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Acronyms and Abbreviations

ANOVA	Analysis of Variance between groups
ASEAN	Association of Southeast Asian Nations
AVRDC	The World Vegetable Center
CLV	Cambodia, Lao PDR and Viet Nam
FAO	Food and Agriculture Organization of the United Nations
GAMIC	Government agricultural marketing information center
GSO	General Statistic Office
ha	Hectare
hr	Hour
kg	Kilogram
km	Kilometer
Lao PDR	Lao People's Democratic Republic
m^2	Square meter
mo	Month
MT	Metric ton
MT/ha	Metric ton per hectare
N	Number of cases
n.a.	Not applicable
NGO	Non-government organization
p	Probability
RIFAV	Research Institute of Fruits and Vegetables
SD	Standard deviation
TV	Television
US	United States
US$/MT	US dollar per metric ton
yr	Year
VND	Viet Namese Dong

1 Vegetables in Viet Nam

Supply chains can be defined as "*…a set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food products, in order to realize superior customer value at the lowest possible costs" (Folkerts and Koehorst, 1998).*

In this study we assess the supply chain for selected vegetables in Viet Nam, and the role different actors play in value addition across the chain, as well as bottlenecks of the chain, in particular postharvest loss. Vegetable production levels and revenues in the CLV region are severely constrained by postharvest losses. Viet Nam alone suffered a $15 million decline in export revenues of vegetables and fruits during the first quarter of 2004 compared to the same quarter in 2003, which was attributed to inadequate postharvest technologies (Socialist Republic of Viet Nam, 2004). Improving the postharvest handling and storage of horticulture crops has become a priority in all three countries (Cambodia, Lao PDR and Viet Nam). A stakeholder meeting at AVRDC–The World Vegetable Center in 2001 with representatives from the ASEAN region identified postharvest technologies as one of the most needed areas for research and development especially for the hot-wet ecologies (Kuo, 2002).

Viet Nam's good climatic and soil conditions have greatly contributed to the country's production of tropical and subtropical vegetables both for local consumption and export markets. Currently, the country is speeding up production of high value vegetables to stimulate employment, raise farmers' income and increase export turnover.

From 2000 to 2004, vegetable production had increased in terms of area, yield and quantity. The production of high quality, fresh and safe, and processed vegetables for the export market have also shown an upward trend, and vegetable production has diversified. During this period, specialization in the production of key vegetable varieties in several vegetable production areas had taken place as well. For instance, tomato and cabbage are popularly grown in the provinces of Da Lat, Ha Noi, Hai Phong and Hung Yen. Likewise, the concentration of cucumber production can be found in the provinces of Da Lat, Ha Noi, Hung Yen, Ha Nam and Nam Dinh, while chili is popularly grown in Bac Ninh, Bac Giang, Hai Phong, Quang Binh, Quang Tri, Thua Thien-Hue, Quang Nam, Da Nang and Thai Binh.

Several vegetables like tomato, cucumber, green bean, baby corn and chili are considered as vegetables with great potential for meeting both local and export demand. Total vegetable production has increased to 886,320 metric ton (MT) in 2004, up from 595,000 MT in 2000 (Figure 1-1). Total area under vegetables has also increased by 36% from 453,000 hectares (ha) in 2000 to 616,000 ha in 2004. Tomato is the single largest commodity group with total production in 2004 amounting to 424,126 MT which includes both fresh and processed products for local consumption and export processing (Figure 1-2).

Another crop which showed robust performance is chili. From 2002-2004, production area and quantity increased by 8% and 40%, respectively (Figure 1-3). Demand for chili is not only limited to fresh produce. Chili is also an important processing material especially for potential export markets.

Today, one of the main bottlenecks in vegetable production is the high incidence of postharvest spoilage affecting all actors along the supply chain. To solve the problem, it is essential to consider the entire production-consumption continuum.

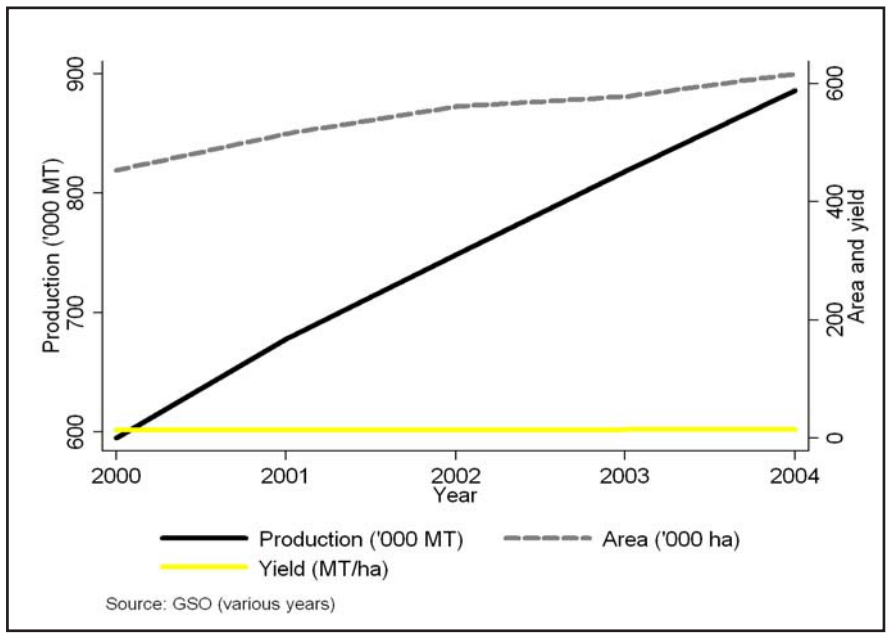

Figure 1-1 Average area, yield and production of vegetables in Viet Nam, 2000-2004

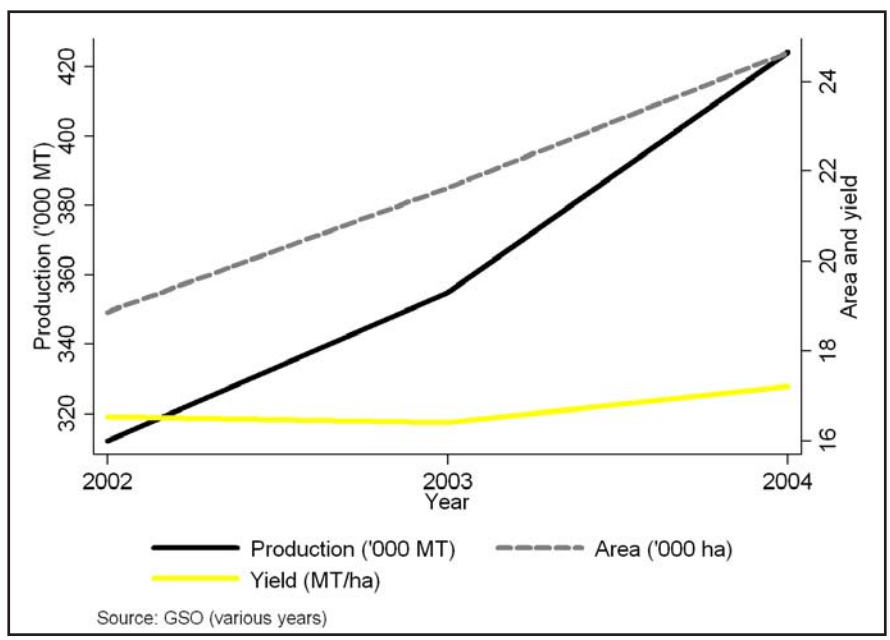

Figure 1-2 Average area, yield and production of tomato in Viet Nam, 2002-2004

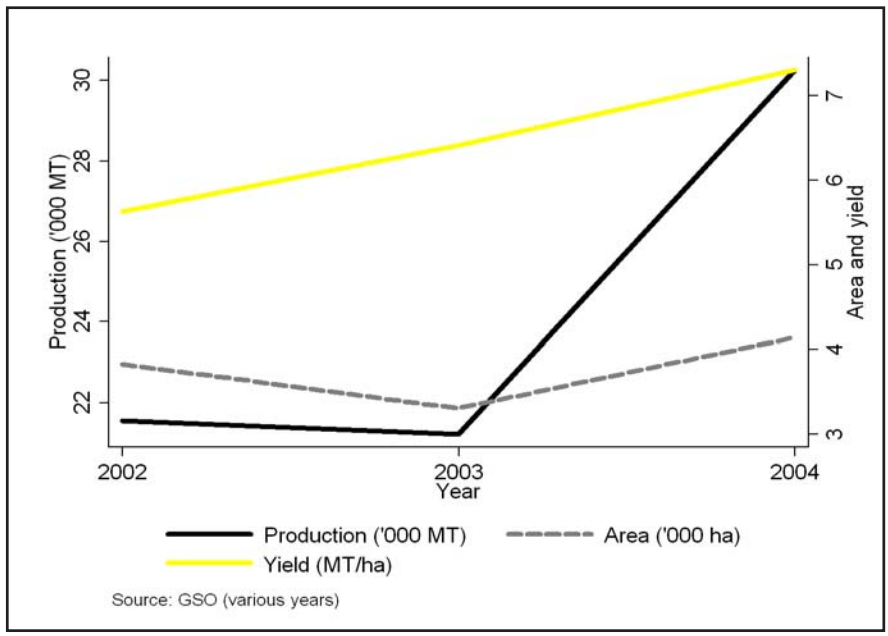

Figure 1-3 Average area, yield and production of chili in Viet Nam, 2002-2004

2 Sample selection, methods and respondent profiles

2.1 Sample selection

Crops were predetermined through expert discussions based on high economic value and high incidence of postharvest losses. In these discussions, getting an understanding of the existing supply chains and the different forms of the prevailing retail outlets (supermarkets, small grocery stores, wet markets, street vendors) were also attempted. In analyzing the supply chains for vegetables, an upstream interview approach (retailers to farmers) was applied. This was selected because using a downstream approach (farmers to markets) would run the risk of interviewing a large share of farmers who may not produce vegetables for commercial purposes. With the sample, the objective was to ensure equal representation of retailers, traders (collectors and wholesalers) and farmers, as well as the crops that this study is particularly interested in. Thus, after establishing the different forms of retail outlets for vegetables and their approximate share in total vegetable sales, the sample size of supermarkets, wet market vendors, small grocery stores, and street vendors were also predetermined. These initial respondents were randomly selected from a list of retailers.

After selecting the retailers, the other supply chain actors were randomly culled from the list of names provided by the retailers interviewed since the survey questionnaire requests all actors to provide names of their primary sources of the crop in question. Traders were then selected based on the list of names provided by the retailers interviewed. Farmers were selected from the names provided by traders, and in some cases, retailers.

2.2 Sample size

Table 2-1 shows the total sample in the study comprising of 158 respondents. Tomato was selected since it is presently a key crop in the winter season. It also has a high transport loss. Chili, on the other hand, was selected since it is one of the key crops in the government's "hunger eradication and poverty alleviation program". Aside from meeting the domestic demand, chili can also be used as processed material for export. While this maybe the case, chili is one of those crops that is heavily affected by diseases and insects, and has high incidence of postharvest spoilage.

The Red River Plain is a large vegetable production area in Viet Nam and is therefore ideal as a sample area for the project. The provinces of Ha Noi, Nam Dinh and Hai Phong were selected since tomato and chili production areas are larger in these provinces than in other areas. In addition, the high level of consumption and the presence of many processing plants also contributed to the selection of these areas. Specifically, the districts of Thanh Tri in Ha Noi, Hai Hau in Nam Dinh, and Vinh Bao in Hai Phong were selected. The total sample size is 158 respondents which include two chili processors from Hai Phong. Sample distribution is as follows: 52 retailers, 49 traders (including processors) and 57 farmers fairly divided among the three sites. Tomato was chosen as the crop to be studied in Ha Noi and Nam Dinh, and chili in Hai Phong. Data were collected between September and October 2005.

