AVRDC
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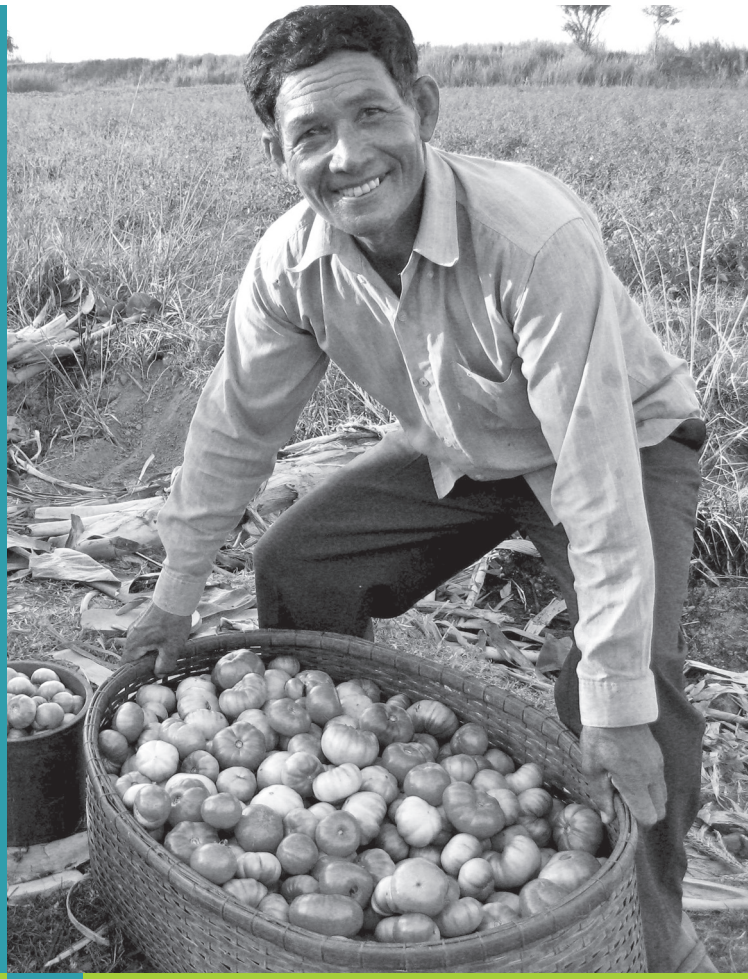
Research in Action 1

Postharvest Training for Supply Chain Actors in Cambodia, Laos, and Vietnam



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Evaluation Report

Postharvest Training for Supply Chain Actors in Cambodia, Laos, and Vietnam

AVRDC – The World Vegetable Center
Shanhua, Taiwan

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AVRDC – The World Vegetable Center is an international nonprofit institute committed to alleviating poverty and malnutrition through vegetable research and development. Our vegetable lines and technologies help small-scale farmers in the developing world boost their yields, increase their incomes, and safely grow nutritious food for their families and communities.

About *Research in Action*

The *Research in Action* series disseminates the practical applications of the Center's work in vegetable breeding, production, marketing, and nutrition. The series aims to encourage vegetable-based enterprise through the extension of ideas, technologies, and skills.

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Acronyms

ADB	Asian Development Bank
AGRIBANK	Vietnam Bank for Agricultural and Rural Development
AVRDC	AVRDC – The World Vegetable Center
AVRDC-HQ	AVRDC – The World Vegetable Center Headquarters, Taiwan
CaC2	calcium carbide
CADC	Clean Agriculture Development Center (formerly Crop Multiplication Center, or CMC)
CMC	Crop Multiplication Center
DAALI	Department of Agronomy and Agricultural Land Improvement
DAFO	District Agriculture and Forestry Office, Lao PDR
Dist	District
FAVRI	Fruit and Vegetable Research Institute
GMS	Greater Mekong Subregion
kg	kilogram
KKVRS	Kbal Koh Vegetable Research Station
Lao PDR	Lao People's Democratic Republic
PHT	Postharvest technology
R&D	Research and development
RETA	Regional Technical Assistance
RIFAV	Research Institute of Fruits and Vegetables (formerly Fruit and Vegetable Research Institute, or FAVRI)
RUA	Royal University of Agriculture
ToT	Training of Trainers

Currencies[1]

Kip	Lao KIP (1 US$ = 8,919.0 KIP)
Riel	Cambodian RIEL (1 US$ = 4,092.2 RIEL)
VND	Vietnamese DONG (1 US$ = 16,708.3 VND)

[1] 2008 averages, www.oanda.com

Introduction

AVRDC – The World Vegetable Center, in collaboration with national partners and through funding from the Asian Development Bank (ADB), has worked in Cambodia, Lao PDR, and Vietnam since 2005 with the overall aim of reducing postharvest losses along the supply chain for high priority vegetable crops.

Supported by ADB, AVRDC conducted RETA 6208 "Improving Rural Livelihoods through Development of Vegetable-based Postharvest Technologies in Cambodia, Lao PDR, and Vietnam" from 2005-2008 to:

- characterize supply chains, assess postharvest loss, and devise strategies to reduce postharvest loss of priority vegetables in Cambodia, Lao PDR, and Vietnam;
- develop postharvest technologies that included tomato and chili varieties with good postharvest traits, crop management for improved shelf life, and fresh produce handling and processing techniques;
- establish a model small-scale enterprise, train researchers and conduct pilot trainings for supply chain actors in postharvest technologies, build capacity of Cambodia, Lao PDR, and Vietnam partners in postharvest research and development (R&D) and small-scale enterprise development; and
- strengthen and expand partnerships across the region in vegetable research through workshops and exchange visits.

