

## CHAPTER I INTRODUCTION

### 1.1 Background

Vietnam is the easternmost country on the Indochina Peninsula in Southeast Asia. It has an area of approximately 331,698 squares kilometers and a population of 89.57 million people (Statistical Yearbook, 2010). The latitude and longitude of Vietnam is 16° 0' North and 106° 0' East. The capital of Vietnam is Hanoi and the latitude and longitude of the capital city are 21° 2' North and 105° 51' East. Vietnam borders China to the north, Laos and Cambodia to the west, Gulf of Thailand to the southwest, and East China Sea - Pacific Ocean to the south. In this position, Vietnam is an important traffic junction between Indian Ocean and Pacific Ocean ([http://www.mapsofworld.com/lat\\_long/vietnam-lat-long.html](http://www.mapsofworld.com/lat_long/vietnam-lat-long.html))

Characteristic of the climate in Vietnam is monsoonal, with many sunny days, much rainfall and high humidity. Although Vietnam is located in the tropical and subtropical climates, it has diversified climate. With the abundant natural resources of land, water, fauna, flora and climate advantages, Vietnam has favorable conditions to develop agriculture, especially vegetables.

In the world, vegetables are crops which grown long-standing. Greek people, ancient Egypt people used cabbage and vegetables as a source of food. Since the year 2000, these areas became the vegetables growing countries with the average of more than 600,000 ha yearly and also has increased gradually over the years. According to Food and Agriculture Organization (FAO), area of vegetables in the world increased

from 14,826,956 ha in 2000 to 18,003,909 ha in 2005 while production increased from 218,336,847 tons to 249,490,521 tons (FAO, 2006).

Vegetables which are used in combination with other fruits are good foods for health due to containing vitamins, antioxidants and natural resistance. Therefore, the demand for fruits and vegetables is very large. Japanese consume more vegetables than any other people of countries in the world. Each year Japan consumes 17 million tons of vegetables, average consumption of 100 kg/person/year. The trend now is consuming more vegetables and wild vegetables which more beneficial for the health. In the world, average consumption per person is 154 - 172 g/day (FAO, 2006).

Thai Nguyen province is an industrial center in the northern region of Vietnam. Its area is 352,621 hectares, including 275,310 hectares of agricultural land area. Thai Nguyen city is the capital city of Thai Nguyen province where concentrates many factories and enterprises such as Cao Ngan power plant, Hoang Van Thu paper mill, Thai Nguyen Iron and Steel joint-stock Corporation (TISCO) etc. There are 8 major universities and many colleges, high schools, vocational schools and big hospitals. With high population density, this is a large market for consumption of agricultural products especially vegetables. In recent years, the city has set up the "belt of food production", in which vegetables are considered to be the most important product.

Thai Nguyen city has area about 18,971 hectares, and population about over 330,000 people (Statis year book, 2010). According to Census of population and housing (2009), in 10 years (1999 - 2009), population of Thai Nguyen city averagely increased 0.7% per year, GDP reached 25 million VND per year (Statistical Yearbook, 2009).

Thai Nguyen city brings common features of the climate in northeastern Vietnam. It has tropical monsoon, cold winter with less rainfall, hot and humid

summer with much rainfall. Climate of Thai Nguyen city is divided into 4 seasons: Spring, summer, autumn and winter. It is in the warm area of Thai Nguyen province, average rainfall is quite large.

Thai Nguyen City has Cau river which is located in the northeast of the city. Cau River derived from Bac Kan province, it flows through the city at approximately 25 km downstream. The river runs through the territory of Tan Long, Tuc Duyen, Trung Vuong, Gia Sang, Cam Gia districts and Huong Son, Luong Son communes. In rainy season, its flow reaches  $3,500\text{m}^3/\text{s}$ , in dry season is  $7.5\text{ m}^3/\text{s}$ . Cau river from Cao Ngan is contaminated by sewages from Hoang Van Thu paper mill (Hang, 2004).

Thai Nguyen has favorable conditions about climate and land for the development of crops especially vegetables. Besides, farmers have tradition and long experience in vegetable production, now the income from growing vegetables is the main source of households in rural area of Thai Nguyen city. According to a survey, growers' income is very high, such as the income of farmers in Tuc Duyen precinct is around 40-50 million VND<sup>1</sup>/sao<sup>2</sup>/year, particularly, there are households have income of 70 million VND/sao/year. Although vegetable area of Thai Nguyen city only occupies a small area in total agricultural land area but consumption proportion of agricultural products is high.

