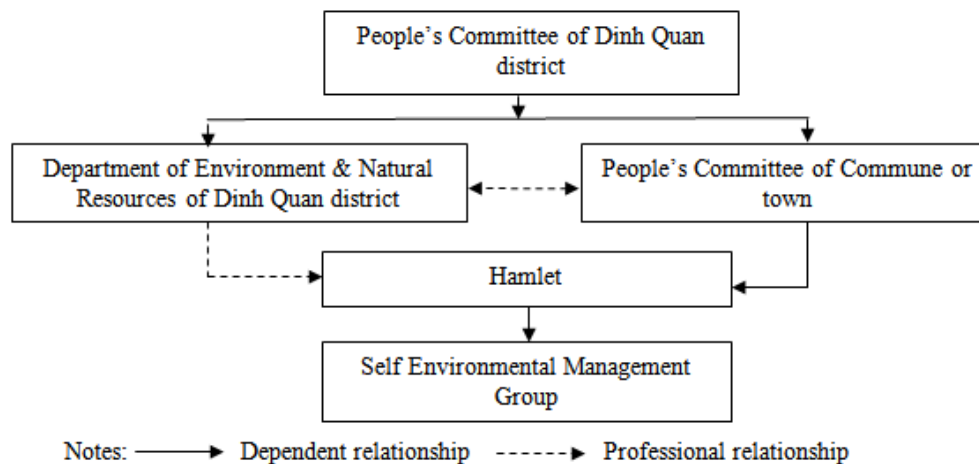


Figure 4.1: Scheme of administration of environmental management system in Dinh Quan district

ii. **The status of environmental protection activities in the areas of the district**

In order to increasing effectiveness of mushroom cultivation and reducing its impact on the environment in the studied area, there are such activities as: disseminating legal documents regarding environmental protection to hamlets in the region; providing technical guidance on planting mushrooms and mushroom cultivation knowledge for non-experienced households; propagating and raising awareness of environmental protection for mushroom growing households; regularly checking compliance with environmental protection of the mushroom producers; organizing training courses on efficient use of fuel and energy, especially cyclical and reuse measures of raw materials and fuels; organizing seminars to disseminate experience on mushroom growing as well as environmental protection among the mushroom households; establishing an environmental self-management group in each hamlet; and supporting, in the capacity of the district management agency, finance for environmental investments for mushroom growing households in the area. Despite the activities and solutions which have been mentioned have been applied, however, efficiency of the environmental protection is not as high as requirements, there is some environmental issue still remained.

d. **Analysing and evaluating the causes of pollution and proposing measures to improve environmental protection effectiveness in the studied areas.**

i. **General assessment of causes of environmental pollution in the areas**

The results gained from the research implementation have showed that quality of the environment in the studied region is reducing in general because many reasons: social – economic development; transportation; livelihood activities of the local people; trade-service activities; and so on, however, the research results also showed that there are three main groups of reasons leading to reducing environmental quality in the studied area, that are: Using machinery and equipment during mushroom cultivation; using chemicals and handling chemical containers after use; and environmental awareness of the local community.

1. **Using machinery and equipment during mushroom cultivation**

In the studied area, the mushroom growers use boilers to sterilize the bags putted on the substrate, fuels used for boilers in mushroom cultivation in the region are mainly firewood. Each time of operating boiler lasts about 4.5 hours with temperature remained about 100°C. Therefore, the main source of pollutant emission generated is from operating boilers. In addition, most of the boilers are domestic and low quality, with average life

expectancy about 08 years as mentioned in catalogue of the boiler's producers; majority of households use boilers that are overdue of use and inappropriate to present requirements regarding environmental protection; and the households use the boilers to support steam in sterising bags not at certain time, they operate boilers any time of day. All of this leads to pollution of the environment of the mushroom growing area, especillay at peak hours.

## 2. Generation of greenhouse gases

The results gained from the research implementation showed that main source polluting the environment in the mushroom growing area of the studied region is the emission from boilers' operation and the contaminants of the boiler's exhaust include ash, CO, CO<sub>2</sub> and etc. Therefore, based on the quantity of fuel using for the boiler's combustion, it can be calculated the volume of such greenhouse gases as CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> generated. According to the statistical data of the Dinh Quan People's Committee (2016) and the results gained from the research implementation, total production of fresh mushroom produced in 2016 was about 493,127 kg; in the process of producing 493,127 kg of fresh mushroom, about 2,958.762 kg of moisture sawdust and 1,972.51 m<sup>3</sup> of firewood had been consumed. By using the emission coefficients and conversion coefficients (N<sub>2</sub>O and CH<sub>4</sub> into CO<sub>2</sub>) of exaust cited in IPCC (2006) and the volume of firewood used, the total of the greenhouse gases generated from using 1,972.51 m<sup>3</sup> of firewood was equivalent to 1,994.94 ton of CO<sub>2</sub>.