Since 2007, AVRDC has received additional funding from ADB for RETA 6376 "Support of Vegetable Value Chains in Greater Mekong Subregion Countries for Prosperity and Poverty Reduction." This financial support has allowed networking activities to include Myanmar, Thailand, and Yunnan, China; facilitated research on postharvest technologies for leafy vegetables; and expanded training activities through a training of trainers (ToT) approach, with the aim of reaching 200 trainers and ultimately 2,000 farmers per country.

To refine the training approach for the large-scale postharvest training, an evaluation of the pilot training of supply chain actors was conducted in February 2009, two years after the training had taken place. The outcomes of the evaluation are presented in this report.

Background

In late 2006–early 2007, a total of 237 agents along the supply chain in Cambodia, Lao PDR, and Vietnam received pilot training in postharvest handling and/ or processing of vegetables. The different components of this training are described below.

1. Training master plan development. To build capability and focus for the implementation of postharvest technology training programs in Cambodia, Lao PDR, and Vietnam, a training workshop for training teams was organized and conducted from 17-20 October 2006 at the Crop Multiplication Center (CMC), Vientiane, Lao PDR, with experts from universities, institutes, and the private sector in attendance. Postharvest technologies for tomato and chili were introduced through hands-on activities from harvesting to processing. The experiential learning exercises were followed by a workshop to develop the country training master plan for future trainers and supply chain actors.

2. Training programs. Table 1 summarizes the 12 training programs carried out by partners in the three countries. The Cambodia team conducted three on-station and one on-site training programs; the Lao PDR team, three on-station and three on-site or mobile training programs; and the Vietnam team, two on-station training programs. The first training program of the three country partners was done on-station and was designed for agricultural extension/technical staff and supply chain leaders (i.e. lead farmers, cooperative managers). It was conducted for 2-3 days, and covered theoretical and practical aspects of fresh produce handling and processing of tomato and chili. The succeeding training programs were mainly designed for vegetable supply chain agents (collectors and wholesalers, retailers and processors) and focused on a specific commodity (tomato or chili) and specific postharvest technologies (e.g. fresh produce handling, paste/puree processing, drying). Hands-on activities were emphasized in all training programs. The objective was to include at least 50 percent women.[2]

[2] Only the Lao PDR team met this target, although the Cambodia and Vietnam teams also involved a significant number of women trainees.

Table 1. RETA 6208 training programs in postharvest technologies (PHT) of tomato and chili in Cambodia, Lao PDR, and Vietnam

Training Title	Date (YR 2007)	Venue	Women/ Men	Total
Cambodia				
PHT, chili and tomato	22-24 Jan	KKVRS	5/19	24
Tomato production and PHT	22 Feb	S'ang Dist	22/20	42
Tomato paste processing	24 Feb	KKVRS	10/3	13
PHT, chili	16 Mar	KKVRS	6/9	15
		No. Participants	**43/51**	**94**
Lao PDR				
PHT, chili and tomato	14-15 Nov 2006	CMC	7/5	12
Tomato paste/puree processing	16 Jan	CMC	8/4	12
Mobile PHT training, tomato and chili	26 Jan	Hadxayfong Dist	8/8	16
Mobile PHT training, tomato and chili	9 Feb	Xaythany Dist	5/15	20
Mobile PHT training, tomato and chili	15 Feb	Vang Vieng Dist	7/2	9
Chili drying	20 Mar	CMC	7/7	14
		No. Participants	**42/41**	**83**
Vietnam				
PHT, tomato and chili	10-12 Jan	RIFAV	15/15	30
PHT, tomato and chili	15-16 Jan	RIFAV	6/24	30
		No. Participants	**21/39**	**60**
		TOTAL PARTICIPANTS	**106/131**	**237**

3. Training content. Training manuals on postharvest technologies for tomato and chili and on specific postharvest technologies for tomato (e.g. tomato paste processing) and chili (e.g. solar drying) were excerpted from the country translations of the Training Workshop Manual and substantiated by the results of postharvest technology research activities. Demonstrations of some technologies were set up prior to the training programs so that trainees could observe the actual outcomes or results brought about by using the technologies. This increased the credibility of the training programs and helped to build the trainees' trust and confidence in the training providers.

4. Training expectations. Trainees evaluated the training experience at the conclusion of each program. Trainees rated the training programs highly, noting the programs met their expectations of gaining knowledge and skills in postharvest technologies because the hands-on techniques presented were simple and easy to follow.

Sample and method

The lead questions for the evaluation of the pilot training were formulated at AVRDC-HQ and distributed to the country partners in early February 2009 for feedback and translation into local languages (Appendix 1). Fifteen respondents per country were selected at random, based on the list of training participants available from the Training Reports for each country (Appendix 2).

Table 2 shows the sample distribution by province and district in the three countries. Respondents were drawn into the sample and those unavailable or unreachable were replaced accordingly. Meetings were arranged ahead of time to firm up administrative and logistical preparations (Appendix 3 summarizes the itinerary). The evaluation team included one AVRDC staff as a meeting facilitator, and one local person as a translator.

Table 2. Sampling distribution by province

Cambodia (N=15)	N	Lao PDR (N=15)	N	Vietnam (N=15)	N
Kandal Province	**15**	**Vientiane Prefecture**	**10**	**Red River Delta**	**15**
Kien Svay District	4	Xaythany District	5	Nam Dinh Province	5
S'ang District	8	Chanthabuly District	1	Hai Phong Province	5
Muk Khampool District	3	Xaysetha District	1	Ha Noi	4
		Hadxayfong District	3	Ninh Binh Province	1
		Vientiane Province	**5**		
		Vang Vieng District	5		

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR) and FAVRI (Vietnam), n=45.

Results

Adoption of technologies

The results show respondents remembered the topics presented in the training courses. Nearly all respondents were able to identify the individual topics covered in the training program, showing that overall, the approach and methods used were suitable.

