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AVRDC - The World Vegetable Center is an international not-for-profit organization committed to ensuring the world's food security through research, development, and training.

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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
ha	Hectare
hr	Hour
kg	Kilogram
LAK	Lao Kip
km	Kilometer
Lao PDR	Lao People's Democratic Republic
m^2	Square meter
MAF	Ministry of Agriculture and Forestry
MAF/DOAG	Ministry of Agriculture and Forestry / Department of Agriculture
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
SD	Standard deviation
TV	Television
US	United States
US$/MT	US dollar per metric ton
yr	Year

1 Vegetables in Lao PDR

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 Lao PDR, 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 Vietnam, 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).

In Lao PDR, with the government's strong emphasis on agricultural development, vegetable production has dramatically improved during the last 25 years reaching its peak in 2002 (809,000 MT) up from 51,000 in 1980 (Figure 1-1). Vegetable area expanded with an annual growth rate of 18%. The robustness of change in vegetable production and area has also led to dramatic improvements in yield per ha amid lower annual growth rate of 4%. The market-oriented economic liberalization measures (i.e. New Economic Mechanism and ASEAN membership among others) beginning in 1986 stimulated economic growth and had a positive effect on vegetable production.

From 1995-2005, there was a steep increase in vegetable area and production up more than 10 times the 1995 figures (FAOSTAT, 2006). Yield per hectare also increased by 19% from 6.5 MT per ha in 1995 to 7.7 MT per ha in 2005 even reaching as high as 14.7 MT per ha in 2002 due to the sharp rise in production during that period.

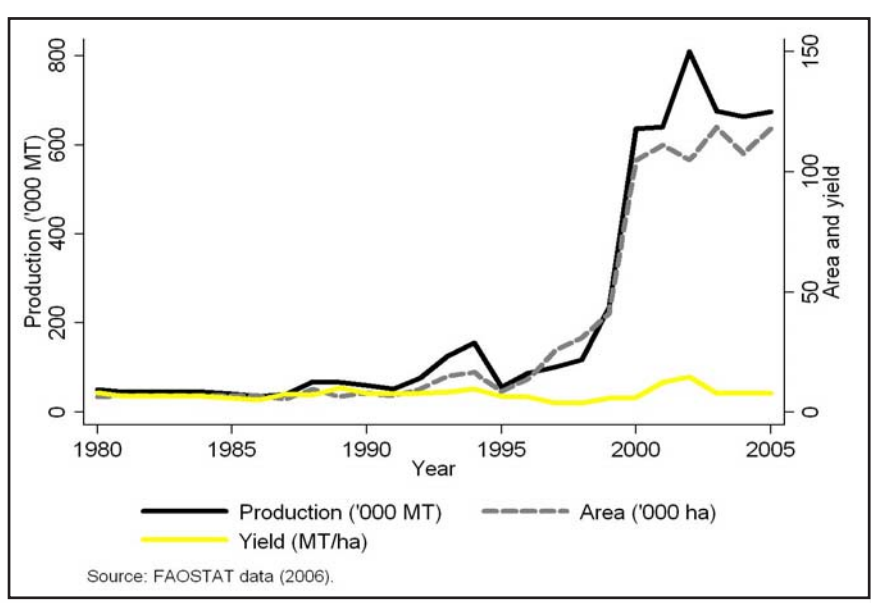


Figure 1-1 Average area, production and yield of vegetables in Lao PDR, 1980-2005.

According to Siphandouang *et al.* (2002), the top ten vegetables in three major vegetable-producing provinces (Savannakhet, Vientiane and Luang Prabang) in the country are cabbage, pak choi, onion, eggplant, lettuce, coriander, yardlong bean, cauliflower, mungbean and cucumber. Given these recent improvements, maximizing the potential of the vegetable sector and reaping its full benefits mean understanding the major bottlenecks affecting the production-consumption continuum. One of them is postharvest losses.

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 prevailing retail outlets (wet markets) 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 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 200 respondents which were interviewed in August 2005. The sample included retailers, wholesalers, collectors, and farmers. An upstream interview approach starting with retailers was applied. Three biggest markets in Vientiane Capital namely Thong Khan Kham, Quadin, and That Luang, were selected as the starting points for the survey with 34 samples. Similarly, 34 respondents from Ban 52 km market, along with several medium-size markets in Vienkham and Phonhuong Districts, were also sampled. At the conclusion of the interview, the retailers were asked to identify names of wholesalers with whom they most frequently interacted. Based on the names received, 26 wholesalers were selected only in Vientiane Capital as suggested by MAF representatives since most of its marketing activities are held there. Names of collectors with whom they most frequently interacted were then solicited from which 40 were selected (22 in Vientiane Capital and 18 in Vientiane Province). These 40 collectors provided the contact details of 66 farmers (34 in Vientiane Capital and 32 in Vientiane Province).

Overall, the total sample was equally divided per actor: 68 retailers, 66 traders (collectors and wholesalers) and 66 farmers. Four crops (tomato, cucumber, chili and yardlong bean) were selected in Vientiane Capital as against two (chili and yardlong bean) in Vientiane Province. The study sought to include a similar sample size for each crop but the four crops' relative importance in agricultural marketing in the Capital led to a smaller sample size for tomato and cucumber.

Table 2-1 Overview of sample size and distribution

Total	Sample size by crop		Sample size by agent		Sample size by district	
200	Tomato	31	Retailers	68	Vientiane Capital	116
	Yardlong bean	69	Wholesalers	26	Vientiane Province	84
	Cucumber	27	Collectors	40		
	Chili	73	Farmers	66		

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 the 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 majority of the supply chain actors who participated in the Lao PDR survey are females, accounting for about 77% of the total number of respondents (Table 2-2). Collecting, wholesaling and especially retailing are women-dominated professions, while farming is still male dominated. Only about 22% of the respondents have high school, university or technical qualifications while the majority attain only secondary education or lower (Table 2-3).

Table 2-2 Gender profile of vegetable supply chain actors in Lao PDR

Supply chain actor	Male		Female		Total	
	N	%	N	%	N	%
Farmer	36	55	30	45	66	33
Collector	3	8	37	93	40	20
Wholesaler	6	23	20	77	26	13
Retailer	2	3	66	97	68	34
Total	47	24	153	77	200	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200.

Table 2-3 Educational background of vegetable supply chain actors in Lao PDR

Education category	Farmer		Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%	N	%
None	5	8	6	15	2	8	8	12	21	11
Primary	30	45	16	40	12	46	22	32	80	40
Secondary	17	26	11	28	7	27	20	29	55	28
High school	7	11	6	15	4	15	10	15	27	14
College/university	2	3					4	6	6	3
Technical	5	8			1	4	4	6	10	5
Other	0	0	1	3					1	1

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200.

2.5 Farmer profile

The average household size of farmers is 5.0, slightly lower than the national average of 6.1 (National Statistics Center, 2004) and the 6.3 reported by Siphandouang *et al.* (2002). The farm households are generally larger in Vientiane Province compared to Vientiane Capital. There are approximately four adults per household and 3,487 square meters (m^2) of cultivated area per adult. Farmers have more than ten years of experience in independent farming. In 2005, their annual sales averaged at US$ 2,680. Between the two sites, farmers in Vientiane Capital have worked as independent farmers for more years, cultivate larger areas per adult, and are relatively richer in terms of annual sales than those in Vientiane Province (Table 2-4).

Table 2-4 Farmer characteristics

Characteristic	Vientiane Capital		Vientiane Province		Total	
	Mean	SD	Mean	SD	Mean	SD
Household size	4.9	1.6	5.1	1.8	5.0	1.7
Number of adults	3.8	1.4	4.3	1.7	4.1	1.6
Cultivated area per adult (m^2)	3,614	4,837	3,352	2,706	3,487	3,923
Years in independent farming	12.1	7.5	10.8	8.4	11.5	7.9
Annual sales of business (US$)	3,255	2,793	2,068	1,021	2,680	2,195

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=66. 1US$ = 10,007.99 LAK.

Farms in Lao PDR are larger than in Cambodia and Viet Nam. The average area of owned farmland is 22,312 m^2. Renting land from others is common with an average land size of 5,000 m^2. About 60% of owned farmlands are cultivated, the majority of which is devoted to vegetables (Table 2-5). The results show an increasing importance of vegetables in the cropping system since the area allocated to vegetables has grown from 35% (Siphandouang *et al*., 2002) to 54% during the last seven years. Farms are usually near all-weather roads with an approximate distance of 1.4 km and about 3.1 km away from the nearest input market. Site-specific, farmlands are slightly larger in Vientiane Province and are nearer to input markets than in Vientiane Capital. Renting land to others is also more common in Vientiane Province since about 97% (National Statistics Center, 2004) of the population own lands, while the area of land rented from other farmers are much larger in the Capital.

Table 2-5 Land details

Farm characteristics	Vientiane Capital		Vientiane Province		Total	
	Mean	SD	Mean	SD	Mean	SD
Distance to nearest all-weather road (km)	1.0	0.9	1.8	2.5	1.4	1.9
Nearest distance to place where inputs are obtained (km)	3.7	3.0	2.5	2.4	3.1	2.7
Land owned (m^2)	21,265	25,048	23,424	18,250	22,312	21,876
Land rented in (m^2)	5,829	6,625	3,840	876	5,000	5,026
Land rented out (m^2)			4,800		4,800	
Land cultivated (m^2)	12,094	15,103	14,077	13,206	13,056	14,142
Vegetable cultivation area (m^2)	4,124	2,271	3,794	2,514	3,964	2,379
Share of vegetable area to total cultivation area (%)	53	30	55	48	54	40

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=66.

Farm inputs mainly come from the market (Table 2-6).These inputs are frequently transported by motorbike, own vehicle and hand cart. In the Capital, boats are also a popular means of input transport (Figure 2-1). Other transportations include public transport, hand tractor with cart, rented vehicle, bicycle and on foot.

Table 2-6 Source of inputs in Lao PDR

Source of input	Vientiane Capital		Vientiane Province		Total	
	N	%	N	%	N	%
Market	25	74	31	97	56	85
Contract-growing arrangement	4	12			4	6
Own	1	3	1	3	2	3
Other	7	21			7	11

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=66. Values are multiple responses.

In general, there is no remarkable difference in terms of employment between male and female workers except that there are more hired part-time male than female workers. Hiring additional casual workers for longer periods to assist in farm-related activities are not predominant. Hired full-time workers work in the farm an average 20 days per month; casual workers' total person-days in a year average 25-27 days only (Table 2-7).

More than 75% of the farmers actively look for information on new varieties and input supply (Table 2-8). The main sources of information are fellow farmers. Other sources are collectors who go to their farms and traders who interact with them at the local markets. In Vientiane Capital, it is striking to note that extension workers do not serve as a source of information to farmers.

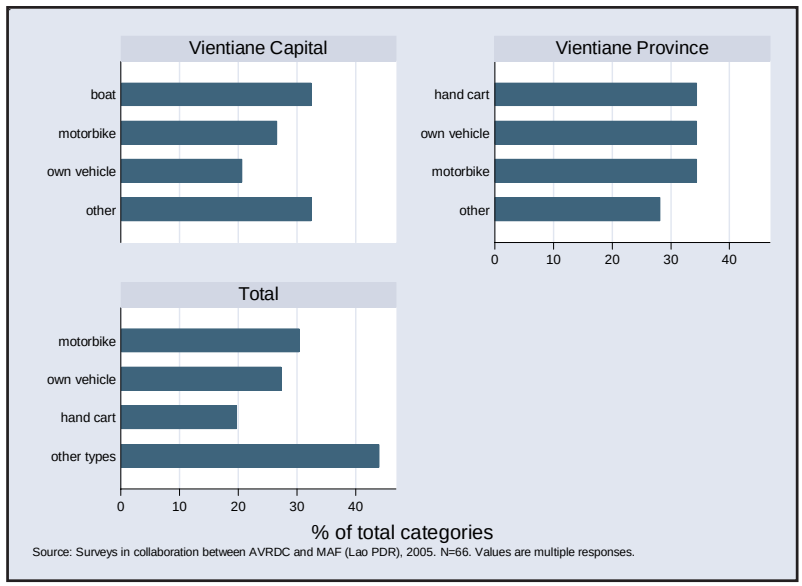


Figure 2-1 Mode of transport of farm inputs in Lao PDR

Table 2-7 Share of female workers to total farm labor, and number of working days of hired farm workers in Lao PDR

Characteristic	Mean	SD
% share of female to		
…Full-time family workers	51	17
…Part-time family workers	46	37
…Full-time hired workers	50	
…Part-time hired workers	34	44
Full-time male workers (person-day/mo)	20	
Full-time female workers (person-day/mo)	20	
Casual male workers (person-day/yr)	25	23
Casual female workers (person-day/yr)	27	19

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=66.

Table 2-8 Source of information on new product varieties and inputs of farmers in Lao PDR

Characteristic	Vientiane Capital		Vientiane Province		Total	
	N	%	N	%	N	%
Seek information on new product varieties and input supply	24	71	26	81	50	76
Source of information						
Radio	5	15			5	8
TV	5	15			5	8
Any trader at the local market	6	18	12	38	18	27
Collector who comes to the farm	10	29	13	41	23	35
Other farmers	19	56	21	66	40	61
Extension officers			3	9	3	5
Other source	3	9			3	5
None	10	29	6	19	16	24
Total	34	100	32	100	66	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=66. Values for source of information are multiple responses.