## 3. Using chemicals and handling chemical containers after use

In process of mushroom cultivation, some kinds of pesticides, herbicides as well as other chemicals have been used for the purpose of preventing insects and pests; decontaminating mushroom farms; and preventing fungal diseases. In order to have basic for assessing the chemical use of mushroom growres, the research has taken survey about knowlegde as well as the way the drugs have been used in the mushroom production. The results of the survey, which are presented in the figure 4.2, showed that using the chemicals of the households is mainly based on personal experience and very few households follow intrsuction of the drug sellers or state officers responsible for agricultural and environmental management. According to the results gaining from the surveys, there are about 76% of the households using the drugs based on their experienes; 20% of the surveyed households use the chemicals as instruction of the drug sellers; and only 4% of the surveyed households use drugs under the guidance of managers, this shows that the households are still not clear about how to effectively use the chemicals and the limitations that could be generated from the drug use.

Handling the waste (chemical containers, packings and wrapping) after use is one of the the reasons leading to environmental pollution, especially burning chemical wrappings and packings without temperature control could generate many toxic substances to the environment. The surveys also revealed that most of the households treat the chemical wrappings and packings by direct burning, with 86.3% of the interviewees use burning method in handling this kind of waste.

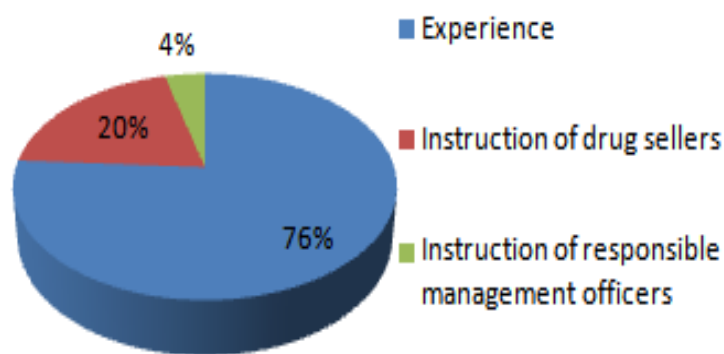


Figure 4.2: The way of chemical use of mushroom growers

In many cases, due to poor setting and calculating amount of chemicals for each mushroom growing season there are some the chemicals left unused and remained for the next mushroom growing season. The surveyed results of the research showed that there is about 90.6% of the unused chemicals kept at the production area without protecting and shielding tools. With such method of keeping the chemicals lead to leaking and spreading the chemicals into the environment and pollute environment as well.

**4.4.1.3. Awareness of mushroom growing people on environmental protection**

The results of surveying 150 households of mushroom growing in the studied area, that are presented in the figure 4.3, showed that knowledge and awareness of the people on the environment very low, especially unmindfulness of the environment. The surveyed results regarding awareness of people on role of the environment are: among the interviewee there is only 1% recognising the environment as important; few households know about role of the environmenty, with 4% of the interviewee recognising the environment is very important; the same ratio (4%) of the interviewee assessed the environment as not important to them; with 24% interviewee assessed the environment as less important; and about 67% of the mushroom growing people are not interested in the role and the importance of the environment.

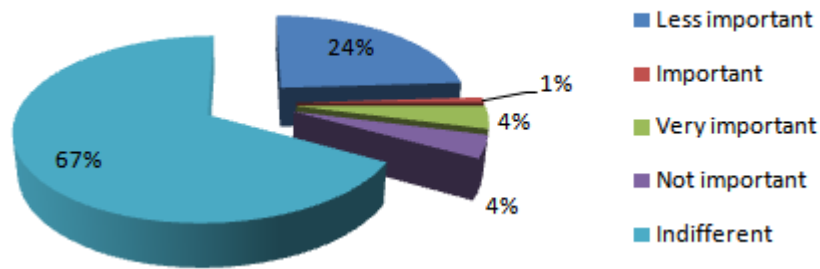


Figure 4.3: Awareness of local people on role of the environment In addition, the research survey related to opinions of the mushroom growers about the relationship between quality of the environment and human health that: 50% of households are not interested in the current state of the environmental components (land, water, air); for the relationship between the environment and human health, most households are not interested in this relationship with 68% of interviewee answered ‘not interested’, and 32% of the interviewees thought the current environment will not affect health and production capacity of the households regarding mushroom cultivation. The results of the survey are illustrated in the figure 4.4 below

