
Activity 1.6

This summary forms part of the ACIAR Project AGB/2012/061
*Improving smallholder farmer incomes through strategic market
development in mango supply chains in southern Vietnam*

Study: Year 1 Study
Factors affecting fruit quality benchmarks

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1 Introduction

Fruit 'quality' is a concept encompassing sensory properties (appearance, texture, taste, and aroma), nutritive value, mechanical properties, safety, and defects. Combined, these attributes give the fruit a degree of excellence and an economic value (Abbott, 1999). Everyone in the mango production and marketing chain—from the grower to the consumer—looks for fruit with no or few defects. However, in each step of this chain, the term 'quality' takes on different meanings and the economic relevance of the various quality traits is largely variable. Further, the quality benchmarks are considered as tools for controlling these variations to meet quality expectation of customers. Mango quality is dependent on many factors including pre-harvest, harvest, and post-harvest practices. After harvest, mango quality cannot improve, and fruit may need to be discarded. This is known as post-harvest loss. A post-harvest loss is normally defined and measured in volume and value of mango discarded or downgraded. Post-harvest losses occur throughout the production chain. Therefore, the identification of causes and origins resulting in losses is important to provide reasonable control measures to minimise fruit loss.

1.1 Defining post-harvest loss

- A post-harvest loss could be defined and measured as the amount and value of mango discarded or downgraded between harvesting the crop and its sale to the final consumer. Losses can be caused by many factors such as physical appearance, ripeness, spillage, crushing, abrasion, pest/insect damage, disease damage, chilling, rotting, or residues. Sometimes the effects of one or more of these factors leads to fruit being discarded as “unfit for sale” with no commercial value. Alternatively, the defect may be tolerated up to a certain limit, and the fruit downgraded in terms of its quality specification, leading to a reduction in its market price. Another common occurrence is that a fruit may be diverted from a higher quality/higher value market channel, to a lower quality/lower value market channel based.
- Downgrading is not always consistent because although standards and specifications exist to define tolerance levels in terms of fruit condition, safety, and other quality factors, the extent of downgrading losses is also determined to some extent by market forces—particularly seasonal supply factors. When markets are over-supplied, a higher proportion of fruit will be downgraded or discarded, leading to a higher level of post-harvest loss than during periods of scarcity. This type of market-related loss can be prevented only by timing harvest with market windows (difficult in co-variate, single-season harvests), or through market diversification. Market diversification may include accessing new market destinations and/or expanding processing capacity to absorb the oversupply. Globally, more fruit is consumed as juice or preserved, dried, or frozen fruit products than is eaten fresh. In most successful fruit industries, processing facilities have been successfully established and have served as buffers against over-production.
- An understanding of post-harvest loss as both complete physical loss (e.g. discarded as unfit for sale) and/or economic loss (lower market prices based on product specifications) is the basis of this study approach to evaluate factors effecting mango quality benchmarks.

1.2 Study objectives

The objectives of this study were to:

- Identify and document relevant farm practices that are currently contributing to quality loss.
- Conduct additional primary research, using in-market observations, to examine product quality captured at street market stalls, in small retail outlets, and within a representative sample of high-end retail markets.
- Supplement observational data with qualitative interviews with buyers in retail grocery to understand quality issues and the causes and impact on price and sales volume.
- Identify critical control points (CCP) that will impact on fruit quality based on current best practice knowledge.
- Conduct fruit monitoring trials from farms to retailers and assess for quality loss at CCP along the chain. Identify types, causes, and scale of losses.

2 Method

2.1 Research design

The general value chain was used to provide a structured lens through which post-harvest losses can be assessed (see Figure 1). Through direct feedback from actors along the value chain, information on the scale and cause of on fruit quality losses and existing business practices were gathered. Through a review and discussions with experts, we established a table of factors affecting quality of mango. On the basis of this table, the CCP were established and used for monitoring post-harvest losses along the value chain.

One hundred mangoes were randomly sampled at each identified CCP in the chain, and evaluated on grade and defects categories using a modified version of the Australian mango defect guide. This helped the researchers to identify what defects occur at each CCP, which can then be linked to a cause.