2.6 Trader profile

In Lao PDR, all retailer-respondents interviewed are wet market vendors who privately own and operate their businesses. Similar with wholesalers, these wet market vendors have been retailing for an average of 8.4 years, while collectors, 8.7 years. Those from the Capital have operated longer than those from Vientiane Province (Table 2-9). In general, wholesalers have the highest turnover among the supply chain actors with an average of US$ 62,569 per annum in 2005. This is closely followed by collectors and retailers. There is however high variability in collectors' turnover especially from the Capital with total sales ranging from US$ 3,407 to US$ 413,670 per annum. Actors from the Capital had higher turnover in 2005 compared with those from Vientiane Province.

There are more female family members, irrespective of the degree of involvement, assisting in the business compared with male members (Table 2-10). Apparently, women's involvement in marketing (collecting, wholesaling and retailing) is much larger than that of men. On average, the ratio of full-time family male as against family female workers is approximately 1:3, while for part-time workers, the ratio is lower. Hiring additional workers is not prevalent in Lao PDR.

Business collaboration in vegetable marketing which typically involves shared information and knowledge and financial support, among other things, is not practiced among respondents of this survey. Only one wholesaler in the Capital out of the 200 respondents interviewed revealed sharing transport services with other wholesalers.

Table 2-9 Years in operation and annual sales of traders in Lao PDR

Characteristic	Supply chain actor	Vientiane Capital		Vientiane Province		Total	
		Mean	SD	Mean	SD	Mean	SD
Years in business	Collector	9.8	6.1	7.3	5.7	8.7	6.0
	Wholesaler	8.4	4.4			8.4	4.4
	Retailer	10.3	6.5	6.6	5.2	8.4	6.1
Annual sales of business (US$)	Collector	63,901	102,935	17,829	19,208	43,168	80,031
	Wholesaler	62,569	60,219			62,569	60,219
	Retailer	14,218	11,377	7,801	7,275	11,009	10,013

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=134.

Table 2-10 Share of female workers to total family labor in trading and retailing, and number of working days of hired workers in Lao PDR

Characteristic	Collector		Wholesaler		Retailer	
	Mean	SD	Mean	SD	Mean	SD
% share of female to						
Full-time family workers	75	24	71	29	86	26
Part-time family workers	45	43	63	48	79	38

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=134.

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 the 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.

The vegetable supply chain in Lao PDR is rather short and direct compared with that in Cambodia and Viet Nam (Figure 3-1). Collectors primarily source their vegetables from farmers, except tomato where importing suppliers play an intermediate role, and sell most of their merchandise to wet market vendors. The remainder is sold to household consumers in the market and street vendors illustrating the retailing functions of collectors. Unlike in Cambodia and Viet Nam, the main suppliers of fresh vegetables to wholesalers in Lao PDR are the farmers and other wholesalers. From the wholesalers, the produce is sold to wet market vendors for retail.

During the dry season when production is low, supply of tomato and chili is augmented by neighboring provinces like Xiengkung Province and importing suppliers. Similar to that in Cambodia, yardlong bean collectors directly sell the produce to wet market vendors and households with little involvement of the wholesalers.

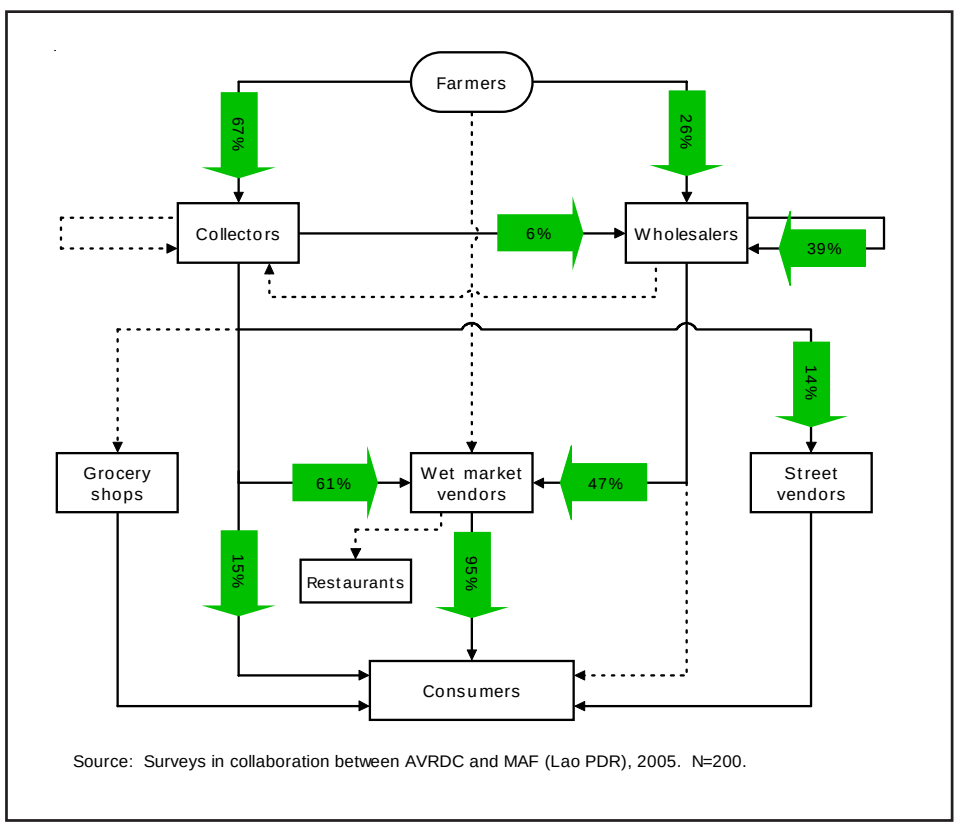


Figure 3-1 Overview of the vegetable supply chain in Lao PDR

Table 3-1 Average number of vegetable suppliers of supply chain actors in Lao PDR

Supply chain actor	Vegetable supplier	Vientiane Capital		Vientiane Province		Total	
		Mean	SD	Mean	SD	Mean	SD
Collector	Farmer	5.2	3.5	8.7	8.0	6.8	6.2
	Wholesaler	17.0	20.1			17.0	20.1
	Collector	9.7	7.2	3.5	1.7	6.1	5.5
Wholesaler	Farmer	9.9	13.5			9.9	13.5
	Wholesaler	10.8	7.0			10.8	7.0
	Collector	8.9	12.3			8.9	12.3
Retailer	Farmer	3.5	0.7	12.6	12.1	11.8	11.8
	Wholesaler	4.5	2.5			4.5	2.5
	Collector	6.1	3.5	8.7	8.1	7.7	6.8

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=134.

The average number of vegetable suppliers of supply chain actors gives an idea of the distance that the produce sometimes travels (Table 3-1). Collectors usually source vegetables from an average of seven farmers. They also source from an average of 17 wholesalers in Vientiane Capital, usually to bring the produce to other regions in the country. About nine collectors supply vegetables to wholesalers in Vientiane Capital, and around four to five wholesalers sell fresh produce to retailers.

Similar with Cambodia and Viet Nam, most farmers in Lao PDR are engaged in the rice and animal (poultry and cattle) trade. Most traders are however mainly involved in the vegetable trade, and only a few engage in selling other non-vegetable food. In Vientiane Capital, few collectors sell fish, rice and poultry; whereas in Vientiane Province, it is sweet potato/ cassava and fish. Wholesalers especially in Vientiane Capital only sell fruits in addition to vegetables (Table 3-2).

Table 3-2 Main food items traded in Lao PDR

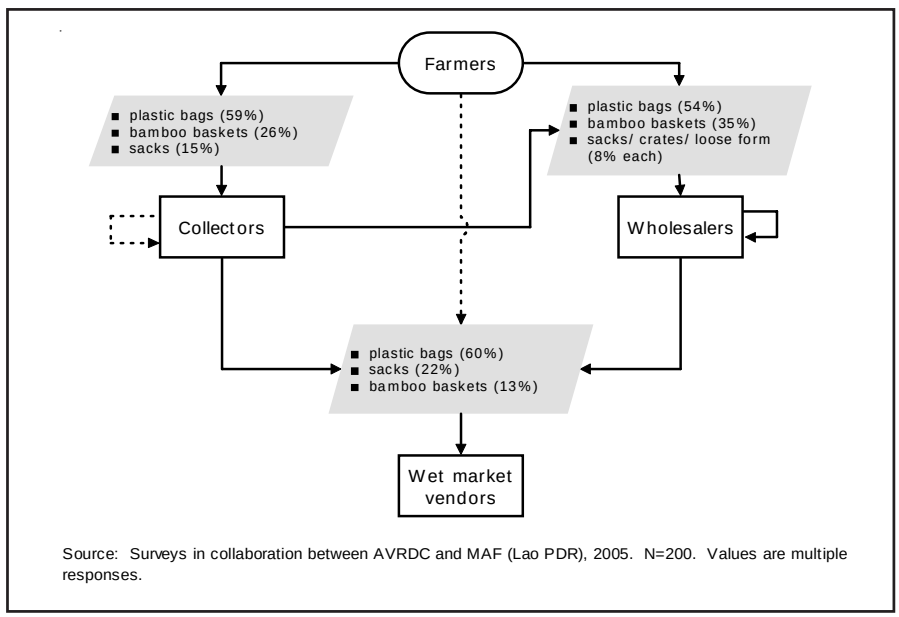
Supply chain actor	Vientiane Capital	Vientiane Province	Total
Farmer	Rice (62%) Poultry (29%) Cattle (21%)	Rice (97%) Poultry (75%) Cattle (59%)	Rice (79%) Poultry (51%) Cattle (39%)
Collector	Fish (9%) Rice (5%) Poultry (5%) Other (5%)	Sweet potato/ cassava (28%) Fish (11%)	Sweet potato/ cassava (13%) Fish (10%) Rice (5%) Poultry (5%)
Wholesaler	Fruits (11%)		Fruits (11%)

Source:Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200. Values are multiple responses.

3.2 Packaging and transport along the chain

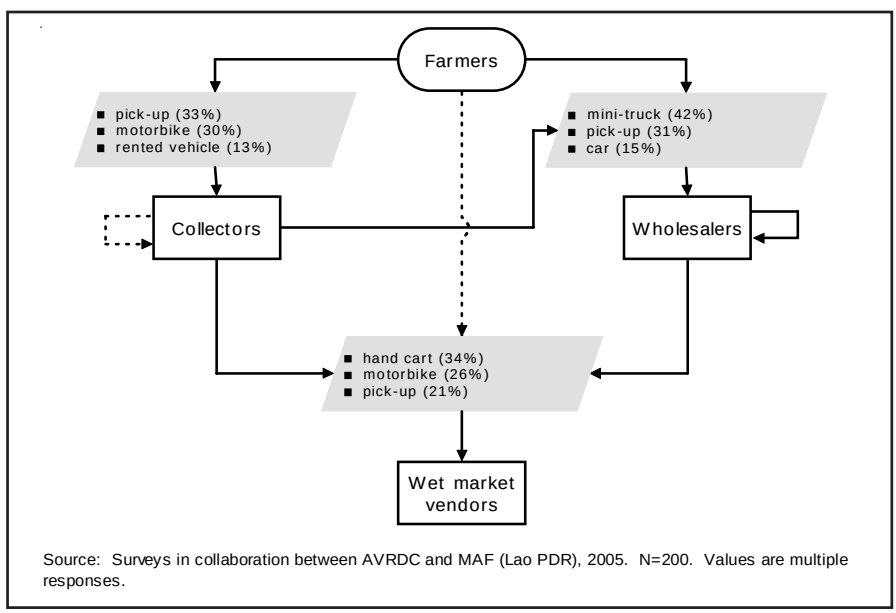
Plastic bags are the popular packaging material of fresh vegetables used by more than 50% of the actors at various levels in the supply chain (Figure 3-2). From farmer to collector or to wholesaler, and from collector to wholesaler, bamboo baskets are the second most commonly used packaging material followed by sacks. Wholesalers also receive vegetables in crates and in loose form. From collectors or wholesalers to wet market vendors, sacks are the second most commonly used container instead of baskets. However, the type of packaging materials used differs with commodity. For instance, tomatoes are transferred from one actor to another primarily in bamboo baskets. Yardlong bean are mainly packed in sacks when received by collectors and retailers, and in plastic bags when purchased by wholesalers. Across the chain, cucumber and chili are mainly sold by suppliers in plastic bags.

The main means of transportation used in purchasing vegetables from suppliers, irrespective of the responsible actor, are pick-up, motorbike, rented vehicle, car, mini-truck and hand cart (Figure 3-3). Pick-up vehicles proliferate in the country due to the seemingly poor road conditions. While only half of wholesalers and retailers wait for incoming fresh vegetable delivery from suppliers, most collectors gather them from farmers in pick-up, motorbike, and rented vehicle. Between collectors and wholesalers, mini-truck, pick-up and car are the three most popular modes of transport. Between wholesalers and retailers, most vegetables are transported in hand cart since both wholesalers and retailers simultaneously operate in the same place, particularly the main markets of Vientiane Capital where transactions between the two occur during early morning.



Source: Surveys in collaboration between AVRDC and MAF (Lao PDR), 2005. N=200. Values are multiple responses.

Figure 3-2 Main packaging materials for fresh vegetables in Lao PDR



Source: Surveys in collaboration between AVRDC and MAF (Lao PDR), 2005. N=200. Values are multiple responses.