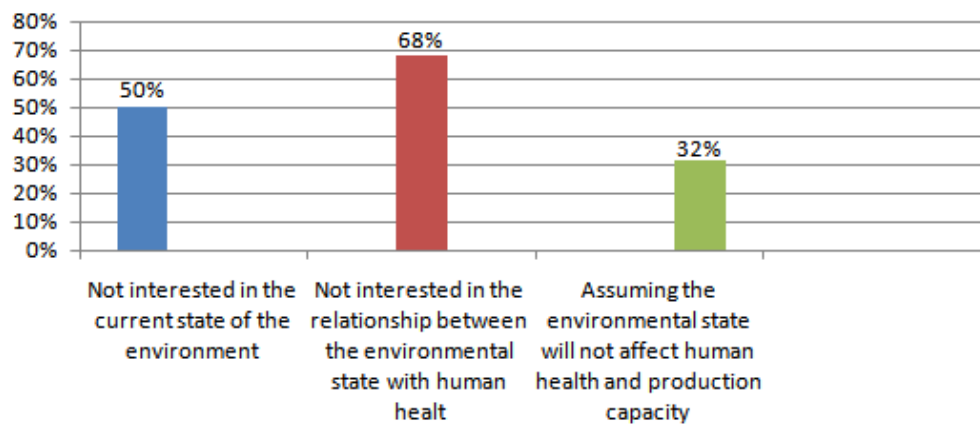


Figure 4.4: The local mushroom growers’ opinion about the relationship between quality of the environment and human health

**e. Proposing measures to improve environmental protection in the studied areas**

Based on the research results, it can be stated that the environment in the mushroom growing area of the Dinh Quan district has signs of pollution, with some environmental parameters have exceeded the limits compared with the Viet Nam Environmental Regulations. As mentioned in the previous sections, there are quite many factors leading to reducing environmental quality in the studied area: equipments using in the production; knowledge and techniques in mushroom cultivation of the local people; and people’s awareness on environmental protection. Therefore, it needs to develop appropriate measures to protect the environment, and the measures, which are proposed to improve the efficiency of environmental management in the studied area, include: reusing and recycling materials in mushroom production process; changing raw materials in production process; housekeeping; and raising awareness of the mushroom growers on environmental protection.

**4.5.1. Reusing and recycling agricultural waste in mushroom cultivation**

One of the environmental impacts of local mushroom development is the release of greenhouse gas into the surrounding environment by using sawdust as an input material for mushroom cultivation, therefore, the



reusing and recycling methods address to input materials and waste discharging from the boiler's operation. In the mushroom production process of the studied region there is a quite large quantity of certain moisture sawdust used as substrate. In order to make a substrate layer for mushroom growing, dried sawdust has been mixed with lime water at the certain ratio, 01kg of lime: 100 liters of water: 01kg of dried sawdust. According the research results, in the year of 2016, total of moisture sawdust used for producing 493,127 kg of fresh mushroom, in the region, is about 2,958.762 kg, it is equivalent to 1,344,891,92 kg of dried sawdust. After one mushroom growing season, the substrate layer mading from the moisture sawdust is disposing and this is treated by people as agricultural waste. At the present time, the mushroom growers in the studied region are using burning method to treat this waste. With conversion rate of exhaust gas in direction burning sawdust about 80% and emission coefficient of exhaust gases mentioned in IPCC (2006), burning 1,344.891 ton of sawdust in the studied area there would release a large volume of greenhouse gases (CO<sub>2</sub>) into the environment. Therefore, the mushroom cultivation of the region could be more effective in the production and reducing impact of the environment if the mushroom growers reuse the waste, for example: replacing firewood by gried sawdust in boiler's combustion.

#### **4.5.2. Change of raw materials in production process**

As mentioned in the previuos section, in the mushroom cultivation process of the studied region there have been about 1,344,891.92 kg of sawdust, 1,972.51 m<sup>3</sup> of firewood used for producing about 493,127 kg of fresh mushroom in 2016. Presently, the mushroomm growers have treated the used sawdust by direct burning and using firewood to support heat for the boilers in the production process, it means that a large amount of greenhouse gases generated from using 1,972.51 m<sup>3</sup> of firewood for boiler's combustion and treating waste of the used sawdust (sawdust after using as substrate in the mushroom production process). Therefore, it is proposed that replacing firewood as combustion materials for boilers by the used sawdust in the mushroom production process, with this method would reduce a quite large quantity of greenhouse gases, which is equivalent to total CO<sub>2</sub> released from complete combustion of 1,972.51 m<sup>3</sup> firewood and 1,344.891 ton used wawdust, into the environment.

