

# IMPROVEMENT OF DOMESTIC AND EXPORT MARKETS FOR VIETNAMESE FRUIT THROUGH IMPROVED POST- HARVEST AND SUPPLY CHAIN MANAGEMENT

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## **Abstract**

*The fruit industry in Vietnam has a great potential and plays an important role in agricultural production. About 85% of Vietnamese households are involved in some way in vegetable, fruit and flower production. These people, especially the farmers, are experiencing dramatic changes in moving from a centrally-planned to a market-orientated economy (Nguyen Dinh Hung, et al., 2004). Exports of fruit and vegetables in 2000 were US\$213 million, in 2003 they fell to \$151 million, but in 2007 exports have now risen to 283 million (Vietnam News 2007). Vietnam is experiencing difficulties in competing with other Asian nations in export markets and its own domestic market, especially with China and Thailand. This suggests that Vietnam's horticultural industries require substantial development to be globally and domestically competitive. With increasing living standards Vietnamese consumers are also demanding safer and higher quality fruit. This CARD project mapped current domestic supply chains to determine customer and consumers preferences and needs. This information was then used to design training programs that focusing on the total supply chain to implement quality management and Good Agricultural Practices (GAP) systems that provide benefits to Vietnamese farmer, supply chain participants and ultimately the consumer. To date about 572 farmers, 79 collectors and wholesalers have had training by this CARD project in pre-and post-harvest GAP practices.*

## **Introduction**

Globally, consumer concerns on food safety and product quality has led to implementation of new food safety systems, but implementing new quality assurance systems is resource demanding, time consuming and expensive for farmers. Farmers in Vietnam are trying to meet food safety and quality guidelines imposed by large national and international retail corporations and companies to remain profitable. Many major retailers have implemented their own quality assurance and product standards leading many farmers, collectors, traders and exporters to believe that this is a means of excluding them from accessing higher value markets. Compared with developed countries, supply chains of Vietnam are longer and often include twice as many participants and are based on traditional practices which are not easily changed.

Fruit and Vegetable crops are highly lucrative compared to staple crops. Horticultural produce has high value-added and income generation potential when compared to livestock and grain production. Horticulture is highly attractive especially for small scale farmers, and has a comparative advantage, particularly where land holdings are small, labour is abundant and markets reasonably accessible (Weinberger and Lumpkin, 2006). This situation is particularly true in Mekong Delta and Central South Cost Province of Khanh Hoa, Vietnam. Ford et al., (2003), suggested that the competitiveness of Vietnamese fruit industries was poor due to:-

- unstable product quality and no quality standards
- poor post harvest technologies and pre-harvest practices
- lack of group co-operative marketing structures

- little information about supply chains, prices and customers needs.

In this CARD project we have addressed these issues by:

- Mapping of current domestic supply chains with particular emphasis on determining consumer preferences and needs, and reporting results back to farmers and other chain participants.
- Providing a better understanding and highlighting possible improvements that can be made by Vietnamese farmers and chain participants for the selected mango and pomelo industries.
- Highly targeted training programs that have been carried out for institutes, supply chain participants and farmers.
- Providing training in pre-and post-harvest technologies to improve fruit quality based on GAP principles of integrated pest, disease, orchard management and product management, maturity indices, to improve environmental and human health in the production and eating of the produce.
- Improving quality standards and quality assurance programs for mango and pomelo.
- Improving mango and pomelo post-harvest technologies to reduce quality loss through new packaging methods, post harvest dipping, washing and sanitising and quality assurance.

Although Vietnamese horticultural farmers do benefit from improved yields, their primary interest has been to make a reasonable living from their farm, and to be environmentally and economically sustainable. Farmers seldom adopt fully, the technology packages developed for them. On the other hand, they frequently adopt what they consider are key elements or building blocks, that they put together to suit their particular needs; “they adapt rather than adopt” (Horne and Stür, 2003). The extension and training processes we are using are based on adult learning processes and participatory action learning (PAL) (Horne and Stür, 2003), train the trainer (TTT) and participant training participant (PTP).

