IMPERATIVES FOR IMPROVEMENT OF FOOD SAFETY IN FRUIT AND VEGETABLE VALUE CHAINS IN VIET NAM

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ASIAN DEVELOPMENT BANK

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On the cover: Ha Noi food market. Vendors sell their fruits in downtown Ha Noi, Viet Nam (photo by ADB).

Contents

Tables and Figures

Tables

Figures

Acknowledgments

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Abbreviations

COVID-19	coronavirus disease
DW	dry weight
E. coli	Escherichia coli
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FW	fresh weight
ha	hectare
kg	kilogram
MARD	Ministry of Agriculture and Rural Development
mg	milligram
MOH	Ministry of Health
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MPL	maximum permissible level
MRL	maximum residue limit
VietGAP	Viet Nam National Public Standard for Good Agricultural Practices

Executive Summary

Key Findings

1. Production of fruits and vegetables in Viet Nam has been changing, which is driven by consumer preferences, urbanization, demographics, and rising incomes. Yet, they are produced with high usage of chemical fertilizers and pesticides. Consumers, in general, particularly in Ha Noi, buy most of their fruits and vegetables from traditional wet markets. Produce sold in these markets are not certified and not traceable to farms. Many wet markets in Ha Noi suffer from insufficient infrastructure. Waste management is unhygienic, and there is no clear separation between the areas selling fruits and vegetables and those selling animals and animal products.

2. Researchers from Vietnam National University of Agriculture (VNUA) collected biological samples of mustard greens, cucumber, and dragon fruit from farms, wholesale markets, and retail markets and analyzed them for Salmonella and Escherichia coli (E. coli) at the Department of Food Processing Technology at VNUA. Their analysis shows that foodborne pathogens are a particular concern for leafy vegetables. About 31% of the mustard greens samples collected from farms had E. coli loads above maximum permissible levels, 67% for samples collected from wholesale markets, and 82% from retail markets. The increase of pathogenic loads across the value chains—from farm to retail—can be traced from lack of hygienic practices in handling of fruits and vegetables by all players.

3. Samples of dragon fruit, mustard greens, and cucumber were also analyzed for five commonly used chemical pesticides, two heavy metals, and nitrate. Pesticide residue analysis was performed at the National Institute for Food Control, while the other contaminants were analyzed at the Department of Food Processing Technology at VNUA. Out the three types of produce sampled, pesticide residue above permissible levels was found only in cucumber. No samples had heavy metals and nitrate concentrations above maximum permissible levels. A banned active ingredient was detected in only one type of produce, mustard greens (in one of 20 samples), and was not found in dragon fruit or cucumber.

4. Chemical pesticide contamination in fruits and vegetables is a key concern of consumers and other stakeholders. Foodborne pathogens are generally perceived as a smaller concern because consumers believe they can manage this risk through food preparation methods, which is a misconception as foodborne pathogens are the most important health risks for Vietnamese consumers (World Bank 2016).

5. The Government of Viet Nam has designated particular areas for "safe vegetable production." These areas currently account for about 40% of Ha Noi's vegetable area of 12,000 hectares. Vegetable farmers in these areas have been encouraged to form producer cooperatives. The government regularly tests soil and water quality and also tests vegetable produce for pesticide residues once a year. Livestock farming is not allowed in these areas to reduce the risk of cross-contamination. These actions contribute to improving the food safety of vegetables to some extent. But they do help government agencies to better support smallholder vegetable farmers and monitor the quality of the produce.

6. Over the past decade, Viet Nam has revised its food safety laws and regulations, and the existing frameworks are mainly in line with international standards (Vu and Anh 2016). The country has a National Food Safety Committee, but there is no central food safety agency. Responsibilities are divided over three ministries (agriculture, commerce, and health), which results in some contradictions and confusion in enacting food safety-related regulations and acts among these ministries.

7. The implementing capacity of government organizations is rather limited. Authorities in charge of food safety seem to remain focused on inspection and control of end products, but not much on preventing contamination in production and marketing processes.

Key Recommendations

1. Organizing smallholder farmers into groups (producers' cooperatives) and introducing "safe vegetable production areas" play a catalytic role in promoting fruit and vegetable safety. This study therefore recommends expanding these practices to other parts of the country.

2. The misuse of chemical pesticides, which is a major concern for consumers, should be reduced through incentives and control mechanisms. Farmers need to be adequately rewarded for safe produce, while also subject to stricter enforcement of existing pesticide regulations. Existing regulations governing pesticide use need to be harmonized. The promotion of safer alternatives to chemical pesticides such as biopesticides will also reduce food safety risks. Farmers should be trained in (i) soil fertility management to avoid overuse of fertilizer, (ii) integrated pest and disease management, and (iii) business development to identify new market niches that value quality and safety of food.

3. The government and the private sector should work together to better categorize fruits and vegetables based on food safety and other quality aspects. Such segmentation of markets reduces competition that is solely based on price and volume, which is a disincentive for suppliers of high-quality produce. A section of a wet market could be designated as "safe fruits and vegetables" showing labels and traceability and supported by regular testing. A feasibility study could be conducted to test the interest of consumers and market vendors and to inform a subsequent pilot program.

4. At the level of food safety management, there is a need for more systematic testing for contaminants and making test results publicly available as this is necessary to guide investments and regain consumer confidence in food safety. There is also a clear need to strengthen the capacity of food safety authorities, both at national and subnational levels. Food safety management needs to be guided by a clear understanding of and focus on risk factors, systematic use of data, and shared responsibilities between private and public sector actors, and preventive measures implemented along the value chain.

Note: This study is based on the pesticide and contaminants residue analysis conducted by the Vietnam National University of Agriculture, Plant Protection Department of Viet Nam. The data presented in this report has not been validated.

I. Introduction

Food safety is very important in achieving the Sustainable Development Goals because when food is not safe, food security and improved nutrition cannot be achieved (FAO 2019). However, it is still a growing concern in many countries in Asia. Underlying factors include increased use of chemical fertilizer and pesticides, improper use of preservatives during transition of food from field to market, increased consumption of processed food, poor enforcement of laws and regulations, and lack of proper storage and logistics. Fresh fruits, vegetables, and animal-sourced foods give rise to particular food safety concerns (Grace 2015) because of their high water content and vulnerability to foodborne pathogens (e.g., bacteria, viruses, parasites) that may enter the food value chain as a result of unhygienic practices and lack of proper agrilogistics anywhere between "field and fork." The mean consumption of fruits and vegetables combined is estimated to be 132.1 kilograms (kg) per person per year in Viet Nam (Table 1), which is well below the 146 kg/person/year or a daily per capita equivalent of 400 grams recommended by the World Health Organization.

Table 1. **Production, Consumption, and International Trade of Fruits and Vegetables in Viet Nam**

WGPG	Vegetables	Fruit
Production area (m^2/person)[a]	114.3	75.2
Production (kg/person/year)[a]	177.9	104.7
Consumption (kg/person/year)[b]	99.7	32.4
Exports (% of production)[a]	0.4	12.9
Imports/exports (ratio)[a]	2.0	0.4

kg = kilogram, m^2 = square meter.

[a] Food and Agriculture Organization of the United Nations (FAO). FAO Corporate Statistical Database (FAOSTAT). http://www.fao.org/faostat/en/#data (accessed 3 August 2021). Data is as of 2019.

[b] A. Afshin et al. 2019. Health Effects of Dietary Risks in 195 Countries, 1990–2017: A Systematic Analysis for the Global Burden of Disease Study 2017. The Lancet. 393 (10184). pp. 1958–1972; and GAIN and Johns Hopkins University. Food Systems Dashboard. https://foodsystemsdashboard.org/ (accessed 3 August 2021). Data is as of 2018 and covers adults 25 years old and above. In comparison, the Viet Nam Household Living Standard Survey estimated the consumption of vegetables at just 21 kg/person/year and fruits at 12 kg/person/year for 2018 (General Statistics Office of Viet Nam. 2021. *Results of the Viet Nam Household Living Standards Survey 2020*. Hanoi: GSO Statistical Publishing House).

This study focuses on the safety of fruit and vegetable value chains in Viet Nam, which are very important in the country as they generate income for millions of smallholder farmers and other value chain actors. The study assesses the food safety in fruits and vegetables in Viet Nam based on primary information through laboratory analysis of samples of selected produce from the field. This study is limited to a small sample size as data were collected during the coronavirus disease (COVID-19) pandemic.

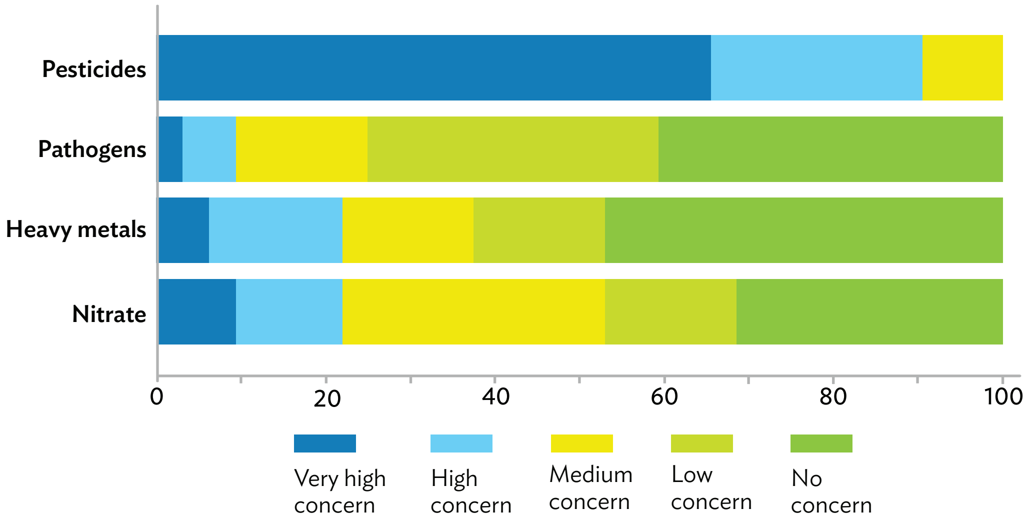
Viet Nam introduced certification of "safe vegetables" (*Rau an toan* or RAT in Vietnamese) in the early 1990s. These are vegetables produced in production zones where government agencies have verified that soil and water quality are good enough to enable safe production. Livestock farming is not allowed in these zones to reduce the risk of microbial contaminants entering the supply chain. The government has encouraged farmers in these zones to form groups (producer cooperatives) to ensure better quality control over production. Government agencies provide cooperatives with training on integrated pest management, safe pesticide use, and safe farming practices; assess soil and water quality annually through laboratory tests; and take random samples of the produce to test for pesticide residues.