Table 2-1 Overview of sample size and distribution

Total	Sample size by crop		Sample size by agent		Sample size by province	
158	Tomato	105	Retailers	52	Ha Noi	53
	Chili	53	Processor	2	Nam Dinh	52
			Wholesalers	28	Hai Phong	53
			Collectors	19		
			Farmers	57		

2.3 Methods

2.3.1 *Data collection*

Four types of questionnaires were developed to gather general and specific information by supply chain actor (retailer, processor, trader and farmer). The generic information sought included: socio-demographic data, postharvest loss estimates, trading information (collaboration with other actors, product trait assessment using Likert-type questions, modes of transport used during purchase from suppliers and delivery to buyers, types of packaging materials for incoming and outgoing products), marketing information (monthly volume of quantities purchased and sold, prices achieved, main trading partners, monthly turnover of entire business), value-adding activities, and attitudes toward postharvest loss. For farmers, production and harvesting practices were also obtained based on the past year's production cycles.

2.3.2 Tests of significance

Most of the analysis relies on descriptive statistics. Significant differences among supply chain actors are estimated based on one-way ANOVA and the Levene test for differences in homogeneity of variances, and are identified based on Duncan's multiple rank test.

2.3.3 Mapping of supply chain and main actors

Quantities sold to the primary buyer identified by the respondents were calculated using the estimate provided on the share of produce sold to these trading partners. Aggregation on the total quantity sold and total quantity sold to primary buyers was done by actor and for each main trading partner identified. This became the basis in our derivation of the actual shares of vegetables for which suppliers at different levels sold to the main buyers in relation to total quantity sold. We then mapped out the volume of transactions in the supply chain downstream (from farmers to consumers) using these percentages. Since our analysis generated several missing links between suppliers and their main buyers, especially between traders and other retailers not considered as primary partners, we also incorporated the upstraem linkages (from retailers to farmers) looking into the main sources of vegetable produce. These were added into the flow chart to obtain a complete picture of the demand and supply side of vegetables in the country.

2.3.4 Estimation of postharvest losses and value of postharvest loss

For farmers, postharvest loss was quantified and calculated as a percentage based on total harvested quantity. For collectors, wholesalers and retailers, loss was estimated as the difference between quantity purchased and quantity sold in relation to total quantity purchased. Traders were requested to estimate the total percentage share of postharvest loss by season. However, these estimates were found to exceed the postharvest loss estimated based on the difference in quantities traded by a factor of two. In this paper, loss is considered as the difference between quantities purchased and sold, although this may include small errors due to personal consumption. Since we collected monthly observations for collectors, wholesalers and retailers for an entire year, and information on all production cycles within the past year for farmers, this is the total number of observations used.

To obtain a value of loss experienced, actual loss in kilogram (kg) was multiplied with the average selling price. This value was divided by the total amount of vegetables produced or purchased by each agent in kg to obtain a value of loss based on a uniform denominator, and added across all agents in the supply chain.

2.4 General profile

The number of females surveyed accounts for about 61% of the total respondents (Table 2-2). Wholesaling and especially retailing are women-dominated professions, while farming and collecting have more men than women. About 37% reached high school and university with the majority attaining only secondary education education or lower (Table 2-3).

Table 2-2 Gender profile of vegetable supply chain actors in Viet Nam

Supply chain actor	Male		Female		Total	
	N	%	N	%	N	%
Farmer	35	61	22	39	57	36
Collector	13	68	6	32	19	12
Wholesaler	7	25	21	75	28	18
Processor	1	50	1	50	2	1
Retailer	5	10	47	90	52	33
Total	61	39	97	61	158	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=158.

Table 2-3 Educational background of vegetable supply chain actors in Viet Nam

Education category	Farmer		Collector		Wholesaler		Processor		Retailer		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
None									1	2	1	1
Primary	5	9			2	7			5	10	12	8
Secondary	35	61	11	58	15	54			26	50	87	55
High school	16	28	7	37	11	39	1	50	17	33	52	33
College/university	1	2					1	50	3	6	5	3
Other			1	5							1	1

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=158.

2.5 Farmer profile

The average household size of farmers is 4.2, slightly lower than the national average of 4.6 (Epprecht and Heinimann, 2004). The households are generally larger in Ha Noi than in Nam Dinh and Hai Phong. There are approximately 3.5 adults per household and 969 square meters (m^2) of cultivated area per adult. While farmers in Viet Nam have more experience in farm cultivation compared with those from Cambodia and Lao PDR, they have the lowest annual sales in 2005 partly due to smaller parcels of land. On average, Viet Namese farmers have 25 years in independent farming. In 2005, their annual sales averaged at US$ 1,387 with the highest in Nam Dinh (US$ 2,439) and the lowest in Hai Phong (US$ 557). Hai Phong farmers have the highest number of years of independent farming but were lowest in sales in 2005. It is not clear whether this low turnover is due to low availability of family labor, serious pest and disease problems, poor farm management operations, or other reasons. Among the three areas, Nam Dinh farmers have the largest cultivated area per adult and highest turnover (Table 2-4).

Table 2-4 Farmer characteristics

Characteristic	Ha Noi		Nam Dinh		Hai Phong		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Household size	4.7	1.0	4.3	1.3	3.7	1.1	4.2	1.2
Number of adults	3.9	1.3	3.5	1.1	3.3	1.0	3.5	1.1
Cultivated area per adult (in m^2)	858	1,080	1,253	696	798	311	969	765
Years in independent farming	23.7	8.3	24.9	7.6	26.6	8.2	25.1	8.0
Annual sales of business (US$)	1,199	485	2,439	865	557	190	1,387	978

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=57. 1 US$=15,967.54 VND.

Viet Namese farmers have smaller owned lands compared with Cambodia and Lao PDR. The average owned farmland is only 3,612 m^2 and land rented from others is about 1,248 m^2 (Table 2-5). About 88% of owned land is cultivated, of which more than 50% is devoted to vegetable farming. This represents a dramatic increase from the 2002 level of 27% of harvested area allocated to vegetable crops. Vegetable plots have also relatively increased in a span of seven years from 400 m^2 plots to approximately 1,908 m^2 (Thuy *et al*., 2002). Farms are usually near all-weather roads and input markets with an approximate distance of 0.5 km and 1.1 km, respectively. Among the three areas, Nam Dinh has the largest farmland and most area devoted to vegetables. Hai Phong farms have the least vegetable production area but are more accessible compared to the two sites in terms of distance to nearest all-weather roads.

Table 2-5 Land details

Farm characteristic	Ha Noi		Nam Dinh		Hai Phong		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Distance to nearest all-weather road (km)	0.4	0.3	0.8	0.7	0.3	0.2	0.5	0.5
Nearest distance to place where inputs are obtained (km)	1.5	1.2	1.2	0.9	0.6	0.4	1.1	0.9
Land owned (m^2)	3,002	4,304	4,808	2,438	3,024	1,065	3,612	2,940
Land rented in (m^2)	1,730	4,168	1,760	2,817	329	461	1,248	2,892
Land rented out (m^2)	22	94	0	0	18	80	13	71
Land cultivated (m^2)	3,049	4,212	4,019	1,989	2,535	1,028	3,192	2,722
Vegetable cultivation area (m^2)	1,703	1,022	3,339	1,919	732	399	1,908	1,660
Share of vegetable area to total cultivated area (%)	77	26	82	18	32	20	63	31

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=57.

Farmers mainly source inputs from cooperatives, private shops and contract-growing arrangements, and very few from the market (Table 2-6). The farm inputs are usually transported by motorbike and bicycle, which in Hai Phong is the only transportation used by farmers (Figure 2-1).

Table 2-6 Source of farm inputs in Viet Nam

Source of input	Ha Noi		Nam Dinh		Hai Phong		Total	
	N	%	N	%	N	%	N	%
Market	2	11	3	16	0	0	5	9
Trader at farmstead	1	6	1	5	0	0	2	4
Contract-growing arrangement	2	11	9	47	0	0	11	19
Cooperatives	13	72	4	21	6	30	23	40
Private shops	2	11	4	21	14	70	20	35

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=57. Values are multiple responses.

Although males are slightly larger in number than females, there is no marked difference in the employment between male and female workers, except that there are more hired part-time males compared to females similar in Lao PDR (Table 2-7). Hired full-time workers work on the farm for an average 24 days per month. Female casual workers are employed 63 days per year, roughly twice the period for casual male workers (39 days per year).

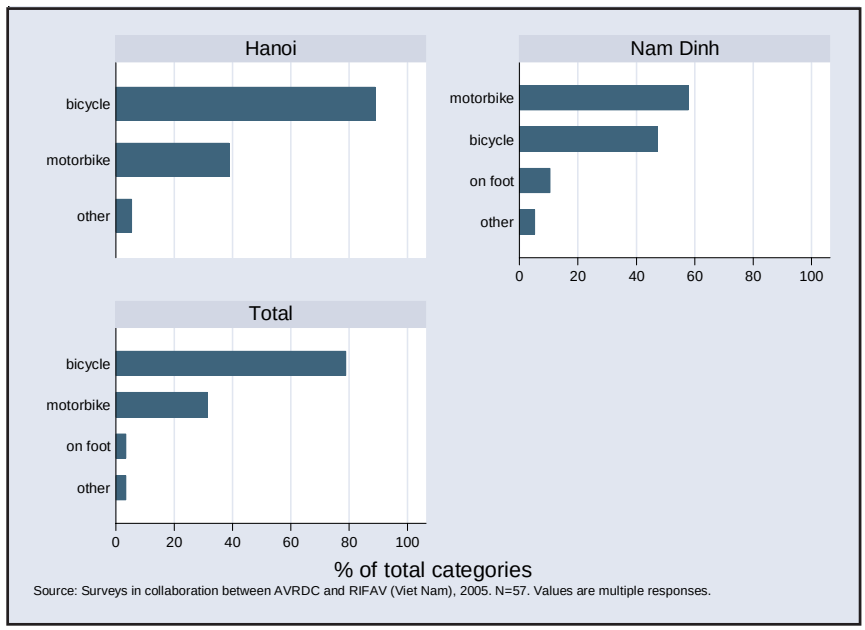

Figure 2-1 Mode of transport of farm inputs in Viet Nam

Table 2-7 Share of female workers to total farm labor and number of working days of hired farm workers in Viet Nam

Characteristic	Mean	SD
% share of female to		
… Full-time family workers	49	24
… Part-time family workers	46	41
… Full-time hired workers	45	10
… Part-time hired workers	35	35
Full-time male workers (person-day/mo)	25	5
Full-time female workers (person-day/mo)	24	5
Casual male workers (person-day/yr)	39	42
Casual female workers (person-day/yr)	63	47

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=57.

All farmers from Ha Noi and Nam Dinh, and 95% of Hai Phong farmers look for information on the latest farm inputs and their sources (Table 2-8). Information sources include cooperatives, other farmers, extension officers and contracting companies. Cooperatives are especially active in Nam Dinh and Hai Phong, and more than 80% of the farmers obtain farm input information from them. Contracting companies are also a major source of new varieties for the farmers in these two areas, and a good source of inputs in Nam Dinh as well.

Table 2-8 Source of information on new product varieties and inputs of farmers in Viet Nam

Characteristic	Ha Noi		Nam Dinh		Hai Phong		Total	
	N	%	N	%	N	%	N	%
Seek information on new product varieties and input supply	18	100	19	100	19	95	56	98
Source of information[a]								
Radio	2	11			2	4		
TV	2	11	3	16			5	9
Newspaper	1	6	1	5			2	4
GAMIC	2	11					2	4
Any trader at the local market	3	17			1	5	4	7
Collector who comes to the farm	1	6	1	5			2	4
Other farmers	6	33	11	58	5	25	22	39
Extension officers	6	33	6	32	4	20	16	28
Cooperative/association	6	33	18	95	17	85	41	72
Contract company(ies)	5	26	9	45	14	25		
NGOs				1	5	1	2	
Other source	4	22					4	7
None				1	5	1	2	
Total	18	100	19	100	20	100	57	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=57. [a]Values are multiple responses.