Figure 3-3 Mode of transport of fresh vegetables in Lao PDR

3.3 Communication and cooperation

A relatively large share of chain actors seek information on both price and preferred quality traits of vegetables (Table 3-3). The share of respondents who seek such information is highest among farmers, and is reduced as the product moves along the chain, but is still relatively high among retailers (71%). The share of respondents who seek information on prices is slightly higher than the share of respondents who seek information on quality traits. For farmers, the most important sources of price information are other farmers (70%), collectors (67%) and any trader in the market (47%). These farmers usually inquire about prices on a daily basis or more than once a week. Collectors, wholesalers and retailers usually obtain price information from other traders on a daily basis. None used TV, radio or any other mass media to obtain price information. The same is true for information on vegetable quality traits. Most respondents are contented with the quality of information available with only an 8% rate of discontent.

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

Type of information	Supply chain actor	Vientiane Capital		Vientiane Province		Total	
		N	%	N	%	N	%
Price	Farmer	31	91	32	100	63	95
	Collector	17	77	12	67	29	73
	Wholesaler	20	77			20	77
	Retailer	21	62	27	79	48	71
Quality traits	Farmer	28	82	26	81	54	82
	Collector	13	59	12	67	25	63
	Wholesaler	18	69			18	69
	Retailer	20	59	28	82	48	71

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200.

It is interesting to understand farmers' perceptions about quality traits and compare them with other actors' perceptions since a large discrepancy would put farmers at a disadvantage (Concepcion, et al., 2004). 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 3-4 shows the average ranks by different respondent type.

As in Cambodia and Viet Nam, all respondents consider freshness of the product as the most important quality trait, while certification and other food safety considerations (free from food-based pathogens, fertilizer or pesticide residues) the least (Table 3-4). Among farmers, traits relating to appearance (freshness, color, size and shape) are the most important. Farmers and collectors appear to overrate the size of produce as a quality trait, as compared to wholesalers and retailers. They also underestimate the importance of food safety traits more than the retailers. In the future, more efforts should be made in educating farmers on consumer demands for food free from pesticide and fertilizer residues.

Contract arrangements are more prevalent in Lao PDR than in Cambodia but less prevalent than in Viet Nam (Table 3-5). Approximately one-third of wholesalers and a slightly lower share of collectors are involved in such a type of arrangement. Among the farmers, only 5% are involved in contract farming, while among the retailers, 9%.

Table 3-4 Assessment of the importance of quality traits of vegetables in Lao PDR

Trait	Farmer	Collector	Wholesaler	Retailer	Significance
Freshness	5.0	5.0	5.0	4.9	*
Color	4.9	4.7	4.8	4.7	
Size	4.5[a]	4.5[a]	4.0[b]	4.2[a,b]	**
Shape	4.4	4.2	4.3	4.2	
Price	3.7	3.7	3.9	3.6	
Grading	3.3	3.8	3.8	3.3	
Packing	2.9	3.4	3.5	3.2	
Certification	1.6	2.3	2.5	2.7	*
Free from food-based pathogens	1.5[a]	2.2[a,b]	1.8[a,b]	2.6[b]	***
Free from fertilizer residues	1.4[a]	2.0[a,b]	1.8[a,b]	2.4[b]	**
Free from pesticide residues	1.4[a]	2.0[a,b]	2.0[a,b]	2.3[b]	**

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200. Participants ranked importance of traits on a scale of 1 (not important at all) to 5 (very important). ANOVA and Duncan tests were used to test significance of difference between groups based on Levene statistic (***=p<0.001; **=p<0.05; *=p<0.01). A different superscript indicates that figures are statistically different at the 5% level.

Table 3-5 Number of vegetable actors with contract arrangements in Lao PDR

Supply chain actor	Vientiane Capital		Vientiane Province		Total	
	N	%	N	%	N	%
Farmer	1	3	2	6	3	5
Collector	6	27	5	28	11	28
Wholesaler	8	31			8	31
Retailer	1	3	5	15	6	9

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200.

3.4 Prices and price margins

Figure 3-4 shows the monthly average retail prices for tomato, yardlong bean, cucumber and chili, and the share of local production in total sales reported by wholesalers. Peak local production usually coincides with low retail prices. Prices are most variable for tomato and the least for yardlong bean. During peak production, tomato prices are only 35% of prices during low production, while that for cucumber, chili and yardlong bean, 44%, 54% and 67%, respectively. During the peak season, the farmers provided 100% of yardlong bean and chili, 48% of tomato and 40% of cucumber of the total produce the wholesalers sold.

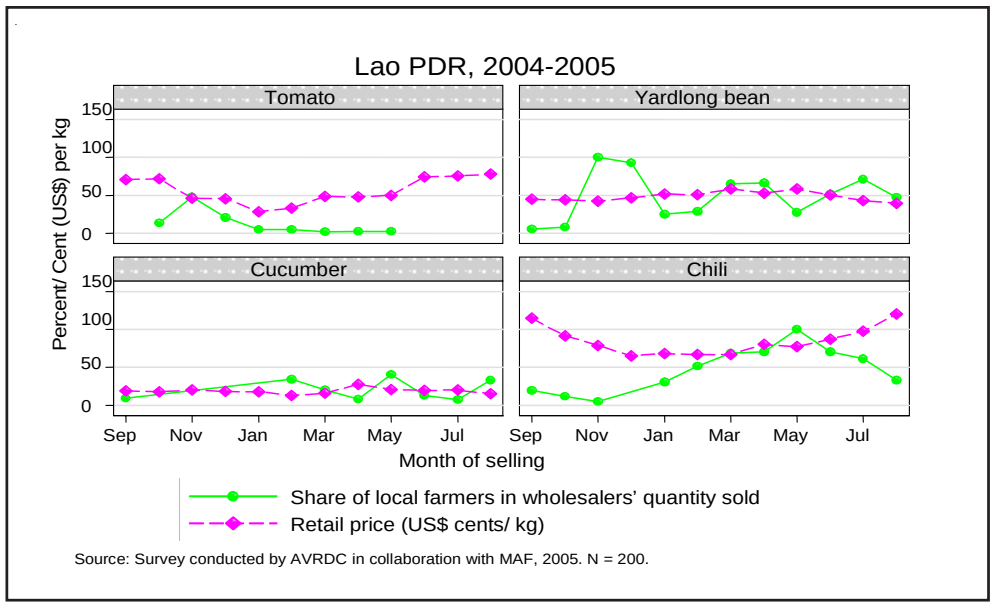


Figure 3-4 Monthly average retail price and share of local production of tomato, yardlong bean, cucumber and chili in Lao PDR

4 Crop supply chains

4.1 Tomato

4.1.1 Economic importance and the supply chain

Individual crop production statistics for tomato are not readily available but based on preliminary key informant interviews, tomato is identified as a major crop of economic importance in the surveyed locations. Siphandouang *et al.* (2002) however reported that tomato is not an important vegetable crop in terms of production area. Of the 66 farmers sampled for this survey, only 16 (24%) were engaged in tomato production, whereas 35% of collectors and 65% of wholesalers were engaged in tomato trade.

Collectors and wholesalers play an important role in the distribution of tomato, both of whom obtain the produce from farmers (Figure 4-1). Some farmers sell produce directly to wet market vendors. Collectors mainly distribute the produce to street market and wet market vendors with only little produce going to wholesalers, while wholesalers either sell to other wholesalers or to wet market vendors.

Total tomato sales are largest among the four vegetable supply chains studied amounting to US$ 532 thousand (Table 4-1). Harvest period is from October to December. Tomato cultivation is an important income source for farmers and wholesalers, providing approximately 46% and 48% of total turnover, respectively. For collectors, tomato contributes only a small share to total turnover (8%). This large discrepancy between collector and wholesaler may either be due to underestimation by wholesalers of their annual income, or a large share of the tomatoes may come from sources other than the collectors sampled. Over the year (2004-2005), the wholesaler-respondents deal with 1,284 MT of tomato equivalent to US$ 409 thousand.

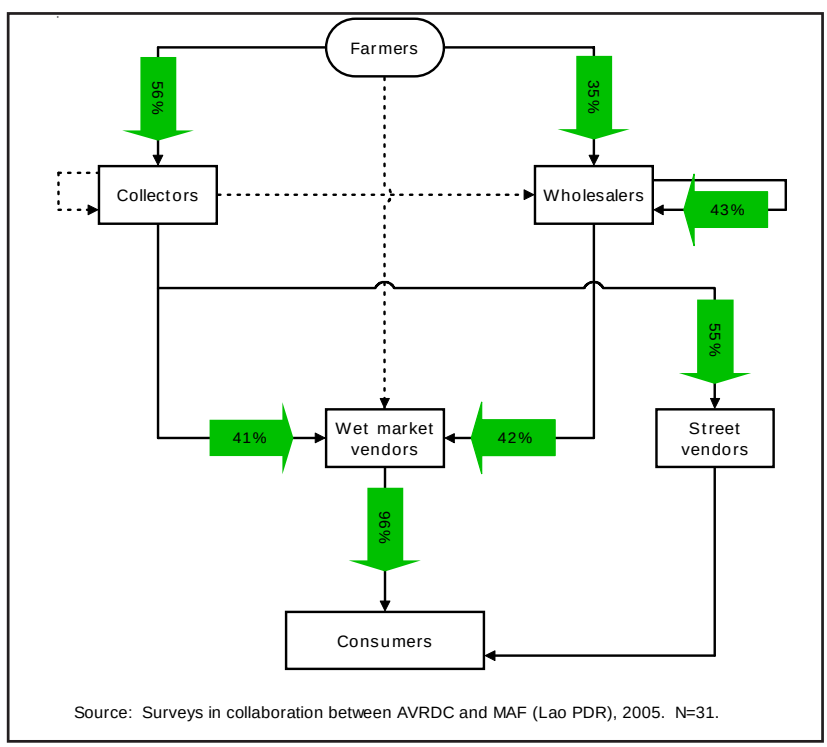


Figure 4-1 Main trading partners in the supply chain of tomato in Lao PDR

Table 4-1 Monthly sales of tomato in Lao PDR, 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			4.0	2.3	40.8	26.0	4.3	3.0	49.1	31.3
Oct-04	30.0	6.0	20.8	8.1	75.6	34.6	5.0	3.6	131.4	52.3
Nov-04	60.6	13.3	20.9	9.2	75.6	34.6	4.8	2.2	161.9	59.3
Dec-04	16.3	2.8	20.9	6.2	172.4	49.8	4.8	2.2	214.4	61.0
Jan-05			20.5	5.8	170.8	49.3	5.0	1.4	196.3	56.5
Feb-05			20.5	5.1	167.9	48.9	4.9	1.6	193.3	55.6
Mar-05			24.4	7.6	166.8	48.6	5.2	2.5	196.4	58.7
Apr-05			22.5	7.7	117.6	22.0	5.3	2.5	145.4	32.2
May-05			22.2	8.8	106.2	17.7	4.2	2.1	132.6	28.6
Jun-05			7.1	3.4	119.7	32.5	4.3	3.2	131.1	39.1
Jul-05			4.8	2.8	35.3	23.5	4.3	3.3	44.4	29.6
Aug-05			3.9	2.2	35.1	21.4	5.2	4.1	44.2	27.7
Total	106.9	22.1	192.5	69.2	1,283.9	409.0	57.4	31.9	1,640.7	532.2
% share to total turnover		45.7		8.0		48.1		24.3		

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=239 observations.

4.1.2 Postharvest losses

All farmers and collectors, 86% of wholesalers, and 78% of retailers incur postharvest loss in tomato due to spoilage (unmarketable yield) estimated at 23, 12, 67, 73 kg per MT produce, respectively (Table 4-2). Losses are highest during the wet season. Wholesalers and retailers incur higher losses than farmers and collectors. The loss was lower during the late dry season (dry 2) as compared to the other two seasons since no farmer in the sample grew tomato at that time. The average sum of all losses from farm to retailer is 175 kg for every MT of tomato produced, or an average of 17.5% of the total production.

Table 4-2 Postharvest loss estimates of tomato in the supply chain in Lao PDR

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	100	100	86	78
Loss values				
- kg per MT	23	12	67	73
- % loss				
Dry 1	3	1	5	8
Dry 2		1	4	7
Wet	1	2	7	8
Average	2	1	7	7
Median	1	0	0	4
Damaged/partially spoiled produce				
Sell at reduced price (%)	25	100	86	78
Price reduction in Dry season (%)	7	42	59	49
Price redcution in Wet season (%)	8	43	65	

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=239 observations. 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.

About 33% of farmers use spoiled product on the farm or in the household. About 25% of the farmers, all collectors, 86% of wholesalers and 78% of retailers sell partially spoiled produce at lower prices. For produce with reduced quality, average price reduction is highest for wholesalers (62%

average) and lowest for farmers (8% average). Collectors also reported price reduction of 43% and 42% during the wet and dry seasons, and wholesalers with 65% and 59%, respectively.

The farmers identify disease infection and damage during harvest as the main reasons for postharvest loss (Table 4-3). These causal factors were confirmed by retailers during focus group discussion. On average, farmers provided one to two reasons for incurring losses suggesting the involvement of only a few loss factors. Collectors' main reason for incurring losses is the humid weather during harvest, while for wholesalers and retailers, it was damage during harvest and transport, and poor packaging, respectively (Table 4-4).

Supply chain actors employ different measures to reduce postharvest loss. Most farmers, collectors and wholesalers identify cool weather as very important to reduce losses, while retailers ensure that the produce purchased is of high quality (Table 4-5).

