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# Safe Vegetable Consumption in Hue City: A Case Study of Food Safety Situation in Vietnam

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**Abstract:** Food safety has become a growing concern for citizens in the modern society when consuming unsafe food that directly impacts public health, life quality and well-being of each country. People of Vietnam in general and specially in Hue city have been facing challenge of vegetable unsafety. A survey concerning the consumption of safe vegetables was conducted in Hue city, Vietnam. Data were collected by using a well-structured questionnaire from representative of 30 consumers, 30 producers and 10 collectors. The results showed that lettuce, sweet potato and Chinese mustard were identified as the most important vegetables to consumers in Hue city. Most of the consumers purchased vegetable every day. The cost of vegetable in every transaction was about 30,000 VND. This expenditure has not created a great motivation for developing safe vegetable production. Most of the consumers in Hue city showed high interest, demand, trust and satisfaction for safe vegetable. However, 50% of the consumers reported that the price of the safe vegetable was quite expensive and price was not matched with their quality. Moreover, there were some disadvantages in each stage of vegetable supply chain. For example, land, seed, capital, cultivation techniques, preliminary processing, preservation, brand name, trademark and place to consume have not met the requirement of high technology production for the supply chain of safe vegetables. The chain linking between the production and consumption of vegetables is not sustainable. Producers and consumers do not have closely links. Vegetable can not be traced to origin and there is no safe certificate. The consumers believe the quality of vegetables depending on the prestige suppliers, such as, the vegetable shops with foreign consultants. Safe vegetables of farmers are very difficult to be certified for safe vegetables. Solutions and suggestions to Hue city are proposed that it is necessary to establish the vegetable production area in Hue city. Vegetable growers should be supported with capital, knowledge, technology, vegetable preliminary processing and preservation. They should be supported to build a trademark and certificate of vegetable safety and establish the chains of effective safe vegetable consumption.

**Key words:** Food safety, vegetable consumption, vegetable supplying chain, Hue city.

## 1. Introduction

According to the World Health Organization (WHO), foodborne illness is one of the causes that could simultaneously kill 2.2 million people each year, of which 1.9 million are children [1, 2]. The Western Pacific region, which includes Vietnam, ranks the second in the world in terms of foodborne diseases [3]. In Vietnam, foodborne disease is considered as one of the significant public health issues in the past years [4]. The causes of unsafe food were caused by microorganisms, natural toxins, chemicals and unknown causes [5]. Agricultural production was considered one of the main sources causing unsafe foods. Work Bank in 2016 reported that there was around 10%-40% of food contaminated with microbes or parasites, pesticide residues, chemical fertilizers and heavy metal which cause foodborne diseases based on the survey of tens of thousands of food samples in Vietnam [4, 6]. Pesticide and chemical fertilizer residues on agricultural products could affect the health of consumers [1]. Pesticide residues, nitrate, heavy metals and micro-organisms were the main hazards in vegetable and fruit value chain [4]. Vietnamese farmers usually apply 10-17 times

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spraying pesticide that was higher than the recommendation of Ministry of Agriculture and Rural Development to control pests and diseases on vegetables and fruits [7]. Truong and Vi [8] reported that pesticides were sprayed 10.4 times for crops per year by farmers in Thua Thien Hue, 5.1 times for winter-spring crops and 5.3 times for summer-autumn crops. This issue is the biggest potential danger in vegetable food safety concerned by most of consumers in Vietnam [9]. Pesticides and nitrogen fertilizer high in vegetables can cause the foodborne diseases [10]. In Vietnam, there were 125,000 new cases of cancers reported in 2012 and this will increase to 190,000 new cases by 2020, when 75,000 deaths will result from cancers per year [11]. The proportion of cancers caused by over-due pesticides and chemical fertilizer in food in Vietnam is unknown. However, there is far more concern about the carcinogenic impact of food than the evidence to support this. For examples, diazinon, malathion and glycophosphate are reported as carcinogenic. The WHO and the Food and Agriculture Organization (FAO) concluded that these pesticides were unlikely to pose a carcinogenic risk through dietary exposure [12]. Consequently, many consumers switch to consume safe foods or organic foods. Good agricultural practices (GAP) represented a solution for manufacturers that they were seeking to address the concerns of consumers in domestic and foreign markets [13].

Hue city is a cultural and tourist center of the country. There are millions of domestic and foreign visitors visiting the city every year. Hue cuisine also plays an important role in promotion to the development of Thua Thien Hue tourism. In the same problems mentioned above, the people of Hue city were also facing the risk of unsafe food consumption [14]. The objective of this study was to focus on analyzing the situation of safe vegetable production and consumption in Hue city. The chains of the safe vegetable supply in some wards in Hue city will be established from the survey data. Based on the results, solutions and suggestions are proposed to Department of Agriculture of Thua Thien Hue province to promote the production and consumption of safe vegetable.

## 2. Methodology

### *2.1 Survey*

#### 2.1.1 Qualitative Research

Qualitative research aimed to identify the indicators for evaluation, questionnaire sheet and scale. Group discussions were conducted with agricultural experts, some producers, consumers and collectors of safe vegetable on the issues related to production and consumption to form the questionnaires. For production activities, the questionnaire focused on the following: crop structure, cultivation area, irrigation water, pesticides, etc.. For consumption activities of safe food, consumption, vegetables purchase, demand of vegetables, consumer awareness, the level of consumer confidence in safe food, the level of satisfaction, the price of food and the reasons that consumers did not purchase safe food regularly were focused on. For purchase activities of safe food, the content of the questionnaire focused on purchasing, awareness, level of confidence and level of interest. The results of the preliminary survey were on the basis to design the questionnaire for the formal study.