The safe vegetable standard was further developed and became the Viet Nam National Public Standard for Good Agricultural Practices (VietGAP), launched in 2008. It consists of 65 control points (MARD 2008), and has crop-specific principles, including soil management, water use, pesticide safety, postharvest management, and farm record keeping. Technical training on VietGAP has been provided to many local extension officers and farmers. Shortly after the launch of the standard, there were 198 farmers, farmer groups, and cooperatives certified in 2010, and this increased to 1,406 in 2017 (Anh et al. 2019). In total, VietGAP certification reached 3,443 hectares (ha) of vegetables and 11,813 ha of fruits in 2017, which is just 0.4% and 1.3% of the total area for vegetables and fruits, respectively (Anh et al. 2019). By 2019, this had increased to about 6,000 ha of vegetables and 22,000 ha of fruits, which is a substantial increase but still only a fraction of the total area for fruits and vegetables (Phuc 2020).

Many farmers did not continue adhering to VietGAP as they found it difficult to comply with all the requirements and to find a market for certified vegetables (Thanh 2016). For instance, in Lam Dong Province, it was reported that the Department of Agricultural and Rural Development supported and certified 400 individual farmers in 2011–2012, but no farmer reapplied for VietGAP when the certificate expired (Tung 2016).

Most consumers buy fruits and vegetables from the wet market, where produce does not have safety labels. There are no stable business relations between retailers and wholesalers. This also makes tracking of produce through the supply chain very difficult. Modern retail is rapidly growing in Viet Nam and the government sees this as a key strategy to improving food safety (Wertheim-Heck and Spaargaren 2016; Wertheim-Heck et al. 2015). Supermarkets and shops usually require vegetables to be sourced from safe vegetable production areas, but there are reports that "safe vegetable farmers" buy produce from other farmers or wholesale markets and resell it to supermarkets (Nong nghiep 2015). Cold chains for fruits and vegetables are also

Figure 1. **Food Safety Concerns Among Key Informants in Viet Nam, 2021**



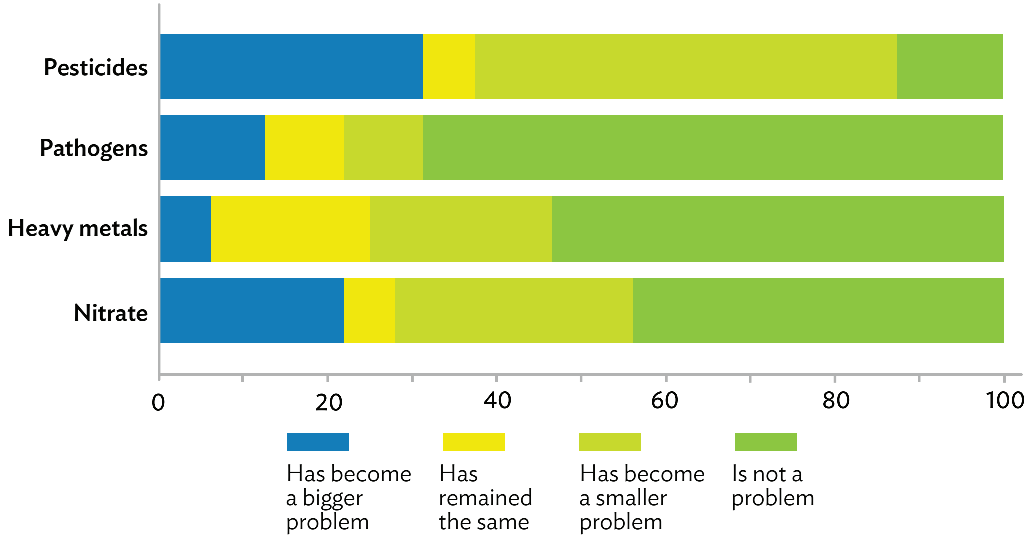
Note: Based on the responses of 32 stakeholders interviewed for this study.
Source: Asian Development Bank.

not well-developed in Viet Nam. It has been estimated that the current cold storage capacity can only store 5% of the country's vegetable production (ADB 2020).

A survey conducted for this study found that about 91% of respondents are highly concerned about contamination of food because of the use of pesticides (Figure 1). This may be because pesticides invoke a greater "fear factor" among consumers as they perceive it as something unnatural and out of their control (Nguyen-Viet et al. 2017). The farmers' practice of mixing different pesticides together is another important factor contributing to high pesticide risk. Mixing is not usually recommended because different chemicals may react and this may reduce their effectiveness and bring hazards. Yet, farmers believe that it makes spraying more effective and reduces the time needed for spraying (Hoi et al. 2009a). A study of vegetable farmers in Lam Dong Province in Viet Nam found that 72% of farmers mixed two pesticides and 28% even mixed three pesticides together (Nguyen et al. 2018). The interviews conducted for this study confirmed problems with pesticide misuse on farms. Scientific studies for Viet Nam have also shown that consumers are mostly concerned about the risk of chemical pesticides (Ha et al. 2019, 2020; Nguyen-Viet et al. 2017; Wang et al. 2012; Wertheim-Heck and Raneri 2020). Consumers are relatively less concerned about foodborne pathogens, partly because of their lack of knowledge and awareness of the problem, and partly because they think that they can solve this problem by washing, peeling, and proper cooking.

The survey also identified respondents' growing concerns about the contamination of fruits and vegetables for all four contaminants as shown in Figure 2. Use of chemical pesticides is of particular concern, with 31% of respondents indicating that the situation has worsened over the last 10 years.

Figure 2. **Changes in the Contamination of Fruit and Vegetables as Perceived by Stakeholders over the Last 10 Years in Viet Nam, 2021**



Note: Based on the responses of 32 stakeholders interviewed for this study.

Source: Asian Development Bank.

Yen (2019) conducted a comprehensive study of salad vegetables sold in Ha Noi, collecting 30 samples each from traditional wet markets, supermarkets, and restaurants. She found that 100% of samples taken from wet markets and restaurants and 57% of samples taken from supermarkets were contaminated with coliform and Escherichia coli (E. coli) bacteria. Such high levels of contamination were also found by Ha et al. (2013) for leafy vegetables collected from farms in southern Viet Nam.

A study among urban consumers in Ha Noi estimated that consumers' worries about food safety have reduced consumption by 8.5% (Ha et al. 2020). Extrapolating this to fruits and vegetables to the whole of Viet Nam would mean an annual economic loss of about $381 million to primary producers. In addition to the economic losses incurred by other value chain actors, the health costs from (i) unsafe food production methods to farmers (e.g., pesticide health effects), (ii) unsafe food intake by consumers (e.g., diarrhea and other foodborne diseases), and (iii) underconsumption of fruits and vegetables, as well as the total economic cost of unsafe fruits and vegetables will easily exceed $1 billion per year. Interventions to improve food safety in fruits and vegetables can therefore yield high returns on investment.

Against this backdrop, the objective of this study is to assess food safety issues related to fruits and vegetables in Viet Nam. The specific objectives are to (i) identify the critical contaminants and contamination points for fruits and vegetables; (ii) review food safety systems, laws and regulations, and their implementation; and (iii) recommend interventions and activities for enhancing vegetable safety in the country.

II. Methodology and Data

Data for the study were collected through a review of published literature; interviews with farmers, input suppliers, and key informants; and sampling of fruits and vegetables at several points in the value chain. All data were collected from June to July 2021 before a lockdown came into effect due to the COVID-19 pandemic. The literature survey was conducted based on the scientific literature available on Google Scholar using keywords such as food safety, pesticide, pathogen, heavy metal, vegetables, and fruits in combination with the country name. These literatures were used to prepare the questionnaires and contextualize the study. Primary data were collected from Ha Noi. This is partly because key informants from regulatory agencies are in Ha Noi, and food safety challenges in Ha Noi have been well-documented in scientific literature. The study focused on produce sold in wet markets rather than supermarkets or grocery stores.

A. Interview Data

Four questionnaires were developed for interviewing key informants, while two questionnaires were used for farmers and agrodealers to collect information and perceptions from a wide range of actors who have a stake in food safety issues in the fruit and vegetable value chains (Appendix 1). Questionnaire 1 was used for government officers working in food safety agencies, plant protection departments, ministries, and universities. Questionnaire 2 was used for private sector companies—including input suppliers, restaurant owners, supermarket owners, exporters, and importers. Questionnaire 3 was used for consumer representatives, which included researchers, journalists, managers of collective kitchens, and consumer protection groups. Questionnaire 4 was used for producers, which included four producer cooperatives in Viet Nam. Questionnaires 5 and 6 were used in the communities where the biological samples were collected from farmers' fields. Table 2 shows the total number of respondents for each category of key informants interviewed in Ha Noi City and nearby districts including Gia Lam and Dong Anh. This study notes that the sample is too small to compare between categories or for statistical analysis.

B. Product Sampling

This study selected one leafy vegetable (mustard greens), one fruit vegetable (cucumber), and one fruit (dragon fruit) for the collection and analysis of biological samples in the months of June and July. The total vegetable plantation in Ha Noi during this season is about 9,600 ha (Hanoi DARD 2020). Mustard greens and cucumber occupy 23% and 5% of this area, respectively (Hanoi DARD 2020). Viet Nam is one of the world's largest producers of dragon fruit, with total production of 1.25 million tons in 2020.

Table 2. **Key Informant Interviews Conducted for the Study**

Government	9
Producers	4
Private sector	17
Retailers/Consumer	2
Total	**32**

Notes:
1. Interviews were conducted from 25 June to 17 July.
2. Farmers and agrodealers were additionally interviewed, but are not included in the table.

Source: Authors' compilation based on study.

The study aimed to assess the presence of different types of contaminants, including chemical pesticides, foodborne pathogens, heavy metals, and nitrate in the selected fruits and vegetables. Each of these contaminants has its own contamination pathway. Pathogen loads may accumulate along the value chains and therefore pathogens were analyzed at farm, wholesale, and retail levels. In contrast, pesticides, heavy metals, and nitrate enter the value chain in the field, and do not accumulate. These were therefore analyzed from farm samples. Contamination with heavy metals is only possible if soils or irrigation water are contaminated with these chemicals. Therefore, contamination levels were first tested in soil and water samples before deciding whether to also analyze heavy metals from product samples.
Table 3 describes the eventual sample selection. A total of 156 samples were tested for microbial contamination, 60 samples were analyzed for pesticide residues, 136 samples were analyzed for heavy metals, and 116 samples were analyzed for nitrate. All samples were selected randomly and put into sterile polyethylene bags, which were placed in ice-packed cool boxes and transported to specialized laboratories for analysis. The minimum weight of each sample was 4 kg of produce. It was confirmed with sellers that all fruit and vegetable samples were produced locally, and not imported.