Table 4-3 Main reasons for tomato postharvest loss at farm level in Lao PDR

Reason	N	%
Hot weather during harvest	3	38
Humid weather during harvest	2	25
Diseases	4	50
Damage during harvest	4	50
Damage during transport	1	13
Other reason of spoilage	2	25
Total	8	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=8. Values are multiple responses.

Table 4-4 Main reasons for tomato postharvest loss at trader and retailer levels in Lao PDR

Reason	Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest			1	14			1	5
Humid weather during harvest	3	50					3	14
Diseases	1	17					1	5
Damage during harvest	1	17	2	29			3	14
Damage during transport	1	17	2	29			3	14
Poor packaging			1	14	4	44	5	23
High temperature in storage facility					1	11	1	5
Poor infrastructure facilities					3	33	3	14
Cannot sell all vegetables					2	22	2	9
Poor quality of purchased vegetable crop					3	33	3	14
Not applicable			1	14	2	22	3	14
Total	6	100	7	100	9	100	22	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=22. Values are multiple responses.

Table 4-5 Measures to prevent loss of tomato along the supply chain in Lao PDR

Measure	Farmer		Trader		Retailer		Total	
	N	%	N	%	N	%	N	%
Harvest during cool weather	3	38					3	10
Careful harvest/ demand careful harvest	1	13					1	3
Observe care during transport/ good transport system	1	13	2	15	2	22	5	17
Collect during cool weather			8	62			8	27
Good packaging					3	33	3	10
High humidity in storage area					1	11	1	3
Good hygiene conditions					1	11	1	3
Not buying more than what is needed					2	22	2	7
Buy high quality vegetable crop					4	44	4	13
Do nothing	2	25	4	31	2	22	8	27
Other preventive measure	1	13					1	3
Total	8	100	13	100	9	100	30	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=30. Values are multiple responses.

4.1.3 From production to value-added activities

4.1.3.1 Production

The average yield recorded for tomato is 45.5 MT per ha, slightly lower than that in Viet Nam. The average production area is 3,556 m^2. The average selling price is US$ 353 per MT, approximately 2.5 times higher than that in Viet Nam and Cambodia. Mean sale per cropping cycle is estimated at US$ 3,800[1] (Table 4-6).

Harvesting starts every month between October and December with total duration of 57 days. In general, farmers themselves do the harvesting. None of the collectors and wholesalers interviewed reported any involvement in harvesting tomato.

Table 4-6 Average yield, production area, selling price and sales of tomato by season in Vientiane Capital, Lao PDR

Characteristic	Season	Mean	SD
Yield (MT/ha)	Wet	47.3	
	Dry 1	45.3	44.0
	Mean	45.5	41.2
Production area (m^2)	Wet	6,400.0	
	Dry 1	3,200.0	1,669.9
	Mean	3,555.6	1,891.5
Selling price (US$/MT)	Wet	324.7	
	Dry 1	356.5	116.6
	Mean	353.0	109.6
Sales (US$)	Wet	9,742	
	Dry 1	3,057	2,095
	Mean	3,800	2,968

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=9 observations. See additional notes in Table 4-2.

[1] Since our sample of tomato growers is rather small, these figures should be considered as indicative only.

4.1.3.2 Storage, packaging and transport

In Vientiane Capital, the produce stays for a very short period at the farm (1.6 hours), almost similar to that at the retailer level (1.5 hours) (Table 4-7). At the collector and wholesaler level, the produce is held for 5.3 hours and 8.1 hours, respectively. In total, the intervening period between harvest and sale to final consumers is 16.5 hours. Right after harvest, farmers usually store tomato on the ground in shaded areas.

Bamboo basket is the most common packaging material for tomato from the farmer to wholesaler (Figure 4-2). Other packaging materials used less frequently include plastic bags, crates and cartons.

Farmers usually transport the harvested tomato to the farmhouse by boat, hand cart or in baskets carried usually on the shoulder (Figure 4-3). Around 44% of farmers transport the produce to their buyers, while collectors and wholesalers usually transport the produce from their suppliers (Table 4-8). Most collectors use large vehicles like pick-ups, mini-trucks, or cars, while all wholesalers use mini-trucks. For retailers, hand cart and pick-up are commonly used.

Table 4-7 Number of hours between harvest/purchase and sale of tomato at different levels in the supply chain in Vientiane Capital, Lao PDR

Supply chain actor	Mean	SD
Farmer	1.6	1.6
Collector	5.3	3.3
Wholesaler	8.1	3.7
Retailer	1.5	0.6
Total	16.5	9.2

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=239 observations.

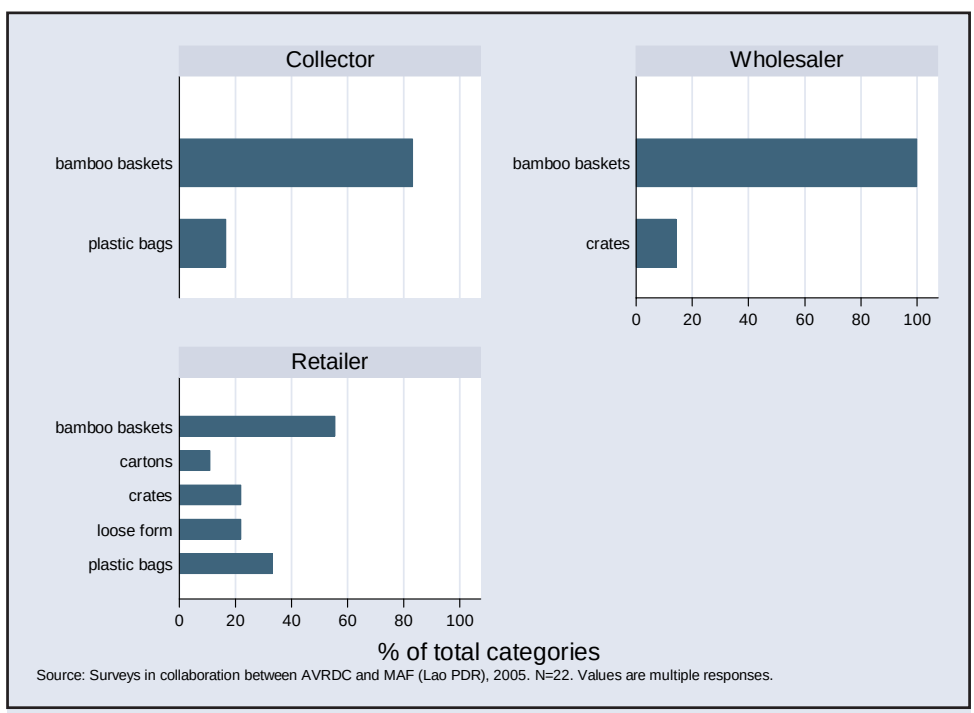


Figure 4-2 Packaging materials for tomato in Lao PDR

Table 4-8 Supply chain actors involved in transporting tomato from their suppliers in Vientiane Capital, Lao PDR

Supply chain actor	N	%
Farmer	4	44
Collector	4	67
Wholesaler	4	57
Retailer	3	33

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=31. In the case of farmers, it is the share of farmers responsible for transporting produce to their buyers.

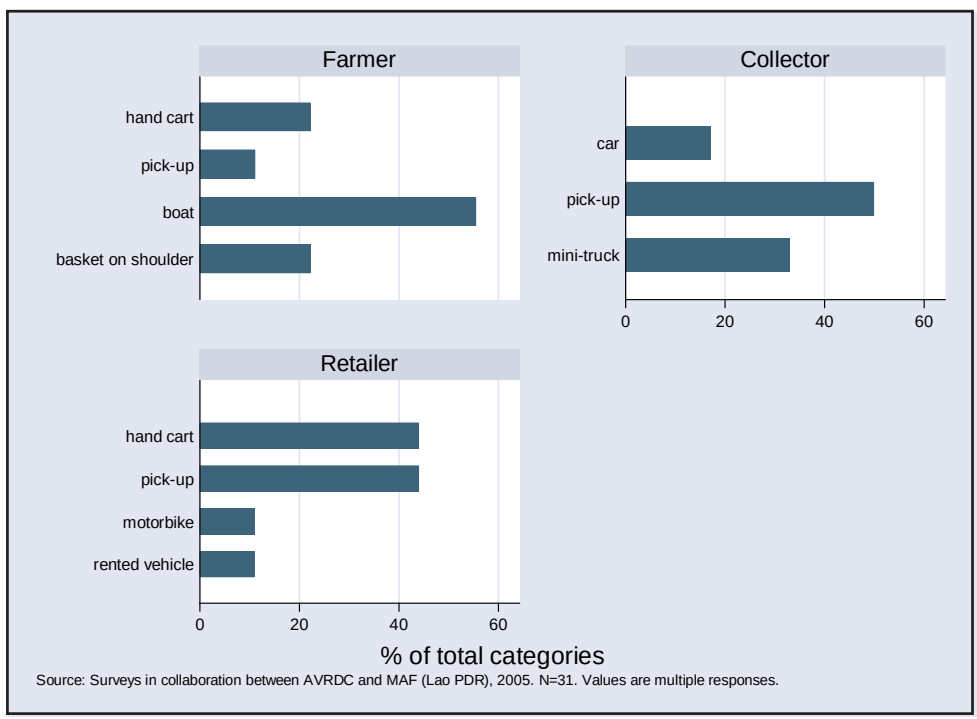


Figure 4-3 Mode of transport of tomato in Lao PDR

4.1.3.3 Value-added activities

While 100% of farmers are doing value-adding activities for tomato, only half of the whole actors in the sample (48%) are involved (Table 4-9). Collectors usually sort, grade, clean, repack and store tomatoes before selling it to their trading partners. Upon reaching the wholesalers, tomatoes are again sorted, graded and repacked. Retailers, before vending to the consumers, also sort, grade and clean the tomatoes. In the sample, all farmers pack tomatoes and only a few collectors and wholesalers repack them. From the few collectors and retailers who do value-adding activities, they usually clean tomatoes before selling the crop to their trading partners. Only collectors store tomatoes.

Table 4-9 Involvement of supply chain actors in value-adding activities for tomato in Lao PDR

Supply chain actor	Involved (%)	Not involved (%)
Farmer	100	
Collector	17	83
Wholesaler	43	57
Retailer	22	78
Mean	48	52

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=31.

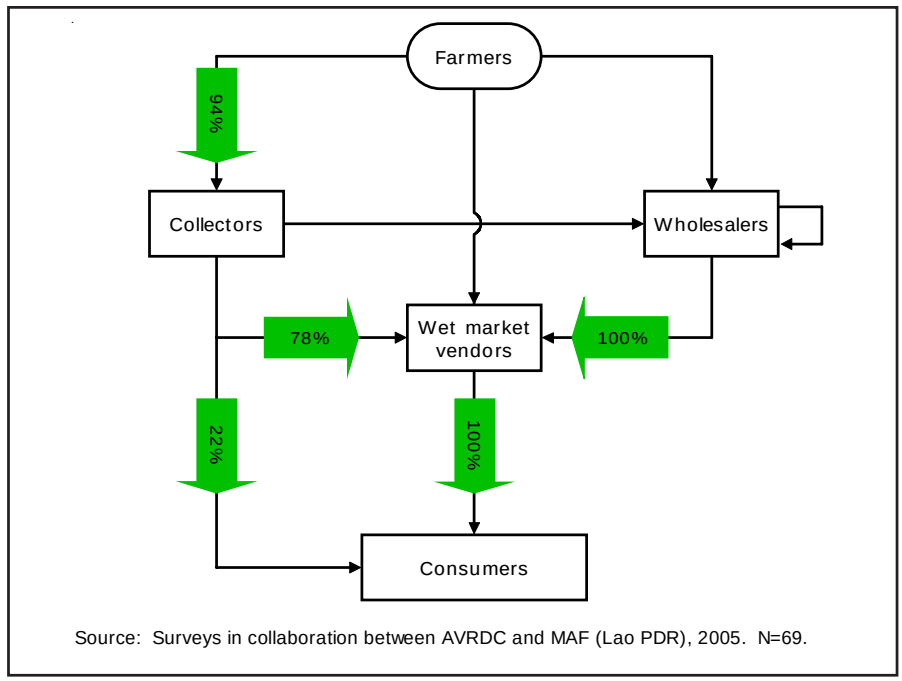
4.2 Yardlong bean

4.2.1 Economic importance and the supply chain

Individual crop production statistics for yardlong bean are not similarly available. However, preliminary key informant interviews identified yardlong bean as a major crop of economic importance in the surveyed locations. This is in contrast with the report of Siphandouang *et al.* (2002) where yardlong bean is not among the five most important vegetable crops in terms of production area. From the sample, 32 farmers (49%), about two-thirds of collectors (63%) and wholesalers (66%) were engaged in the commercial trade of yardlong bean.

In the supply chain, farmers mainly sell their produce to collectors, and to a lesser extent, to wholesalers and wet market vendors (Figure 4-4). The collectors mainly sell to wet market vendors, with the remainder being sold to private households. Only a limited amount is sold to wholesalers. At the retail level, only wet market vendors are involved.

Total turnover of yardlong bean is estimated at US$ 234 thousand ranking it third among the four vegetable crops (Table 4-10). Main harvest months are November and March, but small quantities are harvested over the entire year. The farmers provide 28% of total yardlong bean produce disposed by collectors. For farmers engaged in cultivation of yardlong bean, the crop is an important income source providing 47% of total sales. The crop contributes only a small share of total turnover for collectors (18%) in contrast to its much higher share of wholesalers' turnover (56%). This finding is similar to that in tomato possibly for the same reasons as indicated.