A chain must provide a clear process to handle change, minimise risk, share rewards and deliver transparency through effective communication and knowledge sharing (Collins, 2003; Batt, et al., 2005). PAL and PTP are some of the underling principal practices used to obtain an understanding of the culture, to develop trust and rapport, to be consultative and to obtain supply chain participant input (Collins, 2003; Kolb, 1984).

### **Methodology**

New processes have been developed by this CARD project to assist farmers, collectors, wholesalers, traders, retailers, extension agents and researchers to implement improved horticultural supply chain practices based on GAP principles for Vietnam. The approaches which we are using to build new or improve existing supply chains and to develop their social and evaluation skills so they will become more responsive to customer requirements. The skills that we are attempting to transfer are related to two key areas (Nissen et al, 2007). These are:

1. personnel relationship skills to maintain and develop a GAP supply chain
2. strategic planning process to develop or modify a supply chain including GAP systems approach

### **Relationship development**

To help ensure sustainability and adoption of the GAP systems a new process was developed and used by chain participants (farmers, collectors, wholesalers, traders, retailers and the Vietnamese institutions involved). This process is based on an active decision making by the chain participants. See Figure 1 for graphic representation of this process.

### **Chain strategic planning and development**

This process involves:-

**Step 1.** Define and clarify. To develop a supply chain to reach target markets, agreements must be reached with chain participants on the mission, aims and objective.

**Step 2.** Information gathering. Information is collected, by segmenting the supply chain using priority components for problem analysis La Gra (1990). See Figure 2 for graphical representation of supply chain segmentation.

Processes used to gather information are:- interviews, observational surveys, surveys using sequential sampling, and process analysis at critical points along the chain.

**Step 3.** Compile and summarise information gathered. Organise information gathered into product, information and monetary flows, infrastructure and skills audit and identification of chain champions at each segment along the chain. Indicate where GAP is used.

**Step 4.** Analysis of the information. SWOT analysis and AFFA supply chain analysis that focuses on consumers, creating shared value, getting the product right, effective logistics and distribution, effective information and communication, and effective relationships and where GAP can be introduced and improved.

**Step 5.** Develop new supply chains.

**Part a).** Define the most appropriate supply chain to achieve the supply chain objective, aims and mission. Identify GAP requirements for product, information and monetary flows, product quality assurance, infrastructure and skills development for the chain.

**Part b).** Fine-tune the supply chain using processes such as:

- test of supply chain fit
- start to end focus of the chain
- Simplicity test on the chain
- Integrity test on the chain

**Part c).** Identify areas for improvement using GAP analysis: this should be carried out for the product, using La Gra chain segmentation. This should also include GAP analysis of:

- Knowledge/skills
- Infrastructure/facilities/resources
- Relationships

**Part d).** List the improvements in order of importance

**Step 6.** Develop action plans.

**Part a).** What GAP processes need to be done/provided to implement improvements?

- Product, information and monetary flows
- Knowledge/skills
- Infrastructure/facilities/resources
- Relationships

**Part b).** Develop action plans for:

- What is to be done
- How is it to be done
- Who is responsible
- When will it be done

**Step 7.** Evaluate the performance of the new supply chain. Evaluate the supply chain by monitoring key performance indicators (KPI's), based on GAP, conduct sampling, auditing and undertake process analysis to determine how effective if the chain is at achieving the aims and objectives set out in Step 1.

## Results and Findings

The Australian team devised the processes presented above in the methodology section based on GAP systems to train Vietnamese's institution staff (SIAEP and SOFRI), Vietnamese pomelo and mango farmers, collectors, wholesalers, traders, and retailers. These were used to develop new and improved supply chains for delivery of higher quality safe fruit to their Vietnamese customers. The strategic plan priorities for mango and pomelo chains are shown below in Table 1 and 2. These were developed by mango and pomelo farmers, collectors, wholesalers, traders and retailers with extension and research officers of Southern Sub-Institute of Agricultural

Engineering and Post-Harvest Technology (SIAEP) and Southern Fruit Research Institute via the strategic planning process.

**Supply chain mapping and practices**

Determining the wants and needs target market customers has to been conducted by this CARD supply chain project. This project conducted surveys of mango consumers, retailers, wholesalers, collectors and farmers to develop improved and new supply chains.