A very high share of respondents (all but one) in Vietnam adopted one or more of the postharvest techniques. The share was lower in Lao PDR and Cambodia. In these two countries, around 50 percent of respondents adopted one or more of the technologies covered in the training programs. Two years later, 60 percent of the respondents in Vietnam, 40 percent in Lao PDR, and 27 percent in Cambodia are still using one or more of the technologies. Of these, one or two respondents in each country have modified the technologies to use on other crops, or to use with different inputs (Table 3).

Table 3. Retention and adoption rates of training participants

	Cambodia		**Lao PDR**		**Vietnam**		**All**
	N	%	N	%	N	%	%
Topic retention	14	93	15	100	15	100	98
Adoption of techniques	6	40	8	53	14	93	62
Currently using	4	27	6	40	9	60	44
Modified	1	7	1	7	2	13	11
Stopped	2	13	2	13	5	33	20

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n=45.

Farmers adopted practices for fresh produce and for processing (Table 4). More farmers have adopted fresh produce handling technologies (10) than sun-drying (7) or processing (6) technologies. Fresh produce handling practices include harvesting with an intact calyx (tomato) and using scissors to cut the fruit from the vine; harvesting at the appropriate stage, i.e. when the fruit turns pink; careful handling of produce after harvest, e.g. using soft leaves or old newspapers to cover baskets before loading; gentle loading into appropriate containers; storage of harvested produce in cool rooms or in the shade; sorting and grading by color and size; and packaging into suitable containers. Farmers who adopted practices for fresh produce handling usually have changed a range of practices between harvesting and selling.

> *"After the training, I informed my father about the techniques. Now, after harvesting tomato, we are gently handling the produce and keeping them under the shade. We also put a wet cover (clothes) on top of the tomatoes when we place them on the wooden bed to prevent moisture loss. We did not do any of these before the training."*
>
> — Ry Leakhena, Cambodia

Respondents have adopted practices for chili and tomato drying, including using a simple solar dryer, and for the preparation of chili sauce and tomato paste with improved hygienic standards by filtering water and boiling glass bottles and lids.

> *"Before, I mixed all chilies together and sun-dried them on the roof. Only after the training did I start sorting, cleaning, boiling in hot water, filtering to remove water before sun-drying."*
>
> — Bounnam Sihalath, Lao PDR

> *"Even before attending the training, I was already processing tomato paste for my family. Some people in our commune found molds on the surface of the tomato paste inside the glass bottle. The training showed me how it is properly done, and now I boil the glass bottle and the jar cap before using."*
>
> — Nguyen Thi Ty, Vietnam

Table 4. Overview of postharvest technologies currently in use

Cambodia (N=4)	Lao PDR (N=6)	Vietnam (N=9)
Postharvest practices for fresh tomato (10)		
▪ careful harvesting, cutting tomato fruits including calyx **(2)** ▪ careful handling of fresh produce **(1)** ▪ keeping fresh produce under the shade **(1)** ▪ covering tomato with wet clothes prevent moisture loss **(1)** ▪ using chlorinated water **(1)** ▪ grading by color and size **(1)**	▪ harvesting tomato with calyx intact **(2)** ▪ harvesting tomato and chili using scissor **(1)** ▪ storing tomato **(1)** ▪ sorting chili and tomato by color, size and damage **(1)** ▪ postharvest handling for leafy vegetables **(1)** ▪ market price monitoring **(1)** ▪ packing tomato and chili in a 12-kg bamboo basket **(1)**	▪ tomato harvesting time **(3)** ▪ careful harvesting **(3)** ▪ careful handling **(2)** ▪ proper storage **(3)** ▪ using suitable containers **(2)** ▪ safe production **(1)**
Sun-drying techniques (7)		
	▪ chili sun-drying **(5)**	▪ chili sun-drying **(2)** ▪ tomato sun-drying **(1)**
Processed vegetables (6)		
▪ tomato paste production **(1)**		▪ tomato paste **(5)** ▪ chili sauce **(2)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR) and FAVRI (Vietnam), n=19. Multiple responses. Values in parenthesis are the number of farmers.

Constraints to adoption of postharvest technologies

Table 5 summarizes the reasons why trainees did not take up technologies, and Table 6, the reasons why trainees stopped employing the technologies.

The largest number of farmers (56 percent) did not adopt any of the technologies due to the lack of time, land, or capital. Lack of time may also reflect a lack of interest in the postharvest technologies. For eight participants, most from Cambodia, the training was irrelevant. The study found a high number of Cambodian respondents who are not (or who are no longer) chili or tomato growers. Six trainees were not interested in the training topics offered and, therefore, chose not to adopt any of the technologies.

> *"I stopped cultivating tomato even before the training since my land is limited and has disease problem. I had a big problem maintaining tomato and preventing disease infestation."*
>
> —Try Rum, Cambodia

> *"I only grow the vegetables. My buyers harvest by themselves."*
>
> — Nang Yot, Lao PDR

> *"I have no time to do processing. I have to transport the vegetables to some of my buyers like hotels, restaurants, and private consumers on a daily basis."*
>
> — Bounpheang Sayavong, Lao PDR

Table 5. Reasons why participants did not adopt techniques

Cambodia (N=8)	Lao PDR (N=7)	Vietnam (N=1)
Lack of resources (9)		
▪ does not own land **(2)** ▪ lack of capital **(2)** ▪ lack of time to do processing **(1)**	▪ lack of time to do processing **(4)**	▪ lack of capital, land and time **(1)**
Lack of relevance (8)		
▪ not a tomato/chili grower **(5)** ▪ training topic concentrated mostly on storage which is not applicable to participant **(1)**	▪ no harvest and postharvest activities (only in-charge with planting) **(1)** ▪ became a collector after the training **(1)**	
Lack of interest (6)		
▪ family not keen on consuming tomato paste **(1)** ▪ knew the techniques before the training **(1)** ▪ not interested to try since local technique works **(1)**	▪ knew the techniques before the training **(3)**	

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n = 16. Multiple responses. Values in parenthesis are the number of farmers.