Mustard greens and cucumber were randomly sampled from farmers' fields during the harvesting period as well as from wholesale and retail markets in Ha Noi. Sample locations were selected in consultation with the Division of Plant Protection in Ha Noi. All mustard greens and cucumber farmers included in this study were located in "safe vegetable production areas" in peri-urban areas of Ha Noi. These "safe" areas account for about half of Ha Noi's total vegetable area of 12,000 ha. In these locations, soil and water quality are monitored by government authorities, and livestock farming is not allowed. But this provides no assurance that the vegetables grown there are safe—particularly with regard to chemical pesticide contamination. Farmers in these locations are organized in producer cooperatives, and they produce vegetables intensively year-round. Vegetable producers outside these "safe" areas can be characterized as individual farmers that are not organized in cooperatives and are more dispersed and

Table 3. **Sample Distribution over Control Points, Crops, and Key Contaminants**

Control Point	Crop	Pathogens (2 types)	Pesticides (5 types)	Heavy Metals types	Nitrate
Farm	Soil	0	0	10	0
	Water	0	0	10	0
	Mustard greens	32	20	48	48
	Cucumber	32	20	48	48
	Dragon fruit	0	0	0	0
Wholesale	Mustard greens	15	0	0	0
	Cucumber	15	0	0	0
	Dragon fruit	22	20	20	20
Retail	Mustard greens	11	0	0	0
	Cucumber	11	0	0	0
	Dragon fruit	18	0	0	0

Note: Vegetable samples were taken from farmers' fields in Gia Lam, Dong Anh, Hoai Duc, and Chuong My districts. Wholesale markets included Long Bien, Minh Khai, Southernt, Van Noi, and Yen Thuong. Retail markets included many markets in Ha Noi City and local markets near the sampling locations. Dragon fruit could not be sampled from farms because of the COVID-19 pandemic.
Source: Authors' compilation based on study.

small-scale. Many of them grow rice instead of vegetables during the summer and rainy seasons. Another practical reason for selecting cooperatives was that it was technically possible to collect random vegetable samples from a number of different fields that were ready for harvesting. Nevertheless, it is important to point out that the decision to select samples from "safe" areas may skew the results. However, it was noted that the vegetable samples taken from wholesale and retail markets include all types of producers and are not affected by this bias.

Dragon fruits are not produced in Ha Noi, and most of these produce come from Binh Thuan Province in the south of Viet Nam. It was not possible to travel there to collect samples because of the COVID-19 pandemic. Random samples were thereby taken from wholesale and retail markets in Ha Noi after confirming with the sellers that the produce originated from Binh Thuan Province.

Pesticide residue analysis was performed at the National Institute for Food Control, while all other contaminants were analyzed at the Department of Food Processing Technology at the Vietnam National University of Agriculture. The analysis of heavy metals focused on arsenic, cadmium, lead, and mercury, which are highly toxic but commonly occurring heavy metals. The analysis of foodborne pathogens focused on Salmonella and E. coli, which are indicators of fecal contamination and two of the most frequently reported causes of foodborne illnesses. The analysis of pesticide residues focused on a selection of insecticides, fungicides, and herbicides mentioned by farmers, input suppliers, and food safety experts, which are commonly applied on the selected crops. These were used as proxy indicators for pesticide risk as it was not possible to analyze many different pesticide compounds. The study also quantified nitrate. Nitrate itself is relatively non-toxic, but some of its metabolites and reaction products are potentially carcinogenic. Heavy use of chemical fertilizers, particularly on leafy vegetables, can therefore create a food safety risk. Protocols published by the International Organization for Standardization (ISO) were followed for the analysis of all contaminants. Details are described in Appendix 2.

III. Analysis of Key Contaminants

A. Heavy Metals in Soil and Water Samples for Growing Mustard Greens and Cucumber

Heavy metals in surface water can originate from the weathering of soils, rocks, and anthropogenic disturbances in the natural distribution of heavy metals in surface waters. Soils may become contaminated with heavy metals from factories, garbage waste, chemical fertilizers and pesticides, animal manure, sewage sludge, wastewater irrigation, and atmospheric deposition (Cherfi et al. 2015; Järup 2003; Liao et al. 2011). A total of 10 soil samples and 10 irrigation water samples were taken to quantify concentrations of arsenic, cadmium, lead, and mercury (Table 4).

All four heavy metals were detected in soil samples with lead found to have the highest mean concentration at 23.06 milligrams (mg)/kg of dry weight (DW), followed by arsenic (5.75 mg/kg DW), cadmium (1.75 mg/kg DW), and mercury (0.37 mg/kg DW). The large standard deviations indicate high variation of the chemical concentrations across locations. A comparison of the measured concentrations against the national standard of Viet Nam (QCVN 03-MT:2015/BTNMT) and the European Union (EU) regulation (Directive 86/278/EEC) shows that the mean levels of mercury, arsenic, and lead in soil samples are below maximum permissible levels (MPLs), except for cadmium. Three of the 10 samples have cadmium concentrations that exceeded both the Viet Nam national and EU MPLs.

Mercury, lead, and cadmium concentrations in irrigation water samples were below the detectable limit of the machine at 0.00015 mg/liter. Arsenic was present at a low concentration (0.009 mg/liter) but did not exceed the MPL set by the Government of Viet Nam (QCVN 39:2011/BTNMT) as well as the MPLs set by the Food and Agriculture Organization of the United Nations (FAO) and the United States Department of Agriculture. It can therefore be concluded that there are low health risks of heavy metals in soil and water resources.

B. Risk Assessment of Heavy Metals and Nitrate

Based on the above results, we did not quantify mercury and arsenic in farm produce, but focused on lead, cadmium, and nitrate (Table 5).

[1] See Appendix 2 for details on sampling and laboratory test of samples.

Table 4: **Heavy Metals Detected in Soil and Irrigation Water Samples in Production Areas of Mustard Greens and Cucumber in Peri-Urban Ha Noi, July 2021**
(mg/kg dry weight for soil samples and mg/L for water samples)

Sample Type	Sample Size	Mercury	Arsenic	Lead	Cadmium
Soil	10	0.37 ± 0.18	5.76 ± 3.26	23.06 ± 7.41	1.75 ± 0.80
Water	10	ND	0.009 ± 0.002	ND	ND
Viet Nam MPL for soil[a]		-	15	70	1.5
EU MPL for soil[b]		1 - 1.5	-	50 - 300	1 - 3
Viet Nam MPL for water[a]		0.001	0.05	0.05	0.01
FAO/USDA MPL for water[c]		-	0.10	5.00	0.01

EU = European Union, FAO = Food and Agriculture Organization of the United Nations, kg = kilogram, L = liter, mg = milligram, MPL = maximum permissible level, ND = not detected, USDA = United States Department of Agriculture.

Notes:
1. Level of detection for lead and cadmium is 0.00015 mg/L.
2. Data are expressed as the mean value followed by standard deviation.

[a] National standard of Viet Nam according to QCVN 03-MT:2015/BTNMT for soil and QCVN 39:2011/BTNMT for water.
[b] EU regulation according to Directive 86/278/EEC for soil.
[c] FAO and USDA have similar regulations for water quality for agriculture.

Source: Data collected for this study.

Among the crops studied, mustard greens had the highest concentration of lead at 0.05 mg/kg of fresh weight (FW), while cucumber and dragon fruit had the lowest concentration (0.01 mg/kg FW). Similarly, cadmium was detected in mustard greens at a concentration of 0.009 mg/kg FW, but was not detected in the other crops.

According to scientific evidence, legumes acquire trace metals at low levels, fruit and root vegetables at intermediate levels, and leafy vegetables at high levels (Alexander et al. 2006; Finster et al. 2004; Säumel et al. 2012). However, a variety of other factors, such as plant species and varieties; the type of contaminant; soil conditions; and properties like pH, electrical conductivity, and organic carbon affect how well soil can absorb and accumulate trace metals (Alexander et al. 2006; Khan et al. 2015; Säumel et al. 2012; Waqas et al. 2014). A comparison against the national standard of Viet Nam (QCVN 8-2:2011/BYT), Codex (CXS 193-1995), and the EU (EC No 629/2008) shows that all measured concentrations are well below the MPLs, implying that the selected produce is safe for consumers.

Regarding nitrate, Table 5 shows that mustard greens has the ability of preferential nitrate uptake (275.7 mg/kg FW) as compared to cucumber and dragon fruit. It is known that leaves have a higher capacity to absorb nitrogen-containing compounds than fruits. Interviews with farmers also showed that farmers apply more nitrogen fertilizers on vegetables than on fruits; moreover, the production period of leafy vegetables is shorter. Currently, there is no standard for acceptable nitrate levels in agricultural produce in Viet Nam. A comparison with the EU standard (EC No. 1881/20062) shows that nitrate levels in all samples were below permissible levels and therefore unlikely to cause adverse health effects for consumers.

Table 5: **Heavy Metals and Nitrate Detected in Mustard Greens, Cucumber, and Dragon Fruit Collected in Ha Noi, July 2021**
(mg/kg fresh weight)

Crop	Sample Size	Lead	Cadmium	Nitrate
Mustard greens	48	0.050 ± 0.022	0.009 ± 0.004	275.7 ± 60.3
Cucumber	48	0.011 ± 0.005	ND[a]	103.1 ± 22.6
Dragon Fruit	20	0.010 ± 0.007	ND[b]	54.7 ± 7.9
MPL for leafy vegetables[c]		0.3	0.05	3,000
MPL for fruit[c]		0.1	0.05	NA

kg = kilogram, mg = milligram, MPL = maximum permissible level, NA = not applicable, ND = not detected.

Notes:
1. Mustard greens and cucumbers were collected from farmers' fields in peri-urban Ha Noi; whereas, dragon fruits were collected from markets in Ha Noi.
2. Level of detection for cadmium is 0.0015 mg/kg.
3. Data are expressed as the mean value followed by standard deviation.

[a] Cadmium was not detected in 37 out of 48 cucumber samples; 11 samples had cadmium level < limit of quantification.
[b] Cadmium was not detected in 18 out of 20 dragon fruit samples; 2 samples had cadmium level < limit of quantification.
[c] Based on the national standard of Viet Nam according to QCVN 8-2:2011/BYT for lead and cadmium, and EC No. 1881/20062 for nitrate in leafy vegetables.

Source: Data collected for this study.

C. Risk Assessment of Pesticide Residues

None of the dragon fruit samples had detectable levels of the six pesticides that were analyzed (Table 6). For mustard greens, four of the six pesticides analyzed were not detected while for cucumber, five of the six pesticides analyzed were not detected.