**Consumers:-**The mango variety 'Cat Hoa Loc' was the most popular variety with consumers; 71.43% prefer to purchase and eat this variety, due to its attractive colour, flavour and perceived market prestige. About 76% of consumers purchased from one to three kg of fruit, four to eight times per month. Most consumers purchased from retail markets because they were easy to access, they are able to select individual fruit and had established long-term standing relationships with the vendor. About 51.7% of consumers indicated they had problems when selecting mangoes to purchase due to uneven ripening.

**Retailers:-**Many retailers experienced difficulties in obtaining good fruit. About 45% of all retailers indicated that their purchases did not meet the agreed terms. Agreements were broken on price, quantity and product quality. About 15% of retailers indicated that fruit size was not uniform as per the agreement. Stem-end rot and anthracnose are the biggest causes of fruit loss during storage and sale.

**Wholesalers:-**Major problems faced by wholesalers when purchasing mangoes were; 1) 45% of sellers did not follow the agreed price quantity and quality; 2) 5% did not deliver uniform size; 3) 10% distance and transport problems; 4) 40% combination of many small factors. When selling fruit, major problems faced by wholesalers were; 1) 100% indicated price fluctuations were a major concern especially when markets are saturated; 2) 10% indicated that distance to transport the crop was a major problem; 3) a further 10% indicated that purchases did not follow agreements on price quantity and quality; 4) and 10% indicated that market taxes were to high. Fruit losses were high because, rotting and shrivelling fruit or ugly fruit, are not removed. Purchase weight loss occurs, due to fruit moisture loss and attacks by mice, rats, ants if the fruit are stored for several days.

**Collectors:-**Collectors do not want fruit that is ripe but hard green. Depending upon district, between 50%-100% of collectors will grade fruit. Collector places of trade are usually their house. Reasons collectors' grade fruit are; 1) to return baskets to growers; 2) ensure no ripe fruit is in the consignments; 3) ensure their business and reputation for delivering the fruit quality promised to their customers. Most collectors pack fruit into 30-50 kilograms bamboo baskets. They use two types of bamboo baskets. One basket is made from bamboo woven into a strong inflexible basket. The other is constructed from type of thin, softer, woven bamboo mat.

**Farmers:-** **Both** collectors and farmers prefer to sell mixed grades, even though the farm gate price will be low. This is done to allow farmers to sell Class 3 fruit which is not easy to sell. Many collectors/wholesalers find it extremely difficult to sell Class 3 fruit. This adds significant costs to all aspects of the supply chain and affects farmer returns. About 58% of farmers sell reject fruit at the local market while a further 20% will sell to home consumers. All farmers use pesticides. Pesticide sellers' recommendations have increased farmer's spray load significantly from 26 to 37 sprays per year, whereas the number of insecticide products used per farmer increased from 2.6 to 3.9 with advice from extension staff and media. Only 10% of the 93 participating farmers knew about natural enemies for pests, all of which were predators. Around 20% of the insecticides used belonged to WHO Toxicity Class I, while nearly all the rest belonged to Class II (Van Mele *et al.*, 2001).

**Chain practices:-** Traditional mango supply chains in southern Vietnam are long in terms of number of participants and number of times fruit are handled compared to developed countries. No fruit class and quality standards exist for many of the supply chains. Opportunistic marketing practices by collectors and wholesalers are evident (Quinn *et al.*, 2006). Verbal agreements between chain participants are not strictly enforced or adhered to. Topping is a common practice, where by better quality fruit in each grade are placed on top of each basket.

Very little or no cool chain practices are carried out. Top layers of high quality, extra class fruit and class 1 fruit are wrapped in paper with stalks attached. This is done to reassure customers that the fruit they are about to purchase are fresh. These stalks often break off during handling and transport and sap burn of the fruit results. After studying the mango supply chain, farmer estimates of damaged fruit at the wholesale market is from 25 to 40%. Surveys found that on average 31% of fruit suffer from sap burn and fruit rots. Quality monitoring surveys to establish fruit defects have been carried out on mango by SOFRI staff. Fruit affected by sapburn ranged from 16% to 50% across 5 markets in Can Tho city. Market surveys conducted by Mr. Nissen on mango fruit being sold in northern Vietnam showed that fruit affected by Anthracnose was 34%, sapburn 52%, abrasion marks 21%, and pressure marks 30%, fruit fly 1% and fruit rots (stem end and other rots) 3%. Many fruit had multiple defects severely affecting consumer acceptance and product saleability.