In the three countries, the adoption of processing technologies was less sustainable than fresh produce handling practices (Table 6). Two farmers (22 percent) in Lao PDR who stopped using fresh produce handling technologies did so because they left the farming sector. All other respondents (78 percent) simply stopped using the processing and/or drying techniques due to lack of time and capital. This highlights the need for access to credit; lack of credit can be a constraint to adoption, especially of processing technologies. One respondent had little interest in processing, because processed products are readily available in the market, and because she prefers to consume produce fresh.

"I stopped processing tomato paste because I do not have the equipment (pan, grinder, and raw material). Although they are cheap, my money is spent for my six children's education. The techniques, however, are easy to follow, and I intend to use them again in the future primarily for home consumption."

— Chou Sangleap, Cambodia

"I stopped processing chili because I lack the machinery and capital. I am also quite busy with administrative work at the cooperative."

— Vu Tien Dung, Vietnam

Table 6. Technologies respondents stopped using, and reasons for stopping

Cambodia (N=2)	Lao PDR (N=2)	Vietnam (N=5)
Technologies		
▪ tomato paste **(2)**	▪ postharvest practices for fresh produce **(2)** ▪ chili drying **(2)** ▪ tomato paste **(1)**	▪ chili sauce **(3)** ▪ tomato paste **(2)** ▪ chili sun-drying **(1)**
Reasons for abandoning		
▪ lack of time **(1)** ▪ lack of capital to buy equipment/raw materials **(1)**	▪ stopped collecting/retailing activities **(2)**	▪ lack of time **(3)** ▪ only wanted to try and test the technique **(1)** ▪ lack of capital and machinery **(1)** ▪ chili sauce is readily available in the market **(1)** ▪ prefers fresh tomato to tomato paste **(1)** ▪ year-round production of tomato—no need for processing **(1)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n=9. Multiple responses. Values in parenthesis are the number of farmers.

Benefits of using postharvest technologies

The adoption of the postharvest technologies presented in the training courses has led to a number of benefits for the trainees (Table 7). All adopters in Lao PDR, 86 percent in Vietnam, and 67 percent in Cambodia provided specific examples of the benefits they experienced from applying the improved technologies.

The range of benefits includes, among others, the reduction of postharvest loss and enhanced product quality. Eight out of 24 trainees (33 percent) reported a reduction in postharvest loss, and eight trainees reported an improvement in produce quality. For instance, several farmers in Vietnam recounted how their losses dropped to as little as 1-2 percent from almost 30 percent before the training. One retailer in Lao PDR disclosed that her sun-dried chilies have a similar appearance with those imported from Thailand.

> *"Using the local technique, I cannot store for longer periods. In 1-2 months, there is insect damage and I cannot sell them. After the training, I can store dried chili for 5-12 months, and it has good quality, good color, and higher price in the market."*
>
> — Bounthene, Lao PDR

The results also show that impact on farm profits is large. Around 71 percent (17 of 24) of the adopters reported that their farm profits increased because of higher prices, price differentiation for products of different grades, and farmers being able to sell higher quantities. For instance, one trainee reported that her sales of dried chili increased from 1-2 kg/month to 30-40 kg/month after training. Another retailer recounted that while previous processing of dried chili was for home consumption only, after the training he now sells about 20-30 kg/month. One farmer from Vang Vieng District in Lao PDR, who previously sold approximately 40 kg/year of dried chili for 15,000 KIP/kg, has now increased sales to 100 kg/year for an average price of 20,000 KIP/kg, an increase in price of 33 percent, and a 2.5 fold increase in volume. Another farmer was able to obtain a 25 percent higher price for tomatoes due to a change in harvesting practices. Some farmers (3) also commented on a more stable farm income over the year because a contract arrangement was achieved.

"I was able to get higher prices by selling tomato fruits with stem, about 1,000 Riel/kg, than without, about 800 Riel/kg. I also managed to get different prices for grading tomatoes: Grade 1, 1,500 Riel/kg; Grade 2, 1,200 Riel/kg; and Grade 3, 800 Riel/kg. I believe I achieved better sales as the supply of tomato is not enough in the market."

— Tat Sophol, Cambodia

"Before, I only dried 40 kg for 15,000 KIP/kg. Now, I am drying 100 kg at 20,000 KIP/kg... I have no problem because I can sell them all. I fixed the price at 20,000 KIP/kg."

— Bounthene, Lao PDR

"In the beginning I only wanted to try the techniques in the beginning since I have my own way of chili drying. After using them, I knew they worked because my dried chilies have better quality and command good price. I used to sell them for 15,000 KIP/kg, but now I sell them at 20,000 KIP/kg. My dried chili (hot variety) is always in demand and I can store them longer, even up to one year, when I have good selection."

— Khoune, Lao PDR

"I used to dry chili only for home consumption. After using the new techniques from the training, the quality improved, taste is better, and now I can sell them at the market. The average quantity of dried chili I sell per month is 20-30 kg, and I sell them for 20,000-30,000 KIP/kg. With good price, I get about 500,000-600,000 KIP/month from dried chili. I buy a total of 300-500 kg/month or about 150,000 KIP/month."

— Bounnam Sihalath, Lao PDR

The majority (80 percent) also reported an improvement in their buyer-seller relationship. While some farmers were able to find a larger number of buyers, many farmers reported their buyers are satisfied, and crops can now be easily sold. There are cases in

which the number of buyers doubled or even quadrupled after participation in the training. In one case, a farmer from Hadxayfong District now has 10 collectors coming from Khammouan Province, Pakxe District (Champasak Province) and Xieng Ngeun District (Luang Prabang Province), up from 5–6 collectors in 2007. Another farmer from An Duong District, Hai Phong Province, now has 20 buyers, compared with only 5–7 in the past. Several farmers (4) also mentioned it is now easier to sell their produce. Others reported their buyers now frequently visit their houses to buy more tomatoes.