#### 2.1.2 Quantitative Research

The direct interview method was used to interview the farmers, collectors and consumers. The primary data were collected from the questionnaire sheet interviewing three subjects in three groups of activities: production, purchase and consumption. The interview was conducted from January to February 2017. Field visitation was done to have an overview about the vegetable production models, land use forms and situation of the safe vegetable production, vegetable preliminary processing and preservation. Secondary data were collected from reports relating to the production and consumption of vegetables in Hue city by Department of Agriculture and Rural

Development and Department of Science and Technology of Thua Thien Hue province, Economic Department of Hue city, the scientific articles of production and consumption of safe vegetable.

*2.2 Sampling Method*

A comprehensive survey of 30 producers was conducted in four wards for safe vegetable. A random sampling of 10 collectors was interviewed for safe vegetable. The 30 consumers of safe food were interviewed at safe food shops and markets.

*2.3 Data Analysis*

The data collected on the consumption of clean vegetables (sex, age, education, ranking of important level, demand, amount of purchase, level of interest, level of understanding, demand for product, product supply, level of trust, level of satisfaction, price ) were analyzed for frequency using the software SPSS ver. 16.0 (IBM Inc.).

## 3. Results and Discussion

*3.1 Population, Area, Yield and Output of Vegetables in Hue City*

Hue is located in the coastal central region of Vietnam and is a city of Thua Thien Hue province, covering an area of 70.67 $km^2$ and a population of 354,124 people in 2015 (Table 1). Statistical data showed that Hue was a city having a narrow area but

**Table 1 The population change of Hue city over the years.**

| Communes and wards | Population (person) | | | | |
|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 |
| Phu Thuan | 7,284 | 7,161 | 7,257 | 7,315 | 7,382 |
| Phu Binh | 8,994 | 8,445 | 8,154 | 8,160 | 8,167 |
| Tay Loc | 19,824 | 20,118 | 20,376 | 20,479 | 20,561 |
| Thuan Loc | 15,604 | 15,574 | 15,520 | 15,541 | 15,580 |
| Phu Hiep | 13,272 | 13,089 | 12,777 | 12,700 | 12,760 |
| Phu Hau | 10,396 | 10,547 | 10,875 | 11,026 | 11,201 |
| Thuan Hoa | 14,975 | 15,099 | 15,250 | 15,309 | 15,386 |
| Thuan Thanh | 14,114 | 14,327 | 14,426 | 14,480 | 14,509 |
| Phu Hoa | 5,773 | 5,880 | 6,060 | 6,165 | 6,260 |
| Phu Cat | 8,933 | 9,045 | 9,112 | 9,120 | 9,132 |
| Kim Long | 15,123 | 15,323 | 15,623 | 15,708 | 15,792 |
| Vy Da | 18,801 | 19,013 | 19,209 | 19,304 | 19,345 |
| Phuong Duc | 11,181 | 11,285 | 11,422 | 11,341 | 11,335 |
| Vinh Ninh | 7,617 | 7,594 | 7,532 | 7,545 | 7,536 |
| Phu Hoi | 12,173 | 12,245 | 12,313 | 12,320 | 12,338 |
| Phu Nhuan | 8,953 | 9,019 | 9,113 | 9,168 | 9,160 |
| Xuan Phu | 12,957 | 13,093 | 13,193 | 13,218 | 13,320 |
| Truong An | 16,076 | 16,212 | 16,351 | 16,546 | 16,525 |
| Phuoc Vinh | 21,298 | 21,454 | 21,671 | 21,720 | 21,835 |
| An Cuu | 22,864 | 23,162 | 23,448 | 23,571 | 23,560 |
| An Hoa | 10,063 | 10,435 | 10,677 | 10,820 | 10,902 |
| Huong So | 9,561 | 10,486 | 11,380 | 11,463 | 11,540 |
| Thuy Bieu | 9,598 | 9,674 | 9,853 | 9,878 | 9,993 |
| Huong Long | 10,463 | 10,645 | 10,873 | 10,963 | 11,114 |
| Thuy Xuan | 13,520 | 13,713 | 14,181 | 14,437 | 14,842 |
| An Đong | 16,030 | 16,178 | 16,316 | 16,425 | 16,525 |
| An Tay | 7,103 | 7,254 | 7,383 | 7,420 | 7,524 |
| Total | 342,550 | 346,070 | 350,345 | 352,142 | 354,124 |

Source: Statistical Agency of Hue City, 2015 [15].

high population. Population density in 2015 was 4,807 people/km$^2$. Productivity and output of crop production tended to decrease due to the urbanization (Table 2). The largest area of agricultural land was Huong Long ward (825 ha) and the lowest was Vy Da ward (5.5 ha) (Table 2). Area of vegetables in two crop seasons was less than 500 ha, yield was approximatively 10.0 tons/ha and output was over 4,400 tons (Table 3).