2.6 Trader profile

The retailers that were surveyed are classified according to supermarkets, grocery stores, wet market vendors and street vendors. A good number of retailers own and operate their business while two retailers in Hai Phong and one in Ha Noi are owned by the state (Table 2-9). These retailers have been in operation for more than 10 years (Table 2-10). The supply chain actors from Nam Dinh have the least number of years in operation among the three sites, especially wholesalers and retailers.

Table 2-9 Business type of processor and retailer ownership

Legal status	Ha Noi		Nam Dinh		Hai Phong		Total	
	N	%	N	%	N	%	N	%
State-owned enterprise	1	5			2	11	3	6
Private enterprise	17	89	16	100	17	89	50	93
Joint venture	1	5					1	2

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=54.

Supermarkets have the highest annual turnover in 2005 amounting to US$ 4.896 million, followed by processors (US$ 698 thousand), grocery stores (US$ 84,359), wholesalers (US$ 59,682), collectors (US$ 30,239), wet market vendors (US$11,487) and street vendors (US$ 5,022) (Table 2-10). The volume of transactions of collectors is highest in Nam Dinh while wholesalers in Hai Phong have the highest. For retailers, the volume of transaction is highest in Ha Noi being the largest urban area in Northern Viet Nam.

Table 2-10 Years in operation and annual sales of traders in Viet Nam

Parameter	Supply chain actor		Ha Noi	Nam Dinh	Hai Phong	Total
Years in business	Collector	Mean	11.5	7.9	7.2	8.8
		SD	5.1	5.1	6.0	5.4
	Wholesaler	Mean	9.1	7.4	17.4	10.9
		SD	3.2	6.7	5.8	6.7
	Processor	Mean			9.0	9.0
		SD			8.5	8.5
	Retailer	Mean	10.5	6.6	16.3	11.2
		SD	5.7	2.9	7.1	6.7
Annual sales of business (US$)	Collector	Mean	12,595	54,984	19,014	30,239
		SD	8,304	41,900	20,261	33,200
	Wholesaler	Mean	39,221	44,175	104,642	59,682
		SD	18,387	52,984	62,836	53,992
	Supermarket	Mean	9,174,866		617,127	4,895,997
		SD				6,051,235
	Grocery store	Mean	99,734	68,984		84,359
		SD	91,889	67,179		68,074
	Wet market vendor	Mean	14,576	3,200	16,197	11,487
		SD	8,591	1,545	21,040	14,657
	Street vendor	Mean	5,542	3,037	4,922	5,022
		SD	2,117			1,923
	Processor	Mean			698,104	698,104
		SD			846,091	846,091

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=101.

Generally, the proportion of male workers in the supply chain is higher compared with female workers (Table 2-11). However, wholesaling is dominated by both full-time female family members and hired female workers, complemented by part-time family male workers. On the other hand, collecting is largely done by both full-time and part-time male workers, and full-time family male and part-time family female members. Most workers in the processing plants are full-time hired males and part-time hired females, while in retailing, both full-time and part-time female family members do the work plus full-time and part-time hired males who usually do the hauling and transporting of vegetables in the marketplace. Working days of hired full-time employees do not differ much by gender, which on average is around 20-27 days per month. Except in processing, casual male workers are employed 111 days in a year. Hired casual females in collecting are only employed 55 days in a year.

Compared with Cambodia and Lao PDR, business collaboration is prevalent in Viet Nam. This usually comes in the form of sharing information and knowledge, and financial and logistical support among three to five collaborating actors. For farmers, most common forms of collaboration include sharing labor, harvest, inputs and transport; lending credit; and selling harvest together, among others. Similar with collectors, wholesalers usually share price or market information to other wholesalers in addition to buying vegetables together and sharing transportation. Many wholesalers also lend money to other wholesalers when the need arises which is similarly done by retailers. Retailers also replenish vegetables of other retailers when stocks are depleted.

Table 2-11 Share of female workers to total labor in trading and retailing, and number of working days of hired workers in Viet Nam

Characteristic	Collector		Wholesaler		Processor		Retailer	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
% share of female to								
… Full-time family workers	48	27	80	26	50		82	32
… Part-time family workers	57	38	15	24			60	46
… Full-time hired workers			78	22	33	4	46	24
… Part-time hired workers	35	21	50	71	71	6	30	26
Full-time male workers (person-day/mo)	20		23	11	25	4	27	5
Full-time female workers (person-day/mo)			26	9	25	4	26	5
Casual male workers (person-day/yr)	114	72	100		248	45	120	60
Casual female workers (person-day/yr)	55	47	100		248	45	120	85

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=101.

3 The overall supply chain for vegetables

3.1 Overview on chain and actors

The vegetable supply chain was mapped out using the flow of vegetables from the producer to the consumer level. The percentages in arrows represent the shares of vegetables sold to the main trading partners. Dotted lines represent minimal transaction (< 5%). The main sources of vegetables by each actor were also added to get the overall picture of the demand and supply side of vegetable transactions. These are represented only by lines.

Among the three countries, Viet Nam's vegetable supply chain is the most complex and diverse (Figure 3-1). Farmers not only supply to collectors and wholesalers, but also to farmer cooperatives, processors, and private households or consumers. Although most of the supply predominantly comes from farmers, collectors also buy from wholesalers. A sizeable amount of the collector's produce is sold to wholesalers and to processors. Wholesalers exhibit the same relative dependence on other wholesalers observed in Lao PDR in terms of buying and selling of fresh vegetables. Viet Namese wholesalers take most of these vegetables from collectors and not from farmers which they eventually sell to wet market vendors, grocery stores and street vendors. Supermarkets are largely supplied by collectors. Except for grocery shops which cater mostly to restaurants, households are the main clientele of the other retailers. Processing is an integral component in the chain taking in fresh vegetable supply from farmers, collectors and wholesalers, and selling most of the processed goods to the export market. In some cases, transport contractors are found to augment supply of fresh vegetables especially to wholesalers and processors.

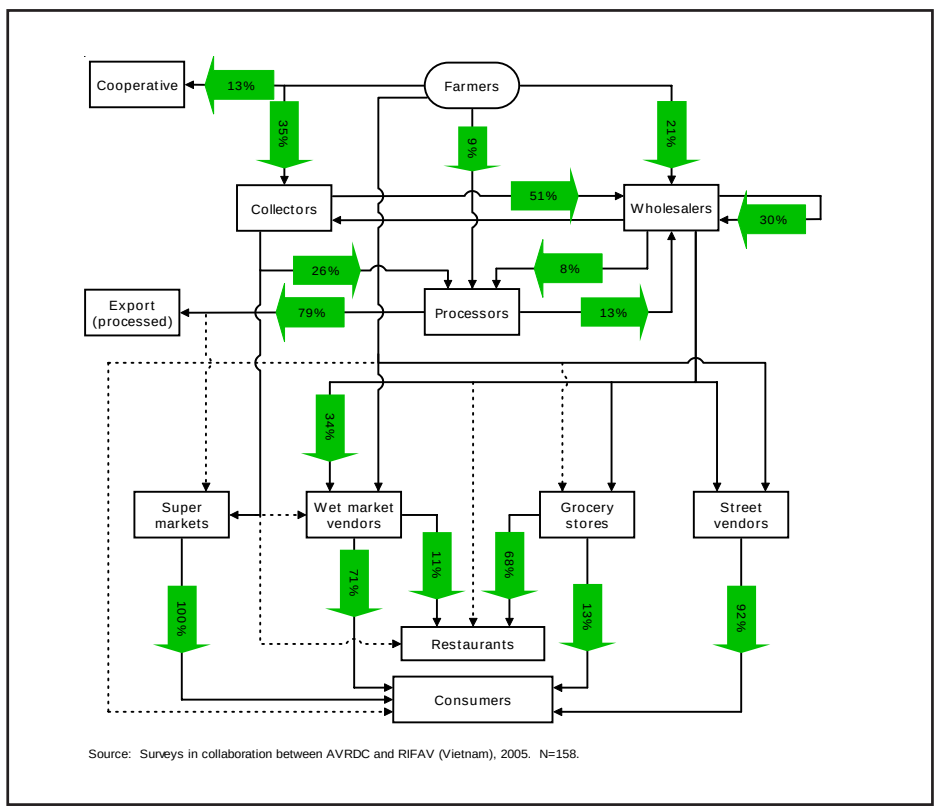

Figure 3-1 Overview of the vegetable supply chain in Viet Nam

Table 3-1 shows the average number of suppliers that actors in the vegetable supply chain for tomato and chili, source their produce from. The table shows a very large variation across different districts. Collectors in Nam Dinh source their tomato from an average of 113 farmers, while Ha Noi collectors are supplied by only 16 farmers. For chili in Hai Phong, the average number of farmers that deal with one collector is 41. Wholesalers in turn deal with a much larger number of collectors in Hai Phong (6) than they do for tomato in Ha Noi and Nam Dinh (2 and 3, respectively). Retailers source their produce from an average of three to four different wholesalers.

Table 3-1 Average number of vegetable suppliers of supply chain actors in Viet Nam

Supply chain actor	Vegetable supplier	Ha Noi		Nam Dinh		Hai Phong		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Collector	Farmer	15.5	17.0	112.6	61.6	40.7	38.9	59.2	60.2
	Collector			4.0		1.0		2.5	2.1
	Wholesaler	2.0		4.0	2.8			3.0	2.0
Wholesaler	Farmer	6.7	4.4	20.0	11.3	11.7	4.2	10.2	7.1
	Collector	2.3	1.3	3.1	1.5	6.3	3.4	3.9	2.7
	Middleman					1.0		1.0	
	Wholesaler	3.0	1.0	3.0	1.3	2.0		2.9	1.1
Retailer	Farmer	4.8	3.7	6.5	2.1	15.5	11.0	8.8	8.7
	Collector	2.0				7.0		3.7	2.9
	Middleman	7.0						7.0	
	Wholesaler	2.5	1.1	4.3	2.5	3.6	1.7	3.4	2.0

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=101.

Similar with Cambodia and Lao PDR, most farmers in Viet Nam are engaged in other commercial ventures, particularly rice and animal trade (poultry and hog). Production of corn is more dominant in Ha Noi, while production of rice is more dominant in Nam Dinh and Hai Phong provinces. Most traders are mainly involved in vegetables, and only a few engage in selling fruits and potato (Table 3-2).

Table 3-2 Main food items traded in Viet Nam

Supply chain actor	Ha Noi	Nam Dinh	Hai Phong	Total
Farmer	Corn (57%)	Rice (89%)	Rice (100%)	Rice (79%)
	Poultry (50%)	Hog (89%)	Hog (85%)	Poultry (70%)
	Rice (44%)	Poultry (74%)	Poultry (85%)	Hog (68%)
Collector	Fruits (17%)		Potato (17%)	Fruits (10%)
			Fruits (17%)	Potato (5%)
Wholesaler	Potato (10%)	Potato (20%)	Fruits (38%)	Potato (18%)
			Potato (25%)	Fruits (11%)
Processor			Fruits (50%)	Fruits (50%)
			Other food (50%)	Other food (50%)

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=158. Values are multiple responses.

3.2 Packaging and transport along the chain

Vegetable suppliers receive their fresh vegetables mostly in sacks, bamboo baskets, Styrofoam boxes, plastic bags and hand baskets (Figure 3-2). When collectors purchase from suppliers and resell their vegetables to wholesalers, the produce comes in bamboo baskets, sacks and Styrofoam boxes. Processors of chili normally takes in fresh chili packed in sacks and hand baskets. Retailers, on the other hand, receive these vegetables mainly in plastic bags. On a per crop basis, when collectors and wholesalers

purchase tomato from suppliers, it is packed in bamboo baskets, Styrofoam boxes and wood boxes, whereas chili, mainly in sacks.