> *"I use the techniques because I can see good results. My tomatoes look fresh, have good color and no shriveling. If we decide to store in the future, I think we can store these tomatoes for longer periods.… And although the profit is the same, I can see more satisfaction from my buyers."*
>
> — Ry Leakhena, Cambodia

Other benefits respondents referred to related to enhanced knowledge and increased consumption.

Table 7. Benefits of using postharvest technologies

Cambodia (N=4 of 6)	Lao PDR (N=8 of 8)	Vietnam (N=12 of 14)
Reduced loss (8)		
▪ reduced loss **(2)**	▪ reduced losses **(1)**	▪ reduced loss **(5)**
Product quality (7)		
▪ better appearance **(1)** ▪ tomato paste is guaranteed clean **(1)**	▪ better appearance **(4)** ▪ longer shelf-life for dried chili **(2)**	▪ tomato paste is guaranteed clean **(2)**
Farm profit (17)		
▪ price differentiation **(1)**	▪ higher price **(8)** ▪ higher quantity sold **(2)** ▪ product diversification **(1)**	▪ higher price **(4)** ▪ product diversification **(3)** ▪ higher quantity sold **(3)**
Income stability (3)		
	▪ contract arrangement **(1)** ▪ regular income **(1)**	▪ stable price **(1)**
Buyer network (19)		
▪ satisfied buyers **(2)**	▪ increased number of buyers **(4)** ▪ crops can now be easily sold **(3)** ▪ satisfied buyers **(2)**	▪ satisfied buyers **(9)** ▪ crops can now be easily sold **(4)** ▪ increased number of buyers **(3)**
Other benefits (10)		
▪ higher consumption of tomato paste **(1)**	▪ more experienced **(1)** ▪ solves the problem due to overpacking**(1)**	▪ improved knowledge **(6)** ▪ higher consumption of tomato paste **(1)** ▪ time saved **(1)** ▪ wastes used as animal feeds **(1)** ▪ expanded relationship with neighbors **(1)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n=24. Multiple responses. Values in parenthesis are the number of responses.

Buyer feedback is essential. It helps trainees find out what their buyers want, and consider how they might improve their produce and products. After they changed their postharvest production practices, most adopters in Lao PDR (75 percent) and Vietnam (72 percent) received positive feedback from the intermediaries (Table 8). In Cambodia, 33 percent of adopters received positive responses. Feedback more frequently referred to fresh produce than to dried produce; none of the feedback mentioned processed products. Intermediaries prefer that farmers retain the calyx when they cut tomato from the vine, although they did note farmers should avoid harvesting tomato fruits with pointed stems since these pierce through fruits and packaging material. Other positive comments noted plastic bags make transporting vegetables easier compared with bundled produce, and reduce mechanical damage and postharvest loss. Overall, results indicate that intermediaries are well aware of the technological changes in farmers' fields and should be involved in training and promotional activities related to changes in postharvest technologies.

> *"Retailers in the market say my dried chili now has good quality and good color. For my fresh produce, I can now sell them all and the demand is high."*
>
> — Chansamone, Lao PDR

> *"My buyers say my tomatoes are very good and they are satisfied with the quality. The color became uniform and mechanical damage during handling was reduced. The leaves on top of the tomato look fresh, and they like this."*
>
> — Tran Van Truyen, Vietnam

> *"My buyers are now satisfied with the quality and safe vegetables I produce. Before, they complain about the mechanical damage, losses and quality, especially the appearance and full color of produce; now, no more."*
>
> — Du Truong Giang, Vietnam

Table 8. Feedback from intermediaries

Cambodia (N=2 of 6)	Lao PDR (N=6 of 8)	Vietnam (N=10 of 14)
Fresh produce (15)		
▪ better appearance **(1)** ▪ harvesting tomato with calyx is better than without **(1)**	▪ better quality (shape and color) and taste **(2)** ▪ plastic bags make transporting easier **(1)** ▪ grading provided customers with choices **(1)**	▪ better quality **(7)**, e.g. color, smell and calyx looks fresh ▪ reduced mechanical damage and postharvest losses **(3)** ▪ longer shelf life **(2)** ▪ no calcium carbide (CaC2) for ripening **(1)**
Dried produce (6)		
	▪ better quality **(4)**, e.g. color and reduction in the number of insects found inside the dried chili fruit after sun-drying ▪ improved taste **(2)** ▪ buyers are interested to know the technique **(1)**	▪ high demand from buyers **(1)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n=18. Multiple responses. Values in parenthesis are the number of farmers.

One important aspect of this evaluation was to assess whether new knowledge and skills acquired through the training programs made a difference in the livelihoods of respondents. Results show positive impacts on the livelihoods of all the adopters from Lao PDR, and half of those from Cambodia and Vietnam (Table 9). Increased income was used to invest in appliances (e.g. gas cooker, TV), equipment for farm operations (e.g. generator for an electric pump, motorbike), and land. In Lao PDR, educational expenses were covered and additional savings were deposited in the bank. One respondent each in Lao PDR and Vietnam reported opening another business.

> *"More money has come in because I was able to purchase more rice straw, fertilizer, and generator for electric pump."*
>
> — Tat Sophol, Cambodia

"My income increased from 300,000 KIP/mo to 700,000 KIP/mo. I was able to build a beer garden in July 2008. Currently, we are using the daily income from the beer garden as a revolving fund and do not deposit it in the bank. Before, our daily income was not guaranteed. Now, sales improved and income became regular."

— Chansamone, Lao PDR

"My income increased remarkably. All my five sons are employed, and I was able to buy more land. After opening up this business, my sons are interested to build another processing plant in Hai Hao Commune."

— Bui Xuan Hanh, Vietnam

"My income increased from 1 million KIP/mo to about 1.2-1.3 million KIP/month. I was able to deposit my salary from DAFO in the bank and use the ones I earned from collecting for our daily expenses."