Hue city was an urban affected by industrial activities, tourism and service, the share of agriculture is very low, but there was a high educational level. However, the vegetable production was still manual, small area and lack of high technology. Vegetables produced by farmers in Hue city were not diverse in terms of type and low quality in comparison with other places, such as Da Lat or Ha Noi. The demand of vegetables increased as the population increased, but land area was reduced due to urbanization. Vegetables are considered one of the agricultural products that are affected by the market, the price often fluctuates but there are very few farmers who based the demand of the market to adjust the cropping schedule and products to serve the consumers.

*3.2 Characteristics of Vegetable Consumer*

The results on consumption of clean vegetable in shops and markets in Hue city are presented in Table 4. The results showed that most of consumers were female (80%), because the people involved in housework were women. The customers in 20-60 years old accounted for a large proportion (83%), because these people were bread-winner in family and in charge of food shopping at home. The survey showed that 46.7% consumers were with education level at high school, 26.7% with education level at secondary school and 23.3% with higher education level. The consumers with lower education level or illiterate were very small (3.3%). This showed that education was one of the important factors that affected the perception of safe vegetable. In addition, the monthly income also contributed to the consumption of safe vegetable. The average monthly income of 3-5 million VND accounted for the largest proportion (36.7%), followed by the group with income 5-10 million VND (33.3%). Anh [16] indicated that most of consumers believed that vegetable was one of the

**Table 2 Total area of annual crops in Hue city.**

| Communes and wards | Area (ha) | | | | |
|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 |
| Thuy Bieu | 339.7 | 332.3 | 297.9 | 281.7 | 281.7 |
| Thuy Xuan | 130.7 | 128.0 | 128.0 | 128.2 | 128.2 |
| Huong Long | 867.1 | 867.0 | 830.7 | 829.7 | 825.5 |
| An Hoa | 378.6 | 372.5 | 363.1 | 360.8 | 360.8 |
| Huong So | 391.9 | 382.5 | 380.0 | 375.3 | 375.3 |
| An Tay | 102.1 | 98.0 | 85.0 | 70.4 | 66.7 |
| Kim Long | 75.6 | 72.5 | 67.9 | 67.8 | 67.8 |
| An Đong | 364.6 | 358.2 | 323.3 | 276.0 | 273.6 |
| Xuan Phu | 118.6 | 112.0 | 75.0 | 63.3 | 63.3 |
| Thuan Hoa | 15.4 | 15.4 | 10.1 | 10.3 | 10.5 |
| Phu Hau | 10.9 | 10.9 | 11.0 | 11.0 | 11.0 |
| Phu Hiep | 28.2 | 28.2 | 20.2 | 15.8 | 14.5 |
| Vy Da | 3.0 | 1.0 | - | 5.5 | 5.5 |
| Tay Loc | 17.5 | 17.5 | 13.4 | 13.0 | 11.5 |
| Thuan Loc | 26.0 | 26.0 | 22.0 | 21.8 | 20.9 |
| Phu Binh | 16.1 | 16.0 | 10.4 | 10.4 | 10.4 |
| Total | 2,886.0 | 2,838.0 | 2,638.0 | 2,541.0 | 2,527.2 |

Source: Statistical Agency of Hue City, 2015 [15].

**Table 3 Area, yield and output of vegetables of Hue city.**

| Index | 2014 | | 2015 | | 2016 | |
|---|---|---|---|---|---|---|
| | Winter-Spring | Summer-Autumn | Winter-Spring | Summer-Autumn | Winter-Spring | Summer-Autumn |
| Area (ha) | 92.3 | 22.5 | 180.5 | 105.5 | 216.7 | 129.9 |
| Yield (tons/ha) | - | - | - | - | 10.0 | |
| Output (tons/year) | - | - | - | - | 4,466.0 | |

Source: Survey Data by Economic Department of Hue City, 2017 (unpublished).

**Table 4 Sex, age, education and monthly income of safe vegetable consumer in shops and markets in Hue city.**

| Criteria | Percentage (%) |
|---|---|
| Sex | |
| Male | 20.0 |
| Female | 80.0 |
| Age (years) | |
| < 20 | 3.3 |
| 20-30 | 16.7 |
| 30-40 | 30.0 |
| 40-50 | 10.0 |
| 50-60 | 23.3 |
| > 60 | 16.7 |
| Education | |
| Illiterate | 0.0 |
| Primary school | 3.3 |
| Secondary school | 26.7 |
| High school | 46.7 |
| Higher | 23.3 |
| Monthly income (VND) | |
| < 3 million | 30.0 |
| 3-5 million | 36.7 |
| 5-10 million | 33.3 |
| 10-15 million | 0.0 |
| > 15 million | 0.0 |

most interest foods about the level of safety. However, the level of safety of vegetables was defined by consumers on the base of the observation and smell, or the prestige from the brand of shops, counters and supermarkets. Most of the safe vegetables did not have the certificate for safe and trademarks for traceability. Sen and Hong [17] reported that safe vegetable productivity in Thua Thien Hue was about 15%-30% lower than that of traditional vegetables, riskier and more labor-intensive. However, about 80% of safe vegetable productivity had to be sold at local markets with the normal price like unsafe vegetables, because there was no any certificate of the safety or trademarks for traceability. As the results, the types of vegetables, which consumers should purchase, depended on the awareness of consumers. This study indicated that education level and customer income will be the decisive factors for purchasing safe vegetables.