The main means of transportation used in purchasing vegetables from suppliers, regardless of who transports – buyer or seller – are motorbike, bicycle, car, mini-truck, horse/ox cart and on foot (Figure 3-3). From the field to the farmhouse, farmers transport their fresh vegetables using bicycle, bamboo frames, and baskets carried on the shoulder. Most collectors and retailers are responsible for transporting their purchased vegetables from the suppliers using motorbike, plus bicycle for retailers. Wholesalers normally wait for the fresh produce to be delivered by their suppliers mounted on motorbike, mini-truck and car. Between chili and tomato, the latter has a wide array of transportation used. From the field to the farm, it is common for chili farmers to transport the crop using bicycles compared with tomato due to the weight. Aside from bicycles, tomato farmers often employ bamboo frames, baskets on shoulders, hand carts and motorbikes to carry them to the farm. Motorbike is found to be a major mode of transport for both crops. Quite a number of retailers transport tomatoes on foot. For chili, cars are also commonly used by most actors in the chain albeit at varying degrees.

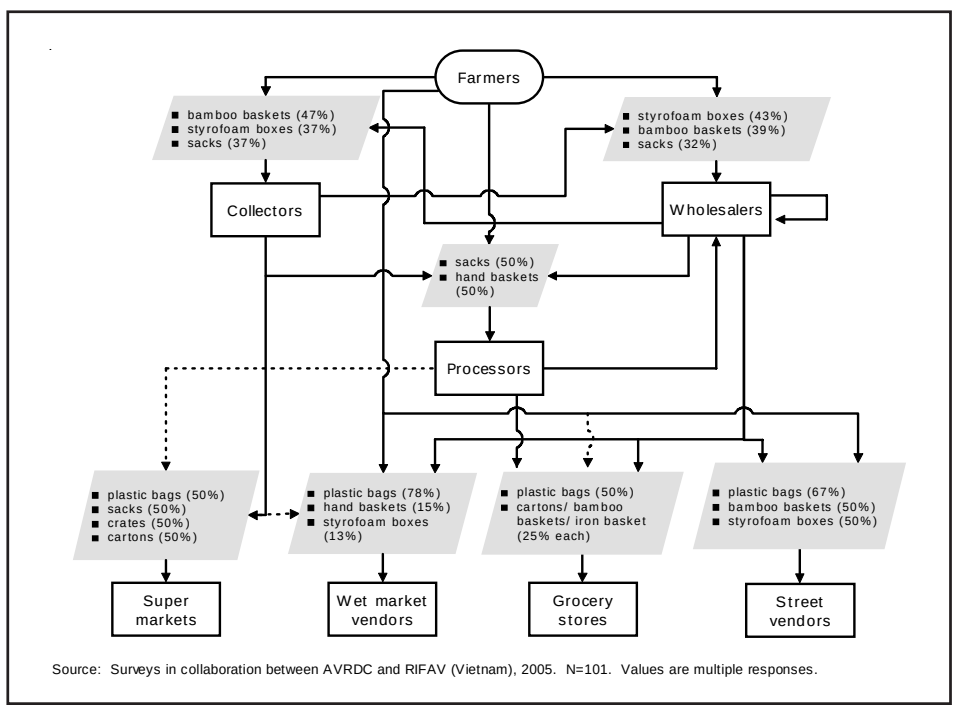

Figure 3-2 Main packaging materials for fresh vegetables in Viet Nam

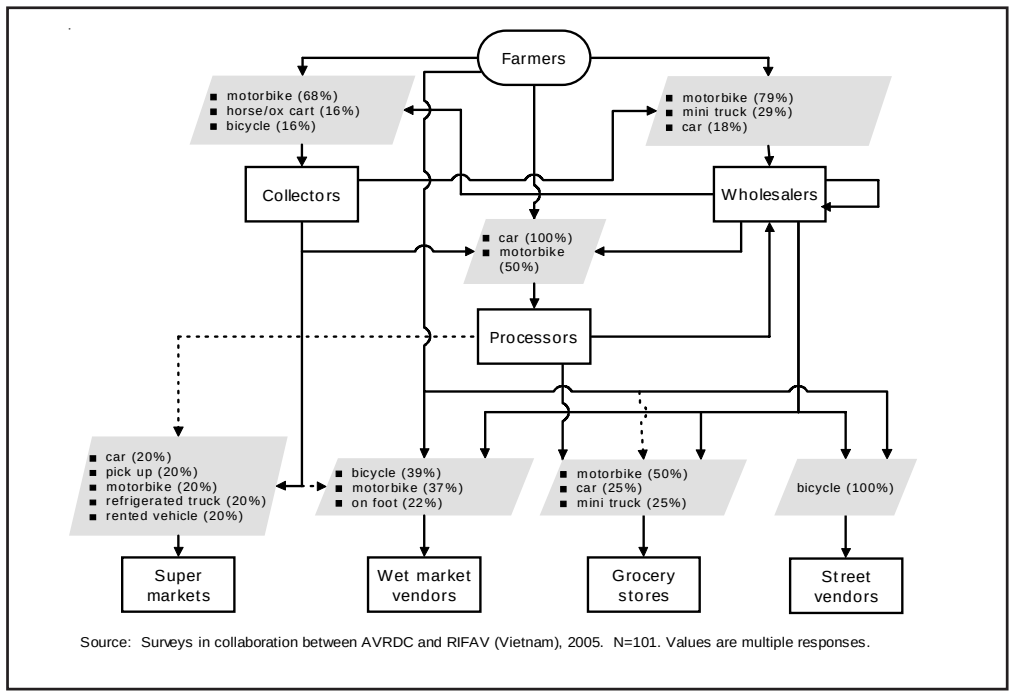

Figure 3-3 Mode of transport of fresh vegetables in Viet Nam

3.3 Communication and cooperation

Compared to the other two countries, a large share of respondents across all types of supply chain actors actively seek price information (Table 3-3). Unlike in Cambodia and Lao PDR, the trend does not decline down the chain, and no marked difference is observed on price and quality trait information. And while there is a strong dependence on price information provided by the actor who purchased the produce in Cambodia and Lao PDR, the most important source of price information in Viet Nam is the cooperative (60%), followed by other farmers (54%) and any trader at the market (40%). Only 9% rely on price information provided by contractors coming to the farm. For collectors, other traders are the most important source (79%), followed by contract companies (32%). Wholesalers mainly rely on information provided by other traders (93%), while retailers rely on their fellow retailers (73%). A total of 28 (18%) actors from the entire sample relied on TV, radio and newspaper to obtain market price information. Most collectors and other downstream actors in the supply chain usually obtain information on a daily basis, similar with 42% of the farmers. One-third of the farmers obtain information on a weekly basis. The level of dissatisfaction among farmers is low (8%), with the rest of the actors being content with the quality of information.

Table 3-3 Number of actors who seek information on market price and quality traits of vegetables in Viet Nam

Type of information	Supply chain actor	Ha Noi		Nam Dinh		Hai Phong		Total	
		N	%	N	%	N	%	N	%
Price information	Farmer	16	89	17	89	20	100	53	93
	Collector	6	100	7	100	6	100	19	100
	Wholesaler	9	90	8	80	8	100	25	89
	Processor					2	100	2	100
	Retailer	18	95	16	100	16	94	50	96
Quality traits	Farmer	17	94	17	89	20	100	54	95
	Collector	6	100	7	100	6	100	19	100
	Wholesaler	9	90	7	70	8	100	24	86
	Processor					2	100	2	100
	Retailer	18	95	12	75	14	82	44	85

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=158.

The number of actors in the vegetable supply chains engaged in contract farming is high in Viet Nam, at an average of 46% and 58% between farmers and collectors. The share of farmers is high especially for tomato growers in Nam Dinh (74%) and for chili farmers in Hai Phong (55%). It is low for retailers with only 6%average (Table 3-4).

Table 3-4 Number of vegetable actors with contract arrangements in Viet Nam

Supply chain actor	Ha Noi		Nam Dinh		Hai Phong		Total	
	N	%	N	%	N	%	N	%
Farmer	1	6	14	74	11	55	26	46
Collector	2	33	5	71	4	67	11	58
Wholesaler	7	70	7	70	1	13	15	54
Processor					1	50	1	50
Retailer	2	11			1	6	3	6

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=158.

Retailers involved in quality assurance programs have been found in Viet Nam compared to Lao PDR and Cambodia. Around 32% of retailers in Ha Noi, the largest share among the three sites, have quality assurance programs in place; in Hai Phong, it is 18% (Table 3-5).

Table 3-5 Number of retailers with quality assurance programs in Viet Nam

Site	N	%
Ha Noi	6	32
Nam Dinh	0	0
Hai Phong	3	18
Total	9	17

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=52.

This research attempted to understand farmers' perceptions about quality traits and compare them to perceptions of other actors in the supply chain, since a large discrepancy would put farmers at a disadvantage. All respondents were thus asked to rank the significance of eleven quality traits on a Likert scale of 1 (not important at all) to 5 (very important). Table 3-6 shows the average ranks by different respondent type. As in the other two countries, all respondents consider freshness of the product the

most important quality trait and packing the least important, except for wholesalers. Two interesting differences as compared to Cambodia and Lao PDR emerge: (a) the significance of grading, price and size are both overrated among farmers as compared to retailers; and (b) food safety related quality traits are given higher importance in Viet Nam, and the rating given by the different actors did not significantly differ from each other.

Table 3-6 Assessment of the importance of quality traits of vegetables in Viet Nam

Trait	Farmer	Collector	Wholesaler	Retailer	Significance
Freshness	4.8	4.6	4.7	4.9	
Color	4.7	4.7	4.5	4.5	
Grading	4.3[a]	4.0[a,b]	4.2[a]	3.8[b]	***
Price	4.2[a]	4.3[a]	4.5[a]	3.8[b]	***
No pesticide residues	4.2	4.4	4.0	4.2	
Size	4.2[a]	4.2[a]	3.3[b]	3.6[b]	***
Free from food-based pathogens	4.1	4.2	3.9	4.1	
Shape	4.1[a]	4.1[a]	3.5[b]	3.7[a,b]	**
No fertilizer residues	3.8	3.9	3.5	3.6	
Certification	3.2	3.2	2.8	2.8	*
Packing	2.6	2.6	3.0	2.4	

Source: Surveys in collaboration between AVRDC and RIFAV. N = 158. Participants ranked importance of traits on a scale from 1 (not important at all) to 5 (very important). ANOVA and Duncan tests were used to examine the significance of difference between groups based on Levene statistic (***=p<0.001; **=p<0.05; *=p<0.01). The same superscript indicates that figures are not statistically different at the 5% level.

3.4 Prices and margins

Figure 3-4 shows the annual fluctuation in retail price and share of produce that wholesalers purchase from local producers. Both crops show a peak production period (tomato in January and chili in April) that coincides with low retail prices. Tomato prices are more variable (the lowest price is 47% of the highest price) as compared to chili (the lowest price is 73% of the highest price). During the peak season, only 6% of all chili sold by the wholesalers interviewed was provided by the farmers that we interviewed, while for tomato, the share was 41% during the peak season.