#### **4.5.3. Strenthng management works and raising people's awareness on environmental protection in the studied area**

Despite the manage environmental works in the region have been concerned by the state management and local people and implemented in coordination: the self environmental management groups have been established; information and knowledges regarding environmental protection and saving of material and enenergy are communicated to the mushroom growing households; and some finacial support has been given to the mushroom producers. However, there is still many shortcomings remained and it leads to low efficiency in environmental protection in the region. In order to overcome the shortcomings, there are following proposes initiated:

- ✓ Organizing propaganda in the form of intensive training, direct meetings with producers and representatives of mass organizations.
- ✓ Implementing a model of some typical households which are good of envirmntal protection and efficient mushroom production in each hamlet and then propagating it to the whole region.
- ✓ Maximizing effectiveness of the mass media in raising awareness about environmental protection.
- ✓ Establishing environmental educational program that could fully be conveyed on radio and television; integrating propaganda on environmental protection and hygiene into the meeting of Youth Union, Women's Union, Veteran's Association, Farmers' Association and mass organizations.
- ✓ It is needed to add professional environmental staff to relevant organizations and units at the commune and hamlet levels; In the immediate future, there need to have at least 01 officer responsible for environmental sanitation management in the hamlet which has intensive mushroom cultivation; and it should be a ficial funding for mobilising the operation of the environmental self-management group.
- ✓ Socialization of environmental management: Implementing the policy of vigorous implementation of social protection of environmental protection activities in order to mobilize the active participation of the people themselves, production households as well as social sectors with preferential mechanisms and policies adequately.

## **V. Conclusion**

Based on the results gained from the research implementation, it could be concluded that:

- ✓ The mushroom cultication in Dinh Quan district has been formed and organized by producers, which are households and individuals, with small scale and scattered; the mushroom growers of the region mainly use traditional methods in mushroom producion process, hence practices and techniques in mushroom cultivation of the region have not been improved.

- ✓ The environmental quality in the area has signs of pollution with parameter of THC in the air and parameter of Mn in the water exceed limitation of Viet Nam Regulation on environmental protection; and there is potential hazard from solid waste disposal by the mushroom growers to the surrounding ecosystem.
- ✓ Awareness of the mushroom growers on the environment and the relationship between the environmental quality and human health is quite low, hence the mushroom growers do not pay much attention to the surrounding environment and can not fulfill their responsibility to protect the environment; there is complaints about environmental problems which have been generated from activities of the mushroom growers in the region.
- ✓ Despite environmental management in Dinh Quan district has been concerned and there is the coordination between the state management agencies and local authorities, but the efficiency of environmental protection in the area is not high as it is expected.

In order to improve the efficiency of mushroom cultivation and protect the environment, it could be suggested the following measures:

- ✓ It is necessary to have a source of funding or budget to carry out specific studies detailing the environmental effects of mushroom growing areas.
- ✓ Consolidating and improving the environmental management system in the area as well as strengthening the public inspection, supervision of environmental protection activities of people in the mushroom growing area.
- ✓ Disseminating and instructing techniques to reduce quantity and toxicity of waste at sources in production.

### Reference

- [1]. Arora, Dilip K.; P. D. Bridge, Deepak Bhatnagar, 2004. *Fungal Biotechnology in Agricultural, Food, and Environmental*. CRC Press.
- [2]. Dong Nai Provincial Department of Environmental Protection, 2016. *Statistical Yearbook of Dong Nai Province in 2016*, Bien Hoa - Dong Nai - Vietnam
- [3]. Doan Hoai Nhan, 2010. Evaluation of the efficiency of mushroom production in An Giang province. Scientific research project, An Giang University, Viet Nam
- [4]. Intergovernmental Panel on Climate Change, 2006. *Guidelines for National Greenhouse Gas Inventories*.
- [5]. acoma, T. (Updated April 19, 2018), *What is the Gas Emitted When Burning Wood*, [http://Sciencing.com/gas-emitted burning wood](http://Sciencing.com/gas-emitted-burning-wood) - Accessed on April 24, 2018.
- [6]. Ministry of Natural Resources and Environment of Viet Nam (2016). Legal documents (environmental field), Bộ Tài nguyên và Môi trường, 2016. <http://www.monre.gov.vn/wps/portal/van-ban-phap-quy/!ut/p/c5>. [Accessed on 15/10/2017]. <https://en.wikipedia.org/wiki/Fungus>.
- [7]. People's Committee of Dinh Quan district, 2016. Report on the situation and results of implementing duties of socio-economic plan and national defense and security in 2016
- [8]. Wikipedia (2018), *Mushroom Definition*, <https://en.wikipedia.org/wiki/Mushroom>: Accessed on April 15, 2018

Nguyen Vinh Quy, Duy Thuong. " Assessing The Environmental Status And Proposing Measures To Improve Environmental Protection Effectiveness In Mushroom Growing Areas of Dinh Quan District – Dong Nai Province." *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)* 12.5 (2018): 18-27.