### *3.3 Consumption of Safe Vegetables*

Survey results on consumption of safe vegetables in Hue city are presented in Table 5. The results showed that lettuce, sweet potatoes and Chinese mustard were the vegetables purchased mostly by consumers. Majority of the consumers would like to purchase vegetables daily (63.3%), but their purchase capacity was less than 30 thousand VND per day. This might be explained that the ability to vegetables store at household conditions was not good and the custom of daily shopping was the characteristic of family in small cities in Vietnam.

**Table 5 Consumption of safe vegetable in shops and markets in Hue city.**

| Criteria | Percentage (%) |
|---|---|
| Ranking of important level | |
| Lettuce | 33.0 |
| Sweet potatoes | 30.0 |
| Kangkong | 10.0 |
| Spinach | 3.0 |
| Chinese mustard | 20.0 |
| Other | 4.0 |
| Demand | |
| Daily | 63.3 |
| 4-6 times/week | 33.3 |
| 1-3 times/week | 3.4 |
| Amount per purchase (VND) | |
| < 30 thousand | 67.0 |
| 30-50 thousand | 17.0 |
| 50-100 thousand | 13.0 |
| 100-200 thousand | 3.0 |

**Table 6 Awareness of safe vegetables of consumer in shops and markets in Hue city.**

| Criteria | Percentage (%) |
|---|---|
| Level of interest | |
| Very uninterested | 0.0 |
| Uninterested | 0.0 |
| Normal | 3.3 |
| Interested | 63.3 |
| Very interested | 33.4 |
| Level of understanding | |
| Very lack of understanding | 0.0 |
| Lack of understanding | 6.7 |
| Normal | 20.0 |
| Understanding | 63.3 |
| Very understanding | 10.0 |
| Demand for safe vegetables | |
| Very no demand | 0.0 |
| No demand | 0.0 |
| Normal | 3.3 |
| Demand | 56.7 |
| Very demand | 40.0 |
| Vegetable supply | |
| Self-cultivation | 33.3 |
| Purchase online | 6.7 |
| Clean vegetable shop | 66.7 |
| Market | 36.7 |
| Supermarket | 16.7 |
| Level of trust | |
| Absolutely untrusting | 0.0 |
| Untruth | 10.0 |
| Normal | 0.0 |
| Trust | 86.7 |
| Absolutely trusting | 3.3 |
| Level of satisfaction | |
| Completely unsatisfied | 0.0 |
| Unsatisfied | 3.3 |
| Normal | 3.4 |
| Satisfied | 90.0 |
| Completely satisfied | 3.3 |
| Price | |
| Too expensive | 0.0 |
| Expensive | 50.0 |
| Accept | 50.0 |
| Cheap | 0.0 |
| Too cheap | 0.0 |

The awareness of the consumer in Hue city on safe vegetables is presented in Table 6. The results showed that the interest of consumer for safe vegetables was very high, with 63.3% and 33.4% who were interested and very interested, respectively. There were 63.3% of consumers who knew about safe vegetables and only 6.7% of people did not know about it. Most of the consumers reported that they had a demand and even a high demand. The safe vegetable stores were chosen by most of the consumers (66.7%). The consumers also grew the safe vegetables for their daily meals. The safe vegetable shops, markets and super markets were the places to purchase vegetables that were believed by the consumers (86.7% and 90% for level of trust and level of satisfaction, respectively). The price of safe vegetable is quite expensive comparing to the common one, therefore, its consumers often has high economic conditions. This is a limitation and a challenge for the planning of safe vegetable development. However, the percentage between the groups who thought the safe vegetables price was acceptable and unacceptable was equivalent (50%).

Sen and Hong [17] reported the lack of information on safe vegetables and evidences creating consumers' trust, and inconvenience of sale locations were factors obstructing the households and individuals who access and use safe vegetables in Thua Thien Hue. This study indicated that consumers in Hue city purchased the safe vegetables on the basis of their belief. They believe in the safe vegetables sold in prestigious shops, although there are no any certificates of vegetable safety and price is high. For example, they like to buy safe vegetables sold in shops with the advice of foreigners. Therefore, building trust and trademark are very important to the consumption of safe vegetable.

### *3.4 Supply Chain of Safe Vegetables in Hue city*

#### 3.4.1 Safe Vegetable Chain

The safe vegetable chain in Hue city is shown in Fig. 1. The supplying chains are as the following:

(1) Chain 1: farmer→consumer: Farmers sold their products directly to consumers in markets, or retail shop. With this sale, farmers could be self-motivated, but rather strenuous. They had to grow and sold their products by themselves. This chain was mainly consumed within the wards and communes of Hue city.