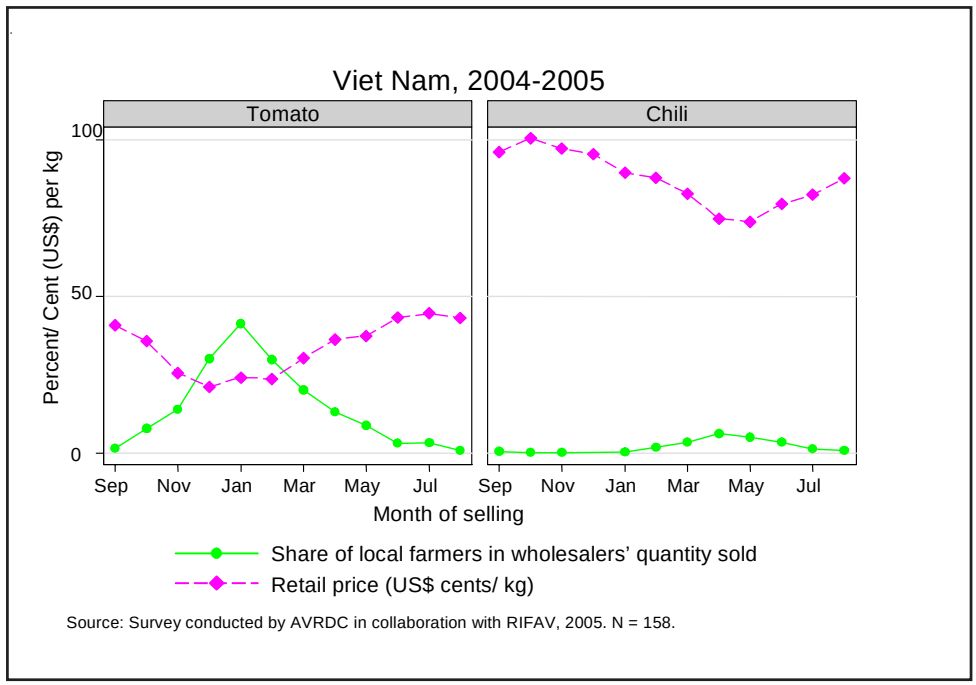

Figure 3-4 Monthly average retail price and share of local production of tomato and chili in Viet Nam

4 Crop supply chain

4.1 Tomato

4.1.1 Economic importance and the supply chain

Tomato is one of the few vegetable crops where production statistics are available. Total annual production in 2004 has been estimated at 424,126 MT (GSO, 2005). It has major economic importance, and a total turnover of US$ 10 million for 2005 has been anticipated. The tomato supply chain sampled within the frame of this study was responsible for a total turnover of US$ 898 thousand (Table 4-1).

The supply chain for tomato is rather complex, as Figure 4-1 shows. Farmers sell a quarter or more of their fresh produce either to collectors or wholesalers, while smaller shares are also being sold to cooperatives and processors. Collectors sell most of their produce to wholesalers and/or processors, and the rest are distributed to retailers. Wholesalers sell a large chunk of fresh tomatoes either to their fellow wholesalers or to wet market vendors and only a small portion to processors.

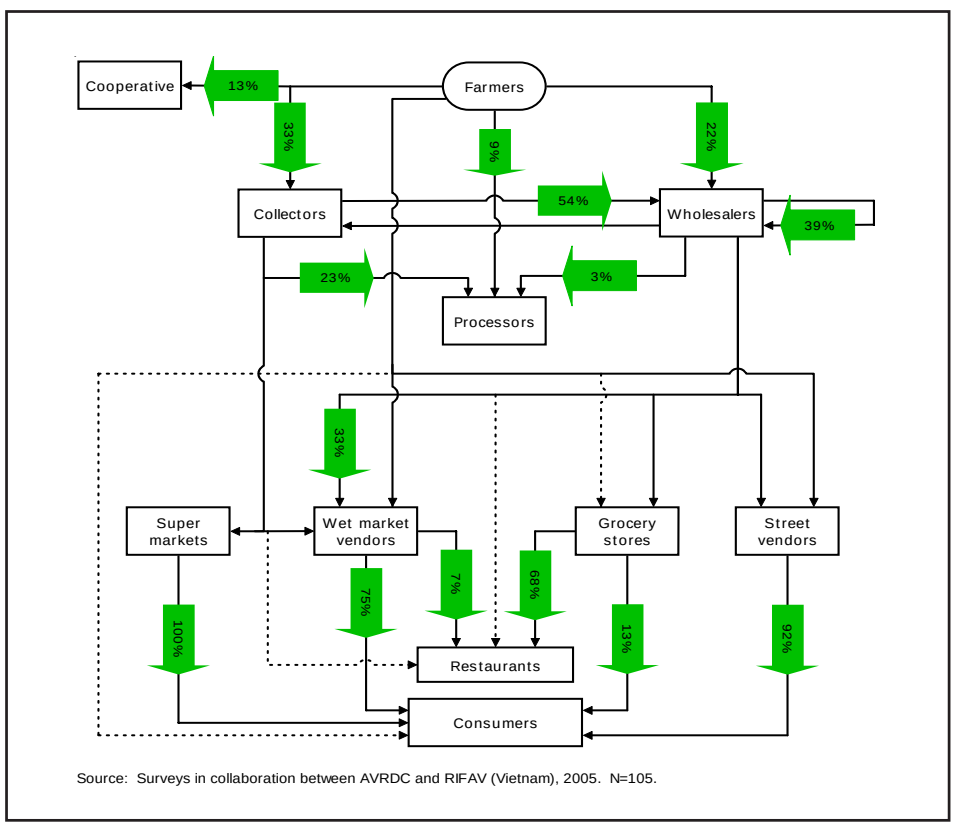

Figure 4-1 Main trading partners in the supply chain of tomato in Viet Nam

The main production period is October to January, with its peak in December. No harvest was recorded in July and August. For farmers engaged in tomato cultivation, the crop represents an important income source with 42% of total turnover derived from this crop. It is even more important for collectors, where tomato contributed 70% of their total turnover. Among wholesalers, the share was 59% (Table 4-1).

Table 4-1 Monthly sales of tomato in Viet Nam, 2004-2005

Month	Farmer		Collector		Wholesaler		Retailer		Total	
	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)
Sep-04	5.0	0.4	37.6	6.8	176.2	50.7	9.8	4.0	228.6	61.9
Oct-04	62.0	5.7	94.9	13.8	205.8	51.5	10.2	3.6	372.9	74.6
Nov-04	64.3	6.8	267.7	28.4	199.6	32.9	11.4	2.9	543.0	71.0
Dec-04	113.5	8.0	589.5	49.2	215.9	36.3	11.8	2.5	930.7	96.0
Jan-05	44.6	3.5	684.9	53.7	181.0	27.6	14.7	3.5	925.2	88.3
Feb-05	1.0	0.1	450.0	35.7	196.7	29.6	18.9	4.5	666.6	69.9
Mar-05	1.7	0.2	451.9	48.3	160.9	31.5	13.0	3.9	627.5	83.9
Apr-05	14.7	1.9	191.1	26.7	164.3	37.5	14.3	5.2	384.4	71.3
May-05	13.0	0.9	171.9	27.7	162.7	41.3	14.0	5.2	361.6	75.1
Jun-05	6.0	1.1	143.2	22.4	188.5	50.9	13.7	5.9	351.4	80.3
Jul-05			25.9	7.6	184.7	51.8	15.0	6.6	225.6	66.0
Aug-05			6.6	2.5	184.6	52.5	12.1	5.2	203.3	60.2
Total	325.7	28.6	3115.1	322.8	2,220.8	494.3	158.9	53.1	5,820.5	898.8
% share to total turnover		42.1		70.1		59.3		0.5		

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=787 observations.

4.1.2 Postharvest losses

All farmers and collectors, 85% of wholesalers, and 78% of retailers incur postharvest loss in the production and trade of tomato estimated at 81, 42, 38 and 27 kg per MT produce, respectively (Table 4-2). This is equivalent to about 8%, 4%, 4% and 3% of the total volume traded. Total average losses are uniform across the different seasons of the year. Usually, losses are highest for farmers and lowest for retailers. The average loss per MT of tomato produced is 188 kg, or 18.8% of total production. The median loss across the chain is lower at 14%, and except for collectors, the difference between the mean and the median is rather small.

Nearly all (90%) farmers reported using spoiled tomatoes on the farm or in the household. Around 88% of farmers and retailers, 84% of collectors and 96% of wholesalers sell the partially spoiled produce at lower prices. The average price reduction was highest for farmers at 27% and lowest for retailers (6%). Collectors and wholesalers also reported price reduction for partially spoiled produce between 6% and 13% during wet and dry seasons.

Main reasons for postharvest loss for farmers are diseases and the humid and hot weather during harvest (Table 4-3). In focus group discussions, it was also mentioned that the produce is carried to markets by primitive medium, such as jute bags, which could not provide adequate protection against physical damages.

For traders and retailers, the main reasons are damage sustained during transport and failure to sell all the produce in the same day. Collectors also consider hot weather during harvest time an important cause of loss although only a single case of collector was found to harvest tomatoes from the field (Table 4-4).

Table 4-2 Postharvest loss estimates of tomato in the supply chain in Viet Nam

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	100	100	85	78
Loss values				
- kg per MT	81	42	38	27
- % loss				
Dry 1	7	4	4	3
Dry 2	10	4	5	3
Wet	9	4	3	3
Average	8	4	4	3
Median	7	2	3	2
Damaged/partially spoiled produce				
Sell at reduced price (%)	88	84	96	88
Price reduction in Dry season (%)	27	6	13	6
Price reduction in Wet season (%)	28	9	12	

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=787 observation. Seasons are based on the months of first harvest or sale. Dry season 1 is from November to January; Dry season 2, February to April; and Wet season, May to October.

Table 4-3 Main reasons for tomato postharvest loss at farm level in Viet Nam

Reason	Dry 1		Dry 2		Wet		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	14	48	6	86	9	64	29	58
Humid weather during harvest	20	69	3	43	8	57	31	62
Diseases	21	72	7	100	9	64	37	74
Damage during harvest	5	17			1	7	6	12
Damage during transport	7	24	1	14	5	36	13	26
Poor quality of variety	2	7					2	4
Cannot sell all vegetables	1	3					1	2
Total	29	100	7	100	14	100	50	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=50 observations. Values are multiple responses. See additional notes in Table 4-2.

Table 4-4 Main reasons for tomato postharvest loss at trader and retailer levels in Viet Nam

Reason	Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	9	69	3	15			12	18
Humid weather during harvest	6	46	5	25			11	16
Diseases	5	38					5	7
Damage during harvest	3	23					3	4
Damage during transport	11	85	19	95			30	44
Poor packaging	3	23	4	20	5	14	12	18
High temperature in storage facility	2	15	6	30	5	14	13	19
High humidity in storage facility	2	15	6	30	4	11	12	18
Low humidity in storage facility			1	5	1	3	2	3
Poor hygiene conditions					3	9	3	4
Poor infrastructure facilities					15	43	15	22
Cannot sell all vegetables	2	15	8	40	14	40	24	35
Poor quality of purchased vegetable crop			1	5	11	31	12	18
Other reason of spoilage					4	11	4	6
No loss	2	15	1	5	4	11	7	10
Total	13	100	20	100	35	100	68	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=68. Values are multiple responses.

Table 4-5 shows the measures that supply chain actors suggested to abate high postharvest loss in tomato. Corresponding to the high number of responses from Table 4-4 that point towards damage during transport, careful transport is a main measure suggested. Farmers also highlight the need for careful harvest and storage in cool facilities. In focus group discussions, producers also highlighted the need to spray chemicals in time, that growing tomato in shelter was a helpful measure, that care should be taken in loading and unloading and that produce should not be packed too thickly. Retailers try not to buy more than what is needed for the day.

Table 4-5 Measures to prevent loss of tomato along the supply chain in Viet Nam

Strategy	Farmer		Trader		Retailer		Total	
	N	%	N	%	N	%	N	%
Harvest during cool weather	14	38					14	13
Careful harvest/ demand careful harvest	21	57	9	27			30	29
Store in cool area	20	54	5	15	7	20	32	30
Observe care during transport	19	51	24	73	8	23	51	49
Harvest after buyer has been identified	11	30					11	10
Collect during cool weather			9	27			9	9
Demand time of harvest			2	6			2	2
Observe care in packaging			11	33	3	9	14	13
Low humidity in storage area					1	3	1	1
Good hygiene conditions					3	9	3	3
Not buying more than what is needed					25	71	25	24
Buy high quality vegetable crop			6	18	13	37	19	18
Do nothing	1	3	2	6	1	3	4	4
Other preventive measure of spoilage	3	8					3	3
Total	37	100	33	100	35	100	105	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=105. Values are multiple responses.