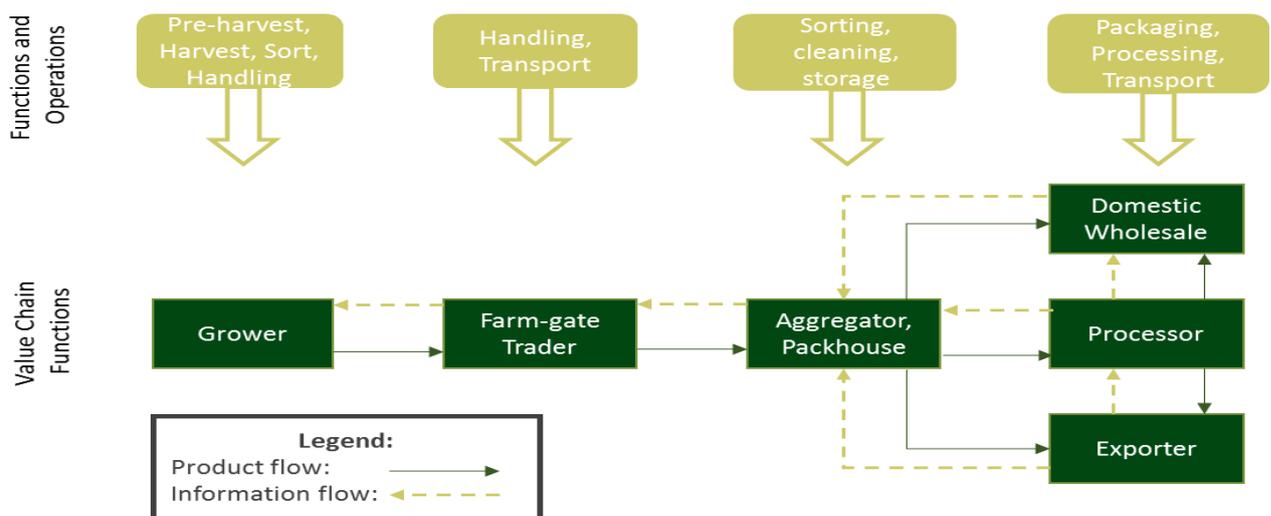


Figure 1. General value chain of mango used for analytical framework

2.2 Target audience

The study focused on two mango varieties, Cat Chu and Hoa Loc. The survey locations included:

1. On-farm: Cao Lanh District and Cao Lanh City, Dong Thap Province and Cai Be district, Tien Giang Province
2. Off-farm: the mango pack houses located at Dong Thap and Tien Giang Provinces
3. Supermarkets/fresh fruit shops at Ho Chi Minh City (HCMC) and Hanoi.

3 Identifying losses and critical control points

3.1 Cultivation practices and common types of loss

The current cultivation practice of mango (Cat Hoa Loc and Cat Chu) in Dong Thap and Tien Giang occurs over a 90-day period (see Figure 2). With this practice, we can identify that post-harvest quality of mango would be strongly affected in stages such as the stage of fruit setting and young fruit, fruit bagging, and harvesting. The types/cause of loss of mango was mainly recorded as pest/insect damages, abrasion, small fruit/undersized fruit, or physiological disorders (such as 'jelly', 'cavity', or 'soft nose of flesh') (see Table 1 and Table 2).