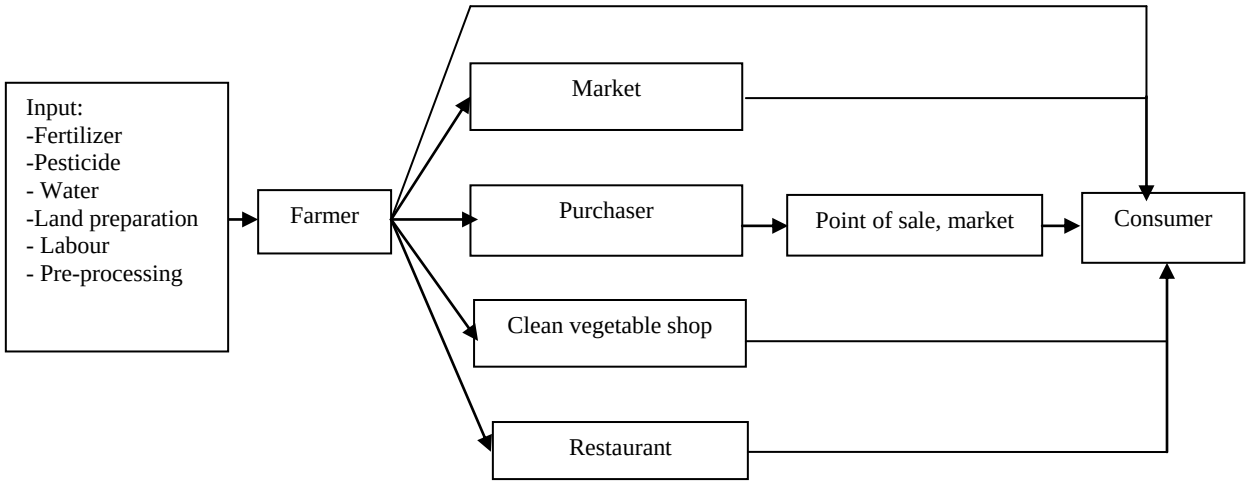


**Fig. 1 Safe vegetable supply chains in Hue city.**

**Table 7 Analysis of input costs for Chinese mustard and lettuce.**

| Criteria | Chinese mustard | | Lettuce | |
|---|---|---|---|---|
| | Amount of money (VND/ha) | Percentage (%) | Amount of money (VND/ha) | Percentage (%) |
| Fertilizer | 1,760,000 | 14.2 | 1,940,000 | 14.5 |
| Pesticide | 200,000 | 1.6 | 200,000 | 1.5 |
| Water | 1,900,000 | 15.3 | 2,260,000 | 16.8 |
| Land preparation | 3,840,000 | 30.9 | 4,000,000 | 29.9 |
| Labour (planting, taking care of plant and harvesting) | 3,780,000 | 30.4 | 4,000,000 | 29.9 |
| Pre-processing | 940,000 | 7.6 | 1,000,000 | 7.4 |
| Preservation | 0 | 0.0 | 0 | 0.0 |
| Total | 12,420,000 | 100.0 | 13,400,000 | 100.0 |

(2) Chain 2: farmer→market→consumer: At present, safe vegetables in Hue city were produced from the small farms and most sold directly to the markets. Farmers had to harvest and transport their products to markets and sold them to retailers, and then the retailers sold them to consumers.

(3) Chain 3: farmer→purchaser→retail outlets or market→consumer: Safe vegetables produced in Hue city and Thua Thien Hue districts were purchased by the collectors at farms. Vegetables were redistributed to retail outlets or markets in the city and then sold for the consumers. Generally, vegetables were distributed like this way, however, farmers were forced by the price of the collectors and their price was lower that the price self-consumed by farmers. The collectors in Hue city were mainly small and medium dealers and most of them would sell vegetables in markets in the city.

(4) Chain 4: farmer→clean vegetable shop →consumer: Farmers shipped vegetables to safe vegetable shops based on the orders of the type and quantity of products. The selling price depended on the fluctuations of the market. In this channel, vegetables supply was not continuous and depended on the demand from the safe shops.

(5) Chain 5: farmer→restaurant→consumer: Vegetables produced by farmers were often purchased directly by some restaurants. The disadvantage of this channel is that the restaurants order vegetables when the restaurant needs. Because of this, farmers could not stabilize their production plan. In addition, there was no constraint between the restaurants and the farmers to ensure that the restaurant would get the products from farmer to keep the supply chain in

continuing.

3.4.2 Analysis of Input Costs of Chinese Mustard and Lettuce

Data of input cost of Chinese mustard and lettuce, two main vegetables supplied in Hue city, are presented in Table 7. Cost of land preparation and labor for planting, taking care of plant and harvesting were two factors accounting for more than 55% of total expenditure (30.9% and 30.4% for Chinese mustard, 29.9% and 29.9% for lettuce, respectively), but the expenditure of processing and preserving were very low. Preliminary processing involves mainly for cutting roots, removing old leaves and leaves damaged by pests, and then vegetables tied in bundles for consumption. Most of the farmers did not have any storage, so vegetables had to be consumed after harvesting. At present, production of safe vegetables in Hue city is not good, so the yield and quality of safe vegetables is limited and farmers are facing challenge to sell their products at high prices.

3.4.3 Analyzing the Components Involved in the Supplying Chain

*3.4.3.1 Farmer*

Households involved directly in production of safe vegetables in Hue city had small production scale. They employed only one or two laborers for the planting, taking care of plant and harvesting (90% households) and they did not hire external workers (Table 8). Households were mostly classified in medium and fair group (73.3%) and their cultivation area was less than 0.1 ha (80% households). The source of capital was not satisfied with their production (90% households). Most of the households used seed, irrigation water and fertilizer that meet the Vietnamese Good Agriculture Practice (VietGAP) standard (80% households). There were 90% of households whose farming techniques meet the requirements of VietGAP. However, preliminary processing and preservation techniques of farmers in Hue city were poor (90% and 75% households). Most of households (80%) earned the profit about 76 million VND/ha from producing safe vegetables.