Emamectin benzoate was detected in one sample of mustard greens but its level was low (0.06 mg/kg FW) and below the legal threshold of both the national standard of Viet Nam (50/2016/TT-BYT) and the Codex (0.20 mg/kg FW). Emamectin benzoate was also detected in 1 of the 20 samples of cucumber at a very high concentration (0.73 mg/kg FW), which exceeds 100 times the maximum residue limit (MRL) of the national standard of Viet Nam (50/2016/TT-BYT). Furthermore, fipronil was detected in 1 of the 20 samples of mustard greens at a mean concentration of 0.29 mg/kg FW. Fipronil is highly toxic and was banned for use in Viet Nam in 2019 (Decision 501/QD-BNN-BVTV), but as mentioned above, it is still available in shops and used by farmers. Fipronil and emamectin benzoate are highly hazardous pesticides and bring high toxicity to the environment and human health with long-term exposure (PAN International 2021).

There is a need for caution in interpreting these results as farmers' access to and use of pesticides may have been affected by the COVID-19 pandemic and associated restrictions. Farmers had problems in exporting dragon fruit and may have reduced pesticide use to reduce costs. The results may therefore not be representative of other years.

Table 6: **Pesticide Residues Detected in Mustard Greens, Cucumber, and Dragon Fruit in Ha Noi, July 2021**
(mg/kg fresh weight)

Pesticide	Dragon Fruit (n=20)	Mustard Greens (n=20)			Cucumber (n=20)		
		MRL[a]	Samples > MRL	Mean	MRL[a]	Samples > MRL	Mean
Cypermethrin	ND		-	-		-	-
Permethrin	ND		-	-		-	-
Spinetoram	ND		-	-		-	-
Abamectin	ND	0.05	0/20	ND	0.010	0/20	ND
Azoxystrobin	ND	5.00	0/20	ND	1.000	0/20	ND
Emamectin benzoate	-	0.20	1/20	0.06 ± 0.01	0.007	1/20	0.73 ±0.1 5
Chlorpyrifos (banned)	-		0/20	ND		0/20	ND
Fipronil (banned)	-		1/20	0.29 ± 0.06		0/20	ND
Glyphosate (banned)	ND		0/20	ND		0/20	ND

- not tested, kg = kilogram, mg = milligram, MRL= maximum residue limit, n = sample size, ND = not detected.

Notes:
1. Mustard greens and cucumbers were collected from farmers' fields in peri-urban Ha Noi; whereas, dragon fruits were collected from markets in Ha Noi.
2. Mean values were calculated over the samples for which the pesticide was detected.
3. Data are expressed as the mean value followed by standard deviation calculated from three technical replicates.
4. Levels of detection (LOD)—chlorpyrifos: 0.005 mg/kg; fipronil: 0.001 mg/kg; emamectin benzoate: 0.001 mg/kg; abamectin: 0.001 mg/kg; azoxystrobin: 0.001 mg/kg; glyphosate: 0.01 mg/kg; cypermethrin: 0.005 mg/kg.

[a] National standard of Viet Nam according to 50/2016/TT-BYT, Codex for MRL pesticide residues in food. MRLs are not provided for banned substances.

Source: Data collected for this study.

D. Risk Assessment of Microbial Pathogens

Pathogens were analyzed from samples collected from farmers' fields and from wholesale and retail markets and tested for Salmonella and E. coli to evaluate microbial loads (Table 7). Salmonella was detected in one of the 32 samples of mustard greens collected from farmers' fields and in one of the 15 samples collected from wholesale markets. None of the 11 samples of mustard greens collected from retail markets tested positive for Salmonella. Also, none of the samples of cucumber and dragon fruit tested positive for Salmonella.

Table 7: Food-Borne Pathogens Present in Mustard Greens, Cucumber, and Dragon Fruit from Markets in Ha Noi, July 2021

Crop	Source	Sample Size	E. coli Samples > MPL	E. coli Range (CFU/g)	Salmonella Samples > MPL	Salmonella CFU/25g
Mustard greens	Farmers' field	32	10	$2.1 \times 10^1 - 3.6 \times 10^5$	1	+
	Wholesale market	15	10	$2.5 \times 10^2 - 2.9 \times 10^4$	1	+
	Retail market	11	9	$9.5 \times 10^2 - 9.8 \times 10^4$	0	ND
Cucumber	Farmers' field	32	0	ND	0	ND
	Wholesale market	15	0	$2.1 \times 10^1 - 8.1 \times 10^1$	0	ND
	Retail market	11	1	$2.1 \times 10^1 - 1.3 \times 10^4$	0	ND
Dragon fruit flesh	Wholesale market	8	0	ND	0	ND
	Retail market	14	0	ND	0	ND
Dragon fruit peel	Wholesale market	4	0	ND	0	ND
	Retail market	14	0	$2 \times 10^1 - 4.4 \times 10^2$	0	ND
MPL[a]				$10^2 - 10^3$		0

CFU = colony-forming unit, g = gram, MPL = maximum permissible level, ND = not detected.

Note: The crop samples were collected in different sampling locations from markets in Ha Noi.

[a] National standard of Viet Nam according to QCVN 8-3: 2012/BYT.

Source: Data collected for this study.

E. coli was more prevalent than Salmonella, and most prevalent in mustard greens. Pathogen loads in mustard greens clearly increased further down the value chain: 31% of the samples collected from farmers' fields had E. coli loads above the MPL of 10^2–10^3 colony-forming unit per gram (CFU/g); and this was also the case for 67% of the samples from wholesale markets and 82% from retail markets.

Contamination with E. coli was much lower in cucumber. E. coli was not detected in samples collected from farmers' fields but detected in 6 of the 15 samples collected from wholesale markets, although all were below the MPL. It was also detected in 1 of the 11 samples collected from retail markets, exceeding the MPL.

Dragon fruit has the least microbial contamination. All the samples, of both the fruit peel and the fruit flesh, were found to be in compliance with the national standard of Viet Nam (QCVN 8-3: 2012/BYT) for both E. coli and Salmonella.

IV. Policies, Laws, and Regulations

A. Regulatory Framework

Viet Nam has comprehensive frameworks of national laws, decrees, and regulations governing food safety (Appendix 3). The 2010 Law on Food Safety, which came into effect in July 2011, assigns food safety responsibilities to three ministries: the Ministry of Health (MOH), the Ministry of Agriculture and Rural Development (MARD), and the Ministry of Industry and Trade (MOIT). Each ministry is responsible for a specific part of the food chain (Table 8). For instance, the MARD is responsible for the safety of primary food production and its wholesale, and the MOIT is responsible for food safety in the production of certain processed food items (e.g., processed milk) and food selling on wet markets, shops, and supermarkets. The MOH has the overarching responsibility for food safety in Viet Nam and also controls the use of food additives, and the food safety and/or hygiene in restaurants, collective kitchens, and canteens.

Table 8: **Three Ministries in the Viet Nam National Food Control System**

Production	Distribution		
	Wholesale	Retail	Eateries
MARD	MOIT	MOIT	MOH
Primary production of crops, livestock, aquaculture, and fishing		Wet markets, street vendors, grocery shops, supermarkets	Restaurants, canteens, street food vendors

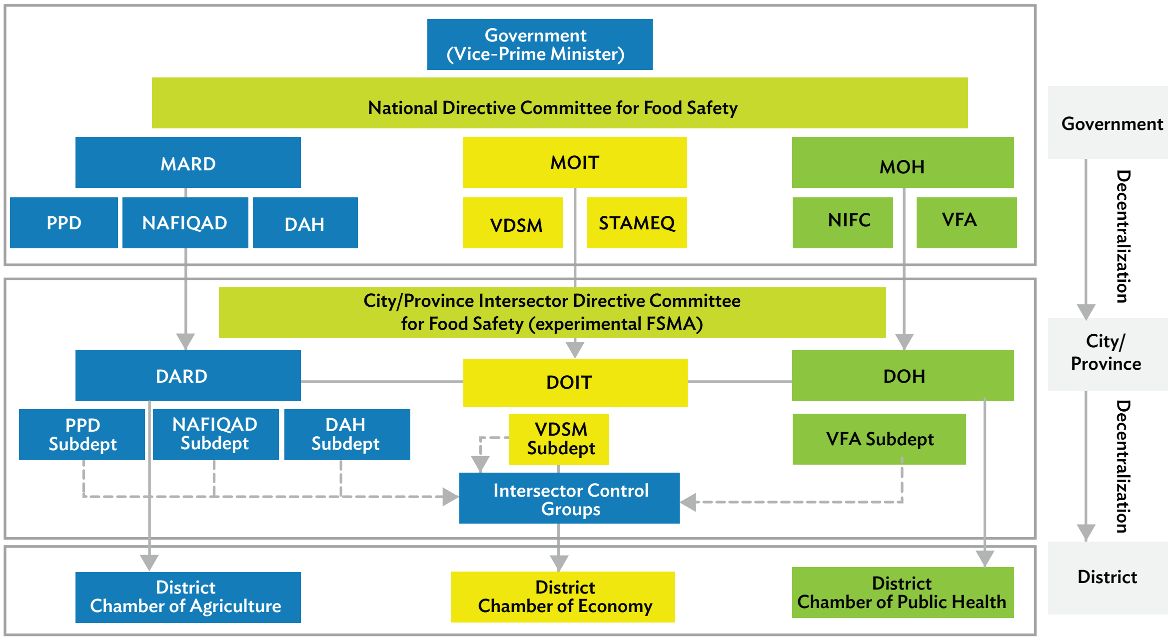
Source: Elaborated from Pham and Dinh (2020) as cited in Vu, P. H. and D. T. Anh. 2016. *Food Safety: Some Understandings on Agricultural Products, Production and Distribution System, and Government Policies.* Hanoi: Agricultural Publishing House.

Each ministry has assigned specific departments or agencies to control certain aspects of food safety (Figure 3).

Each department or agency has offices at provincial and district levels, which receive technical guidance from their ministries while their day-to-day operations are managed by the people's committees of the provinces or districts they belong to.

The stakeholders interviewed for this study mentioned that the current control system leads to inconsistencies as different ministries issue contradicting regulations, or outdated regulations are not withdrawn or updated in a timely fashion. For instance, the MOH specifies MRLs for broad-spectrum organochlorine pesticides such as aldrin and dieldrin, heptachlor,

Figure 3: Viet Nam's National Food Control System



DAH = Department of Animal Health; DARD = Department of Agriculture and Rural Development; DOH= Department of Health; DOIT = Department of Industry and Trade; FSMA = Food Safety and Modernization Act; MARD = Ministry of Agriculture and Rural Development; MOH = Ministry of Health; MOIT= Ministry of Industry and Trade; NAFIQAD = National Agro-Forestry Fisheries Quality Assurance Department; NIFC = National Institute for Food Control; PPD = Plant Protection Department; STAMEQ = Directorate for Standards, Metrology and Quality of Viet Nam; VDSM= Viet Nam Department of Survey and Mapping; VFA= Viet Nam Food Administration.