Source: Surveys in collaboration between AVRDC and MAF (Lao PDR), 2005. N=69.

Figure 4-4 Main trading partners in the supply chain of yardlong bean in Lao PDR

Table 4-10 Monthly sales of yardlong bean in Lao PDR, 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			31.8	10.8	11.7	4.1	6.4	2.9	49.9	17.8
Oct-04	1.9	0.4	31.0	11.0	11.7	4.2	5.9	2.6	50.5	18.2
Nov-04	31.2	7.6	21.6	6.0	11.4	4.1	7.3	3.1	71.5	20.8
Dec-04	1.5	0.4	21.8	7.0	14.3	7.2	6.9	3.2	44.5	17.8
Jan-05	6.1	1.8	20.9	6.1	14.9	7.5	7.5	3.8	49.4	19.2
Feb-05	2.6	0.6	20.0	6.3	15.1	6.8	7.4	3.8	45.1	17.5
Mar-05	17.1	4.8	21.5	5.6	15.2	7.0	7.4	4.3	61.2	21.7
Apr-05	3.3	1.2	28.8	8.9	15.3	7.7	7.4	3.9	54.8	21.7
May-05	5.2	1.6	25.4	7.0	15.2	7.8	6.3	3.7	52.1	20.1
Jun-05	6.6	1.6	32.5	11.4	11.4	4.1	6.0	3.0	56.5	20.1
Jul-05	9.7	2.5	32.6	11.6	11.4	4.0	6.3	2.7	60.0	20.8
Aug-05	1.3	0.6	32.0	10.9	11.6	3.9	6.9	2.7	51.8	18.1
Total	86.3	23.0	319.8	102.8	159.1	68.4	81.9	39.8	647.1	234.0
% share to total sales		46.5		17.6		56.3		16.2		

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=571 observations.

4.2.2 Postharvest losses

Nearly all farmers (94%) and collectors (93%), all wholesalers, and 76% of retailers experience postharvest loss in yardlong bean (Table 4-11). The total produce which could not be sold due to spoilage for the respective supply chain actors is estimated at 77, 10, 10 and 26 kg per MT produce, translating to about 8%, 1%, 1% and 3% of the total volume produced/traded. There is not much difference in postharvest loss by season. Among chain actors, farmers incur the highest loss while collectors and wholesalers, the lowest. From the farm to retailers, postharvest loss is estimated at 123 kg for every MT produce, or 12.3% of total production volume.

Around 71% of the farmers use the partially spoiled product on the farm or in the household. In addition, 47% of farmers sell these blemished produce at a price 2% lower than the maximum price. Collectors and wholesalers report price reduction in the range of 42% to 46% for the entire year. Retailers lower prices by 43% for partially spoiled produce.

Farmers' main reason for postharvest loss is disease infection (Table 4-12). In focus group discussion, it was raised that even though farmers harvest yardlong bean early, diseases are still a major obstacle to reckon with. On average, farmers provided 1.3 reasons suggesting that only a few factors contribute to postharvest loss. For traders, losses occur mainly due to their failure to sell all the produce in the same day. On a per actor basis, collectors' main cause of loss is disease infection while for wholesalers, it is damage during transport. Retailers additionally pointed out poor quality of purchased crop as a cause of loss (Table 4-13).

Regarding measures to prevent postharvest loss, most farmers harvest during cool periods and traders synchronize this strategy by collecting the produce during the cool periods (Table 4-14). For retailers, careful packaging is most frequently mentioned.

In focus group discussions, it was pointed out that yardlong bean is one of the crops that deteriorate in quality the fastest, and thus has to be sold within 24 hours after harvest. All focus groups expressed interest on technological intervention that could extend the storage life of yardlong bean.

Table 4-11 Postharvest loss estimates of yardlong bean in the supply chain in Lao PDR

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	94	93	100	76
Loss values				
- kg per MT	77	10	10	26
- % loss				
Dry 1	7	1	1	3
Dry 2	9	0	1	2
Wet	7	1	1	3
Average	8	1	1	3
Median	7	0	1	0
Damaged/partially spoiled produce				
Sell at reduced price (%)	47	93	100	72
Price reduction in Dry season (%)	20	46	42	43
Price reduction in Wet season (%)	22	43	45	

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=571 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 4-12 Main reasons for yardlong bean postharvest loss at farm level in Lao PDR

Reason	Dry 1		Dry 2		Wet		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	2	13	1	7			3	7
Humid weather during harvest			2	13	2	14	4	9
Diseases	15	94	14	93	13	93	42	93
Damage during harvest			1	7	1	7	2	4
Damage during transport	1	6					1	2
Other reason of spoilage	1	6	4	27	3	21	8	18
Total	16	100	15	100	14	100	45	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=45 observations. Values are multiple responses.
See additional notes in Table 4-11

Table 4-13 Main reasons for yardlong bean postharvest loss at trader and retailer levels in Lao PDR

Reason	Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	2	14					2	4
Humid weather during harvest	2	14					2	4
Diseases	5	36	1	17			6	13
Damage during harvest	1	7					1	2
Damage during transport	2	14	3	50			5	11
Poor packaging	3	21	1	17	6	24	10	22
High temperature in storage facility					4	16	4	9
Cannot sell all vegetables	2	14	2	33	10	40	14	31
Poor quality of purchased vegetable crop					9	36	9	20
Other reason of spoilage	2	14			1	4	3	7
No loss	1	7			6	24	7	16
Total	14	100	6	100	25	100	45	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=45. Values are multiple responses.

Table 4-14 Measures to prevent loss of yardlong bean along the supply chain in Lao PDR

Measure	Farmer		Trader		Retailer		Total	
	N	%	N	%	N	%	N	%
Harvest during cool weather	14	58					14	20
Careful harvest/ demand careful harvest	5	21	4	20			9	13
Store in cool area			1	5	3	12	4	6
Observe care during transport/ good transport system	6	25	1	5	4	16	11	16
Harvest after buyer has been identified	6	25					6	9
Collect during cool weather			13	65			13	19
Demand time of harvest			2	10			2	3
Observe care in packaging			1	5	12	48	13	19
Good hygiene conditions					3	12	3	4
Not buying more than what is needed					8	32	8	12
Buy high quality vegetable crop					8	32	8	12
Do nothing	5	21	7	35	3	12	15	22
Other preventive measure of spoilage	1	4			1	4	2	3
Total	24	100	20	100	25	100	69	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG (Lao PDR), 2005. N=69. Values are multiple responses.

4.2.3 From production to value-added activities

4.2.3.1 Production

The average yield of yardlong bean is slightly higher in Vientiane Capital (8.3 MT per ha) than in Vientiane Province (7.4 MT per ha) (Table 4-15). Yields are higher in early dry season than in wet season in the Capital while the opposite exists in Vientiane Province. Production area also differs, with greater land area devoted to yardlong bean in Vientiane Province than in the Capital regardless of season. The average selling price is US$ 342 per MT, approximately twice the selling price in Cambodia. Between the two study areas, Vientiane Province has higher selling price, particularly during the wet season and early dry season, than Vientiane Capital. Total sales have the same trend as selling price with mean of US$ 581 per cropping cycle.

Harvesting starts every month between October and August. In general, farmers are responsible for harvesting. No collector and wholesaler harvests yardlong bean. The total duration of harvesting recorded is 37 days, a week longer than in Cambodia.

Table 4-15 Average yield, production area, selling price and sales of yardlong bean by season in Lao PDR

Parameter	Season	Vientiane Capital		Vientiane Province		Total	
		Mean	SD	Mean	SD	Mean	SD
Yield (MT/ha)	Wet	7.2	1.4	9.9	16.2	9.4	14.4
	Dry 1	10.0	4.0	6.5	1.6	8.2	3.4
	Dry 2	6.7	1.4	5.2	2.1	5.8	1.9
	Mean	8.3	3.2	7.4	10.1	7.7	8.3
Production area (m^2)	Wet	2,667	924	3,000	1,316	2,933	1,225
	Dry 1	1,950	542	3,333	1,095	2,682	1,111
	Dry 2	2,200	790	3,140	1,251	2,788	1,170
	Mean	2,165	708	3,142	1,201	2,796	1,147
Selling price (US$/MT)	Wet	274.8	25.0	362.9	95.6	345.3	92.7
	Dry 1	323.5	62.4	405.0	79.5	366.7	81.4
	Dry 2	358.9	46.4	286.2	83.6	313.4	79.0
	Mean	327.4	57.9	350.4	97.3	342.2	85.5
Sales (US$)	Wet	467.1	106.4	581.9	299.8	559.0	272.9
	Dry 1	610.4	358.4	790.7	252.3	705.8	310.8
	Dry 2	492.6	228.2	456.5	393.0	470.0	332.2
	Mean	543.5	279.6	602.1	337.9	581.3	316.7

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=48 observations. See additional notes in Table 4-11.

4.2.3.2 Storage, packaging and transport

Immediately after harvest, most farmers store the produce on the ground in the shade. Some farmers store produce in baskets or plastic sacks. The harvested produce is held for about three hours at the farm before being sold to collectors (Table 4-16). Collectors from Vientiane Capital keep the produce for an average of three hours, while those from Vientiane Province, nine hours. The time difference can be accounted for the fact that collectors from Vientiane Province sell to wholesalers in Vientiane Capital, who in turn, keep the produce for about seven hours. At the retailer level, the produce stays for an average of two to three hours. In total, the elapsed time between harvest and sale to consumers is about 20 hours.

Collectors receive the produce usually packaged in sacks, plastic bags or bamboo baskets and rarely in loose form (Figure 4-5). At the wholesaler level, the produce is packed in plastic bags and bamboo baskets. Retailers mainly receive the produce in sacks.

Table 4-16 Number of hours between harvest/purchase and sale of yardlong bean at different levels in the supply chain in Lao PDR

Supply chain actor	Vientiane Capital		Vientiane Province		Total	
	Mean	SD	Mean	SD	Mean	SD
Farmer	2.2	0.8	3.2	1.7	2.9	1.5
Collector	3.3	1.7	9.0	3.8	7.0	4.2
Wholesaler	7.2	5.1			7.2	5.1
Retailer	1.7	0.5	2.9	3.2	2.5	2.7
Total	14.4	8.1	2.9	3.2	19.6	13.5

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=571 observations.

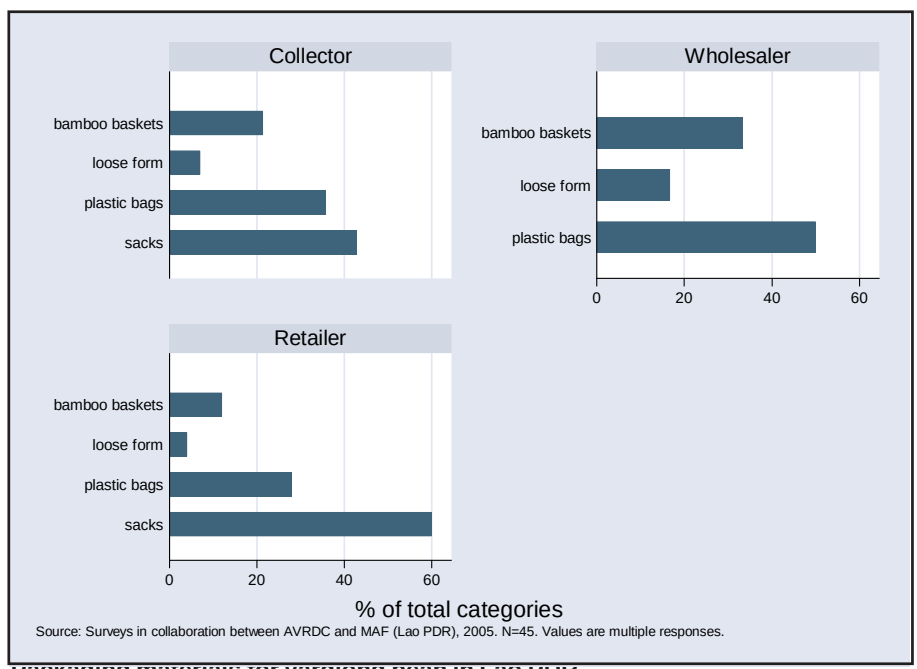


Figure 4-5 Packaging materials for yardlong bean in Lao PDR

Most collectors are responsible for picking up the produce from the farm (Table 4-17). In a few cases, farmers transport the produce to collectors in Vientiane Province. Half of the wholesalers pick up the produce by themselves. More retailers are involved in the transport of produce in Vientiane Capital than in Vientiane Province.

Table 4-17 Supply chain actors involved in transporting yardlong bean from their suppliers in Lao PDR

Supply chain actor	Vientiane Capital		Vientiane Province		Total	
	N	%	N	%	N	%
Farmer			2	12	2	8
Collector	4	80	8	89	12	86
Wholesaler	3	50			3	50
Retailer	6	75	8	47	14	56

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=69. In the case of farmers, it is the share of farmers responsible for transporting produce to their buyers.

Farmers usually transport the produce by hand tractors, hand carts or hand-carry from the field to their farmhouse (Figure 4-6). When collectors pick up the produce from the farm, they use motorized vehicles such as pick-ups, motorbikes or other rented vehicles. Wholesalers rely on cars or pick-ups, while retailers use motorbikes or hand carts.