### **GAP pre-harvest orchard management systems to enhance fruit quality**

#### ***Mixed farming vs. integrated farming system based on GAP***

Consumers are demanding safer food products and the implementation of quality assurance standards places greater emphasis on farm design and orchard layout. Management methods that utilise safer production systems need to be implemented. They include:

- integrated pest and disease management (IPM & IDM) systems
- management systems that reduce chemical inputs through targeted spraying
- use of natural enemies to control pests and diseases
- pest and disease control strategies, such as fruit bagging utilising new material to improve light penetration to deliver high quality fruit
- tree canopy management to facilitate production of high quality fruit that can be easily harvested and marketed with reduced chemical usage.

The average farm size in Vietnam is about 0.66 hectares per household (FAO RAP, 2004; World Bank, 2006; GSO VHLSS, 2003). In the past, before “Doi Moi”, state farms were considerably larger. Our survey findings are similar to FAO and GSO VHLSS findings in that the average mango farm size is about 0.4 - 0.6 hectares. Farmers often grow many types of crops together in a mixed farming system. Mixed farming systems were devised to spread risk and provide subsistence for farmers and their families (Anh and Sakata, 2006), but this system usually makes produce un-saleable due to practices such over spraying of unregistered chemicals for pest and diseases control. For example, the use of registered chemicals at correct rate for one tree crop may contaminate the tree crop growing next to it in a mixed farming plot/orchard and spray drift can make the fruit not fit for sale, breaching quality assurance and food safety standards.

This project carried out orchard design training to correct this problem. Farmers were provided with a system that allows them to move from a mixed farming system to a integrated farming system based on small monoculture blocks. Trees are systematically removed and replanted to a GAP designed orchard. Training conducted covered:-

- Land degradation
- Acid sulphate soils (ASS)
- Soil and water to reduce erosion and contamination (eliminating nutrient runoff, mulching and soil health)
- Positioning of infrastructure and inputs to obtain maximum efficiency and utilisation of available farm land
- Top working and rejuvenation of an orchard was also carried out.

The speed and amount of trees that are removed is based on farmer’s ability to remain economically viable. Systematic tree removal and replanting systems were designed in training workshops with farmers in the Mekong Delta to provide them with practical experience in redesigning/re-engineering their orchards.

### **GAP canopy management and controlling tree size**

Our Card project found that the majority (84%) of “Cat Hoa Loc” mango trees in the Mekong Delta are between 5 and 15 years of age. About 45% of trees are 5-10 years old, 39% between 10 and 15 years. Most mango trees are very large. Due to their large size, about 30 percent of the fruit is not capable of being harvested from these large trees. This excessive tree size compounds problems with fruit quality due to difficulties of harvesting and controlling pests and diseases. Canopy management is not practiced by many Vietnamese farmers. Trees are not trained or pruned to a desired shape and often grow over 6 metres tall, significantly increasing production costs and reducing fruit quality.

Mango trees are terminal bearers (flowers on the ends of the branches) and the more branches the tree has, the better the potential yield. Training of farmers was undertaken to assist them in developing a tree of no more than 3.5 to 4 metres high with a spreading inverted umbrella shape. Light interception and distribution are the keys to high yields and high quality fruit. Without capturing sunlight, trees cannot manufacture the carbohydrates and food required to produce high yields of good sized, well-coloured, high quality fruit. These advanced tree training systems also increase profitability through improved labour efficiency, tree maintenance, and improved disease and pest control.

### **Yield manipulation to improve productivity using GAP**

For the Mekong delta, mango fruit production occurs between March and May. Many farmers try to manipulate their mango trees into producing two crops per year. One crop is produced between March and May, and a second crop in December - January. Off season production is difficult to achieve due to unfavourable weather conditions during the flowering and fruit development periods.