— Chanthy, Lao PDR

One particular trainee from Vietnam is a remarkable example of the high potential for employment creation in a favorable environment. A former collector from Hai Hau District, Nam Dinh Province, he invested in a processing plant because farmers in his area have expanded production of vegetables due to the higher income that can be realized compared to rice production. Subsequently, there was a surplus of tomato and chili during production peaks. The training course he attended in January 2007 provided him with technologies on handling and processing of tomato and chili and advice on factory construction and processing equipment. After attending the training course, he decided to invest in land (6,000 m^2 for the processing plant), building/factory (Figure 1), equipment (Figure 4) and two transport trucks, and he borrowed capital from the Vietnam Bank for Agricultural and Rural Development (AGRIBANK). He started drying tomato and chili in December 2008, and has expanded his drying operations to other products, such as Vietnamese palm, onion, pumpkin, ginger and garlic. He also intends to move into producing tomato paste and chili sauce, as well as other products, such as pickled cucumber and syrups. Currently, he employs up to 100 people. He is

exploring export markets and has initiated discussion with two export companies that would sell his products to Russia and some European countries.

> *"The postharvest techniques are economically efficient. My turnover increased to 4 million VND/360 m^2 from 3 million VND/360 m^2. It also saved me time since now I follow the natural ripening method; increase my income by 20%; and reduced my losses to 1-2% from 30%. I also can now sell them all."*
>
> — Nguyen Van Hinh, Vietnam

Figure 1. Collector making tomato delivery To Hanh Quan Processing Plant

Figure 2. Sorting tomato before processing

Figure 3. Cherry tomatoes waiting for processing

Figure 4. Solar dryer (l) and washing tank (r) in the processing plant

Table 9. Impact on livelihoods

Cambodia (N=2 of 6)	Lao PDR (N=8 of 8)	Vietnam (N=8 of 14)
▪ higher income **(2)** ▪ able to buy more assets (rice straw, fertilizer, and generator for electric pump) **(1)**	▪ higher income **(8)** ▪ able to purchase more assets (land, motorbike, bicycle, TV, satellite dish, CD player, furniture, poultry) **(6)** ▪ send children to school **(3)** ▪ save money in the bank **(3)** ▪ opened another business (beer garden) **(1)**	▪ higher income **(8)** ▪ able to buy other assets (land, motorbike, computer, TV, gas cooker, air pot) **(4)** ▪ provide employment to family members **(1)** ▪ encouraged sons to open processing facility in another commune **(1)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR) and FAVRI (Vietnam), n=18. Multiple responses. Values in parenthesis are the number of farmers.

Recommendations for future training

All respondents were asked to provide recommendations for future training. Table 10 provides the details from a large number of participants in the survey. The answers were grouped into three areas: topics for future training, participants, and materials and methods applied. Many respondents suggested broadening the topics to include more on production techniques, especially disease and pest prevention and management, and postharvest management (e.g. postharvest practices of other vegetables, more advanced methods for storage, and market identification).

> *"Future training should teach more about integrated pest management since right now, I am having a problem with a soil worm that eats the roots of my leafy vegetables. Also, include techniques on how leafy vegetables can have good appearance."*
>
> — Hun Thy, Cambodia

A number of respondents (4) suggested improving how trainees are selected, to make sure that participants are "real farmers" who will apply the techniques learned. A similar number of trainees also suggested that more participants should be invited in the future.

Another recommendation was to invite traders and intermediaries to the training courses; however, this had been done during the training programs.

> *"My suggestions are to: (a) select the right people who can provide the knowledge to other farmers; (b) teach the basic knowledge that can be easily understood: (c) select farmers who are willing to do the techniques after the training; (d) include pre-harvest practices/techniques in future training; and (e) devote more time on hands-on training."*
>
> — Nguyen Van Hung, Vietnam

Under material and methods, most of the suggestions mentioned the length of training time and the practical application of skills: participants request more training time (e.g. training sessions to be repeated over the years), and more hands-on activities.

> *"Improve the training duration. It was too short. Also, show more on how to make tomato juice, and more hands-on practice."*
>
> — Khoune, Lao PDR

Table 10. Recommendation for structure of large-scale Training of Trainers

Cambodia (N=11)	Lao PDR (N=13)	Vietnam (N=13)
Topics (22)		
▪ broaden training topics to include leafy vegetables **(1),** production techniques **(7)**, especially on disease prevention and/or pest management **(4)**, to achieve high yield **(2)**, to improve appearance of leafy vegetable **(1)** ▪ provide sample seeds after training **(3)**	▪ broaden training topics to include mushroom cultivation **(2)**, chili sauce processing **(1)**, leafy vegetables **(2)**, and on disease identification, prevention and use of fertilizers/pesticides **(1)**	▪ broaden training topics to include other vegetables **(1)**, pre-harvest practices **(1)**, tomato-eggplant grafting for off-season production **(1)**, high yielding varieties **(2)**, new and advanced methods for storage **(2)** processing, and where to market produce **(1)**
Material and Methods (13)		
▪ increase number of training materials during training programs **(1)** ▪ provide more hands-on activities **(1)**	▪ increase training time **(4)** ▪ provide more hands-on activities **(3)** ▪ conduct more training programs during the year to help participants recall them easily **(2)**	▪ provide pilot processing facility to showcase technologies **(2)** ▪ teach basic knowledge that can be understood **(2)** ▪ increase number of training programs **(1)** ▪ provide more hands-on activities **(1)**
Participants (9)		
▪ improve how participants are selected **(1)**	▪ invite traders to join the farmers' training to combine knowledge **(1)** ▪ increase number of participants **(1)**	▪ improve how participants are selected **(3)** ▪ increase number of participants **(3)**

Source: Survey conducted by AVRDC – The World Vegetable Center in 2009 in collaboration with DAALI (Cambodia), CADC (Lao PDR), and FAVRI (Vietnam), n=37. Multiple responses. Values in parenthesis are the number of farmers.