Every year, farmers alternately grew vegetables on the same area of 2-5 vegetables. Vegetables for harvest leaf were about 1 month and vegetables for harvest tuber or fruit were 2-3 months. The main season was winter-spring (November to March). The most unfavorable season was the autumn-winter months (September-November) due to flood and shortage of water in summer months (June-August). The cultivation process depended on the type of vegetable, but there were some main characteristics:

(1) Harvesting process: Harvesting process depended on type of vegetable, mode of sale (sold in kg or bulk sale) and consumers (farmers or traders). Mostly, vegetables, such as Chinese mustard and lettuce, were harvested, put in baskets and then taken for preliminary processing. Preliminary processing included: cutting roots and old leaves, rearranging (depending on the type of vegetables), and then washed and tied in the bundle. For vegetables for fruits (e.g., cucumber, according to farmers), they were picked in the basket, then selected and put into the package. Vegetables for leaves (Chinese mustard or lettuce) lost about 20% of its weight (due to removing roots, stems and old leaves) and vegetables for fruits lost about 5% of its weight.

(2) Modes of consumption: Bulk sale was one of the popular sales with farmers in Hue city. Farmers announced to traders the volume of vegetables that they could harvest each day. If the trader agreed, the farmer would be able to harvest and put into basket or plastic bags. This way was preferred to farmers, because the vegetables were sold and consumed regardless how quality of the product was.

(3) Customers and transactions: Traders who knew farmers for years, were reputable in buying and selling, and bought and sold by “price agreements” with farmer were the main customers to farmers. In addition, farmers could sell their products to the new traders who they did not know and they usually required a deposit in advance. Most of farmers were

unsatisfied to the traders, because they were forced by the price that traders proposed, when the market fluctuates, even if they has been agreed in advance (oral agreement). A small amount of products were sold to local retailers or farmers could sell their vegetables by themselves at the market to consumers.

(4) Market: Market was a link in the chain of safe vegetables supply in Hue city. Major wholesale markets could be mentioned, as Bai Dau and Dong Ba market where were the markets focused on the vegetable purchase from farmers in Thua Thien Hue province as well as other province, such as Da Lat and provinces in the North. Small markets usually provided vegetables from wholesale markets or vegetables from other provinces or from free sellers. The demand of safe vegetable from the people in Hue city was very large, but it was not a simple issue to ensure enough amount of vegetable to provide. There are many shops of the safe vegetable business in the city due to the increasing demand of the consumers. People focus on more investment in safe vegetable production and business to create higher economic efficiency. At present, there are many safe food shops in the city, such as Hue farmer's shop (Japanese advisor), Su Su Xanh, Que Lam and Mai organic shop. These stores provide a full range of safe and quality foods for local consumers.

**Table 8 Factors involved in safe vegetable production chain.**

| Criteria | Percentage (%) |
|---|---|
| Number of employees (person) | |
| 1 | 36.7 |
| 2 | 53.3 |
| 3 | 3.3 |
| 4 | 6.7 |
| Number of hiring employees (person) | |
| 1 | 96.7 |
| 2 | 3.3 |
| Type of household[a] | |
| Fair | 16.7 |
| Medium | 56.7 |
| Poor | 26.7 |
| Cultivation area | |
| ≤ 1,000 $m^2$ | 80.0 |
| > 1,000 $m^2$ | 20.0 |
| Source of capital[a] | |
| Bad | 53.3 |
| Medium | 36.7 |
| Fair | 10.0 |
| Seed quality[a] | |
| Bad | 13.3 |
| Medium | 46.7 |
| Fair | 36.7 |
| Good | 3.3 |
| Water quality | |
| Bad | 10.0 |
| Medium | 33.3 |
| Fair | 40.0 |
| Good | 16.7 |
| Quality of fertilizer[a] | |
| Bad | 6.7 |
| Medium | 40.0 |
| Fair | 40.0 |
| Good | 13.3 |
| Cultivation techniques[a] | |
| Bad | 10.0 |
| Medium | 43.3 |
| Fair | 36.7 |
| Good | 10.0 |
| Preliminary processing[a] | |
| Bad | 70.0 |
| Medium | 23.3 |
| Fair | 6.7 |
| Preservation techniques[a] | |
| Bad | 76.7 |
| Medium | 23.3 |
| Fair | 0.0 |
| Consume[a] | |
| Bad | 53.3 |
| Medium | 40.0 |
| Fair | 6.7 |
| Profit/ha (VND) | |
| ≤ 76 million | 80.0 |
| > 76 million | 20.0 |

[a] Bad: meeting below 40% requirements of production; medium: meeting 40%-60% requirements of production; fair: meeting from 60%-80% requirements of production; good: meeting over 80% requirements of production.

**Table 9 Factors involved in safe vegetable purchase chain.**

| Criteria | Percentage (%) |
|---|---|
| Vegetable type | |
| Lettuce | 20.0 |
| Sweet potatoes | 70.0 |
| Chinese mustard | 10.0 |
| Form of sale | |
| Processed | 60.0 |
| Not preliminarily processed | 40.0 |
| Frequency of purchase | |
| Daily | 100.0 |
| Amount of money | |
| < 200 thousand | 40.0 |
| 200-500 thousand | 30.0 |
| 500 thousand to 1 million | 20.0 |
| > 1 million | 10.0 |

*3.4.3.2 Reseller*

(1) Collectors: Collectors purchased vegetables produced in Hue city, districts in Thua Thien Hue province and other provinces. Collectors could purchase freely or order an amount of vegetables for households. Sweet potato, lettuce and Chinese mustard were the vegetables purchased in the most (70%, 20% and 10%, respectively) (Table 9). Vegetables were purchased in two forms—not pre-processed (40%) and semi-processed (60%). Vegetables were purchased daily to ensure a good taste and meet the demand of the customers. The amount of money for each purchase was less than 1 million VND.