Our CARD Project found that 87.5% of the farmers use plant growth regulators to manipulate their trees. Training was conducted in the use of paclobutrazol, a plant growth regulator used in combination with thiourea to cease vegetative growth and produce flower buds. This floral induction method involves a soil drench of paclobutrazol applied at a rate determined by multiplying the diameter of tree canopy (in meters) with 1.0–1.5 g. of active ingredients of paclobutrazol. At 75-90 days after application of paclobutrazol, 0.5% thiourea is sprayed to the tree for bud breaking. Flower inflorescences are usually visible within 2 to 4 months after the paclobutrazol application, depending upon variety and seasonal weather conditions. The success in producing off-season mango is highly dependent on other factors such as climatic conditions, mango varieties, orchard management and most importantly the experience of mango growers (Nartvaranant, Subhadrabandhu, and Tongumpai, 2000). Paclobutrazol has the potential to move into ground water based on its water solubility and its ability to bind to soils, therefore extreme care should be taken when applying and using paclobutrazol. Thiourea is reasonably anticipated to be human carcinogen based on sufficient evidence of carcinogenicity in experimental animals (IRAC, 1974). The primary routes of potential human exposure to thiourea are inhalation and dermal contact. The greatest risk of potential exposure exists for workers involved in the use of thiourea, especially in agriculture where use without protective breathing apparatus and protective clothing will place the user as a significant risk of developing cancer. Training was conducted on chemical handling and safety to ensure farmers knew how to avoid risks to their health.

### **GAP IPM/IDM strategies**

IMP/IDM strategies to reduce of agricultural pesticide use and maximise the use of biological and cultural controls, rather than a strict chemical control method is needed in Vietnam for both mango and pomelo. Chemicals must play a supportive rather than dominant role. Pesticides should be used strictly when needed, as determined by pest monitoring systems and natural enemies encouraged providing a means of control. The use of selective, non-disruptive chemicals must be preferred over broad-spectrum chemicals that can create an in-balance in orchards. This project found that monitoring of pest and disease levels is non-existent. Training

in pest and disease identification and control for both mango and pomelo was undertaken. For example the disease anthracnose (*Colletotrichum gloeosporioides* or *Colletotrichum acutatum*) attack leaves, twigs and fruit in the orchard well before harvest. This disease may lay dormant on the surface of the fruit and during the post-harvest phase accelerate its growth, severely damaging fruit quality and its saleability. Training was conducted by this CARD project in disease identification, and strategies of control using GAP systems at the pre-harvest stage. About 13% of farmers now practise fruit bagging in the off season (rainy season) to stop pest (especially fruit fly) and disease damage.

#### **GAP post-harvest systems (grading, sizing packaging and handling methods)**

New product description languages and quality standards for pomelo and mango have been developed by this CARD project. How to assess external and internal quality characteristics are described in these quality guides. Characteristics, such as shape, colour, size, pest and disease damage and internal flesh colour flavour and texture have been documented. These sizing, grading and quality standards are now being used by the mango and pomelo cooperatives to develop new supply chains and markets for their fruit.

New fibre board packaging was developed for mango in Vietnam by this CARD Project. A single layer carton, containing 9 fruit in single cells with a total weight of 4 to 5kg, 105 mm deep and 350mm long and 305mm wide, with 16 holes of 14mm in diameter to allow cool air to penetrate inside the carton was used. The sides and ends of the carton are folded to form the lid. It was found that large mango fruit in excess of 500grams were too large for this carton. Cost to manufacture this carton is 10,000 VND which added 2,000 to 2,500 VND per kg to the fruit marketed in these cartons. Marketing fruit in these cartons is not for local trade but for high value markets. These cartons ensure the product will meet GAP and food safety standards by protecting fruit from contaminants, it will also reduce fruit bruising, and rubbing when compared to the traditional 35kg bamboo baskets method of marketing mango fruit.