Summary and conclusions

AVRDC – The World Vegetable Center, in collaboration with national partners, aims to reach 200 trainers and ultimately 2,000 farmers per country with a training program designed to address fresh produce handling, drying, and processing of vegetables. For this purpose, we carried out an evaluation of a pilot training program conducted two years ago, and interviewed a random sample of previous trainees. Two years later, 60 percent of the respondents in Vietnam, 40 percent in Lao PDR, and 27 percent in Cambodia are still using one or more of the technologies taught during the training. Most popular are the technologies for fresh produce handling and sun-drying.

The benefits were high among the trainees who adopted the technologies. Most important to farmers was the improved networks, which in turn lead to greater demand for their produce from a larger number of buyers. The majority of the intermediaries had an explicitly positive attitude towards the technology changes. In many cases, this translated into higher farm profits and profit stability. Farmers reported an increase in price between 25 to 30 percent, and in many cases, substantial increases in the volume of sales. There were reports that losses had gone down to 2 to 3 percent, from the previous rate of 20 to 30 percent. Substantial improvements in income were observed for those who adopted the improved postharvest technologies, ranging from 25 to 30 percent. Other beneficial impacts at the community level also were reported, and the most remarkable among these was employment generation. One respondent in our survey has created an additional 100 jobs in his locality after venturing into processing. In another case, the additional income generated through enhanced postharvest handling operations resulted in investment into an enterprise outside the agriculture sector.

The highest number of respondents who stopped using the improved postharvest technologies was found among those who tried the processing techniques. The fresh produce handling technologies involve little additional effort and investments, thus adoption rates are high. In contrast, a move to commercial processing requires investment in infrastructure and equipment, which is difficult without access to capital and risky in an environment where small-scale businesses are not supported by the political environment.

Because the benefits of fresh produce handling are high and attainable without the need for large investments, it is worth asking why a significant number of trainees in Cambodia and Lao PDR chose not to adopt the technologies. For most of these respondents, the training was irrelevant. The study found a high number of Cambodian respondents who, at the time of the training, were not growing or handling chili or tomato. A number of trainees also lacked interest in the topics offered and, therefore, did not adopt any of the practices.

These findings suggest careful selection of participants is crucial for the success of future training programs. Trainers and trainees alike should be selected based on criteria that indicate the likelihood of the respondent to make further use of the technologies. Current involvement in production, handling, and marketing of fresh or processed vegetables is one such indicator. Another approach could be to request that participants make a small contribution to the training program, perhaps in-kind, e.g. food. As in the past, training program participants should include all actors along the supply chain, because intermediaries play an important role in the uptake of technologies.

The limited access to capital in Cambodia and Lao PDR should be considered in the training design. In both countries, previous studies conducted by AVRDC indicate that farmers' use of credit is very limited. One possible approach is to involve NGOs that provide microfinance in the training programs. This may enhance uptake of equipment-intensive processing technologies.

Recruiting the most successful trainees to lead future training programs is one way to expand on experiential learning. The positive experiences of these successful trainees can convince others about the usefulness of the technologies.

Overall, this evaluation shows adoption of postharvest technologies has a significant impact on rural livelihoods and an overall positive effect on the development of rural economies.

Appendix

Appendix 1. Lead questions

1. After the training, did you decide to use any of the techniques you learned there? If yes, which techniques, and for which crops? Compare with your previous practices. (if no: continue with 9)

2. Why did you decide to use them?

3. Are you still using them? If yes: In the same way, or have you modified them? If you have modified them, how did you modify them?

4. How did you overcome the added costs and effort expended for the changes in your harvesting/postharvest handling practices?

5. If you stopped using them and went back to your old practices: Why? What were the problems you encountered?

6. What feedback have you had from intermediaries (collectors/wholesalers/retailers) regarding the quality of the produce, packaging (if changed) or shelf life of the product?

7. What benefits for your farm and marketing operations did you get when you changed your harvesting and postharvest handling practices? Did it translate to better sales? Did you find any new markets?

8. Can you see changes in your life because of the improvements in harvesting and postharvest handling practices? What changes?

9. If you did not use any of the techniques covered in the training: Why?

10. Do you have suggestions on how to improve the training? Which?

Appendix 2. Respondents and training programs attended

Country: Cambodia

Name	Syleap Sam	Khaw Sreykhouch	Chou Sangleap	Khut Samang	Hun Thy
Role	Farmer	School snack vendor	Farmer	Farmer	Farmer
					
District	Doun-sot Village, Kien Svay District	Doun-sot Village, Kien Svay District	Doun-sot Village, Kien Svay District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Bareangkraw Village, Svay Pretel Commune, S'ang District
Training attended	Tomato paste processing 24 Feb 07	Tomato paste processing 24 Feb 07	Tomato paste processing 24 Feb 07	Tomato production and PHT 22 Feb 07	Tomato production and PHT 22 Feb 07
Name	**Suy Thona**	**Pich Lat**	**Pen Kimyeang**	**Ry Leakhena**	**Tat Sophol**
Role	Garment factory worker	Farmer	Farmer	Student	Farmer
					
District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Bareangkraw Village, Svay Pretel Commune, S'ang District
Training attended	Tomato production and PHT 22 Feb 07	Tomato production and PHT 22 Feb 07	Tomato production and PHT 22 Feb 07	Tomato production and PHT 22 Feb 07	Tomato production and PHT 22 Feb 07
Name	**Try Rum**	**Lot Nan**	**Ou Out**	**Ou Lam**	**Pou Sokhun**
Role	Farmer-retailer	Farmer-collector	Farmer	Corn seller	Farmer
					