However, the city also uses land for food production, with an area of 8,888.12 hectares of agricultural land, 60% of agricultural area used for growing rice, 10% used for corn and 9% for vegetables (Statistical Yearbook, 2008).

<sup>1</sup> US\$ = 20,000 VND,

<sup>2</sup> 1 sao = 360 square metres

## 1.2 Vegetable cultivation in Vietnam

Vietnam has a long history of growing vegetables. The climatic conditions are suitable for growth, development and creation of vegetable seeds, including both vegetables of tropical and temperate origin.

There are about 70 species of plants used as vegetables or processed into vegetables. Local vegetables have been grown with more than 30 species. 15 species are general vegetables that are growing in Vietnam and 80% of these species are leaf eating vegetables. There are two major areas of planting vegetables. They are Red River Delta and Southern Delta. The most popular vegetable which is grown throughout the country is cabbage which is grown in northern part of Vietnam. For farmers, vegetable crops are very important for income of households.

However, vegetable production in Vietnam is mainly in small scale. In Vietnam, growing vegetables depends much on fertilizers and pesticides. In addition, production environment is affected by industrial wastes, sewages and human activities. Without environmental considerations, lack of selective application of scientific techniques together with the lack of knowledge about vegetable growing in cultivation process have made the products of green vegetables contaminated with  $\text{NO}_3^-$ , heavy metals, microbial pathogens and chemical plant protection. Problems of vegetable pollution occur in almost all vegetable growing areas of the country (Hai *et al.*, 2000; Tuan *et al.*, 2003).

The current structure of vegetables are mainly short-term vegetables which are spinach, assorted vegetables such as jute, basella alba, bitter melon, beans etc; few long-day vegetables such as cabbage, kohlrabi, tomatoes, cauliflower etc. Long-day

vegetables in Thai Nguyen city is provided mainly from other growing vegetable areas. The reason due to small average cultivated area so growers only focused on producing short-day vegetables for much rotation, usually 4-5 crops/year, even 6-7 crops/year for land of growing vegetable (Hang, 2007).

Thai Nguyen city has 28 administrative divisions including 19 wards and 9 communes, in which the communes and wards which have large area and tradition of vegetable production such as Tuc Duyen ward, Luong Son commune, Quyet Thang commune, Quang Vinh ward, Cam Gia ward etc. In particular, Tuc Duyen ward is the main vegetable growing area, where has largest vegetable growing area and the highest yield of vegetables in the city (Statistics Department of Thai Nguyen city, 2006).

Since 1997, the issue of clean vegetable production has been concerned by Plant Protection Department, many training classes about IPM have been opened for farmers growing vegetables. In 2001, sample plots of safe vegetable production were applied and from 2003 to 2004, the program of producing safe vegetables implemented in the two cooperatives Dai Dong and Tien Ninh in Tuc Duyen ward with the area of 3 ha. Vegetables grew are cabbage, broccoli, spinach, vegetable jute, basella albe, sweet cabbage, kohlrabi etc, annual production output of about 400 tons. However, effectiveness of the program was not high due to consciousness of growers about food safety issues was limited, run by profit, safe vegetable production process was not completed. Moreover, areas applied were not isolated with normal growing vegetable areas or isolated from toxic waste sources. So, all of those made consumers not trust the quality of safe vegetables, therefore, they were consumed very little.

In terms of irrigation, Cau River flows through Tuc Duyen ward, the ward has small system of ditches which meets basic demand of supplying water and drainage for agriculture production.

Tuc Duyen ward is a center ward of Thai Nguyen city. Ward's economy is primarily agriculture. Quality of human resources of the ward is quite good, labors trained occupied high proportion. People live mainly on agriculture (about 68%) so their lives still have many difficulties. Tuc Duyen's agriculture focuses on vegetable production and intensive cultivation. But growing vegetables are now revealing it's opposite side which are: Farming techniques of the farmers are still low, using a large assortment of chemical fertilizers, plant protection pesticides in order to increase yields, limit diseases, along with the customary use of fresh manure which is untreated, all of those things have made agricultural environment and agricultural products seriously polluted (Hang, 2007).