4.1.3 From production to value-added activities

4.1.3.1 Production

Average yield of tomato among farmers is 55 MT per ha during the wet season, and slightly lower during the early and late dry season at 49 MT/ha and 37 MT/ha, respectively (Table 4-6). Yields are higher in Ha Noi than in Nam Dinh. The average area under tomato production per farmer is 898 m^2 in Ha Noi, and 1,992 m^2 in Nam Dinh. Only farmers from Nam Dinh grow tomatoes during the late dry season. The average selling price is lowest during the early dry season and highest during the late dry season in Nam Dinh. There is less price fluctuation in Ha Noi compared to Nam Dinh. The average value of sales per production cycle is nearly double in Nam Dinh (US$ 915) compared to Ha Noi (US$ 547), which can be explained by the larger production area in the former than in the latter.

Table 4-6 Average yield, production area, selling price and sales of tomato by season in Viet Nam

Parameter	Season	Ha Noi		Nam Dinh		Total	
		Mean	SD	Mean	SD	Mean	SD
Yield (MT/ha)	Wet	61.5	11.9	43.7	16.3	55.2	15.7
	Dry 1	56.7	20.7	43.6	11.1	49.0	16.8
	Dry 2			36.8	6.5	36.8	6.5
	Mean	58.8	17.3	42.0	11.2	49.0	16.3
Production area (m^2)	Wet	731	226	2,340	1,124	1,306	1,030
	Dry 1	1,023	553	2,413	1,165	1,838	1,175
	Dry 2			723	397	723	397
	Mean	898	459	1,992	1,233	1,533	1,119
Selling price (US$/MT)	Wet	129.8	28.4	133.4	35.9	131.1	29.9
	Dry 1	128.1	47.0	99.7	43.8	111.5	46.5
	Dry 2			153.9	29.2	153.9	29.2
	Mean	128.8	39.2	118.6	45.0	122.9	42.6
Sales (US$)	Wet	498.9	131.9	1,221	661.8	756.9	523.9
	Dry 1	584.6	426.1	1,042	949.4	852.9	799.4
	Dry 2			388.3	252.2	388.3	252.2
	Mean	547.9	329.7	915.2	829.0	761.0	686.0

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=50 observations. See additional notes in Table 4-2.

4.1.3.2 Storage, packaging and transport

Farmers begin to harvest from September until June. In general, farmers are responsible for harvesting. Only one collector out of 13 disclosed harvesting the crop himself. No wholesaler was responsible for harvesting tomato.

On average, the total duration of harvesting was 120 days in Ha Noi and 63 days in Nam Dinh. The harvested produce stays for long periods at the farm, about 172 hours in Ha Noi and 44 hours in Nam Dinh (Table 4-7). At the collector, wholesaler and retailer levels, the produce stays for about 19, 7 and 3 hours, respectively. The average total time between production and sale is 127 hours, or 5.3 days.

After harvest, farmers usually store produce on the ground (> 55%), but only a small share could recall storing in the shade. Approximately 40% of farmers store tomatoes in baskets, while the one collector who harvests tomatoes by himself stores tomatoes in crates (Figure 4-2).

Farmers and collectors store tomatoes in their own storage facilities, while wholesalers rely more on rented storage spaces (Figure 4-3). A large share of retailers do not have their own storage facilities; if they do, it is usually off-site.

Main packaging material differs with each chain actor; bamboo basket for collectors, Styrofoam box for wholesalers, and plastic bag for retailers (Figure 4-4). Other more frequently used packaging materials are Styrofoam and wood box for collectors, and bamboo basket for wholesalers.

Farmers usually transport tomatoes from the field to the farmhouse by bicycle (Figure 4-5). While most farmers said they deliver the produce to their trading partners, in most cases (69%), collectors pick up the produce from the farm (Table 4-8). Collectors and wholesalers mainly use motorbikes to transport tomatoes; collectors also use horses or ox carts, while wholesalers also transport them in mini-trucks or other rented vehicles. Retailers mainly use bicycles or motorbikes.

Table 4-7 Number of hours between harvest/purchase and sale of tomato at different levels in the supply chain in Viet Nam

Supply chain actor	Ha Noi		Nam Dinh		Total	
	Mean	SD	Mean	SD	Mean	SD
Farmer	172.0	76.6	43.9	27.9	97.7	83.2
Collector	9.7	4.4	27.4	22.0	19.4	18.6
Wholesaler	7.8	3.3	6.6	2.8	7.2	3.1
Retailer	3.1	1.6	2.2	1.3	2.7	1.5
Total	192.6	85.9	80.1	54	127.0	106.4

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=787 observations.

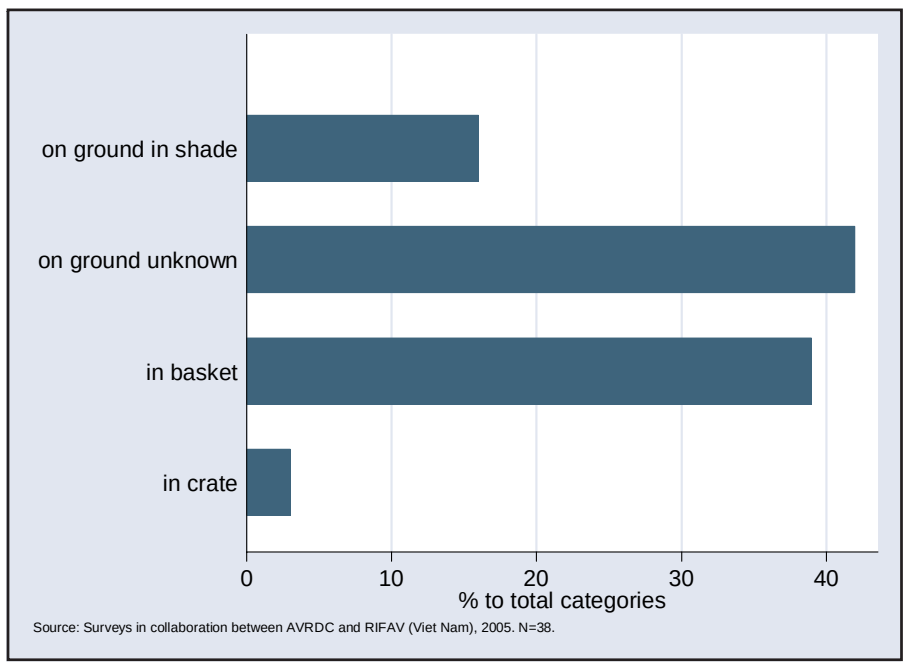

Figure 4-2 Storage of tomato at farm level in Viet Nam

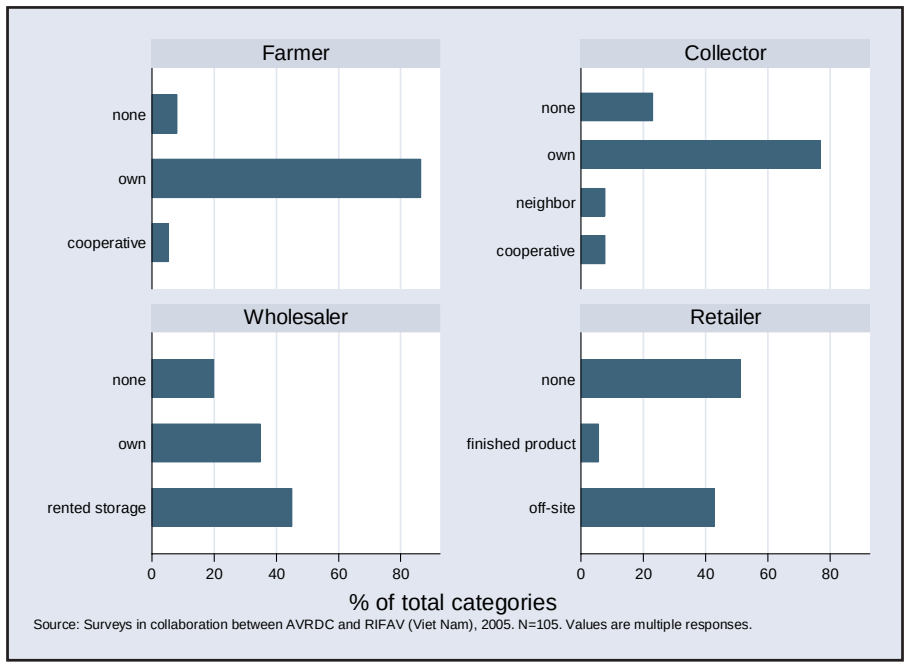

Figure 4-3 Storage facilities for tomato in Viet Nam

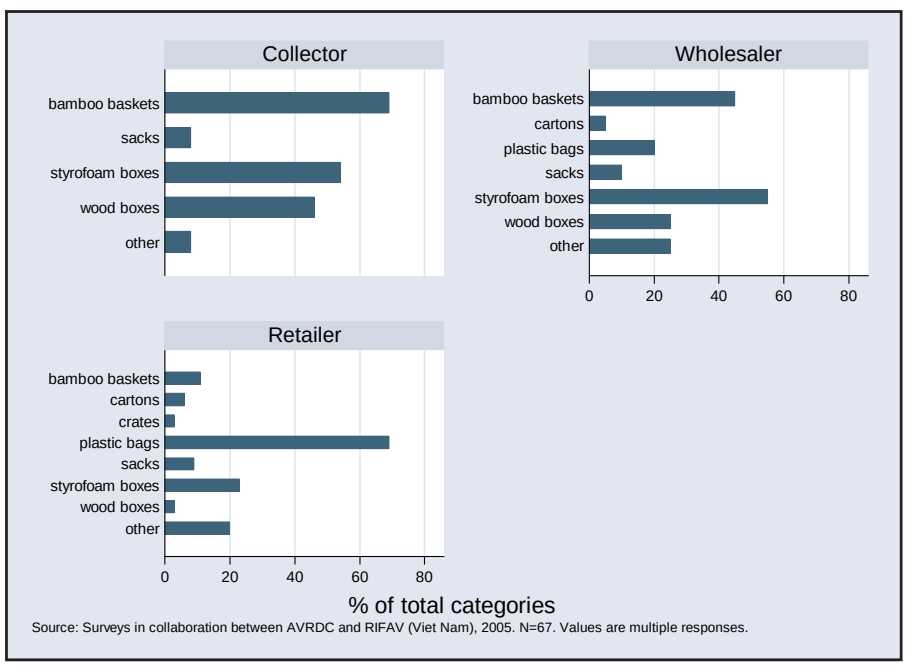

Figure 4-4 Packaging materials for tomato in Viet Nam

Table 4-8 Supply chain actors involved in transporting tomato from their suppliers in Viet Nam

Supply chain actor	Ha Noi		Nam Dinh		Total	
	N	%	N	%	N	%
Farmer	13	72	19	100	32	86
Collector	6	100	3	43	9	69
Wholesaler	3	30	5	50	8	40
Retailer	15	79	12	75	27	77

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=105. In the case of farmers, it is the share of farmers responsible for transporting produce to their buyers.