(2) Retailing points: Retailing points was usually the kiosks and small food stalls on the streets. Retailers from retailing points could meet the demand of the urban population and provided high levels of convenience.

(3) Safe food shop: Safe food shops were the shops providing foods with safety certificates and tracing its provenance. However, there were some stores purchasing foods that did not have any certificates of safety. Safe food shops only met the demand of safe food for customers in small quantities, but the product was quite diverse and rich in types.

(4) Restaurant: The restaurants, which were mainly the wedding restaurants, were also a participant in the chain, because vegetables were provided to serve for food processing.

*3.4.3.3 Consumer*

Consumers were an important link of the safe food supply chain of Hue city. Most of consumers, who could purchase likely the safe food, were people of medium and good level income.

The production, distribution and consumption of safe vegetables in Hue city was about recent 7-10 years. This issue was later as compared with other places in the country. For example, safe vegetables have been produced and consumed in Hanoi since 1996 [18, 19]. The reports indicated that supplying channels of safe vegetables had a diversification with various managements and organization established in Hanoi more than 20 years. The current supply chain for safe vegetables in Hue only meets a part of the needs of producers and consumers. According to Son and Anh [18], three major groups of activities were to be successfully implemented in a value chain to bring safe vegetable to end consume. These were production of safe foods, distribution and marketing. Vegetable growers in Hue produce their products in small areas, lack of capital, planting only 2-3 vegetables per crop, poor preliminary treatment and preservation. The chain link between the production and consumption of the vegetables is unsustainable. Producers and consumers do not have closely links. Vegetable sold to consumers can not be tracing to the provenance and there is no safe certificate. In addition, the inspection of safe vegetables business is not carried out in the past years, and this leads to that safe vegetable are difficult to compete with common vegetables. The consumers believe the quality of vegetables depending on the prestige of the suppliers, such as the vegetable shops with foreign consultants. Safe vegetables produced by farmers in Hue are very difficult to be certified for safety. Production and consumption of safe vegetables in Thua Thien Hue were reported to face many difficulties. Producing safe vegetables was more risky, yield was lower (15%-30%) and labor to

production was more than that in unsafe vegetables [17]. Because of this, vegetable growers can not comply with the process of producing safe vegetables. About 85% of household survey in Viet Tri city showed they did trust vegetables more when their quality is guaranteed by an official food safety certification by the Vietnam authorities [9]. The vegetables certified for the safety have been produced in accordance with national regulations, which address food safety primarily from a pest management perspective. In addition, it is not clearly defined by agencies and departments to ensure the quality of safe vegetables, so it was difficult to create trust to consumers [17, 20, 21]. In similarity, Hoa et al. [22] reported that poor management and lack of supply chain administration knowledge caused difficulties for local farmers and Da Nang citizens to interact with safe vegetables, which is consistent with this study.

## 4. Conclusions

In the current study, it showed that the population of Hue city and people's income have increased over the last years, so the area of vegetables produced in the city has increased to meet the needs of the people. Safe vegetables produced by farmers in Hue city were not diverse in terms of type and the quality was not high in comparison with other places, like Da Lat, Hanoi and Mekong Delta. The vegetable consumers in Hue city spending on each purchase was less than 30 thousand VND per time. This expenditure has not created a great motivation for developing safe vegetable. The interest of consumers to safe food was becoming increasing and their demand was also increasing. They believed and were satisfied with the vegetables produced in the local. However, the prices of safe vegetables were not matched with quality. Some links of the chain of safe vegetables supply in the city of Hue have been limited. For example, land, seed, capital, cultivation techniques, preliminary processing, preservation, trademark and place to consume had not met the requirement of high technology production for the supply chain of safe vegetables. Safe vegetables of farmers were very difficult to be certified for safety. Vegetables could not be tracing to the provenance and there was no safe certificate. The consumers believed the quality of vegetables depending on the prestige of the suppliers, such as the vegetable shops with foreign consultants.

In order to meet the increasing demand of safe vegetables, it is necessary to plan the reasonable development of production area in Hue city. Investment in infrastructure for the safe vegetable production and consumption to create a production model towards modernization and professionalism should be done. In addition, farmers should be supported with capital, knowledge, technology, vegetable preliminary processing and preservation. They should be supported to build a trademark, brand name and certificate of vegetable safety and establish the chains of effective safe vegetable consumption. The support from the Thua Thien Hue People's Committee and local authorities establish and promote the close link between the producers and businessman engaging in the production-business of safe vegetables.

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## References

[1] Zhang, W. J., Jiang, F. B., and Ou, J. F. 2011. "Global Pesticide Consumption and Pollution: With China as a Focus." *Proc. Int. Acad. Ecol. Environ. Sci.* 1 (2): 125-44.

[2] World Health Organization (WHO). 2002. "WHO Global Strategy for Food Safety: Safer Food for Better Health." Food Safety Programme, World Health Organization. Accessed August 30, 2017. http://apps.who.int/iris/bitstream/10665/42559/1/9241545747.pdf.