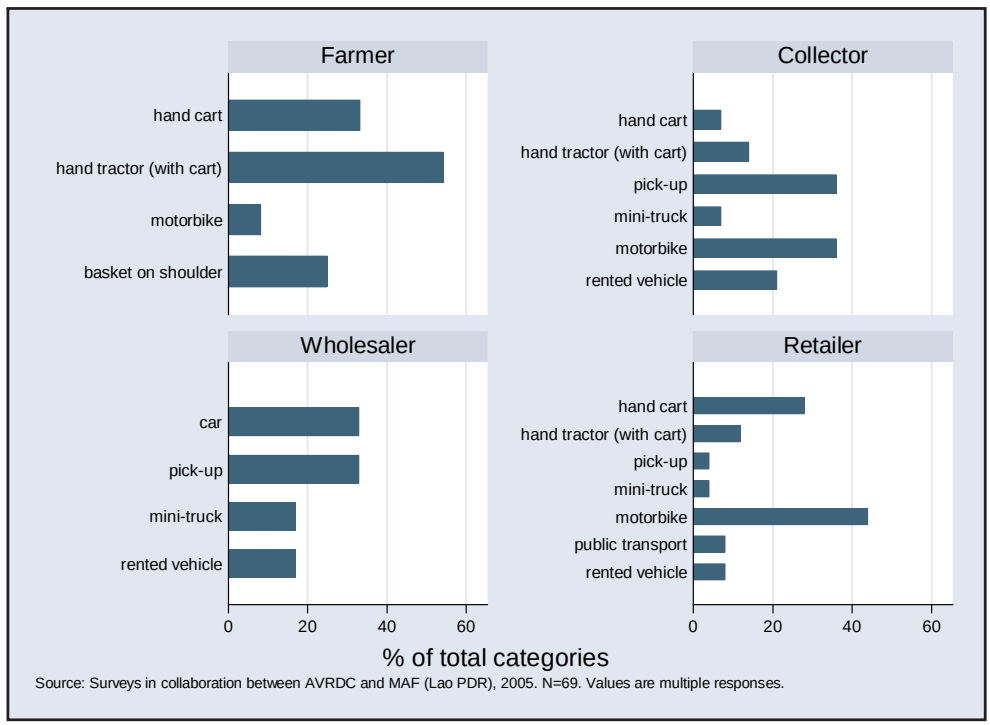


Figure 4-6 Mode of transport of yardlong bean in Lao PDR

4.2.3.3 Value-adding activities

Around 78% of the actors in the chain are involved in value-adding activities (Table 4-18). The share is highest among farmers (92%) and lowest for wholesalers (33%). The common value-adding activities are sorting, grading, cleaning and packing, with a little transporting and pre-cooling for some actors. Collectors sort, grade, clean, repack and transport the produce. Wholesalers clean and grade before selling the produce to their trading partners. On the other hand, retailers sort, grade, clean, repack, while a few pre-cool the produce before selling to the final consumers. It can be observed that transporting is mainly done by collectors.

Table 4-18 Involvement of supply chain actors in value-adding activities for yardlong bean in Lao PDR

Supply chain actor	Involved (%)	Not involved (%)
Farmer	92	8
Collector	86	14
Wholesaler	33	67
Retailer	72	28
Mean	78	22

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=69.

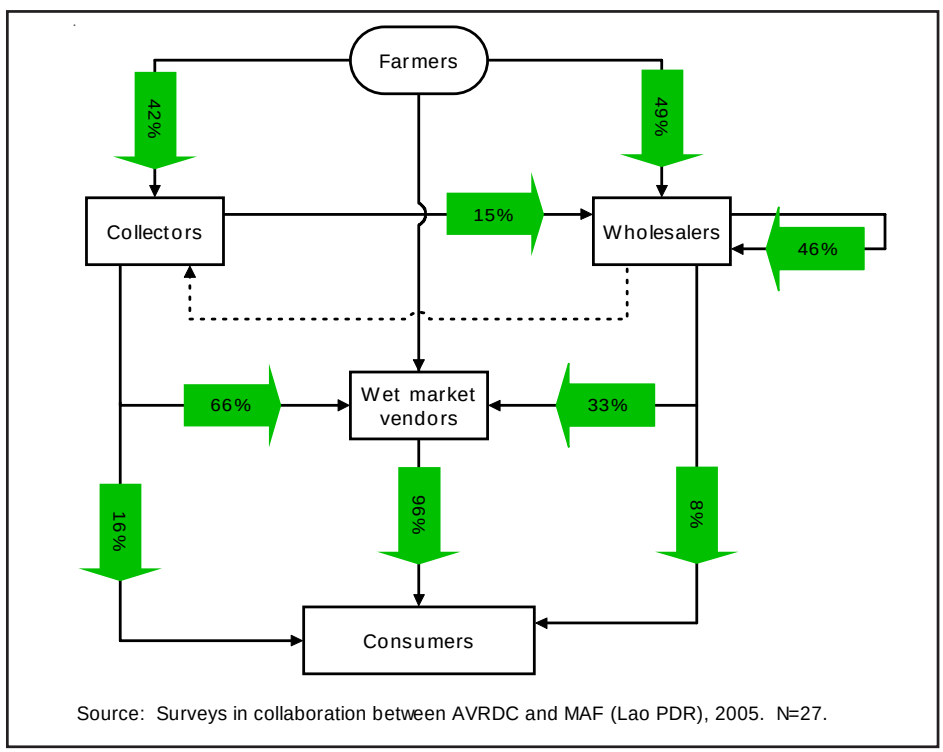
4.3 Cucumber

4.3.1 Economic importance and the supply chain

As with tomato and yardlong bean, production statistics for cucumber are not also available. Based on preliminary key informant interviews, cucumber is a major crop of economic importance in the surveyed locations, although according to Siphandouang *et al.* (2002) it is not among the five most important vegetable crops in terms of production area. From the sample, 21% of farmers, 50% of the collectors and 42% of the wholesalers are commercially engaged in the cucumber trade.

Farmers sell the produce both to collectors and to wholesalers (Figure 4-7). Collectors sell most of their produce to wet market vendors, while a small share is sold directly to private households and to wholesalers. Wholesalers sometimes sell back to collectors but in other provinces. Wholesalers either sell to other wholesalers, to wet market vendors or in a few cases, directly to private households.

In terms of quantity traded and total sales, cucumber ranks last among the four vegetable supply chains with a total turnover of US$ 205 thousand (Table 4-19). Main harvest months are February and May, and no harvest was recorded from October to January. For farmers engaged in cucumber production, the crop represents an important income source giving 59% of their total turnover. Cucumber sales contribute 40% of the total turnover of collectors and retailers, and 50% for wholesalers.



Source: Surveys in collaboration between AVRDC and MAF (Lao PDR), 2005. N=27.

Figure 4-7 Main trading partners in the supply chain of cucumber in Lao PDR

Table 4-19 Monthly sales of cucumber in Lao PDR, 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	5.9	0.5	16.0	2.0	63.1	8.0	24.8	4.6	109.8	15.1
Oct-04			16.2	2.2	65.2	8.3	9.8	1.7	91.2	12.2
Nov-04			14.9	1.9	56.2	7.8	11.3	2.3	82.4	12.0
Dec-04			15.6	1.9	72.2	10.0	10.4	1.9	98.2	13.8
Jan-05			15.8	2.4	72.9	10.0	10.9	1.9	99.6	14.3
Feb-05	28.3	2.5	15.5	1.9	72.9	9.0	25.5	3.2	142.2	16.6
Mar-05	12.8	1.2	13.9	1.9	81.1	12.8	13.3	2.1	121.1	18.0
Apr-05	11.9	1.2	14.7	2.1	106.0	24.9	15.1	4.2	147.7	32.4
May-05	26.8	2.4	15.5	2.0	75.8	10.9	13.3	2.8	131.4	18.1
Jun-05	10.0	0.8	14.9	2.4	79.7	10.8	24.8	4.8	129.4	18.8
Jul-05	10.2	0.9	15.4	2.5	93.3	11.9	13.4	2.7	132.3	18.0
Aug-05	17.9	1.7	15.3	1.8	64.8	8.3	28.6	4.3	126.6	16.1
Total	123.7	11.1	183.6	25.0	903.1	132.7	201	36.5	1411.4	205.3
% share to total sales		59.4		40.2		50.0		39.5		

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=254 observations.

4.3.2 Postharvest losses

All farmers and retailers, 60% of collectors and half of wholesalers experienced postharvest loss in cucumber production estimated at 22, 56, 5, and 4 kg per MT produce, respectively (Table 4-20). Losses are highest during the wet season as with tomato. Among the chain actors, retailers incur the highest loss especially during the early dry season while collectors and wholesalers have very minimal losses. Total losses from the farm to retailer level amount to 87 kg per MT produce, or 8.7% of the total production.

Almost all farmers (96%) use the partially spoiled product on the farm or in the household. Farmers (38%), collectors (40%), wholesalers (33%) and retailers (100%) also sell these blemished produce at a much lower price. Average price reduction is 32% for farmers, 50% for collectors and wholesalers, and 49% for retailers during the wet and dry seasons.

Table 4-20 Postharvest loss estimates of cucumber in the supply chain in Lao PDR

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	100	60	50	100
Loss values				
- kg per MT	22	5	4	56
- % loss				
Dry 1		0	0	7
Dry 2	2	0	0	5
Wet	3	1	1	5
Average	2	1	0	6
Median	1	0	0	3
Damaged/partially spoiled produce				
Sell at reduced price (%)	38	40	33	100
Price reduction in Dry season (%)	31	50	50	49
Price reduction in Wet season (%)	32	50	50	

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=254 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.

Main reasons for postharvest loss are disease infection and high humidity during harvest (Table 4-21). This was a multiple-response question and, on average, farmers provided 1.8 different reasons suggesting that only few factors contribute to postharvest loss in cucumber. For traders and retailers, losses occur mainly because they could not sell the produce in the same day (Table 4-22). Some wholesalers identify hot weather and damage during harvest as causes of loss.

Across the chain, the most frequently cited measure to prevent postharvest loss is to do nothing (Table 4-23). This is not surprising since cucumber has relatively small loss compared with other crops. At specific chain level, most cited measures to reduce loss vary. Farmers concede that harvesting should be done during cool weather and that the harvested produce should be stored in cool areas. Traders collect the produce during cool weather; while retailers do not buy produce more than what is needed.

Table 4-21 Main reasons for cucumber postharvest loss at farm level in Lao PDR

Reason	Dry 2		Wet		Total	
	N	%	N	%	N	%
Hot weather during harvest	3	38	8	53	11	48
Humid weather during harvest	7	88	7	47	14	61
Diseases	7	88	7	47	14	61
Other reason of spoilage			9	60	9	39
Total	8	100	15	100	23	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=23 observations. Values are multiple responses. See additional notes in Table 4-20.

Table 4-22 Main reasons for cucumber postharvest loss at trader and retailer levels in Lao PDR

Reason	Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	1	20	2	33			3	16
Humid weather during harvest			1	17			1	5
Diseases	1	20	1	17			2	11
Damage during harvest	1	20	2	33			3	16
Damage during transport	1	20					1	5
Poor packaging					1	13	1	5
High temperature in storage facility					2	25	2	11
High humidity in storage facility					1	13	1	5
Poor hygiene conditions					1	13	1	5
Poor infrastructure facilities					2	25	2	11
Cannot sell all vegetables	2	40	1	17	4	50	7	37
Poor quality of purchased vegetable crop					3	38	3	16
Other reason of spoilage			1	17	1	13	2	11
No loss	2	40	3	50			5	26
Total	5	100	6	100	8	100	19	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=19. Values are multiple responses.

Table 4-23 Measures to prevent loss of cucumber along the supply chain in Lao PDR

Measure	Farmer		Trader		Retailer		Total	
	N	%	N	%	N	%	N	%
Harvest during cool weather	7	88					7	27
Careful harvest/ demand careful harvest	3	38	2	20			5	19
Spray water on harvest			3	30			3	12
Store in cool area	5	63	2	20			7	27
Observe care during transport/ good transport system	4	50	2	20			6	23
Collect during cool weather			4	40			4	15
Demand time of harvest			2	20			2	8
Observe care in packaging					2	25	2	8
Not buying more than what is needed					4	50	4	15
Buy high quality vegetable crop					3	38	3	12
Do nothing	1	13	4	40	3	38	8	31
Total	8	100	10	100	8	100	26	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=26. Values are multiple responses.

4.3.3 From production to value-added activities

4.3.3.1 Production

Cucumber production yields an average of 20.5 MT per ha which is higher than that in Cambodia (Table 4-24). Average production area is 2,523 m^2 while selling price is US$ 91 per MT or approximately US$ 20 higher than the selling price in Cambodia. Average sale is about US$ 426 per cropping cycle .

Harvesting starts every month between February and September with a total duration of 20 days. In general, farmers harvest the produce while none of the collectors and wholesalers interviewed does harvesting.

4.3.3.2 Storage, packaging and transport

The harvested produce stays for about three hours at the farm before being sold to collectors (Table 4-25). Collectors in turn keep the produce for an average of 6.5 hours before selling it. The produce stays at the wholesaler level for 7 hours and retailer level, four hours. Thus, the intervening period between harvest and sale to consumers is about 21 hours.

More than 75% of farmer-respondents store the produce on the ground in shaded area. Few farmers keep the produce directly into plastic bags.

In terms of packaging, collectors and retailers mainly receive the produce in plastic bags similar to wholesalers but the latter may, in few cases, receive the produce in crates or loose forms. In terms of product transport, no farmer is involved in transporting produce to buyers (Table 4-26). In contrast, all collectors and most retailers do the transporting of the produce from their suppliers. Only a few wholesalers do the same. Farmers usually transport cucumber in hand carts (Figure 4-8). Collectors and wholesalers use either pick-up or *tuktuk* (a three-wheeled passenger motorbike), while retailers use hand cart as the transportation medium.