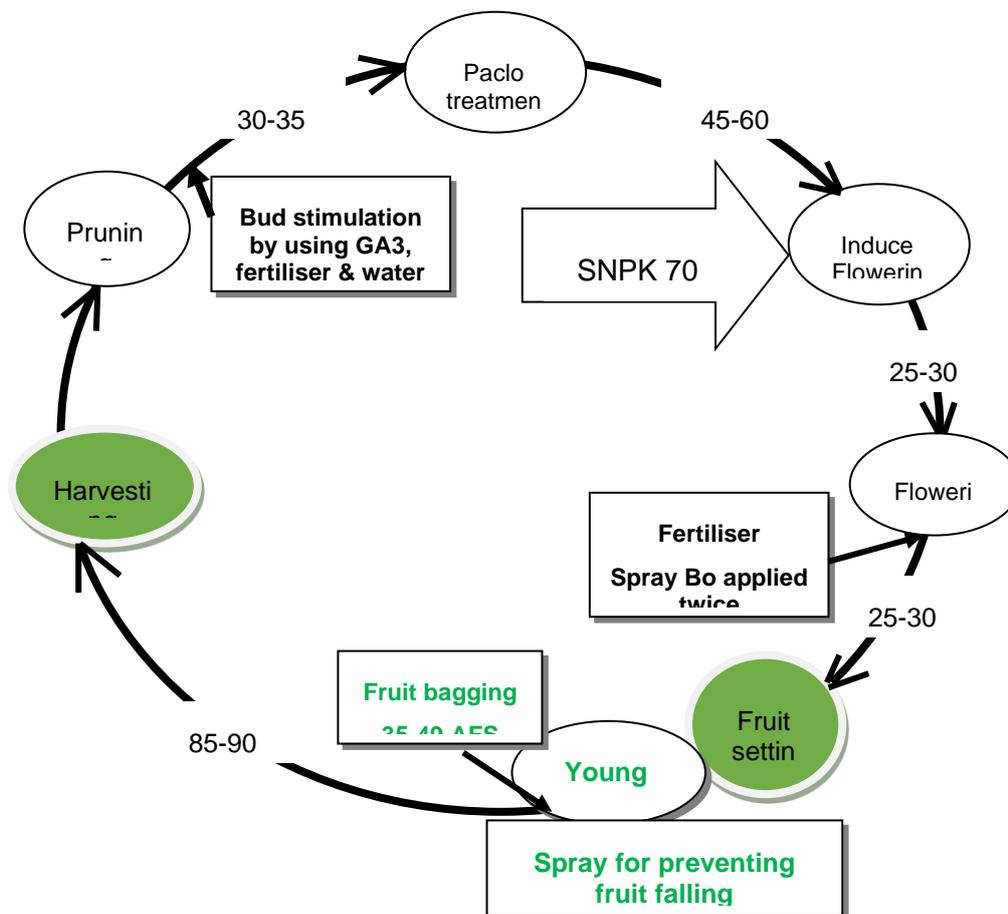


Figure 2. Mango flowering induction cycle, Dong Thap and Tien Giang

Source: Author's analysis

Table 1. Common types of loss, pre-harvest stage

Type of loss	Pre-harvest impact/outcome
Sap burn	Improper practice of the phase of fruit bagging
Abrasion	Improper practice of the phase of fruit bagging
Undersized fruit/small fruit	Imbalance in nutrition supply, no thinning at bagging
Pest/insect damage	Improper practice for protecting at the stage of fruit set and young fruit
Lenticel spot	
Physiological disorders (jelly/cavity/soft nose)	Calcium deficiency

Source: Author's analysis

3.2 Post-harvest loss

Based on interviews and market discussion, common types of loss along the value chain was captured (see Table 2).

Table 2. Common causes of loss, pre-harvest and post-harvest stages

VC level	Current technology	Effect of loss
Farmers	Harvesting: harvest pole Field collection: baskets and plastic crates Sorting, grading and packing Field collection and transport: none	Immature, overripe, abrasion, sap burn, contamination, harvest damage (bruise, wounds)
Collectors/ traders/ exporters	Transport: trucks, all sizes Ambient temperature receival go-downs Basic mechanised handling lines (de-sap, washing tank or washing machine) Heat treatment Refrigerated stores Ripening facilities	Sap burn, physical damages, abrasion chilling injury, fruit rots, dehydration.
Retailer	Refrigeration Display shelves	Rots, dehydration, chill damage, abrasion.

Source: Author's analysis

3.3 Identification of critical control points

The CCPs were identified for assessing mango post-harvest losses. These included: at harvest, at the packhouses of local trades in Dong Thap and Tien Giang provinces, and in supermarkets/fresh fruit shops based in Ho Chi Minh City and Hanoi.

CCPs that impacted quality based on current best practice knowledge were identified. These included:

How the value chain operates and the underlying structure

1. Who does this and where does their responsibility start/finish?
 - For the cooperatives: They instruct collectors how to choose the garden, choose the fruits in accordance with the requirements of company.
 - For the cluster (club): They have a harvest assignment schedule to divide to members. Farmers transport mangoes to the collection place and company trucks will bring mangoes to the company.
 - Farmers harvest mangoes according to market demand (when market has high price, farmers keep the fruit on the tree and wait for the best price).
2. Farmers mark mango bags to determine fruit maturity.
3. When harvesting, farmers remove fruit bags, putting mangoes into baskets, transporting them to cooperatives, and then mangoes are sorted and sold to company.
4. Farmers do not treat mango latex after harvesting.
5. The cooperatives are responsible for supervision and inspection.
6. Company employees grade mangoes.
 - Reject rates = 1–30 % (due to young or low-quality mangoes with decay or physical injury)

Feedback from interviews noted market requirements of:

- The visual image of fruit should not present as damaged, either outside or inside.
- Enough supply of fruit to ensure ongoing supply.
- A consistent presentation of fruit at the designated level of maturity.