A new plastic reusable, multipurpose crate for mango is also under development to meet high value markets. This crate will hold 20 fruit, weighing about 8 to 11kg. This is a single layer crate 140mm high, 600mm long and 400mm wide that is stackable. A layer of paper is wrapped around each fruit. The cost is 150,000 VND to manufacture, adding about 100VND/kg to the fruit marketed in these plastic crates.

Post-harvest practices at the farm/cooperative level have significantly changed. Fruit are now washed in clean water, then dipped in hot water at 52°C for 5 minutes to control fruit rots. This is being undertaken by the Cat Hoa Loc Mango Cooperative. This practice has decreased the incidence of fruit rots by 20 to 30%.

New supply chains have been tested for CHL mango cooperative. In the traditional supply chains operating in Vietnam mango fruit shelf life is only 5-6 days. The new supply chain (without cold facilities) can extend the mango shelf-life by 2-3 days and reduce fruit damage by 30-38% compared to the traditional supply chain practices. The cool chain system developed by this project for supply of high quality mango fruit to METRO, shelf-life was doubled and fruit diseases and damage was decreased by 45-60%.

Trials are presently being conducted by SIAEP on Nam Roi Pomelo to improve shelf life and saleability with the My Hoa Pomelo Cooperative. Food and Drug Agency (FDA) approved waxes, applied on the skin of the pomelo are being trailed, along with vacuum plastic wrapping and traditional methods of packaging, handling and storing of Pomelo. Preliminary results have shown that shelf life has been increased from 1 month to 2 months.

#### **CARD Project GAP achievements and economic impacts**

##### **GAP Accreditation**

The Cat Hoa Loc (CHL) Mango Cooperative is in the process of applying to obtain VietGAP. In September 2008, 21 mango growers with a total of 17.6 ha, will be checked for accreditation

to VietGAP. Some mango growers are now applying pruning & training techniques due to this CARD project which has never been practiced in the past.

The My Hoa Nam Roi Pomelo Cooperative will get GLOBAL GAP certificate in the near future. A total of 26 orchards, 23 ha in size will be checked by the international organization SGS on 17<sup>th</sup> July 2008.

Both CHL mango and My Hoa pomelo cooperative have built up their own packing house to apply new post-harvest technologies. The CHL Mango Cooperative have also been highly successful in developing a supply chain based on GAP principles developed by this CARD project. CHL Mango Cooperative, have supplied approximately 700kg of fruit to Metro and a further 200kg through CARD project. The cooperative received about 22,000VND/kg from Metro for good quality fruit that met the quality standards developed by this project. The CHL Mango Cooperative has now signed a new contract with Metro to supply mango for the coming year. In addition a further 50 tonnes of mango fruit have been supplied by CHL Mango Cooperative to a processor at a fixed price of 16,000 VND/kg for the Japanese market.

#### Economic impacts

Many farmers and extension agents and researchers assumed fruit bagging would provide a better quality fruit. This production method had not been subject to an economic analysis to determine how profitable fruit bagging could be. In this CARD project SOFRI staff carried out such an economic assessment of the benefits of fruit bagging in the off season. Based on these CARD project findings for an orchard of 1000m<sup>2</sup> with a planting density of 22, 10 year old mango trees, fruit bagging increased the orchard profitability by 14,190,000 VND in the off season.

Socio-economic farmer surveys on Xoai (Mango) cultivar “Cat Hoa Loc” farmers in the Hoa Hung Commune, Cai Be District, Tien Giang Province in the Mekong Delta of Vietnam indicated that growers with high levels of management practices and high input levels obtain a profit of 15,105,000 VND per 1000m<sup>2</sup>. That was 2.1 times greater than growers with mid level management practices and mid level inputs and 3.7 times greater than grower with low level management practices and inputs.

Further socio-economic farmer surveys of Buoï (Pomelo) cultivar “Nam Roi” in the My Hoa Commune, Binh Minh District, Vinh Long Province in the Mekong Delta of Vietnam indicates that farmers with high levels of management practices and high input levels obtain a profit of VND 3,576,000 per 1000m<sup>2</sup>, 2.4 times greater than growers with mid level management practices and mid level inputs and 3.9 times greater than grower with low level management practices and inputs.