Source: Elaborated from Pham and Dinh (2020) as cited in Vu, P. H. and D. T. Anh. 2016. *Food Safety: Some Understandings on Agricultural Products, Production and Distribution System, and Government Policies.* Hanoi: Agricultural Publishing House.

chlordane, and DDT (Circular No. 50/2016/TT-BYT); however, all of these were banned by the MARD in the early 1990s (MARD 1992). Technical regulations issued by the Ministry of Natural Resources and Environment (MONRE) also specify MRLs for these pesticides (QCVN 15:2008/BTNMT) (MONRE 2015). Furthermore, Circular No. 50/2016/TT-BYT provides regulations on MRLs of pesticide in food, and the MONRE has a list of 39 active ingredients allowed for use in soil (Technical Regulations QCVN 15:2008/BTNMT). Such a situation leads to confusion among stakeholders.

The National Technical Regulation on MRLs of microorganisms on food issued by the MOH in 2012 (QCVN 8-3:2012/BYT) only sets limits for microorganisms in fruits and vegetables that are consumed fresh, but not those that are usually cooked, which include most vegetables. This explains why food control agencies under the MARD have not tested microorganisms for fruits and vegetables, as tests for most of them are not required. The interview with respondents from production cooperatives and retailers also showed that none of them had a good understanding of the food safety risk of foodborne pathogens. For prepared food sold in large restaurants and collective kitchens, owners are legally required to store food samples daily so that, in case of food poisoning incidents, the MOH food control agencies can determine the cause of the incidence by analyzing these samples. Respondents from collective kitchens confirmed that they practice this, but only for some of their main dishes as it would be impractical for them to do this for every dish as they do not have the capacity to store that many samples, which is also expensive.

B. Implementing Capacity

About two-thirds of respondents in Viet Nam rated the capacity of the public sector to manage food safety as inadequate. Of the 32 people interviewed, 31% suggested that there is a need for capacity building among government staff in charge of food safety, while 38% thought that there is a need for capacity building of fruit and vegetable producers in food safety. More than half of the respondents (53%) also thought that there is a need to restructure some of the food safety laws and regulations as the legal framework has become too large and too complex, which complicates enforcement. A particular issue was the shared responsibilities of the MOIT, MOH, and MARD, with several respondents suggesting that it may be better to have a central food safety agency under the MARD.

The very large number of chemical pesticides registered for use in agriculture has been a key challenge for monitoring their safe use. For insecticides, fungicides, and herbicides, there were 837 pesticide products on the market in 1999 and more than 3,000 in 2008 (Hoi et al. 2013). The number of registered active ingredients and formulated products has exponentially increased thereafter. For instance, there were 1,515 active ingredients and 5,603 formulated products registered in Viet Nam in 2013 and 1,611 active ingredients and 5,901 products in 2016.

Pesticide residue analysis is costly, and it is not done regularly or systematically for produce sold in wet markets. It is also unclear which agency should be responsible for this. The management system for plant-based foods of the Ministry of Nong Nghiep is still fragmented. The Plant Protection Department is responsible for primary production stages of agricultural production. Independent processing and preliminary processing establishments are under the authority of the National Agro-Forestry Fisheries Quality Assurance Department, and the MOH is responsible for controlling it in restaurants and canteens. Test data are also not made available publicly on a regular basis. Most of the published data on pesticide contamination comes from research projects, which vary in methods and scope, and are therefore not comparable over time.

V. Recommendations

A. Farm-Level Production and Postharvest Handling

1. Organize fruit and vegetable producers into groups

This study's findings suggest that the introduction of "safe vegetable production area" plays a catalytic role in promoting fruit and vegetable safety in Viet Nam. It is also evident from the survey and consultation with various stakeholders that government agencies can better support and monitor food safety in fruits and vegetables if farmers are organized into groups. Grouping of farmers makes it easier for government agencies to support them with training, testing of soil and water quality, and restrictive zoning to reduce the risk of contamination. The grouping of fruit and vegetable farmers also allows for better production planning, joint purchase of inputs, quality control, transportation, and marketing. Therefore, the study recommends expanding the government's strategy involving safe vegetable production areas and organizing farmers into groups.

2. Reduce the misuse of chemical pesticides through incentives and control

Overuse of pesticide is an important driver of food contamination in Viet Nam. To reduce pesticide misuse, it is necessary to create stronger incentives for food safety compliance while also improving the enforcement of existing regulations. In terms of incentives, it is important that farmers applying safe practices get rewarded. Training on safer and more effective use of pesticides encourages farmers to use biopesticides. Doing this requires market segmentation, for instance, by creating specific supply chains for safe produce with appropriate monitoring to ensure quality and gain consumer trust. In terms of control, it is important that existing regulations governing pesticide use are harmonized to avoid contradictions, and that they are better enforced, particularly at the level of pesticide trade. The promotion of safer alternatives to chemical pesticides such as biopesticides could also give an incentive to reduce pesticide misuse.

B. Value Chain Development

3. Install cold storage rooms at retail markets

The use of cold storage rooms at retail markets could greatly reduce postharvest losses and reduce the risk of microbial contamination. A feasibility study could be conducted to estimate costs and benefits, test the interest of market vendors, and describe their particular needs, which could be used to design a pilot for testing.

4. Designate safe fruit and vegetable sections in traditional wet markets

Fruits and vegetables sold in traditional wet markets in Viet Nam are not differentiated for safety and quality. Even if produce comes from farms that have good quality standards and have traceability systems in place, they are not differentiated in wet markets. A section of a wet market could be designated as "safe fruits and vegetables" showing labels and traceability and supported by regular testing.

C. Food Safety Management System

5. Conduct regular testing and make results publicly available

Systematic testing of fruits and vegetables for chemical residues and foodborne pathogens is important to identify problems, guide corrective actions, and monitor progress. Currently, testing is done sporadically by authorities that are also responsible for food safety. These authorities do not have an incentive to publish data publicly. However, this lack of transparency just intensifies consumer worries about food safety. Researchers and nongovernment organizations that report test results often focus on fruits and vegetables and locations (e.g., along highways or areas known to be contaminated) with a high food safety risk, which are not representative of the overall situation. Any trend discerned and policy formulated based on these results could be misleading. Testing should be done systematically and in a transparent manner, wherein results are publicly disclosed for the interest of the consumers. A pilot could be conducted in retail markets to publicly display test data and examine its effects on the perceptions and behavior of vendors and consumers. Training on where, when, and what produce should be selected for testing is required. Pesticide residue monitoring programs on fruits and vegetables should be carried out on a regular basis to ensure food safety requirements.

6. Strengthen the capacity of food safety authorities

Despite having modern food safety laws in place, Viet Nam has a traditional approach to managing food safety where the emphasis lies on the inspection of end products and punishment of violators. There is a need to modernize this approach and look not just at the quality of the end product, but also at the process by which food is produced and transformed from "farm to fork." Food safety management should be guided by a clear understanding of and focus on risk factors, systematic use of data, shared responsibilities between private and public sector actors, and preventive measures implemented along the value chain. There is an urgent need to strengthen the capacity of food safety authorities, both at national and subnational levels, in terms of human resource capacity, better facilities, and more adequate budgets. A technical assistance project with multilateral and/or bilateral support to enhance physical and human resource capacity, which involves training on and benchmarking of global best-case examples, should be undertaken.

Appendixes

Appendix 1: Questionnaires Used

Questionnaire 1: Government authorities in charge of food safety

Scope: around 8–10 persons from different agencies and levels (2 at ministry, 2 at province, 4–5 at district level):

General part:

1. Information of interviewee (name, position, organization, gender, contact), overall food safety concerns

2. What authorities are in charge of food safety?

3. What are their roles? (e.g., standard setting, monitoring and detection, enforcement/legal action)

4. How do these authorities work together or coordinate their work?

5. What have been major challenges to food-safety in fruits and vegetables in Viet Nam?

- Which fruits and vegetables are of particular concern?
- Do these problems affect urban and rural areas equally?
- Are some of the concerns season-specific?
- Are some concerns specific to the source of the product (e.g., imports)?
- Do these problems affect wet markets and supermarkets equally?

6. Please indicate which of the following contaminants are a concern to food safety in fruit and vegetables:

Fruit and vegetable contamination with:	Select 1 option per row				
	Very high concern	High concern	Medium concern	Low concern	No concern currently/not aware of it
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite / Nitrate					
6. Other, specify:					

7. How have problems with these contaminants changed over the last 10 years? Use table below:

Fruit and vegetable contamination with:	Select 1 option per row				
	Is not a problem / not aware of it	Has become a bigger problem	Has become a smaller problem	Problem has remained the same	If changed, what are some of the key drivers?
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite / Nitrate					
6. Other, specify:					

8. What have been major changes in food-safety governance of fruit and vegetables in Viet Nam over the last 10 years?

Specific part the organization performance:

9. What is the capacity of your organization in terms of expertise, staffing, facilities and budget to manage food safety in general and fruit and vegetable food safety in particular?

10. When was your organization established?

11. What roles does your organization play in the area of food and vegetable (F&V) safety?

12. (if involved into regulation enforcement):

- What inspection and monitoring programs are in place?
- How have these programs been coordinated? (i.e., with other agencies).
- In your opinion, do you think that current programs/activities are sufficient to deal with the problem?
- What have been major constraints to effectively implementing these programs/activities?
- What are the underlying causes of these constraints?
- What are the mechanisms to sanction violators of food safety regulations?
- Have these been effective in your opinion? If not sufficiently, what can be done more?

13. (if involved into F&V sampling and tests):

- How many samples of F&V were collected and analyzed during 2020?
- Which fruit and vegetables were targeted? Why?
- What contaminants were analyzed? Why these?
- What were the test results?
- Are these test results available publicly? If not, why?

14. (if involved into capacity building):

- What services has your organization provided to the F&V sector?
- How have you delivered the services (joint-executed, training, online services.)
- What are financial sources for running those services?
- Who are major customers of your services?
- How have your services contributing to promote safe F&Vs in the province/VN?

15. What are the constraints in implementing such roles in F&V safety?

Resource	Select 1 option per row		Explain why
	Adequate	Inadequate	
Staff numbers			
Technical skills of staff			
Facilities			
Finance/budget			
Other			

16. Are these problems different between rural and urban areas?

- Production (including access to chemical inputs, technology, information, enforcement...)
- Market (wet vs certified F&Vs, enforcement & sanction...)