4 Results

4.1 Monitoring post-harvest loss at critical control points

To date, one post-harvest assessment of losses at CCPs has been undertaken in Cao Lanh District, Dong Thap Province and Ho Chi Minh City (see Tables 3, 4, 5, 6, 7, 8).

Table 3. Post-harvest losses, Cat Chu mango, at harvest

Items	Percentage (%)	Price (VND)
Bagged/un-bagged	Bagged/white bag	
1st grade	50.52	28,000 – 25,000
2 nd grade	30.96	15,000 – 25,000
3 rd grade	12.31	11,000 – 9,000
Quarantine defect		
Scale	No	
Fruit fly	No	
Defects		
Overripe	5.36	
Abrasion	7.20	
Bruising	0.75	
Soft nose	0.19	
Sap burn	10.27	
Undersized/small fruit	5.51	
Lenticel spotting	2.12	
Fruit rot	0.57	
Insect damage	13.70	
Sooty mould	0.60	
Sun burn	0.20	
Immature appearance	0.50	
Wounds	0.62	
Misshapen	0.20	
Harvest damage	0.20	
Unidentified issues	0.10	
Total fruit audited	122.17	
Total defects (3rd grade)	12.31	
Out of grade	6.21	8,000 – 5,000

Source: Author's analysis

Note: Cat Chu mango farm, My Xuong, Cao Lanh, Dong Thap Province

Table 4. Post-harvest losses, Cat Chu mango, Dong Thap

Items	Percentage (%)	Price (VND)
Bagged/loose	Bagged/yellow bag	
1st grade	53.70	32,000 – 28,000
2nd grade	37.54	25,000 - 18,000
3rd grade	8.76	15,000 – 10,000
Quarantine defect		
Scale	No	
Fruit fly	No	
Major Defects		
Fruit rot	2.96	
Overripe	8.76	
Sap burn	56.48	
Undersized/small fruit	1.85	
Wounds	1.85	
Total fruit audited	239	
Total defects (3rd grade)	9.38	
Out of grade	4.81	

Source: Author's analysis

Notes: My Xuong Cooperative, Cao Lanh, Dong Thap Province;
Mango exports to Russia, Korea, Japan, Australia;
Mango domestic supply to Nam An store, Ho Chi Minh City.

Table 5. Post-harvest losses, Cat Chu mango, Hanoi

No.	Packer/grower	1st grade (%)	2nd grade (%)	3rd grade (%)	Fruit rot (%)	Sap burn (%)	Abrasion (%)	Bruising (%)	Overripe fruit (%)
1	Nga Tiên Packhouse	43.94	40.73	12.13	2.75	90-95	60-70	2.29	13.50
2	Packhouse	42.44	44.77	10.47	2.33	90-95	60-70	1.74	12.79
3	Packhouse		100 (<250gr)		0.61	95.00	0.61	0.61	0.00

Source: Author's analysis

Table 6. Post-harvest losses, Hoa Loc mango, at harvest

Items	Percentage (%)	Price (VND)
Bagged/un-bagged	Bagged/white bag	
1st grade	59.12	80.000 – 70.000
2nd grade	13.15	50.000 – 40.000
3rd	5.63	20.000
Quarantine defect		
Scale	No	
Fruit fly	No	
Defects		
Overripe	5.16	
Fruit rot	0.54	
Abrasion	5.54	
Sap burn	2.6	
Bruising	0.58	
Undersized/small fruit	0.33	
Lenticel spotting	1.98	
Insect damage	1.36	
Under skin browning	0.37	
Wounds	1.07	
Harvest damage	2.56	
Total fruit audited	353	
Total defects (3rd grade)	5.63	
Out of grade	22.10	

Source: Author's analysis

Notes: Hoa Loc mango farm, My Xuong, Cao Lanh, Dong Thap Province;
 Hoa Loc mango farm, Hoa Hung, Cai Be district, Tien Giang Province.

Table 7. Post-harvest losses, Cat Chu mango, Ho Chi Minh City

No.	Markets	Price (VND)	Process reject fruit (%)	Fruit rots	Sap burn	Dehydration	Overripe	Bruising	Note
1	Big C - Supermarket	29,000	5		x	x		x	Dehydration (20-30 %)
2	Nam An store	29.900	5		x	x			
3	Coop Mart	30.000	5 - 10	x	x	x	x	x	Rejected fruits sold in frozen pieces Purchased every day (20-30kg)
4	Vin Mart	29.900			x	x		x	Significant dehydration
Overall		29.700	5 - 10	1/4	4/4	4/4	1/4	3/4	