#### **Conclusions**

CARD Project training of SIAEP and SOFRI staff and material supplied has assisted SIAEP in the delivery of training workshops for Metro in their joint project with GTZ and the Ministry of Commerce in Vietnam. Materials supplied and training carried out by this CARD project have assisted SIAEP staff in the ADB project and workshops to assist farmers in developing new agricultural supply chains to supply Metro stores with produce that meet their specifications, particularly on product quality and food safety. ***This project has provided training for of more than 572 farmers and 79 collectors and wholesalers has been completed by project staff. Workshop evaluations have indicated that over 90% of farmers were very satisfied with material supplied and workshops conducted.***

On average, in Vietnam, production input costs usually account for 40 to 60 percent of the gross returns. With the implementation of new grading and packaging systems a further 40 percent could be easily added to those costs (Nissen et. al., 2006; George and Nissen, 2004). Experiments using heat treatment and improved packing (fibreboard carton box, and plastic crate for Cat Hoa Loc mango) and cool chain management practices for sell fruit to high value

Vietnamese markets have shown great potential. Farmer cooperatives contracts with Metro have shown results that improved fruit quality increased economic earnings. Even though implementing greater quality assurance standards and GAP systems will cause production and marketing costs to increase, by targeting high value markets, economical returns can be achieved. Economies of scale through group marketing and the cost of organising efficient and effective supply chains will stop the mitigation by large supermarkets against small-scale producers and exporters.

A highly critical element in setting up a successful supply chain setting is demonstrating benefits to the supply chain participants and the need to form groups to achieve better economies of scale and increased bargaining power. Work has to be conducted at both ends of the chain, the producer and the final customer. This work has to be executed simultaneously, as neglecting either end of the chain limits the ability of the producer and chain to supply a product suited to the target market. Farmers, collectors, traders, wholesalers, exporters, all have shown a high level of commitment and significant progress has been made on documenting the current supply chains for mango and pomelo and excellent progress made on the implementation of the new improved supply chains by this CARD project. The implementation of the strategic and action plans for mango and pomelo is progressing well.

These methodologies used by this CARD project have provided valuable lessons in engaging farmers, collectors, wholesalers, traders and retailers to actively participate in developing new supply chains. By providing training, information on how supply chains function, and how each chain participant can implement GAP, food safety and quality assurance systems has improved their socio-economic standing. This CARD Project provides a model on how to engage chain participants from the field to the plate to ensuring they are socio-economically sustainability.

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## APPENDIX

**Table 1. Top 5 Priorities for the Mango Strategic Plan:- Listing in Order of Importance for Mango Industry**

Priority Rating	Priority Description
1	Improve production process (e.g. follow GAP)
2	Need to improve the linkages between farmers – traders – customers, scientists and government also need to be involved
3	Need market information for export and domestic markets
4	Improve packing and storing procedures/Need technical support to improve storing, packing and packaging material
5	Government to help with planning and development for specialised fruit growing area

**Table 2. Top 5 Priorities for the Pomelo Strategic Plan:- Listing in Order of Importance for Pomelo Industry**

Priority Rating	Priority Description
1	Supporting techniques from seedling–farming–harvesting (Guidance for GAP)
2	Advice/counsel on standards/specifications of products
3	Intensively farming and programming production area
4	Training on IPM
5	Improving applicability of farming techniques and technologies of harvesting, packing and transporting