17. What have been major changes in your organization (structure/personnel/budget...), why & how have these contributing to F&V safety management?

Possible solutions:

18. In your opinion, what needs to be done to improve food safety in F&V?

19. How can your organization contribute to this?

20. Is there a need to make changes to food safety laws and regulations?

21. What is the potential of cold chain penetration/logistics for fruit and vegetables?

22. What is the potential of certification for fruit and vegetables?

23. Other comments/ideas:

24. Will more awareness programs improve the situation?

25. What are the possible bottlenecks to execute government initiatives?

26. What coordination among or between the agencies you suggest for taking better actions?

27. Do you know a country's standard that we can follow?

Questionnaire 2: Private sector governance of food safety

Scope: around 12–15 persons: 1–2 supermarkets, 1–2 wholesalers, 3 retailers, 2 exporters, 3–5 LABs/certifying bodies (including participatory guarantee scheme [PGS] and/or Viet Nam National Public Standard for Good Agricultural Practices [VietGAP]), 2 input providers.

General part:

1. Type of business

2. Information of interviewee (name, position, organization, gender, contact), overall food safety concerns

3. To what extent is food safety in F&V a concern to your business?

- To what extent is it a concern to your customers?
- Are some of the concerns season-specific?
- Are some concerns specific to the source of the product (e.g., imports)?

4. Please indicate which of the following contaminants are a concern to food safety in fruit and vegetables:

Fruit and vegetable contamination with:	Select 1 option per row				
	Very high concern	High concern	Medium concern	Low concern	No concern currently/not aware of it
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite / Nitrate					
6. Other, specify:					

5. How have problems with these contaminants changed over the last 10 years? Use table below:

Fruit and vegetable contamination with:	Select 1 option per row				If changed, what are some of the key drivers?
	Is not a problem/ not aware of it	Has become a bigger problem	Has become a smaller problem	Problem has remained the same	
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite / Nitrate					
6. Other, specify:					

6. What are the key challenges to improving food safety in F&Vs?

7. Are you satisfied with the regulatory framework governing F&V food safety? Explain.

8. What are best practices of private sector food safety interventions in F&V?

- Input providers–clarify what and how?
- Producers–clarify what and how?
- Traders–clarify what and whom (collectors/wholesalers/retailers)
- Consumers–clarify what and how?
- Others–clarify what and how?

9. What are the relevant successful actors, lessons learned, and recommendations? Specific parts on organization performance:

10. (optional) What is capacity of your organization in F&V supply chain? (i.e., quantity of F&Vs or chemicals traded/month or year).

11. What efforts has your organization made to improve food safety and/or minimize food safety risks in F&V?

- Types of F&Vs sorting seasonally–clarify what and why?
- Targeted production areas / suppliers–clarify what and why?
- Contracting–clarify what and why?
- Monitoring–clarify what and why?
- Certification/labeling/traceability–clarify what and why?
- Logistics (cold chains/processed...)–clarify what and why?

12. In your opinion, have these efforts been successful? Please explain.

13. How have these efforts been changed/improved over time?

14. What are major challenges in your organization on food-safety improvement in F&V?

- Human resources (incl technical capacity)–clarify
- Facilities–clarify
- Finance–clarify
- Bureaucracy–clarify
- Others–clarify

15. How do you plan to overcome some of these challenges?

Possible solutions:

16. In your opinion, what needs to be done to improve food safety in F&V?

17. How can your organization contribute to this?

18. Is there a need to make changes to food safety laws and regulations?

19. What is the potential of cold chain penetration/logistics for fruit and vegetables?

20. What is the potential of certification for fruit and vegetables?

21. Other comments/ideas:

Questionnaire 3: Consumers' union/collective kitchens/F&V researchers/ journalists

Scope: around 5–7 persons (2 at consumer's unions; 2–3 collective kitchen; 2–3 researchers/journalists).

General part

1. Respondent type:

2. Information of interviewee (name, position, organization, gender, contact), overall food safety concerns

3. What have been major challenges to food-safety in fruit and vegetables in Viet Nam?

- Which fruit and vegetables are of particular concern?
- Are some of the concerns season-specific?
- Are some concerns specific to the source of the product (e.g., imports)?
- Do these problems affect urban and rural areas equally? Do these problems affect wet market and supermarkets equally?

4. In your opinion, are consumers sufficiently aware about food safety issues in general, and for fruit and vegetables in particular? Please explain.

5. Please indicate which of the following contaminants are a concern to food safety in fruit and vegetables:

Fruit and vegetable contamination with:	Select 1 option per row				
	Very high concern	High concern	Medium concern	Low concern	No concern currently/not aware of it
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite/Nitrate					
6. Other, specify:					

6. How have problems with these contaminants changed over the last 10 years? Use table below:

Fruit and vegetable contamination with:	Select 1 option per row				If changed, what are some of the key drivers?
	Is not a problem / not aware of it	Has become a bigger problem	Has become a smaller problem	Problem has remained the same	
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite/Nitrate					
6. Other, specify:					

7. How do consumers react to food safety issues?

- Consumers buy fewer F&V because of concerns
- Consumers avoid certain retail outlets or certain F&Vs (seasonally)–Why
- Consumers buy F&V at supermarkets/shops–Why
- Consumers buy certified/labelled F&V–Why
- Consumers buy F&V from specific delivery system: What & Why?
- Consumers buy more processed F&V (cleaned & cooked) & Why
- Others:

8. What has changed in F&V safety in recent years? Why & How?

9. With regard to ensuring food safety in F&V, do you have trust in:

Stakeholders involved into F&V safety management:	Select 1 option per row				Explain why
	High level of trust	Medium level of trust	Low level of trust	Don't know/ don't want to say	
1. Farmers					
2. Supermarkets					
3. Wet markets					
4. Government agencies					
5. Certified F&V					
6. Other, specify:					

10. What F&V brands or labels are associated with greater trust among consumers?

11. What do you expect about food safety in F&V in the future? & Why?

Possible solutions:

12. In your opinion, what needs to be done to improve food safety in F&V?

13. How can you/your organization contribute to this?

14. Is there a need to make changes to food safety laws and regulations?

15. What is the potential of certification for fruit and vegetables?

16. Other comments/ideas:

Questionnaire 4: Agricultural cooperatives

Scope: around 2–3 cooperatives

General part:

1. Type of organization:

2. Information of interviewee (name, organization, adds, contact) Overall food safety concerns

3. To what extent is food safety in F&V a concern to producers?

4. Please indicate which of the following contaminants are a concern to food safety in fruit and vegetables:

Fruit and vegetable contamination with:	Select 1 option per row				
	Very high concern	High concern	Medium concern	Low concern	No concern currently/not aware of it
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite/Nitrate					
6. Other, specify:					

5. How have problems with these contaminants changed over the last 10 years? Use table below:

Fruit and vegetable contamination with:	Select 1 option per row				If changed, what are some of the key drivers?
	Is not a problem/ not aware of it	Has become a bigger problem	Has become a smaller problem	Problem has remained the same	
1. Chemical pesticides					
2. Salmonella					
3. E. coli					
4. Heavy metals					
5. Nitrite/Nitrate					
6. Other, specify:					

6. What are the key challenges to food safety improvement in F&Vs?

Cooperative performance:

7. When was your cooperative established?

8. How many farmers participate in your cooperative? And production areas?

9. What is capacity of your organization in F&V production? Specify for types of crops/products:

- Types and quantity, seasonally.
- Target markets and share

10. How has this changed overtime? Why?

11. What efforts do you (your organization) make to improve food safety and/or minimize food risks?

- Input uses–clarify what and how?
- Training
- Types of F&Vs growing seasonally–clarify what and why?
- Farming practices–clarify what and how?
- Contracting–clarify what and why?
- Monitoring–clarify what and why?
- Adopting certification–clarify what and how?
- Logistics (cold chains/sorting practices, transports...)– clarify what and why?

12. How have these efforts been changed/improved overtimes? Clarify for different efforts

13. What are major challenges in your cooperative on food-safety improvement?

- Human resources (incl technical capacity)–clarify
- Facilities–clarify
- Finance–clarify
- Bureaucracy–clarify
- Others–clarify

14. How do you plan to overcome some of these challenges? Possible solutions:

15. In your opinion, what needs to be done to improve food safety in F&V?

16. How can your cooperative contribute to this?

17. Is there a need to make changes to food safety laws and regulations?

18. What is the potential of cold chain penetration/logistics for fruit and vegetables?

19. What is the potential of certification for fruit and vegetables?

20. Other comments/ideas:

Questionnaire 5: Agrodealers

I. General information

1. Crop of focus for this interview (=target crop):

- ☐ Cucumber
- ☐ Kale
- ☐ Dragon fruit
- ☐ Mango
- ☐ Stem amaranth

2. Respondent name:

3. Gender:

4. Province/district:

5. Village/community:

6. Type of business:

- ☐ Retail/shop owner
- ☐ Wholesale

II. Pesticide use in the target crop

7. What are the key pests and diseases on [target crop]?

8. What chemical pesticides are usually applied to treat these pests and diseases?

9. Which of these have the highest risk for human health?

10. Are there any biopesticides used to treat these as well?

- If not, why?

III. Safety in farmers' pesticide handling

11. In your opinion, are there any problems with pesticide misuse or overuse in your community?

- If so, what problems have you observed?
- What is the cause of these problems?
- What can be done to address the problem?

12. Is [target crop] produced in your community safe to eat? Please explain.

13. Do you recommend farmers to mix different pesticide products to make the spraying more effective?

14. Do you recommend farmers to use a stronger dosage of a product if their field is heavily infected by a pest?

15. In your opinion, do farmers usually follow the safety instructions on the label when mixing or spraying pesticides?

16. Are there problems in your community with pesticides that are fake, of poor quality, or of unknown origin? If so, please describe the problem.

IV. Safety in pesticide handling of the shop

17. What type of training have you attended in order to become a trader in pesticides?

18. Did you obtain an official license?

19. Did the authorities ever come and check your license?

Questionnaire 6: Farmers

I. General information

1. Crop of focus for this interview (target crop):

☐ Cucumber

☐ Kale

☐ Dragon fruit

☐ Mango

☐ Stem amaranth

2. Respondent name:

3. Gender:

4. Province/district:

5. Village/community:

6. For how many years have you produced [target crop]?

7. What area have you planted to [target crop] this season?

8. To whom do you usually sell [target crop]?

- What kind of buyer is this? (e.g., collector, wholesaler, retailer)
- What product quality aspects are important to this buyer?