Table 4-24 Average yield, production area, selling price and sales of cucumber by season in Vientiane Capital, Lao PDR

Parameter	Season	Mean	SD
Yield (MT/ha)	Wet	20.2	8.5
	Dry 2	21.0	6.7
	Mean	20.5	7.7
Production area (m^2)	Wet	2,300	1,007
	Dry 2	2,880	1,421
	Mean	2,523	1,191
Selling price (US$/MT)	Wet	92.0	10.5
	Dry 2	89.7	10.9
	Mean	91.1	10.5
Sales (US$)	Wet	389.1	177.8
	Dry 2	484.6	181.9
	Mean	425.8	182.0

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=26 observations. See additional notes in Table 4-20.

Table 4-25 Number of hours between harvest/purchase and sale of cucumber at different levels in the supply chain in Vientiane Capital, Lao PDR

Supply chain actor	Mean	SD
Farmer	3.2	1.8
Collector	6.5	3.5
Wholesaler	7.3	3.1
Retailer	3.9	6.1
Total	20.9	14.5

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=254 observations.

Table 4-26 Supply chain actors involved in transporting cucumber from their suppliers in Vientiane Capital, Lao PDR

Supply chain actor	N	%
Collector	5	100
Wholesaler	2	33
Retailer	6	75

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=27.

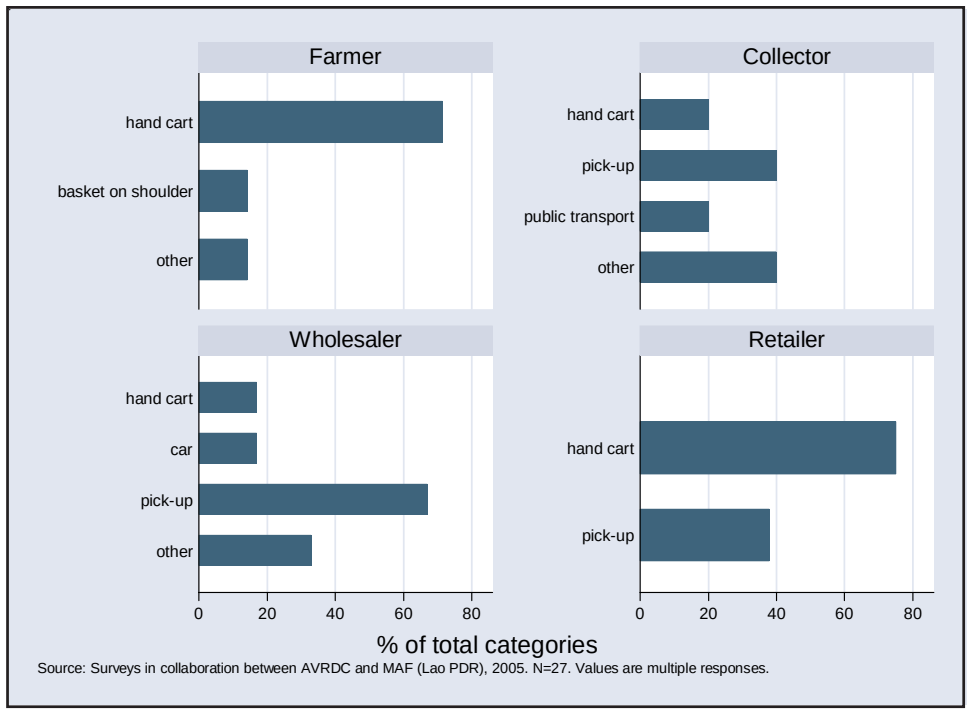


Figure 4-8 Mode of transport of cucumber in Lao PDR

4.3.3.3 Value-added activities

Around 52% of chain actors are doing value-adding activities for cucumber (Table 4-27). Most farmers are doing value-adding compared with the other actors. The common activities employed are sorting, grading and packing. Collectors usually sort, grade and repack cucumber before selling it. Upon reaching the wholesalers, cucumber is again sorted, graded and repacked. Few retailers sort, grade and clean cucumber.

Table 4-27 Involvement of supply chain actors in value-adding activities for cucumber in Lao PDR

Supply chain actor	Involved (%)	Not involved (%)
Farmer	88	12
Collector	40	60
Wholesaler	50	50
Retailer	25	75
Mean	52	48

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=27.

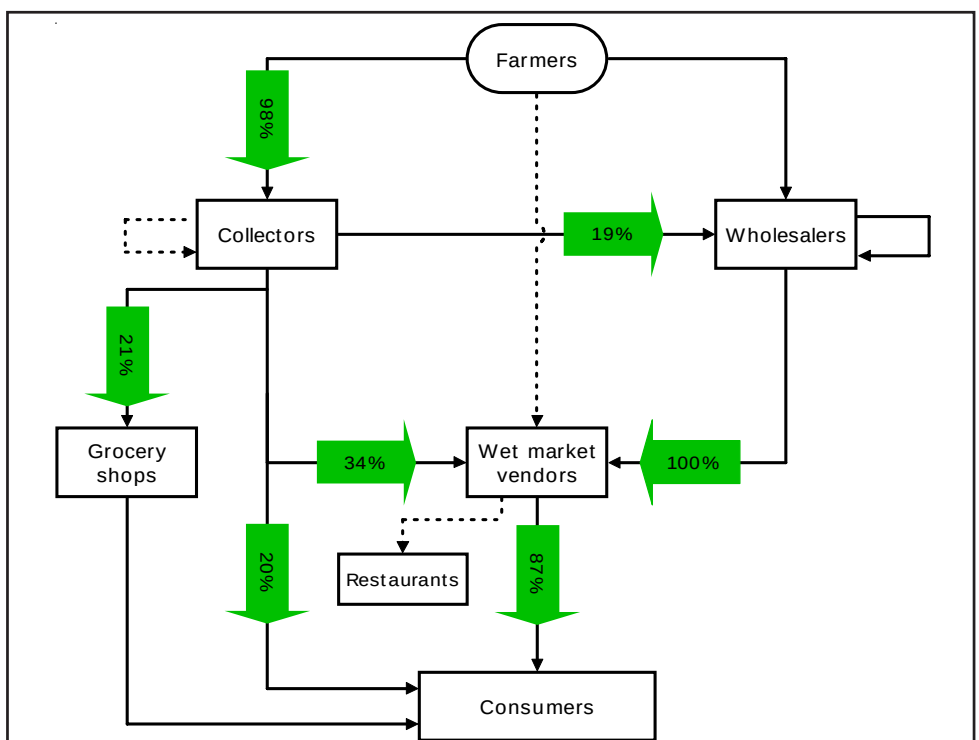
4.4 Chili

4.4.1 Economic importance and the supply chain

Chili is one of the few vegetable crops where production statistics are available. In 2003, total production has been estimated at 12,500 MT from an area of 7,000 ha, approximately 6% of the total vegetable production area in the country (Ministry of Agriculture and Forestry, 2003). Preliminary key informant interviews identified chili as a major crop of economic importance in the surveyed locations, although according to Siphandouang *et al.* (2002), it is not among the five most important vegetable crops in terms of production area. Farmers, collectors and wholesalers represent 53%, 60% and 65% of the respondents engaged in the commercial trade of chili.

In the supply chain, collectors play an important role in the distribution of produce (Figure 4-9). They sell 19% of the produce to wholesalers and the remainder is sold to other collectors, wet market vendors, grocery stores, or directly to private households.

Chili ranks second among the four vegetable supply crops in terms of total turnover valued at US$ 263 thousand (Table 4-28). Main harvest is from January to March, with small additional harvest until June. No harvest was recorded for the remaining months. For farmers, chili cultivation is an important income source with product sales representing 43% of total turnover. For collectors, chili also contributes a large share (36%) to the total turnover, while for wholesalers, only 26%.



Source: Surveys in collaboration between AVRDC and MAF (Lao PDR), 2005. N=73.

Figure 4-9 Main trading partners in the supply chain of chili in Lao PDR

Table 4-28 Monthly sales of chili in Lao PDR, 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			6.4	7.1	16.6	10.3	5.1	5.9	28.1	23.3
Oct-04			6.2	5.9	16.8	10.4	5.3	4.8	28.3	21.1
Nov-04			7.5	5.6	17.3	10.1	6.9	5.5	31.7	21.2
Dec-04			7.5	5.7	14.2	7.2	6.8	4.4	28.5	17.3
Jan-05	23.2	8.3	6.6	4.8	11.2	6.1	7.0	4.8	48.0	24.0
Feb-05	18.2	6.5	7.5	5.8	11.3	6.2	6.9	4.6	43.9	23.1
Mar-05	13.8	6.0	6.8	5.7	13.7	8.9	7.9	5.3	42.2	25.9
Apr-05	4.9	1.9	6.7	5.8	14.1	9.2	6.9	5.5	32.6	22.4
May-05	7.3	2.8	6.9	6.8	11.2	6.7	6.3	4.9	31.7	21.2
Jun-05	1.3	0.5	7.3	7.0	13.8	7.7	6.3	5.4	28.7	20.6
Jul-05			7.2	7.8	13.7	8.6	4.8	4.7	25.7	21.1
Aug-05			6.4	7.6	13.5	8.6	4.4	5.3	24.3	21.5
Total	68.6	26.1	83.2	75.6	167.5	99.9	74.7	61.1	394.0	262.7
% share to total turnover		43.2		35.7		26.2		21.8		

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=585 observations.

4.4.2 Postharvest losses

Around 77% of farmers, 87% of collectors, all wholesalers and 77% of retailers experienced postharvest loss in chili production estimated at 47, 12, 5 and 42 kg per MT produce, respectively (Table 4-29). Losses are nearly similar across the seasons. Among the actors, farmers and retailers incur more losses than collectors and wholesalers. The average sum of losses from the farm to retailer is 106 kg per MT produce, or 10.6% of the total production.

Only 19% of farmers use spoiled product on the farm or in the household, while 23% sell partially spoiled produce at lower prices. Average price reduction for farmers is 31%. In addition, price reduction for collectors is 46%, and 51%, while for wholesaler, 37% and 33% during the wet and dry seasons, respectively. Retail price is reduced by 33% due to partial deterioration of produce quality.

Main reasons for postharvest loss are disease infection and hot weather during harvest (Table 4-30). More than half of the farmer-respondents also identify poor quality of variety as a cause of loss. On the average, farmers provided 1.1 reasons suggesting only few loss factors involved. For traders, losses are mainly due to failure in selling all the produce during the day, although collectors and wholesalers also consider damage during transport as a major problem (Table 4-31).

Most farmers and traders underscore the importance of cool condition to minimize losses (Table 4-32). However, their second most frequently cited measure reflects apathy towards losses as they admitted that nothing can be done for such losses. For retailers, buying high quality produce and not buying more than the need are the most frequently cited measures to reduce losses.

In the focus group discussions with some collectors, it was pointed out that they are interested to learn about drying techniques to reduce spoilage.

Table 4-29 Postharvest loss estimates of chili in the supply chain in Lao PDR

Parameter	Farmer	Collector	Wholesaler	Retailer
% share with loss	77	87	100	77
Loss values				
- kg per MT	47	12	5	42
- % loss				
Dry 1	7	1	0	3
Dry 2	5	1	0	3
Wet	3	2	1	5
Average	5	1	1	4
Median	4	0	0	3
Damaged/partially spoiled produce				
Sell at reduced price (%)	23	73	100	77
Price reduction in Dry season (%)	35	51	33	33
Price reduction in Wet season (%)	25	46	37	

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=585 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 4-30 Main reasons of chili postharvest loss at farm level in Lao PDR

Reason	Dry 1		Dry 2		Wet		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	3	100	2	100	15	79	20	83
Humid weather during harvest					4	21	4	17
Diseases	3	100	2	100	17	89	22	92
Damage during harvest	3	100			6	32	9	38
Damage during transport	1	33			1	5	2	8
Poor quality of variety	3	100			10	53	13	54
Other reason of spoilage			1	50	2	11	3	13
Total	3	100	2	100	19	100	24	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=24 observations. Values are multiple responses. See additional notes in Table 4-29.

Table 4-31 Main reasons of chili postharvest loss at trader and retailer levels in Lao PDR

Reason	Collector		Wholesaler		Retailer		Total	
	N	%	N	%	N	%	N	%
Hot weather during harvest	2	13	1	14			3	6
Humid weather during harvest	2	13					2	4
Diseases	2	13					2	4
Damage during harvest	2	13					2	4
Damage during transport	5	33	6	86			11	23
Poor packaging	1	7	1	14	5	19	7	15
High temperature in storage facility					2	8	2	4
High humidity in storage facility	1	7			8	31	9	19
Poor hygiene conditions					1	4	1	2
Poor infrastructure facilities					3	12	3	6
Cannot sell all vegetables	6	40	3	43	9	35	18	38
Poor quality of purchased vegetable crop					6	23	6	13
Other reason of spoilage					1	4	1	2
Not applicable	2	13			7	27	9	19
Total	15	100	7	100	26	100	48	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=48. Values are multiple responses.