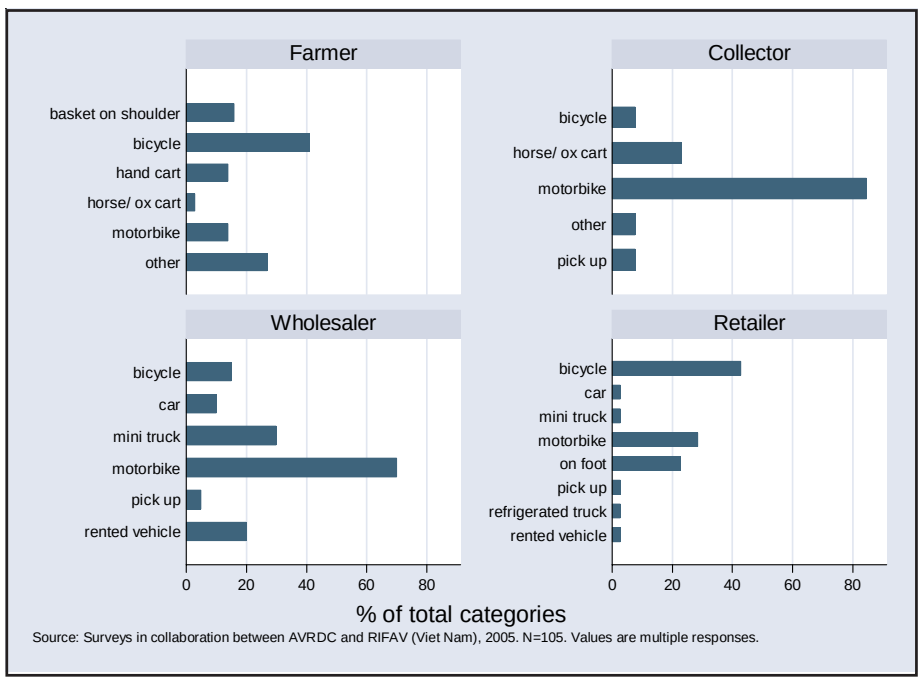

Figure 4-5 Mode of transport of tomato in Viet Nam

4.1.3.3 Value-added activities

Almost all actors (85%) are involved in value-adding activities (Table 4-9). As the produce travels from producers to consumers, participation of actors in value-adding activities diminishes. The most common activities are sorting, grading, cleaning, transporting, storage and packing. While storage occurs in all actors, it happens quite often among collectors. Cleaning is usually done at the farmer and retailer levels. Pre-cooling and packing are also commonly done by farmers and collectors. Repacking becomes minimal in Viet Nam as tomato passes from one actor to another compared with Cambodia and Lao PDR.

Table 4-9 Involvement of supply chain actors in value-adding activities for tomato in Viet Nam

Supply chain actor	Involved (%)	Not involved (%)
Farmer	97	3
Collector	100	
Wholesaler	80	20
Retailer	69	31
Mean	85	15

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=105.

4.2 Chili

4.2.1 The supply chain and economic importance

Data on chili production is available for selected districts only. Total annual production in major chili-growing districts during 2004 has been estimated at 30,260 MT, produced on 41,410 ha (GSO, 2005).

Similar to the supply chain for tomato, the chili supply chain involves various linkages (Figure 4-6). Farmers sell most of the produce to collectors who, in turn, sell mostly to processors with only a small share going to wholesalers. Processors mainly cater to exporters. Wholesalers also supply processors with its chili requirements but the bulk is sold to wet market vendors and other wholesalers who distribute them to other regions.

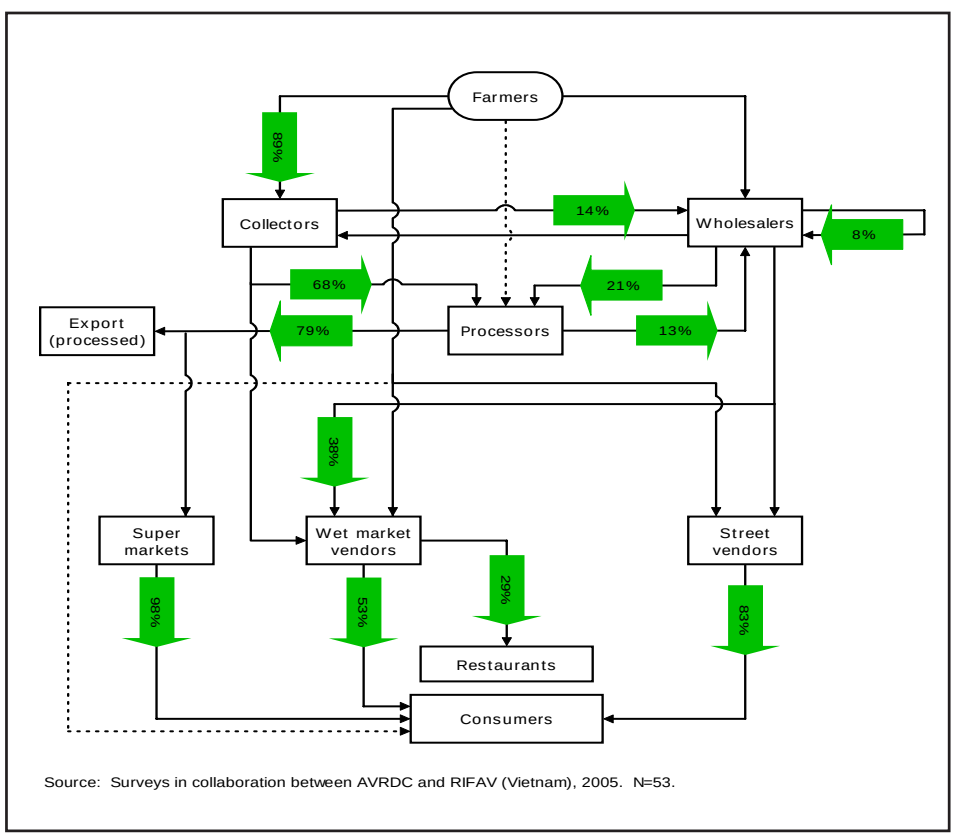

Figure 4-6 Main trading partners in the supply chain of chili in Viet Nam

The chili supply chain sampled within the frame of this study was responsible for a total turnover of US$ 506 thousand (Table 4-10). The main harvest period is March to April. No harvest was recorded from May to December. Chili represents only a minor share in farmers' income with only 15% of total sales derived from its cultivation. It is more important for collectors and wholesalers where sales from chili contribute 54% and 51% of total turnover, respectively.

Table 4-10 Monthly sales of chili in Viet Nam, 2004-2005

Month	Farmer		Collector		Wholesaler		Retailer		Total	
	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)	Quantity (MT)	Sales ('000 US$)
Sep-04			1.4	0.8	74.8	47.1	1.6	1.5	77.8	49.4
Oct-04			1.4	0.8	90.9	71.6	1.7	1.7	94.0	74.1
Nov-04			1.4	0.8	93.8	72.4	1.7	1.7	96.9	74.9
Dec-04			0.8	0.4	95.7	55.9	1.8	1.7	98.3	58.0
Jan-05	0.4	0.1	9.5	2.9	52.2	22.2	1.7	1.5	63.8	26.7
Feb-05	1.0	0.1	12.5	3.7	53.7	23.4	1.6	1.4	68.8	28.6
Mar-05	5.2	0.8	19.7	4.9	53.0	21.8	1.5	1.3	79.4	28.8
Apr-05	6.3	0.8	32.2	7.9	55.5	16.0	1.5	1.1	95.5	25.8
May-05			61.0	12.9	55.0	13.7	1.4	1.0	117.4	27.6
Jun-05			54.4	12.1	52.0	13.4	1.4	1.1	107.8	26.6
Jul-05			44.1	10.6	79.9	31.2	1.4	1.2	125.4	43.0
Aug-05			14.8	3.3	78.5	39.0	1.4	1.3	94.7	43.6
Total	12.9	1.7	253.2	61.1	835.1	427.7	18.7	16.4	1,119.9	506.9
% share to total turnover		15.3		53.6		51.1		1.9		

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=354 observations.

4.2.2 Postharvest losses

All farmers and collectors, 85% of wholesalers and 78% of retailers experience postharvest loss in the production and trade of chili estimated at 70, 52, 16 and 31 kg per MT produce, respectively (Table 4-11). Total average losses of chili differ widely with season. Losses during the dry season are much higher than during the wet season. It is shown earlier that chili production mainly occurs during the dry season. Total average losses are highest for farmers and lowest for wholesalers and retailers. The average loss incurred over the year is 169 kg per MT, or 16.9%. The median is similar to the mean value, and slightly lower only in the case of farmers and wholesalers.

Only a quarter (25%) of the farmers use partially spoiled product on the farm or in the household. In addition, 85% of farmers sell partially spoiled produce at lower prices. Average price reduction for farmers is 21%; collectors and wholesalers, between 5 to 8% during the wet and dry seasons; and retailers, 7%.

As with tomato, farmers' main reasons for postharvest loss in chili are disease infection and the humid and hot humid weather during harvest (Table 4-12). For traders and retailers, the main reason provided was that not all produce could be sold during the same day. Collectors and wholesalers also consider the hot and humid weather during harvest time as a major cause for loss, while retailers pointed out poor infrastructure facilities (Table 4-13).

Viet Namese respondents are more proactive compared to respondents from the other two countries in addressing postharvest problems across the chain as shown by a wider array of preventive measures enumerated (Table 4-14). The main measure to prevent postharvest loss is storage in cool area, followed

by harvesting during cool weather. Retailers also stressed that they will try not to buy produce more than what is needed. In focus group discussions, respondents agreed that produce should be kept in plastic containers during transport, should be handled with care during loading and unloading, should be sold directly after procurement, and should avoid packing chili too thickly.

Table 4-11 Postharvest loss estimates of chili in the supply chain in Viet Nam

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	100	100	85	78
Loss values				
- kg per MT	70	52	16	31
- % loss				
Dry 1	11	11	1	3
Dry 2	7	8	2	3
Wet		0	2	3
Average	8	5	2	3
Median	7	5	1	3
Damaged/partially spoiled produce				
Sell at reduced price (%)	85	83	100	88
Price reduction in Dry season (%)	21	5	6	7
Price reduction in Wet season (%)		7	8	

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=354 observations. See additional notes in Table 4-2.

Table 4-12 Main reasons for chili postharvest loss at farm level in Viet Nam

Reason	Dry 1		Dry 2		Total	
	N	%	N	%	N	%
Hot weather during harvest			10	53	10	50
Humid weather during harvest			12	63	12	60
Diseases	1	100	17	89	18	90
Damage during harvest			2	11	2	10
Damage during transport	1	100	2	11	3	15
Poor quality of variety			2	11	2	10
Other reason of spoilage			1	5	1	5
Total	1	100	19	100	20	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=20 observations. Values are multiple responses.

Table 4-13 Main reasons for chili postharvest loss at trader and retailer levels in Viet Nam

Reason	Collector		Wholesaler		Processor		Retailer		Total	
	N	%	N	%	N	%	N	%	N	%
Hot weather during harvest	2	33	3	38					5	15
Humid weather during harvest	3	50	3	38					6	18
Diseases	1	17	2	25					3	9
Damage during harvest			1	13					1	3
Damage during transport	1	17	1	13					2	6
Poor packaging			1	13					1	3
Poor sorting					1	50			1	3
Poor grading					1	50			1	3
High temperature in storage facility			3	38			2	12	5	15
High humidity in storage facility	1	17	1	13	1	50	2	12	5	15
Low humidity in storage facility			1	13	1	50			2	6
Poor hygiene conditions							1	6	1	3
Poor infrastructure facilities					2	100	4	24	6	18
Cannot sell all vegetables	2	33	3	38			10	59	15	45
Poor quality of purchased vegetable crop							3	18	39	
No loss							2	12	2	6
Total	6	100	8	100	2	100	17	100	33	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=33. Values are multiple responses.

Table 4-14 Measures to prevent loss of chili along the supply chain in Viet Nam

Measure	Farmer		Trader		Retailer		Processor		Total	
	N	%	N	%	N	%	N	%	N	%
Harvest during cool weather	17	85							17	32
Careful harvest/ demand careful harvest	2	10	1	7					3	6
Spray water on harvest			1	7					1	2
Store in cool area	12	60	8	57	3	18	1	50	24	45
Observe care during transport/ good transport system			4	29	2	12	1	50	7	13
Harvest after buyer has been identified	4	20							4	8
Collect during cool weather			3	21					3	6
Observe care in packaging			1	7			1	50	2	4
Processing vegetables immediately							1	50	1	2
Not buying more than what is needed					15	88	1	50	16	30
Buy high quality vegetable crop					2	12			2	4
Do nothing	3	15	3	21	1	6			7	13
Total	20	100	14	100	17	100	2	100	53	100

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N = 53. Values are multiple responses.