9. Which time of the day [target crop] is usually harvested?

10. How to preserve [target crop] on the farm until it is collected or brought to the market?

- Do you apply water? If so, from what source?
- Are any chemicals applied to maintain freshness?

11. How is the [target crop] packed?

12. In your opinion, which difficulties do you face to maintain product quality during production and selling of [target crop]?

II. Pesticide use in the target crop

13. What are the key pests and diseases on [target crop]?

14. What chemical pesticides are usually applied to treat these pests and diseases?

15. Which of these have the highest risk for human health?

16. Are there any biopesticides used to treat these as well?

- If not, why?

17. Do you follow any production standard for producing [target crop]? If yes, please explain which one. For example, PGS, VietGAP, Global Standard for Good Agricultural Practices (GlobalGAP).

18. How often do you usually spray [target crop] from planting until harvesting?

19. After spraying, do you usually wait some period of time before harvesting the crop?

- If yes, how long do you usually wait?

III. Safety in farmers’ pesticide handling

20. In your opinion, are there any problems with pesticide misuse or overuse in your community?

- If so, what problems have you observed?
- What is the cause of these problems?
- What can be done to address the problem?

21. Is [target crop] produced in your community safe to eat?

- If no, why?

22. Do farmers in your community mix different pesticide products to make the spraying more effective?

23. Do farmers in your community use a stronger dosage of a product if their field is heavily infected by a pest?

24. In your opinion, do farmers usually follow the safety instructions on the label when mixing or spraying pesticides?

25. Are there problems in your community with pesticides that are fake, of poor quality, or of unknown origin? If so, please describe the problem.

IV. Water use

26. Do you use irrigation to produce [target crop]?

27. What is the source of the water?

28. Do you think that this source could be contaminated with?

- Manure of cows or other animals
- Fertilizers
- Pesticides
- Household sewage
- Industrial waste

29. Have you ever checked the water quality parameters? If yes, what are the sampling frequency and analysis results?

30. Have you ever checked the soil parameters? If yes, what are the sampling frequency and analysis results?

Appendix 2: Analysis of Contaminants

1. Sampling and Sample Collections

The samples were taken at different control points, as mentioned in Table 3, page 7 of this report according to TCVN 9016:2011 for vegetables; TCVN 7538-2,3 -2005 (ISO 10381 – 1: 2001) for soil; and TCVN 6663-3:2006 (ISO 5667-3:2012) for water. Table 3 describes the eventual sample selection. A total of 156 samples were tested for microbial contamination, 60 samples were analyzed for pesticide residues, 136 samples were analyzed for heavy metals, and 116 samples were analyzed for nitrate. All samples were selected randomly and put into sterile polyethylene bags, which were placed in ice-packed cool boxes and transported to specialized laboratories for analysis. The minimum weight of each sample was 4 kilograms (kg) of produce. It was confirmed with sellers that all fruit and vegetable samples were produced locally, not imported.

Mustard greens and cucumber were randomly sampled from farmers' fields during the harvesting period as well as from wholesale and retail markets in Ha Noi. Sample locations were selected in consultation with the Division of Plant Protection in Ha Noi. All mustard greens and cucumber farmers included in this study were located in "safe vegetable production areas" in peri-urban areas of Ha Noi. These "safe" areas account for about half of Ha Noi's total vegetable area of 12,000 hectares. In these locations, soil and water quality are monitored by government authorities, and livestock farming is not allowed; but this provides no assurance that vegetables grown there are safe—particularly with regard to chemical pesticide contamination. Farmers in these locations are organized in producer cooperatives and produce vegetables intensively year-round. Vegetable producers outside these "safe" areas can be characterized as individual farmers that are not organized in cooperatives, and are more dispersed and small-scale; many of them grow rice instead of vegetables during the summer and rainy season. Another practical reason to select cooperatives was that it was technically possible to collect random vegetable samples from a number of different fields that were ready for harvesting. Nevertheless, it is important to point out that the decision for selecting samples from "safe" areas may bias the results. However, we note that vegetable samples taken from wholesale and retail markets include all types of producers and are not affected by this.

Dragon fruit is not produced in Ha Noi, but mostly comes from Binh Thuan Province in the south of Viet Nam. It was not possible to travel there to collect samples because of the coronavirus disease (COVID-19) pandemic. Random samples were therefore taken from wholesale and retail markets in Ha Noi after confirming with the sellers that the produce originated from Binh Thuan Province.

The analysis of heavy metals focused on arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg) as highly toxic but commonly occurring heavy metals. The analysis of foodborne pathogens focused on Salmonella and Escherichia coli (E. coli) as indicators of fecal contamination and the two most frequently reported causes of foodborne illnesses. The analysis of pesticide residues focused on a selection of insecticides, fungicides, and herbicides mentioned by farmers, input suppliers, and food safety experts as commonly applied on the selected crops. These were used as proxy indicators for pesticide risk as it was not possible to analyze many different pesticide compounds. The study also quantified nitrate. Nitrate itself is relatively nontoxic, but some of its metabolites and reaction products are potentially carcinogenic. Heavy use of chemical fertilizers, particularly on leafy vegetables, can therefore create a food safety risk. Protocols published by the International Organization for Standardization (ISO) were followed in the analysis of all contaminants.

2. Testing for Contaminants and Analysis of the Results

Tests for microbial, heavy metals, and nitrate were performed by the researchers of Vietnam National University of Agriculture at its Microbiology and Chemistry Laboratories, while the tests for pesticide (fungicide, insecticide, and herbicide) residues were performed by the National Institute for Food Control. The analytical methods for quantifying the pathogens and chemical residues are described below.

Pesticides

Seven insecticides (Cypermethrin, Permethrin, Spinetoram, Abamectin, Emamectin benzoate, Chlorpyrifos, and Fipronil) and one fungicide (Azoxystrobin) in mustard greens, cucumber, and dragon fruit were determined following the AOAC Official Method 2007.01.[2] This uses the "quick, easy, cheap, effective, rugged, and safe" method (QuEChERS), which involves a single-step buffered acetonitrile extraction and salting out of liquid–liquid partitioning from the water in the sample with magnesium sulfate ($MgSO_4$). Using a combination of primary and secondary amine (PSA) sorbent and $MgSO_4$, dispersive solid-phase extraction (SPE) cleanup was performed to eliminate organic acids, excess water, and other components. After chromatographic separation, the extracts were analyzed using mass spectrometry (MS) technique. Glyphosate was determined in mustard greens, cucumber, and dragon fruit following the "quick method" for the analysis of numerous highly polar pesticides in foods of plant origin via LC-MS/MS involving simultaneous extraction with Methanol (QuPPe).[3]

Heavy metals

Lead and cadmium in fruits and vegetables

Lead and cadmium in mustard greens, cucumber, and dragon fruit were determined following the AOAC Official Method 2015.01.[4] In brief, the sample aliquots were weighed out into microwave digestion vessels. They were mixed with concentrated

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2 AOAC International. 2007. *AOAC Official Method 2007.01 Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate*. https://nucleus.iaea.org/sites/fcris/Shared%20Documents/SOP/AOAC_2007_01.pdf.

3 Anastassiades, M. et al. 2020. *Quick Method for the Analysis of Numerous Highly Polar Pesticides in Food Involving Extraction with Acidified Methanol and LC-MS/MS Measurement*. Food of Plant Origin (QuPPe-PO-Method v11).

4 AOAC International. 2015. *AOAC Official Method 2015.01 Heavy Metals in Food*. https://brooksapplied.com/wp-content/uploads/2015/07/AOAC-Method-2015.01.pdf.

nitric acid (HNO_3), 30% hydrogen peroxide, and gold + lutetium solution. Samples were digested at a minimum temperature of 190°C for a minimum of 10 minutes, and then the vessels were cooled to room temperature. The digestates were diluted at least four times prior to analysis with 1% (v/v) HNO_3 diluent. The samples were then analyzed using Inductively Coupled Plasma–Mass Spectrometry (ICP–MS).

Lead, cadmium, mercury, and arsenic in water

Ten water samples were collected from different districts in Ha Noi area where mustard greens and cucumber were grown. Lead, cadmium, mercury, and arsenic were determined following the Standard Method for Examination of Water and Wastewater (SMEWW) 3125B:2017.[5] The samples were preserved immediately after collection by acidifying with concentrated HNO_3 to pH < 2. They were then stored in a refrigerator at 4°C to prevent change in volume due to evaporation. The samples were then subjected to microwave-assisted digestion. Accurately 45 milliliters (mL) of well-shaken sample was transferred into the digestion vessel, and 5 mL concentrated HNO_3 was pipetted into each vessel. Samples were digested at 160 ± 4°C for 10 minutes and then, for the second stage, it slowly rose to 165°C–170°C for 10 minutes. At completion of the microwave digestion, the vessels were cooled for at least 5 minutes in the unit before removal, and the samples were then kept outside the unit for further cooling to room temperature. Whenever the digested sample contained particulates, they were filtered, centrifuged, or settled overnight and decanted before preserving. All samples were analyzed using ICP–MS.

Lead, cadmium, mercury, and arsenic in soil

Ten soil samples were collected from different districts in Ha Noi area where mustard greens and cucumber were grown. Lead, cadmium, mercury, and arsenic were determined following the United States Environmental Protection Agency (US EPA) Method 3051A.[6] About 0.5 grams of well-mixed soil sample was transferred into an appropriate vessel equipped with a controlled pressure relief mechanism. Ten milliliters of concentrated nitric acid was added to the vessel. The vessel was placed in the microwave system according to the manufacturer's recommended specifications. The temperature of each sample was allowed to rise to 175 ± 5°C in approximately 5.5 ± 0.25 minutes and remained at 175 ± 5°C for 4.5 minutes, or for the remainder of the 10-minute digestion period. The vessels were taken out of the microwave system after letting it cool for at least 5 minutes during the microwave program. Afterward, the vessels were gently uncapped after reaching room temperature level. Whenever the digested sample contained particulates, which may clog nebulizers or interfere with injection of the sample into the instrument, the samples were centrifuged, allowed to settle, or filtered. All samples were analyzed using ICP–MS.

5 Standard Methods for the Examination of Water and Wastewater. 2018. 3125B Metals by Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) Method. https://www.standardmethods.org/doi/abs/10.2105/smww.2882.048

6 United States Environmental Protection Agency. 2007. *Method 3051A (SW-846): Microwave Assisted Acid Digestion of Sediments, Sludges, and Oils.* Revision 1. Washington, DC.