Table 4-32 Measures to prevent loss of chili along the supply chain in Lao PDR

Measure	Farmer		Trader		Retailer		Total	
	N	%	N	%	N	%	N	%
Harvest during cool weather	14	56					14	19
Careful harvest/ demand careful harvest	4	16	2	9			6	8
Store in cool area			5	23	1	4	6	8
Observe care during transport/ good transport system	2	8	3	14	4	15	9	12
Harvest after buyer has been identified	2	8					2	3
Collect during cool weather			11	50			11	15
Demand time of harvest			3	14			3	4
Observe care in packaging			2	9	6	23	8	11
Low humidity in storage area					2	8	2	3
High humidity in storage area					1	4	1	1
Good hygiene conditions					2	8	2	3
Not buying more than what is needed					10	38	10	14
Buy high quality vegetable crop					10	38	10	14
Do nothing	10	40	6	27	3	12	19	26
Other preventive measure of spoilage	1	4	1	5	2	8	4	5
Total	25	100	22	100	26	100	73	100

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=73. Values are multiple responses.

4.4.3 From production to value added activities

4.4.3.1 Production

Average chili yield in the sample is much higher in Vientiane Capital (21.3 MT per ha) as compared to Vientiane Province (8.6 MT per ha) (Table 4-33). The average production area of chili per farmer is also larger in Vientiane Capital (2,780 m^2) than Vientiane Province (1,156 m^2). Selling price and sales of chili similarly differ with area. Vientiane Capital has about 2.5 times lower selling price than Vientiane Province. However, average sales are more than twice as much in the Capital (US$ 1,625) than Vientiane Province (US$ 562). These results are surprising; however, it can be seen that the differences are consistently large over seasons and the standard deviations for prices in both locations are similar. These differences may be due to different varieties in use, as indicated by the large differences in yield.

Harvesting is mostly done by farmers and starts every month between January and June. None of the collectors or wholesalers interviewed is responsible for harvesting the produce. Harvesting season is much longer in the Capital (187 days) than in Vientiane Province (89 days).

4.4.3.2 Storage, packaging and transport

Chili spends about two hours at the farm before its sale to collectors (Table 4-34). Collectors in turn keep the produce for an average of seven hours before selling it. Produce stays at the wholesaler and retailer level for four and three hours, respectively. The total elapsed time between harvest and sale to consumers is about 16 hours.

Table 4-33 Average yield, production area, selling price and sales of chili by season in Lao PDR

Parameter	Season	Vientiane Capital		Vientiane Province		Total	
		Mean	SD	Mean	SD	Mean	SD
Yield (MT/ha)	Wet	15.8	4.6	9.8	6.3	12.2	6.0
	Dry 1	18.7	4.9	9.2	6.8	13.9	7.4
	Dry 2	25.0	14.1	8.0	3.3	13.7	11.5
	Mean	21.3	10.6	8.6	4.3	13.4	9.6
Production area (m^2)	Wet	2,000	566	1,033	666	1,420	763
	Dry 1	3,467	1,848	1,867	1,617	2,667	1,783
	Dry 2	2,680	890	980	553	1,547	1,054
	Mean	2,780	1,202	1,156	846	1,781	1,264
Selling price (US$/MT)	Wet	264.4	50.1	616.2	104.0	475.5	207.8
	Dry 1	281.2	118.0	716.1	175.5	498.7	273.2
	Dry 2	311.4	116.8	810.2	133.2	643.9	273.0
	Mean	293.0	99.3	756.1	149.6	578.0	264.2
Sales (US$)	Wet	799.9	325.8	458.0	187.5	594.8	281.4
	Dry 1	1,674	916.7	645.5	62.5	1,160	809.5
	Dry 2	1,926	1,393	568.3	390.5	1,021	1,045
	Mean	1,625	1,124	562.1	316.7	971.0	890.6

Source: Surveys in collaboration between AVRDC and MAF/DOAG. 2005. N=26 observations. See additional notes in Table 4-29.

Table 4-34 Number of hours between harvest/purchase and sale of chili at different levels in the supply chain in Lao PDR

Supply chain actor	Vientiane Capital		Vientiane Province		Total	
	Mean	SD	Mean	SD	Mean	SD
Farmer	1.2	.6	3.0	3.1	2.3	2.6
Collector	8.3	4.3	5.6	4.4	6.7	4.5
Wholesaler	3.6	2.9			3.6	2.9
Retailer	2.7	3.3	3.2	3.6	3.0	3.5
Total	15.8	11.1	3.2	3.6	15.6	13.5

Source: Surveys in collaboration between AVRDC and MAF/DOAG. 2005. N=585 observations.

Right after harvest, more than 50% of the farmer-respondents store the produce in plastic bags, while about 25% store the produce on the ground in shaded area. Only a few farmers store the produce in baskets.

For packaging, chili is transferred from one actor to another mainly in plastic bags (Figure 4-10). In a few instances, the produce is packaged in bamboo baskets at the collector level, and sacks and cartons at the wholesaler level.

No farmer is involved in the transport of produce to their buyers. Most collectors do the collection and transport of produce from the farms (Table 4-35). Wholesalers are also partly responsible for transporting the produce. Retailers in Vientiane Capital usually transport the purchased crop by themselves, while in Vientiane Province, few retailers are involved since the produce is delivered to them.

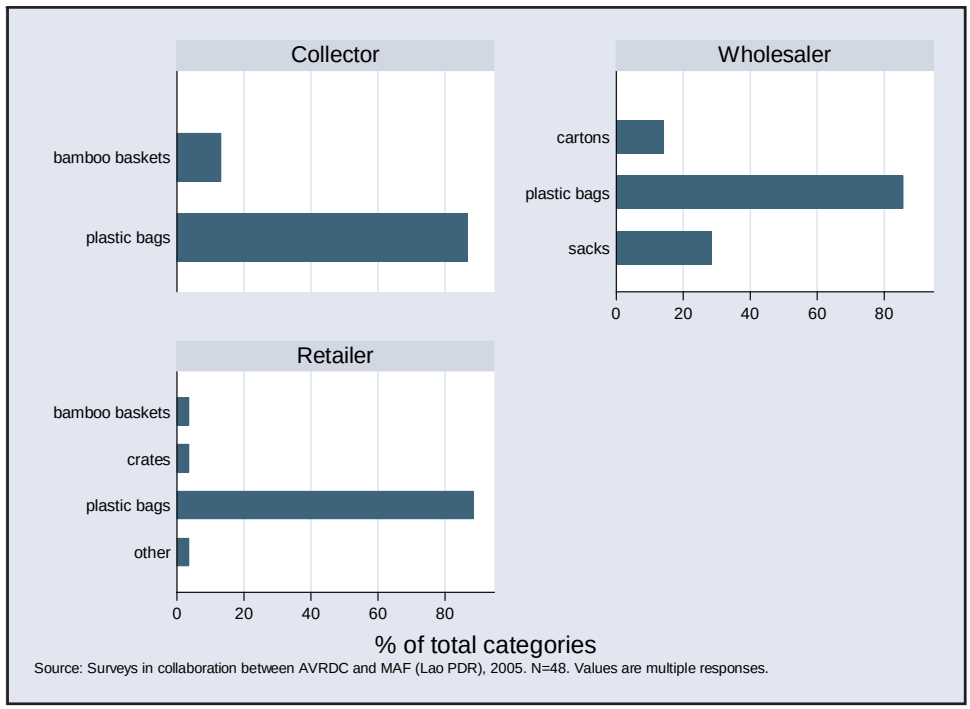


Figure 4-10 Packaging materials for chili in Lao PDR

Table 4-35 Supply chain actors involved in transporting chili from their suppliers in Lao PDR

Supply chain actor	Vientiane Capital		Vientiane Province		Total	
	N	%	N	%	N	%
Collector	5	83	8	89	13	87
Wholesaler	3	43			3	43
Retailer	7	78	5	29	12	46

Source: Surveys in collaboration between AVRDC and MAF/DOAG. 2005. N=73.

Most farmers transport the produce from the field to the farmhouse using baskets carried on the shoulder or hand carts (Figure 4-11). Among collectors, the most prevalent mode of transportation is the motorbike. Wholesalers mainly use mini-trucks, pick-ups or rented vehicles, while retailers use a variety of transport media but more frequently, hand cart, pick-up and motorbike.

4.4.3.1 Value-added activities

Only 49% of the actors in the chain are involved in value-adding activities similar to that for tomato (Table 4-36). This time, however, the share is highest among retailers and lowest for wholesalers. The common activities are sorting, grading, cleaning and packing. Collectors sort, grade and clean the produce before selling it to their trading partners, while a few repack the produce. Wholesalers only grade the produce upon arrival from the suppliers. At the retailer level, chili is again sorted, graded and cleaned before finally selling to the final consumers.

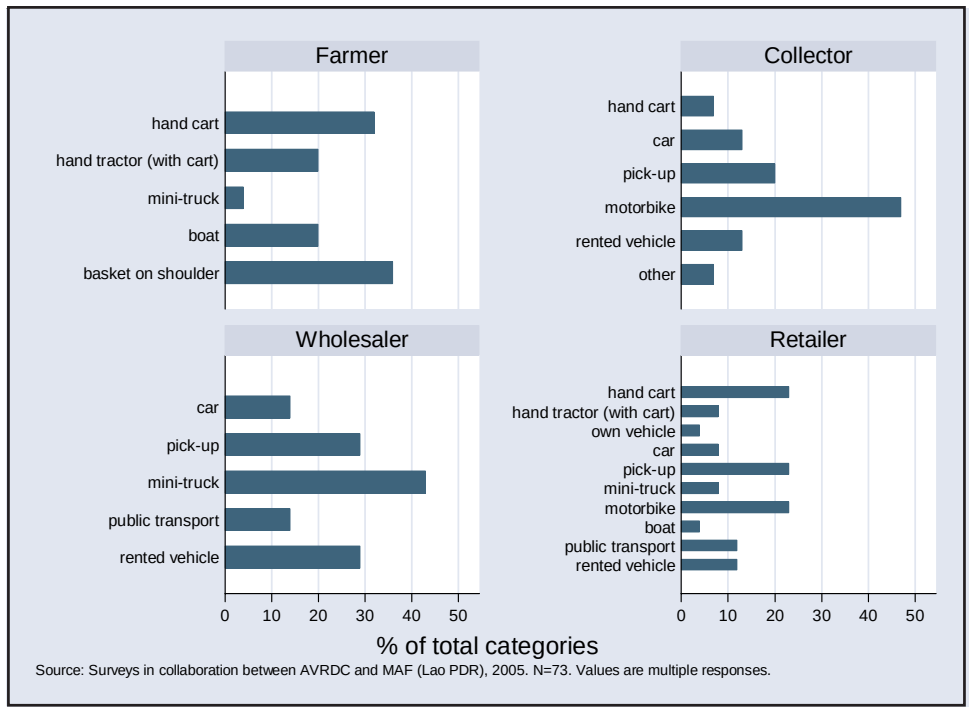


Figure 4-11 Mode of transport of chili in Lao PDR

Table 4-36 Involvement of supply chain actors in value-adding activities for chili in Lao PDR

Supply chain actor	Involved (%)	Not involved (%)
Farmer	32	68
Collector	53	47
Wholesaler	29	71
Retailer	69	31
Mean	49	51

Source: Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=73.

5 Discussion

To obtain a value of loss experience, actual loss in kg was multiplied by the average selling price (Table 5-1). 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 similarly high for tomato and chili (around US$ 84 and US$ 88 per MT, respectively) and low for cucumber (US$ 13 per MT).

Unfortunately, the crops under study do not have a complete set of either market or production data. Among tomato, yardlong bean and cucumber, total losses are highest for tomato since it has a relatively larger market sales than the other two. Summarized annual loss for tomato in Vientiane markets is approximately US$ 171,800. Since crop production data is available for chili, the annual value of loss was derived from the annual production multiplied by the economic value of loss estimated on the basis of the data which amounts to US$ 1.1 million per year. Approximately half of this loss is incurred at the retailer level.

Total annual vegetable production in Lao PDR is approximately 662,678 MT (FAOSTAT, 2006). Based on the average loss value calculated above, total postharvest losses in vegetables have an average value of US$ 42.5 million per annum.

Table 5-1 provides an overview on possible strategies to reduce postharvest loss in vegetables. The table shows that the economic value of loss in cucumber is lower than in the other three crops. Interventions to reduce postharvest loss should thus focus on tomato, yardlong bean, or chili. While the economic loss is highest at the level of retailers (because they sell the largest quantities of vegetables), farmers bear a high share in the overall loss (Table 4-11, Table 4-20, Table 4-29). Interventions should thus focus on farmers to allow them to reduce their loss. Focus could especially be placed on improving harvesting and packaging practices. Particular emphasis could be placed on quickly removing field heat in harvested crops and on simple structures for evaporative cooling, to reduce quality deterioration at the beginning of the supply chain.

Table 5-1 Average loss in US$ per MT of produce dealt with in Lao PDR

Supply chain actor	Tomato	Yardlong bean	Cucumber	Chili	Average
Farmer	7.9	26.7	2.0	27.9	19.3
Collector	3.7	3.6	0.8	13.5	7.0
Wholesaler	30.8	3.6	0.6	3.1	9.2
Retailer	41.8	14.6	9.4	43.7	28.7
Total	84.2	48.5	12.8	88.2	64.2
Annual production (2003) (MT)				12,506	662,678
Annual value of loss, based on production (US$)				1,103,029	42,543,928
Annual sales in 2003, Vientiane market[a] (MT)	2,040	632	1,125		
Annual value of loss, based on sales (US$)	171,768	30,652	14,400		

Sources: 1/ Surveys in collaboration between AVRDC and MAF/DOAG, 2005. N=200. [a] Kethongsa, Thadavong and Moustier (2004).

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