Source: Author's analysis

Table 8: Post-harvest losses, Hoa Loc mango, Ho Chi Minh City

No.	Markets	Grade	Price (VND)	Process reject fruit (%)	Fruit rots	Sap burn	Dehydration	Overripe	Bruising	Note
1	Big C Supermarket	2	70000	5		x	x		x	
4	Coop Mart	2	74000	5		x	x		x	
5	Nam An store	2	74000	5 – 10	x	x				Rejected fruit sold as frozen pieces Anthracnose, intermittent
2	Ben Thanh Wet market	1	130000	5	x	x	x			
3	Gift box retailer	1	200000	5 – 10		x		x		Mangoes are not a 'big' line
6	Small fruit retailer	1	130000	5 – 10	x	x	x			
Overall				5-10	3/6	6/6	4/6	1/4	2/4	

Source: Author's analysis

4.2 Common issues

Common issues included:

1. Post-harvest losses of Cat Chu and Hoa Loc mango at a CCP.
 - Most causes of post-harvest losses at harvest time are due to abrasion, over-ripeness, and size (small fruit). The most influential reason is sap burn and insect damage.
2. Post-harvest losses of Cat Chu and Hoa Loc mango at a CCP.
 - Overripe fruit and sap burn are the main reasons for post-harvest losses at the packhouse.
 - The significantly high levels of sap burn at the packhouse are indicative of harvesting and transportation problems.
3. Post-harvest losses of Hoa Loc mango at the CCPs in the market.
 - Most retail chains have no refrigeration and are set up for the quick movement of fruit.
 - Small volumes are supplied regularly.
 - Almost none of the fruit in any of the retailers is sold at eating ripeness, thus indicating that there may be problems with bringing the fruit to this stage, due to losses from dehydration and disease. This could be imposing a major limitation on how much fruit is sold, as it eliminates the impulse buyer.
 - Dehydration and immature fruit appear to be a very common issue across most retailers.
 - Disease is an issue for fruit held for a few days.
 - Wastage appears to be around 5–10%.
 - Most supermarkets are purchasing grade 2 fruit.

5 Conclusion

To date the study has observed that defected fruits are classified into grade 2, 3, or out of grade and the price of the mangoes are much lower (30-50%) than the 1st grade. However, 1st grade of Hoa Loc and Cat Chu mango fruit at both harvesting and packhouse are about 50-60%. It is important to note that size is the primary grading parameters at the farm and packhouse level.

There is a need to reduce post-harvest loss by applying the new techniques in cultivation, harvesting, and post-harvest handling such as: pruning (branches and fruits), flowering, IPM (control disease and insect), harvest index, field packing/grading, post-harvest management (de-sap, post-harvest diseases, dehydration, ripening, cool chain management), and transportation.

In summary, this initial study has given some good preliminary results. However, further monitoring of quality loss at the CCP is ongoing through 2020 and into 2021.

6 References

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7 Appendix

7.1 Fieldwork – 2019

Harvesting



Cat Chu mango, first class



Cat Chu mango, defects



ABRASION



OVER RIPE



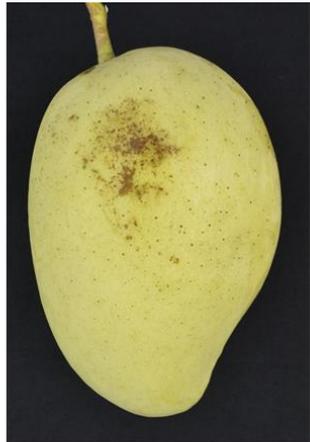
**UNDERSIZE
FRUIT /
SMALL FRUIT**



SAP BURN



LENTICAL BROWNING



INSECT DAMAGE



SCAR



UNUSUAL



HARVEST DAMAGE

Hoa Loc mango, first-class



Hoa Loc mango, defects



SAP BURN



OVER RIPE



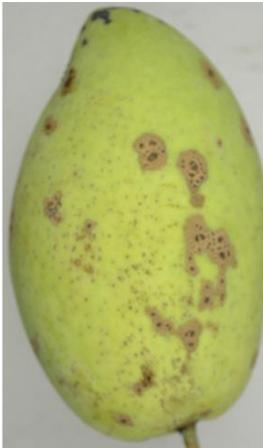
LENTICAL BROWNING



BACTERIAL BLACK SPOT



SMALL FRUIT



INSECT DAMAGE



PHYSICAL DAMAGE



ABRASION



ROTS

Cat Hoa Loc, fruit grading



Hanoi packhouse