Nitrate

Nitrate was extracted from the fruit and vegetable samples with water at 70°C following the AOAC (1997) method.[7] Briefly, 40 mL deionized water was added to the 5-gram homogenized sample and the solution was maintained for 15 minutes in a water bath at 70°C. The sample was cooled to room temperature, transferred to a 100 mL volumetric flask, and the volume was made with deionized water. The extracts were filtered through Whatman No. 4 filter paper, and the filtrate was diluted with water to obtain the desired concentration of nitrate. The nitrate content was determined using a derivative spectrophotometric method.[8] The potassium nitrate (KNO_3) standard was diluted with distilled water to create working standard solutions of 10, 20, 30, 40, 50, 60, 80, and 100 milligrams (mg) per liter, which were then kept at 4°C. Five grams of salicylic acid was dissolved in concentrated sulfuric acid and diluted to 100 mL with the same acid. A 2N sodium hydroxide solution was also prepared. Calibration was done using the aliquots of working standard solutions, salicylic acid, and 2N sodium hydroxide. Nitrate content was determined using 0.1 mL of the extract, which was thoroughly mixed with 0.4 mL salicylic acid solution. After 20 minutes at room temperature, 9.5 mL 2N sodium hydroxide solution was slowly added. Nitrate in mustard greens, cucumber, and dragon fruit was expressed as mg nitrate-nitrogen (NO_3-N) per kg dry weight.

Microbial contaminants

Salmonella

Salmonella was detected using conventional culture-based methods according to ISO protocol 6579-1:2017. A total of 25-gram sample was homogenized with 225 mL of Buffered Peptone Water (BPW) (BD, Sparks, USA) and incubated at 37°C for 18 hours. After pre-enrichment, 100 mL of this sample were taken and mixed with 10 mL of Rappaport Vassialidis medium with soya (RVS broth) (BD, Sparks, USA), then 1 mL was taken to mix with 10 mL of Muller Kauffmann tetrathionate-novobiocin (MKTTn broth) (BD, Sparks, USA). Cultures were incubated at 41.5°C for RSV broth and at 37°C for MKTTn broth for 24 hours. After the selective enrichment step, a loopful of each enriched sample was streaked on a differential medium, Xylose Lysine Desoxyscholate agar (XLD agar). The XLD agar was incubated at 37°C and examined after 24 hours. Suspected colonies were identified biochemically and serologically.

E. coli

The detection of E. coli was done following ISO protocol 166499-2:2001. E. coli was isolated from sampled vegetables and fruits as blue green colonies on tryptone-bile-glucuronide agar (TBX). One mL of the test sample was transferred to a sterile petri dish using a sterile pipette. Approximately 15 mL of the TBX medium, previously

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[7] AOAC International. 1997. *Official Methods of Analysis of the Association of Official Analytical Chemists. 16th edition (3rd revision)*. Method 976.14. Gaithersburg, Maryland.

[8] Lastra, O.C. 2003. Derivative Spectrophotometric Determination of Nitrate in Plant Tissue. *Journal of AOAC International*. 86 (6). pp .1101–1105.

cooled at 45°C in the water bath, was poured into each petri dish. The inoculum was carefully mixed with the medium and then allowed to solidify, with the petri dishes standing on a cool horizontal surface. The inoculated dishes were inverted so that the bottom was uppermost, and they were placed in an incubator at 44°C for a maximum of 24 hours. The typical colony-forming unit (CFU) of ß-glucuronidase-positive E. coli in each dish containing less than 150 typical CFU and less than 300 total (typical and nontypical) CFU was counted.

Appendix 3: Food Safety Laws and Regulations

Title	Description	Effective
Laws		
Law on Crop Production No. 31/2018/ QH14	Prescribes plant varieties; fertilizers; cultivation; harvest, preliminary processing, preservation, processing, trading, and quality management of crop products. It also defines rights and obligations of organizations and individuals engaged in crop production and state management of crop production.	Jan-2020
Law on Food Safety No. 55/2010/QH 12	Provides for rights and obligations of organizations and individuals in assuring food safety; conditions for assuring safety of foods and food production, trading, import and export; food advertisement and labeling; food testing; food safety risk analysis; prevention, stopping, and remedying of food safety incidents; food safety information, education, and communication; and responsibilities for state management of food safety.	Jul-2011
Law on Inspection No. 56/2010/ QH12	Provides for the organization and activities of state inspection and people's inspection, including specialized inspection.	Jul-2011
Law on Product and Goods Quality No. 05/2007/ QH12	Provides for the rights and obligations of organizations and individuals producing or trading in products or goods as well as organizations and individuals conducting activities related to product and goods quality; and the management of product and goods quality; includes awarding of national prizes and prizes awarded by organizations or individuals for good quality products.	Jul-2008
Law on Standards and Technical Regulations No. 68/2006/ QH11	Provides for the formulation, announcement, and application of standards; the formulation, promulgation, and application of technical regulations; and the assessment of conformity with standards and technical regulations.	Jan-2007

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Table continuation

Title	Description	Effective
Decrees		
Decree No. 94/2019/ND-CP	Details some articles in the Law of Crop Production No. 31/2018/QH14 for crop varieties and farming practices.	Feb-2020
Decree No. 04/2020/ND-CP	Revises and supplements some points of the Decree No. 31/2016/ND-CP dated 6 May 2016 of the Government of Viet Nam regarding punishments for violations on crop varieties, plant protection and quarantine; and Decree No. 90/2017/ND-CP dated on31 July 2017 of the Government of Viet Nam regarding punishments for violations on veterinary.	Feb-2020
Decree 135/ QD- BYT	Revises and supplements contents to newly issued regulations on food safety and nutrition under the MOH management.	Jan-2019
Decree No.115/2018/ ND-CP	Specifies sanctions of administrative violations on food safety.	Oct-2018
Decree No. 123/2018/ND-CP	Revises and supplements articles for some decrees regulating conditions for investment and business in the agriculture sector.	Sep-2018
Decree No. 15/2018/ND-CP	Details some Articles of the Law on Food Safety for implementation.	Feb-2018
Decree No. 31/2016/ND-CP	Provides regulations on punishments for violations on crop varieties, plant protection and quarantine.	Jun-2016
Decree No. 199/2013/ND-CP	Defines the functions, tasks, powers, and organizational structure of the MARD.	Nov-2013
Circulars		
Circular No. 17/2018/TT-BNNPTNT	Provides regulations on the management of food safety assurance conditions for producing and trading units of agroforestry products that are not qualified for granting food safety certification, within the MARD management scope.	Jan-2019
Circular No. 06/2018/TT-BNNPTNT	Revises Circular No. 48/2012/TT-BNNPTNT dated on 26 September 2012 issued by the MARD regarding GAP certification of agroforestry products.	Aug-2018
Circular No. 50/2016/TT-BYT	Provides regulations on pesticide MRLs on food.	Jul-2017
Circular No. 14/2015/TTLT-BNNPTNT-BNV	Details instructions on functions, duties, power, and organizational structure of agencies specialized in agriculture and rural development under the People's Committees at district and provincial levels.	Mar-2015
Circular No. 21/2015/TT-BNNPTNT	Provides regulations on pesticides.	Aug-2015

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Table continuation

Title	Description	Effective
Circular No. 51/2014/TT-BNNPTNT	Provides regulations on conditions for food safety compliance and management applied for small-scale producers.	Feb-2015
Circular No. 13/2014/ TTLT-BYT-BNNPTNT-BCT	Details allocation of tasks and cooperation among regulatory agencies in food safety management.	Apr-2014
Technical Regulations and Standards		
QCVN 01-188:2018/ BNNP TNT	National technical regulations on pesticide quality	Feb-2019
TCVN 11892-1:2017	National Standards on VietGAP – Part 1: Crops	2017
QCVN 03-MT:2015/ BTNM T	National Technical Regulations on heavy metal MRLs on soil.	2015
QCVN 08-MT:2015/ BTNM T	National Technical Regulations on surface water quality.	2015
QCVN 01-132:2013/ BNNP TNT	National Technical Regulations on Fresh Vegetable, Fruit and Tea - Conditions for Ensuring Food Safety in Production and Packing subjects.	2013
QCVN 8-3:2012/BYT	National Technical Regulations on microorganism MRLs on food.	2012
QCVN 8-2:2011/BYT	National Technical Regulations on heavy metal MRLs on food.	2011
QCVN 15: 2008/BTNMT	National Technical Regulations on pesticide MRLs on soil.	2008
Decisions		
MARD Decision No. 1120/QD-BNN-TCCB	Defines functions, responsibilities, powers, and organizational structure of the NAFIQAD.	Mar-2017
MARD Decision No. 1290/QD-BNNTCCB	Assigns and decentralizes the monitoring and inspection of food safety for agricultural, forestry, and fishery products within the MARD's authority.	Apr-2015
PM Decision No.: 20/QD-TTg	Approves of the National Strategy for Food Safety in the period of 2011-2020 and a Vision toward 2030.	Jan-2012
PM Decision No. 2406	Lists of national target programs 2012-2015; includes target program on food safety and hygiene.	Dec-2011
Ha Noi Government Decisions		
Decision No. 14/2019/QD-UBND	Defines functions, responsibilities, and powers on the management of food safety for Ha Noi administrative units.	Jul-2019

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Table continuation

Title	Description	Effective
Decision No. 2582/QD-UBND	Defines functions, responsibilities, and powers on the management of agricultural inputs and safety for agroforestry products of Ha Noi administrative units.	Jun-2015
Decision No. 104/2009/ QD- UBND	Regulations on management of safe vegetable production and trade in Ha Noi.	Sept-2009
Decision No. 70/2009/QD-UBND	Defines functions and responsibilities of communal plant protection workers in communes having agriculture in Ha Noi.	May-2009

GAP = Good Agricultural Practices, MARD = Ministry of Agriculture and Rural Development, MOH = Ministry of Health, MRL = maximum residue limit, NAFIQAD = National Agro-Forestry Fisheries Quality Assurance Department, PM= Prime Minister, VietGAP = Viet Nam National Public Standard for Good Agricultural Practices.

Source: Updated from World Bank. 2017. *Viet Nam Food Safety Risks Management: Challenges and Opportunities*. Hanoi. https://openknowledge.worldbank.org/handle/10986/26412 License: CC BY 3.0 IGO.

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Imperatives for Improvement of Food Safety in Fruit and Vegetable Value Chains in Viet Nam

This publication explores how Viet Nam can improve the safety of its fruit and vegetables, including through production and postharvest handling, value chain development, and a stronger food safety management system. It notes that building confidence in safe fruit and vegetables would encourage consumers to eat more of them, boosting people's health and producers' livelihoods. The publication draws on the results of safety tests, a stakeholder survey, and a literature review. Its recommendations include expanding producers' cooperatives and designated safe vegetable production areas, using incentives and controls to drive down chemical pesticide misuse, and publishing the results of regular testing.

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