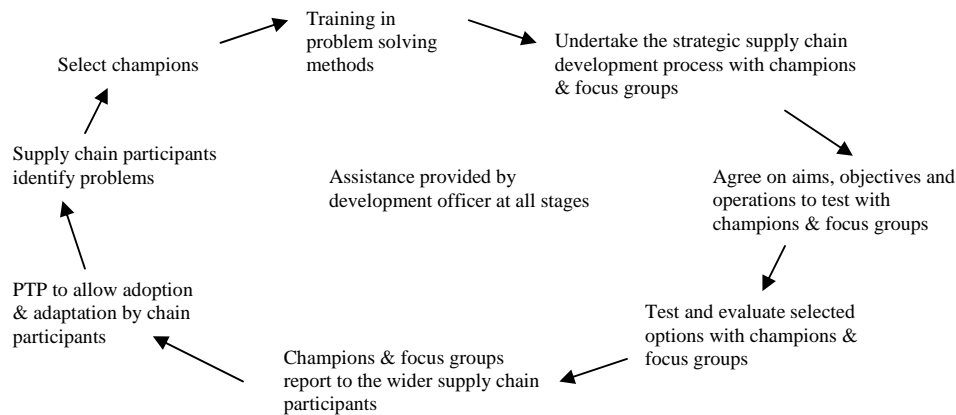


Figure 1. Participatory action learning cycle for supply chains

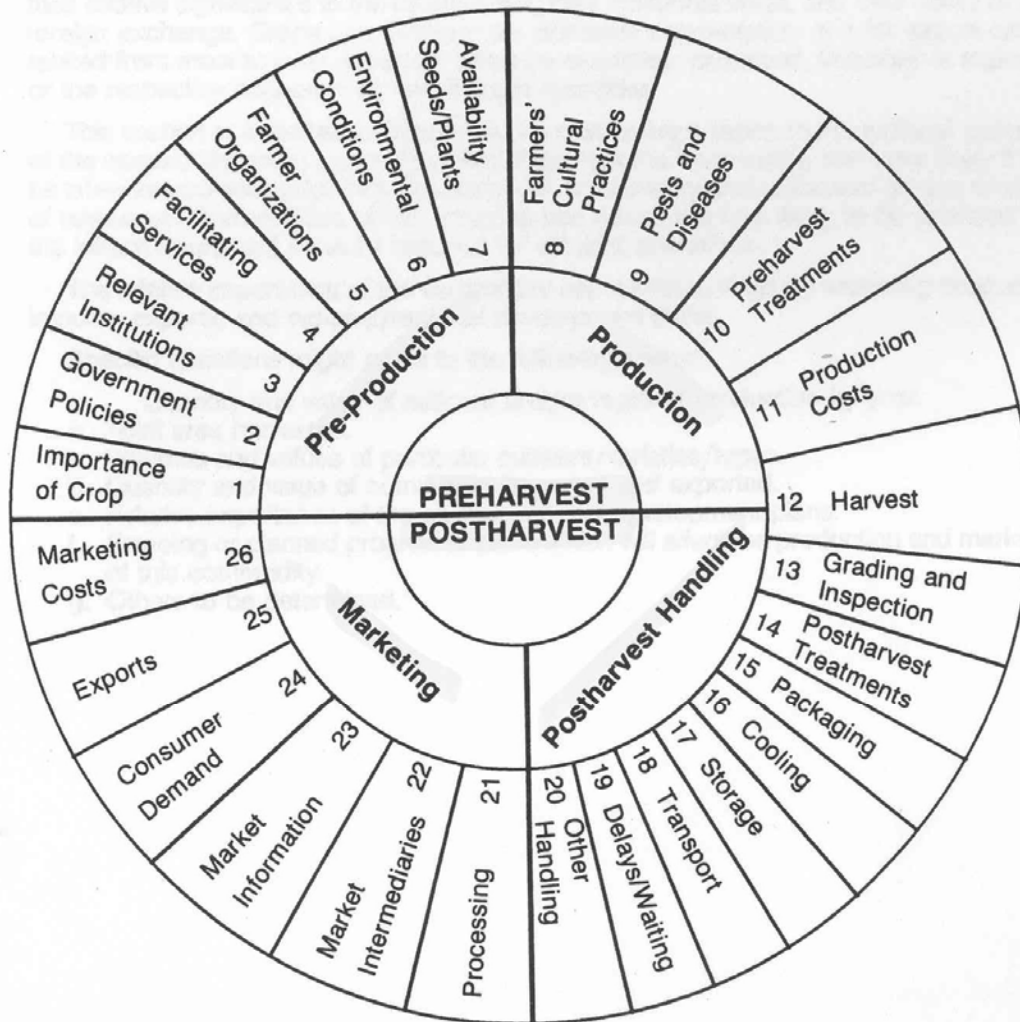


Figure 2. Chain segmentation using priority components La Gra (1990)