4.2.3 From production to value-added activities

4.2.3.1 Production

Average yield of chili among farmer-respondents is 22 MT per ha from an average area of 343 m^2 per farmer (Table 4-15). In Hai Phong, the average selling price is US$ 137 per MT which generated an average sales valued at US$ 86 per production cycle.

Table 4-15 Average yield, production area, selling price and sales of chili by season in Hai Phong, Viet Nam

Parameter	Season	Mean	SD
Yield (MT/ha)	Dry 1	23.4	
	Dry 2	21.5	9.5
	Mean	21.6	9.3
Production area (m^2)	Dry 1	192.0	
	Dry 2	351.4	120.6
	Mean	343.4	122.7
Selling price (US$/MT)	Dry 1	125.3	
	Dry 2	137.8	51.3
	Mean	137.2	50.0
Sales (US$)	Dry 1	50.1	
	Dry 2	88.1	55.8
	Mean	86.2	55.0

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N = 20 observations. See additional notes in Table 4-2.

4.2.3.2 Storage, packaging and transport

The harvest period begins in January until April. Harvesting is done by farmers, and only one collector out of six harvests the produce. None among the wholesalers harvests chili. Similar with farmers, the average time chili is kept at the collector's level between purchase and sale is 19 hours (Table 4-16). The time is shorter for wholesalers at 12 hours, and retailers (5 hours). Thus, on average, chili spends 54 hours in the supply chain. In one case a wholesaler reported a US$0.3 storage cost/day.

Majority of farmers store chili on the ground in the shade (Figure 4-7). All collectors and 95% of wholesalers package chili in sacks (Figure 4-8). Retailers repack the produce in plastic bags.

Farmers usually transport chili from the field to the farmhouse by bicycle (Figure 4-9). Collectors and especially wholesalers wait for deliveries of fresh vegetables from their suppliers transported by motorbikes and bicycles (Table 4-17). Most retailers pick up their supply of fresh produce from suppliers riding motorbikes and bicycles. Thus, it can be inferred that most of the produce are transported in relatively small quantities.

Table 4-16 Number of hours between harvest/purchase and sale of chili in Hai Phong, Viet Nam

Supply chain actor	Mean	SD
Farmer	18.6	7.7
Collector	19.2	7.4
Wholesaler	11.7	8.3
Retailer	4.8	5.3
Total	54.3	28.7

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N = 354 observations.

Table 4-17 Supply chain actors involved in transporting chili from their suppliers in Hai Phong, Viet Nam

Supply chain actor	N	%
Farmer	15	75
Collector	2	33
Processor	1	50
Retailer	13	76

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N = 53. In the case of farmers, it is the share of farmers responsible for transporting produce to their buyers.

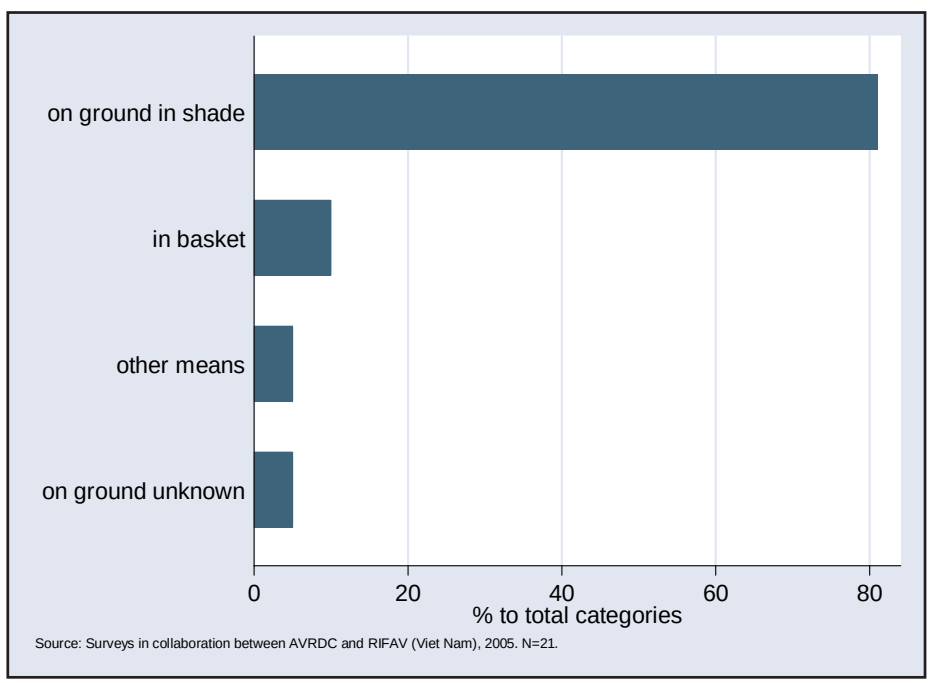

Figure 4-7 Storage of chili at farm level in Viet Nam

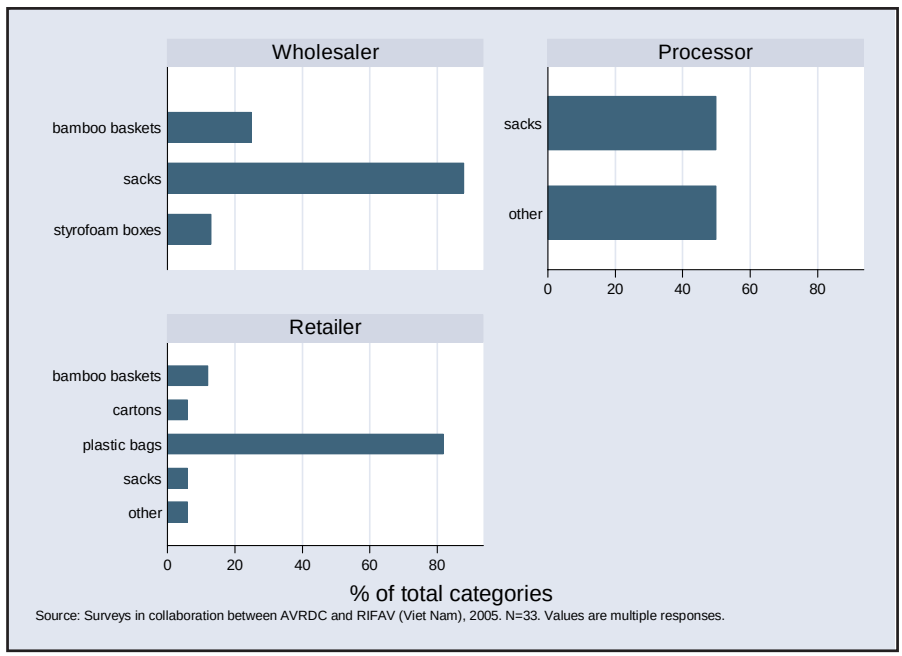

Figure 4-8 Packaging materials of chili in Viet Nam

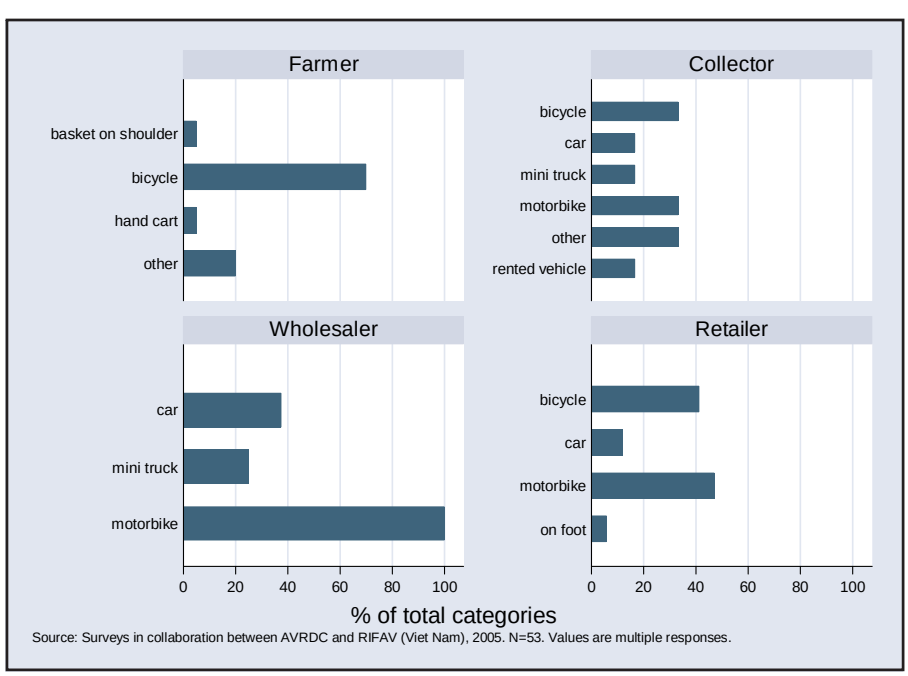

Figure 4-9 Mode of transport of chili in Viet Nam

4.2.3.3 Value-added activities

Except at the farm level, actors down the chain have little value-adding activities for chili (Table 4-18). The most common value-adding activities are sorting, grading, cleaning and transporting. Cleaning takes place at the farmer and retailer levels. Wholesalers do not transport chili compared with other actors. A small share of collectors and wholesalers repack chili before selling them to their trading partners. On the processing side, other value-adding activities include drying, labeling, canning and preserving.

Table 4-18 Involvement of supply chain actors in value-adding activities for chili in Viet Nam

Supply chain category	Involved (%)	Not involved (%)
Farmer	95	5
Collector	33	67
Wholesaler	38	62
Processor	100	0
Retailer	53	47
Mean	60	40

Source: Surveys in collaboration between AVRDC and RIFAV, 2005. N=53.

5 Discussion

To obtain a value of loss experience, actual loss in kg was multiplied by the average selling price. This value was divided by the total amount of vegetables produced or purchased by each actor in kg, to obtain a value of loss based on a uniform denominator, and added across all actors in the supply chain. The loss value for each kg produced or handled is higher for chili (US$ 55 per MT) compared to tomato (US$ 34 per MT). For chili, the value of loss per unit handled is highest at the retail level while for tomato the loss is equally distributed between farmers, wholesalers and retailers (Table 5-1).

Total tomato production in Viet Nam was nearly 425 thousand metric tons during 2004. This results in a value of annual postharvest loss of US$ 14.6 million worth of product. For chili, total production was 30 thousand MT, and total value of loss was US$ 1.7 million.

Table 5-1 Average loss in US$ per MT of produce dealt with in Viet Nam

Supply chain actor	Tomato	Chili	Average
Farmer	10.0	9.2	9.8
Collector	6.3	11.5	7.6
Wholesaler	8.7	7.4	8.3
Retailer	9.4	27.1	15.5
Total	34.4	55.2	41.2
Annual production (2004) (MT)	424,126	30,260	
Annual value of loss based on production (US$)	14,589,934	1,670,352	
Annual quantity of sales in Ha Noi markets (2003)[a] (MT)	9,490		
Annual value of loss based on sales in Ha Noi market (US$)	326,456		

Source: Surveys in collaboration between AVRDC and RIFAV, 2003. N=158. [a] An, Vagneron, Thinh, Dam, Hang, Thoai and Moustier (2003).

Table 5-1 illustrates that postharvest loss translates into large economic loss which is higher for tomato due to larger production area than chili. On the other side, the economic value of each MT of vegetable dealt with is larger for chili than for tomato. However, since chili contributes to only a small share of total farm income, a reduction in postharvest loss in tomato can be expected to show a larger impact.

In focus group discussions, all actors in the supply chain agreed that postharvest measures are required both for tomato and chili. For tomato, producers would like to learn more about intensive production technologies, as well as preservation technologies directly after harvest. They are also interested in improved tomato seed, especially resistance to diseases. Similarly for chili, producers are interested in intensive cultivation technologies, and in preventive measures against diseases and insects. Farmers are also interested to learn more about harvesting and preservation technologies. Among collectors, wholesalers and retailers, more emphasis is placed on preservation and packaging technologies (the latter for tomatoes).

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