District	Bareangkraw Village, Svay Pretel Commune, S'ang District	Poum Koh Pra Village, Pom Tom Commune, Kien Svay District	Prey Dompo Commune, Muk Khampool District	Prey Dompo Commune, Muk Khampool District	Prey Dompo Commune, Muk Khampool District
Training attended	Tomato production and PHT 22 Feb 07	Tomato paste processing 24 Feb 07	PHT for Chili 16 Mar 07	PHT for Chili 16 Mar 07	PHT for Chili 16 Mar 07

Country: Lao PDR

Name	Bougeane Fongsamut	Nang Yot	Somphone Alunsak	Bounpheang Sayavong	Khampou Chanthamaly
Role	Farmer	Farmer	Retailer	Retailer	Market manager
					
District	Xaythany District, Vientiane Capital	Xaythany District, Vientiane Capital	Xaythany District, Vientiane Capital	Thong Khan Kham Market, Chanthabuly District, Vientiane Capital	Xaysetha, Vientiane Capital
Training attended	PHT for tomato and chili 9 Feb 07	PHT for tomato and chili 9 Feb 07	PHT for tomato and chili 9 Feb 07	PHT for chili and tomato 14-15 Nov 07	Tomato paste/puree processing 16 Jan 07
Name	**Bounnam Sihalath**	**Bounsou Kiamyxay**	**Done**	**Noune Bouliwan**	**Khoune**
Role	Retailer	Collector (former farmer)	Farmer	Farmer	Farmer
					
District	Xaythany District, Vientiane Capital	Xaythany District, Vientiane Capital	Hadxayfong District, Vientiane Capital	Hadxayfong District, Vientiane Capital	Hadxayfong District, Vientiane Capital
Training attended	Chili drying 20 Mar 07	PHT for tomato and chili 9 Feb 07	Mobile, PHT for tomato and chili 26 Jan 07	Mobile, PHT for tomato and chili 26 Jan 07	Mobile, PHT for tomato and chili 26 Jan 07
Name	**Chanthy**	**Viengkhone Khannavong**	**Vannalone**	**Chansamone**	**Bounthene**
Role	DAFO staff (former collector)	DAFO staff (former retailer)	DAFO staff (former retailer)	Farmer	Farmer
					
District	Phon Vieng Commune, Vang Vieng District, Vientiane Province	Vang Vieng District, Vientiane Province	Vang Vieng District, Vientiane Province	Phon Vieng Commune, Vang Vieng District, Vientiane Province	Vang Mieng Commune, Vang Vieng District, Vientiane Province
Training attended	Mobile, PHT for tomato and chili 15 Feb 07	Mobile, PHT for tomato and chili 15 Feb 07	Mobile, PHT for tomato and chili 15 Feb 07	Mobile, PHT for tomato and chili 15 Feb 07	Mobile, PHT for tomato and chili 15 Feb 07

Country: Vietnam

Training attended: Postharvest technology for chili and tomato, January 15-16, 2007

Name	Bui Xuan Hanh	Tran Van Truyen	Vu Van Duy	Vu Ho Dien	Vu Tien Dung
Role	Collector-processor	Deputy head of cooperative, part-time farmer	Farmer	Cooperative officer, part-time farmer	Head of cooperative, part-time farmer
					
District	Hai Hau, Nam Dinh	Nghia Hung, Nam Dinh	Nghia Hung, Nam Dinh	Hai Hau, Nam Dinh	Hai Hau, Nam Dinh
Name	**Nguyen Van Hinh**	**Nguyen Thi Ty**	**Pham Van Chien**	**Bui Dinh Long**	**Vu Van Dong**
Role	Head of the cooperative, part-time farmer	Cooperative member, part-time farmer	Farmer and Deputy head of the cooperative	Farmer	Farmer and cooperative member
					
District	An Duong, Hai Phong	An Duong, Hai Phong	Vinh Bao, Hai Phong	Kien Thuy, Hai Phong	Vinh Bao, Hai Phong
Name	**Le Quang Tan**	**Nguyen Van Hung**	**Le Dinh Binh**	**Du Truong Giang**	**Ngo Thi Trong**
Role	Farmer, cooperative member	Farmer, Head of the cooperative	Farmer, Vice-chair of the Communist party in the commune	Farmer, cooperative member	Farmer, cooperative member
					
District	Dong Anh, Ha Noi	Long Bien, Ha Noi	Phuc To, Ha Tay	Yen Khanh, Ninh Binh	Dong An, Ha Noi

Appendix 3. Team members and itinerary

Vietnam (8-15 February 2009)

Christian Genova, AVRDC-HQ

Nguyen Tuan Minh, Deputy Director, Department of Postharvest Technology, RIFAV

Feb 10 (Tue)	Nam Dinh Province
Feb 11 (Wed)	Hai Phong Province
Feb 12 (Thu)	Dong Anh and Long Bien Districts and Phuc Tho, Ha Tay in Ha Noi
Feb 13 (Fri)	Ninh Binh Province and Dong Anh, Ha Noi

Lao PDR (15-22 February 2009)

Christian Genova, AVRDC-HQ

Sysalong Kinnavong, Assistant to the Director, Clean Agriculture Development Center
Sao Senekhamta, Head of ICS Unit, CADC

Feb 17 (Tue)	Xaythany, Chanthabuly and Xaysetha Districts
Feb 18 (Wed)	Xaythany and Hadxayfong Districts
Feb 19 (Thu)	Vang Vieng District, Vientiane Province
Feb 20 (Fri)	Vang Vieng District, Vientiane Province

Cambodia (22 February – 3 March 2009)

Christian Genova, AVRDC-HQ

Borarin Buntong, Lecturer, Royal University of Agriculture, RETA 6376 Local Postharvest Technology consultant

Feb 23 (Mon)	Doun-sot Village, Kien Svay District
Feb 24 (Tue)	Svay-Pretel Commune, S'ang District, Kandal Province
Feb 25 (Wed)	Svay-Pretel Commune, S'ang District, Kandal Province
Feb 26 (Thu)	Pom Tom Commune, Kien Svay District and Prey Dompo Commune, Muk Khampool District

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