The production of vegetables is mainly implemented by small farmers. Households of farmers at Tuc Duyen ward has grown many vegetables and used many irrigation water sources, fertilizers, pesticides to maintain productivity of vegetables. Currently, the problems on vegetables' quality are very interested by people and management levels, especially the pollution of heavy metals in vegetable products. Quality of vegetables is much dominated by quality of water source and land. While water and land is much affected by pollution of heavy metals, especially cadmium (Cd) and lead (Pb) because this place is located on the bank of Cau river which is heavily influenced by industrial zones, residential areas, central market and supermarkets (Report of Environmental Monitoring in Thai Nguyen province, 2007).

### 1.3 Problem of heavy metals in Vietnam

Heavy metals refer to high metal atoms and they are often toxic to life. They are often associated with problems of environmental pollution. The origin of emissions of heavy metals may be nature (such as Arsenic (As)), or from human activities, mainly from industry (industrial wastes) and agriculture, sea (such as products prepared for agriculture, fisheries, etc) (Prasad, 1974).

As a result of increasing anthropogenic activities, the heavy metal pollution of soil, water, and atmosphere represents a growing environmental problem affecting food quality and human health. Heavy metals may enter the food chain as a result of their uptake by edible plants, thus, the determination of heavy metals in environmental samples is very important (Alirzaveya *et al.* , 2006; Kachenko *et al.* , 2004).

Industrial or municipal wastewater is mostly used for irrigation of crops, mainly in periurban ecosystem, due to its easy availability, disposal problems and scarcity of fresh water. Irrigation with wastewater is known to contribute significantly to the heavy metals content of soil. Heavy metals are very harmful because of their non-biodegradable nature, long biological half-lives and their potential to accumulate in different body parts. Most of the heavy metals are extremely toxic because of their solubility in water. Even low concentrations of heavy metals have been damaging effects to man and animals because there is no good mechanism for their elimination from the body. Nowadays, heavy metals are ubiquitous because of their excessive use in industrial applications. Wastewater contains substantial amounts of toxic heavy metals, which create problems (Chen, 2005; Singh, 2004). Excessive accumulation of heavy metals in agricultural soils through wastewater irrigation may not only cause soil contamination but also affect food quality and safety (Muchuweti *et al.*, 2006).

Heavy metals may have significantly toxic and hazardous effects on human health, especially cadmium (Cd) and lead (Pb), as non-essential elements (Bakirdere *et al.*, 2008).

Thai Nguyen city has rich and plentiful natural resources. Thai Nguyen also has many kinds of minerals such as: Coal, iron, stone, limestone, sand and gravel, etc. These conditions have promoted the development of metallurgy, heavy industry, and mining industry in the area. In particular, coal in Thai Nguyen is considered the second largest reserves in the country, after Quang Ninh. There are two major rivers flowing through Thai Nguyen city are Cau river and Cong river.

The city has many industrial production facilities for mining, metallurgy, engineering, construction materials, and consumer goods. Thai Nguyen City is one of the largest metallurgical centers nationwide, in which Thai Nguyen Iron and Steel joint-stock Corporation (TISCO) built during the '60s - the cradle of Vietnam's steel industry. It is one of the biggest metallurgical industries in the country and now is continuously invested for development. In addition, there are also many paper mills, steel mills, cement factories and coal plants. Specifically, this place focused factories such as Hoang Van Thu paper mill, Cao Ngan power plant etc. Beside, in recent years, many cement plants for high capacity have been constructed. So the amount of waste water from factories discharge into the environment per day very much such as Hoang Van Thu paper factory 400m<sup>3</sup>/day. Toxic waste and dirty water contaminate Mo Bach stream and water source of Cau river. Gia Sang steel mill and the Cam Gia steel zone discharge daily big amount waste water is not treated on polluting streams in Gia Sang ward, Tuc Duyen precinct etc. According to information of the Ministry of Industry, quality of Cau river water was worsened; beside, many parts of the river



have been polluted to an alarming level. Pollution is the highest region of the Cau river flows through Thai Nguyen city, especially at the point of discharge, Hoang Van Thu paper mill, Thai Nguyen Iron and Steel joint-stock Corporation (TISCO), etc where quality of water sources does not meet Vietnam standard 5942 - 1995 (Vietnam Industrial Report, 2003). Pb concentrations in surface water and in some areas of Thai Nguyen city are higher 2-3 times and Cd concentrations are higher 2 - 4 times than Vietnam permission standard (Duc, 2006).

Therefore, this study was conducted with three main purposes as follows: (1) describing current situation of vegetable production in the target research area. (2) determining the accumulation of heavy metals (Cd, Pb) in soils and selected vegetables. (3) finally determining the factors affecting accumulation of heavy metals (Cd, Pb) in soil and vegetables.