



## Low cost, high impact solutions for improving the quality and shelf-life of mandarins in local markets

Mandarin (*Citrus reticulata Blanco*) is an important fruit crop grown in SAARC countries. Almost all mandarin fruits are marketed domestically, although small volumes are exported by producing countries to other countries within and outside the region. Known for its excellent flavor and nutritional value, the easy-to-peel fruit is commonly consumed in the fresh form or in fruit salad preparations as well as in the form of fresh juice.

Like other fresh fruits, mandarins are highly perishable because of their high moisture content and delicate nature. If not harvested at the right stage of maturity and handled properly throughout the supply chain from harvest to retail the produce suffer losses in both quantity and quality, resulting in a reduction of income for all involved in their production and subsequent post-harvest handling. Furthermore, improper handling shortens the market or shelf-life of mandarin which limits sales volume and returns to retailers.



Improvements in the typical mandarin supply chain: harvesting at the correct stage of maturity with a clipper (A) and packaging of mandarin using 20 kg capacity plastic crates with plastic liners at the bottom and between layers of fruit (B).

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### The importance of good post-harvest handling practice

Post-harvest begins where production ends, that is at harvest. Good practice in harvesting and in post-harvest handling is essential in maintaining quality (fresh appearance, flavor and nutritional value), extending shelf-life and assuring the safety of mandarins for the benefit of consumers. Post-harvest losses in mandarin are the result of poor harvesting techniques, careless handling and poor packaging and transport conditions. It is therefore important that efforts are made to prevent or minimize these losses across the mandarin supply chain, so that farmers, marketers, and consumers alike can benefit.

### Improving handling practice in mandarin supply chains

Under the FAO Technical Cooperation Project, TCP/RAS/3502, titled, *Reduction of Post-harvest Losses in Horticultural Chains in SAARC Countries*, good post-harvest handling practice along with simple technologies were piloted with stakeholders.

Technical improvements piloted with stakeholders in traditional mandarin supply chains in Nepal are summarized below:

**Table 1: Traditional and improved practices in mandarin supply chains**

Operation	Typical handling practice	Improved handling practice
Harvesting	Harvesting at over-mature stage by pulling	Harvesting at the correct stage of maturity using a clipper
Packaging	Plastic crate, 20 kg capacity; no plastic liner at the bottom and in between layers of fruit	Plastic crate, 20 kg capacity; with plastic liner at the bottom and in between each layer of fruit

## The results

### 1. Post-harvest losses

Post-harvest losses in mandarins at the wholesale level were mainly due to moisture (weight) loss, packaging and transport-related damage and poor quality (soft) fruits, while at the retail level, losses incurred were due to weight loss and loss due to quality deterioration during display of mandarins on sale.

At the wholesale market, weight loss, mechanical damage, and poor quality fruits for traditional handling were 0.7 percent, 4.3 percent and 2.2 percent respectively, resulting in a total loss of 7.2 percent. With the improved handling practice, weight loss, mechanical damage and poor quality fruit were 0.7 percent, 2.4 percent and 1.0 percent respectively, or a total loss of 4.1 percent. Therefore, a 43 percent reduction in total post-harvest loss was achieved because of the improvements introduced.

At the retail level, weight loss and loss due to quality deterioration on the 11<sup>th</sup> day of display using traditional handling practice were 6.8 percent and 6.2 percent respectively, or a total loss of 13 percent. On the other hand, with improved handling practice a total loss of 4.6 percent, consisting of 4.6 percent weight loss and no loss due to quality deterioration on the 11<sup>th</sup> day of display. Improvements in the handling practice resulted in a loss reduction of 65 percent.

**Table 2: Losses at various stages of traditional and improved chains**

Parameter	Supply chain level	Handling practice	
		Traditional	Improved
Total loss (%)	Wholesaler	7.2	4.1
	Retailer	13.0	4.6
System loss (%)	Farm to retail	20.2	8.7

For the entire post-harvest handling system (farm to retail), system loss was markedly reduced from 20.2 percent to 8.7 percent as a result of post-harvest interventions or improvements carried out in the typical mandarin supply chain, equivalent to a 57 percent loss reduction.

## 2. Shelf-life

Shelf-life is the length of time that a commodity may be stored or displayed for sale without becoming unfit for use or consumption. At the retail level, the shelf-life of mandarin harvested at the over-mature stage was 8 days, with the proportion of marketable fruits at 99 percent. With the improved practice, the shelf-life was extended to 11 days with 100 percent marketable fruits, resulting in an increase in shelf-life by three days. In effect, retailers can get more benefit in terms of increased sales volume and hence, returns from mandarins handled using the improved practice.

## 3. Produce safety

Application of good practice in handling mandarin from harvest to retail is critical in minimizing the risk of contamination posed by pathogenic microorganisms that may originate from the fruit itself as well as from workers who come in contact with produce during handling. With good post-harvest practice, consumers of mandarin are assured of buying good quality and safe produce that will not cause harm to their health, thus sustainable consumption of the fruit can be expected. In the end, all actors involved in the mandarin supply chain (farmers, wholesalers, retailers) and other stakeholders can also benefit.

## Cost and returns analysis

Cost and returns analysis was used to determine the profitability of adopting improvements in the typical mandarin supply chain. Expected changes in cost and returns were calculated for the three supply chain levels, i.e. farmer, wholesaler and retailer, based on the assumption of marketing 100 kg mandarin and using post-harvest loss data and other relevant information gathered by the project. A summary of the results is presented in the Table 3.

**Table 3: Cost and return analysis of improvements introduced at different levels of the supply chain**

3A

Item	Farmer	
	Typical practice	Improved practice
Gross returns, Rs	5 565.00	5 754.00
Total cost*, Rs	3 800.00	3 817.00
Total net income, Rs	1 765.00	1 936.92
Net income /kg, Rs	17.65	19.37

\* Includes production cost at Rs 30/ka.

3B

Item	Wholesaler	
	Typical practice	Improved practice
Gross returns, Rs	5 565.00	5 754.00
Total cost, Rs	4 900.00	4 900.00
Total net income, Rs	1 065.00	1 254.00
Net income /kg, Rs	10.65	12.54

3C

Item	Retailer	
	Typical practice	Improved practice
Gross returns, Rs	7 830.00	8 586.00
Total cost, Rs	6 400.00	6 400.00
Total net income, Rs	1 430.00	2 186.00
Net income /kg, Rs	14.30	21.86

Under the current marketing system, the farmer would not benefit from the improvements in the typical post-harvest handling system of mandarin. This is simply because the farmer sells the mandarin crop to contracting buyers, i.e. collectors/wholesalers, even while the immature fruits are still on the tree. However, the farmer can benefit from the improvements if the mandarin crop is harvested and sold directly to the collector or wholesaler. In this case, the net income accruing to the farmer under the improved practice would be higher than the traditional practice.

For both the wholesaler and retailer, the improved practice gave a higher net income compared to the typical practice, with the retailer gaining a higher benefit than both the farmer and the wholesaler. Therefore, the adoption of improved practice would benefit the three supply chain actors but to different degrees.

With the improved practice, the consumer as well would benefit in terms of better access to good quality mandarin fruits over an extended retail period.

*This information sheet summarizes the results of the FAO Technical Cooperation Project: TCP/RAS/3502 Reduction of post-harvest losses in Horticultural chains in SAARC Countries*

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