[3] Havelaar, A. H., Kirk, M. D., Torgerson, P. R., Gibb, H. J., Hald, T., Lake, R. J., Praet, N., Bellinger, D. C., De Silva, N. R., Gargouri, N., Speybroeck, N., Cawthorne, A., Mathers, C., Stein, C., Angulo, F. J., and Devleesschauwer, B. 2015. "World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010." *PLoS Medicine* 12 (12): e1001923.

[4] The Work Bank. 2016. *Vietnam Food Safety Risks Management: Challenges and Opportunities.* Washington, D.C.: World Bank Group.

[5] Department of Food Safety. 2012. "Situation of food Poisoning 2007-2012 and Measures to Prevent Food Poisoning in the Coming Time." Ministry of Health. Accessed August 30, 2017. http://vfa.gov.vn/so-lieu-bao-cao/ngo-doc-thuc-pham/23.vfa. (in Vietnamese)

[6] Hanh, T. T. T., Phuc, P. D., Sinh, D. X., Ngan, T. T., Tuat, C. V., and Hung, N. V. 2016. "Antibiotic Residues, Growth Promoters and Heavy Metals in Pork at Wet Markets in Vietnam, 2015." Presented at Food Safety Risks Management in Vietnam: Challenges and Priorities, Round Table Discussion in Hanoi, January 7-8, 2016.

[7] Hanh, N. T., and Thoa, D. K. 2016. "Vegetables and Fruits: Food Safety Situation in Vietnam." Presented at Food Safety Risks Management in Vietnam: Challenges and Priorities, Round Table Discussion in Hanoi, January 7-8, 2016.

[8] Truong, N. V., and Vi, N. T. H. 2016. "Survey on Pesticide Use in Thua Thien Hue Province." *Sci. Tech. J. Agric. Rural Dev.* 3: 36-43. (in Vietnamese)

[9] Wertheim-Heck, S. C. O., Spaargaren, G., and Vellema, S. 2014. "Food Safety in Everyday Life: Shopping for Vegetables in a Rural City in Vietnam." *J. Rural Stud.* 35: 37-48.

[10] Anh, L., and Tuyen, D. 2011. "Food Poisoning due to Eating Cabbage Applied with Pesticides." Accessed August 30, 2017. http://dantri.com.vn/suc-khoe/ngo-doc-thuc-pham-tap-the-do-an-bap-cai-co-chat-bao-ve-thuc-vat-1300795783.htm. (in Vietnamese)

[11] Ministry of Health. 2016. *Joint Annual Health Report (JAHR) 2015: Strengthening Grass-Root Health towards Universal Health Coverage*. (in Vietnamese)

[12] FAO/WHO. 2016. *Pesticide Residues in Food 2016.* Rome: Food and Agriculture Organization of the United Nations and Geneva: World Health Organization.

[13] Chan, K. 2016. *Manual on Good Agriculture Practices.* Tokyo: Asian Productivity Organization, 203.

[14] Union of Vietnam Science and Technology Associations. 2016. "Situation of Safe Vegetables Consumption in Hue City." Accessed August 30, 2017. http://text.123doc.org/document/1342176-thuc-trang-tieu-thu-rau-an-toan-tren-dia-ban-thanh-pho-hue.htm. (in Vietnamese)

[15] Statistical Agency of Hue City. 2015. *Thua Thien Hue Statistical Yearbook 2015.* (in Vietnamese)

[16] Anh, D. T. 2005. "Research on Sustainable Development of Safe Vegetables in Hanoi." Ph.D. thesis, Hanoi Agriculture University. (in Vietnamese)

[17] Sen, L. T. H., and Hong, H. T. 2012. "Factors Affecting Safe Vegetable Production and Consumption in Thua Thien Hue Province." *Hue Univ. J. Sci.: Agric. Rural Dev.* 71: 253-66. (in Vietnamese)

[18] Son, H. T., and Anh, D. T. 2006. "Analysis of Safe Vegetables Value Chain in Hanoi." Agrarian System Department, Vietnam Agriculture Science Institute. Accessed August 30, 2017. http://www.sme-gtz.org.vn/Portals/0/AnPham/5-Analysis%20of%20safe%20vegetables%20value%20chain%20in%20Hanoi-ENG.pdf.

[19] Thuan, N. T. 2003. "Current Situation of Production and Distribution of Safe Vegetables in Van Noi Commune, Dong Anh District, Hanoi City." *J. Agric. Sci. Tech.* 2: 157-63. (in Vietnamese)

[20] Toan, D. S. 2005. "Survey on the Status of Production and Consumption of Safe Vegetables in Thua Thien Hue Province." M.Sc. thesis, University of Agriculture and Forestry, Hue University (HUAF). (in Vietnamese)

[21] Vu, H. 2011. "Situation and Solutions for Developing Safe Vegetables in Thua Thien Hue." Department of Science and Technology of Thua Thien Hue Province. Accessed August 30, 2017. https://skhcn.thuathienhue.gov.vn/?gd=1&cn=132&tc=2914. (in Vietnamese)

[22] Hoa, P. T. N., Phuong, N. H., and Hang, B. T. T. 2012. "Improving the Supply Chain of Safe Vegetable for the Key Area in Tuy Loan-Da Nang." In *Proceedings of the 8th Student Research Conference of the University of Danang*, 1-9. (in Vietnamese)