

# POST-HARVEST LOSSES OF HORTICULTURAL PRODUCE

R. A. Werner and B. R. Kaini  
Small Marketing Infrastructure Project (NEP/89/CO4)  
Harihar Bhawan, Lalitpur, Nepal

## ABSTRACT

Post-harvest losses of fruits and vegetables are 12 to 35% of crop yields that reduce economic productivity in Nepal. Mechanical injuries, physical damages, micro-biological decay, physiological alterations, inadequate marketing opportunities, packaging and transportation systems are some key elements that cause losses after harvest. Some of these issues are discussed and presented in this paper along with the project activities of the Small Marketing Infrastructure Project.

Additional Key Words: Perishables, marketing, fruits, vegetables

## INTRODUCTION

Throughout the time, in developing countries, many actions have been taken place to increase production and productivity, and farmers have answered positively to requests to produce more. Less actions have taken place in the field of post-harvest handling and marketing. Fresh fruits and vegetables are perishable produce: they are easily subject to appearance deterioration, flavour, nutritive value and saleability decrease, and to total spoilage once they have reached commercial maturity and are harvested. Three aspects are outstanding in this sense: weight of moisture loss; actual physical losses, and reduction in nutritive value. The magnitude of post-harvest losses in fresh fruits and vegetables in developing countries, as reported by several authors, is estimated to be from 20% to 50%, depending upon the commodity. Monetary losses related to quality reduction are also obvious, as prices are reduced for low quality produce at the market outlets. Losses are more significant at the end of the marketing chain in which the value of fresh produce has been aggregated by handling, packaging, transportation, taxes and other expenses. This value increases many times from farm to consumption areas, magnifying the economical significance of wastage at any point along the marketing chain.

Under a market oriented concept, actions for prevention or reduction of post-harvest losses are to be taken at subsequent levels, starting with production planning (farmer's decision to produce a saleable commodity) and following through harvesting, assembly, preparation for the market, distribution and use by final consumer, considering the technical and economical aspects involved. In this sense, in order to reduce losses economically, there is the need for: (a) support the decision-making process on: what to produce; where to grow; how much to produce; when to produce and sell; for which market, (b) understand physiological processes of specific commodities and their relation to maturation, ripening, environmental requirements, functional disorders and parasitic diseases (the biological and environmental factors involved in deterioration), and (c) invest in economically viable post-harvest infrastructure, equipments and materials, and in technically viable, economically



justified and socially desirable technology procedures to delay senescence and maintain quality. From the point of view of institutions and functions, actions to normalize the supply and to reduce losses have to be taken at levels as: formal education; professional training; research; transport; storage; processing; market information, and fundamentally, on planning.

From the point of view of marketing and post-harvest technology (and most important when dealing with perishable crops) it has to be considered that the increasing production will have to be collected, transported and distributed to consumers (and stored in some cases), with economical efficiency. Infrastructure, market information, technical assistance in post-harvest and marketing, and other facilities will have to match with this increasing production to avoid localized gluts that would force down prices leading to discouragement for farmers engaged in this activity, as frequently occurs in many production areas. For sustainable production, adequate marketing and post-harvest programme needs to be developed and implemented to support and guide the horticultural development in the country

### **PERISHABILITY OF HORTICULTURAL PRODUCE**

Horticultural produce corresponds to a wide range of important components of human nutrition, deriving from different plant tissues/organs. The different plant parts (plant organs that serve as source of fruits and vegetables) have specific physiological characteristics: some are very prone to rapid senescence after harvest and others, if properly stored, may withstand longer periods. The common feature in general sense is their perishability after harvesting, if compared to other groups of agricultural crops. Fruits and vegetables are easily subject to appearance deterioration, flavour, nutritive value and saleability decrease and to total spoilage once they have reached commercial maturity and are harvested.

#### **Extent of losses in Nepal**

Information on the nature and extent of losses after it leaves the farm and until it reaches the terminal markets and the consumers is available from different sources and it is clear that vegetables offered in retail markets are sometimes disappointing to consumers, indicating important quantitative and qualitative losses. Physical losses derived from momentary and localized surplus, due to incentives to increase production without analyzing the market outlets/possibilities and transportation availability are mentioned in several areas and cases but not reported systematically. Monetary losses have been reported for the same reason. A situation occurring systematically in Lalbandi (Sarlahi), gives a good example to explain the "Spider-web Theorem": to a given volume of supply, corresponds a certain price. One year of good price stimulates production next season, beyond the market capacity dropping the prices to a level that does not stimulate production next year. When the prices rise due to reduced supply, production is stimulated once more, resulting again in prices drop. As a result, there are significant monetary losses from the price reduction that not always benefit the consumer and that, in extreme cases, doesn't justify harvesting, when farmers leave products rotten in their fields. The UNCDF Kalimati Wholesale Market Project estimates that as much as 25% of produces are wasted after harvest. The Master Plan for Horticulture Development considers and uses (as conservative), weight based losses of 25% in vegetable, 20% in fruits and 32% in potatoes (including seed potatoes). The same document reports a specific case of 35% physical losses on apples transported from Marpha to Pokhara. Similarly, important losses of apples in Dolpa have been mentioned, without consistent data on the extent. Tomiyasu and Verma (1990) reported that the losses of junar



(orange) correspond to as much as 29%, during storage on local system. Specific research conducted by FAO in Terai, Kalimati Market and retail shops in Kathmandu (Werner et al. 1991), showed physical losses corresponding to 22.85% in tomatoes; 15.84% in cabbage and 12.28% in cauliflower. It has to be noted that moisture losses were not measured, so the monetary losses resulting from the differences in weight are not considered and would range from an additional 5 to 10%. The same study concluded that there are monetary losses due to quality reduction. Prices were shown to be sensitive to quality, and the price reduction ranged from 16.65 to 28.82%. The mentioned Master Plan for Horticulture Development reports similar prices variation due to quality in two cases: (a) oranges in good quality being sold at Rs. 18/kg and poor quality oranges at Rs. 5/kg and (b) potatoes transported from Bhairahawa to Pokhara showing a price reduction of 33% due to mechanical damages.

### Nature of losses

As mentioned earlier, economical and physical losses occur, from time to time, due to lack of or scarcity of, information about the market opportunities (market demand and production forecasts) and are directly related to the decision on production: these losses have to be credited to inadequate planning.

Handling procedures from farm to retail have participation in the losses, in different extent, starting at harvesting and following the handling/packaging/transportation chain through the marketing channel. Mechanical injuries, physical damages, micro-biological decay, physiological alterations are derived from the packaging/transportation system that in great extent leads or conditions the handling procedures adopted.

Farmers have the tendency to take to the market all the product they harvest, without any selection for maturity or for insect/disease damages. Under this concept, it can be assumed that at farm level itself, post-harvest physical losses are minimum, under normal conditions. In special cases, as reported by farmers and technicians, due to minimum prices (lack of buyers and of transport), products were lost in the field, without harvesting (tomatoes in Lalbandi and cabbage in Damauli). In Terai, for example, harvesting maturity is conditioned by the weekly local market (in some places twice a week), leading to both immature as well as over-ripen products being harvested. Traditional packaging used by farmers for fruits and vegetables are bamboo baskets (tokari and doko). In the case of the Hat Bazaars in terai, these are brought to the market mainly carried by farmers family or, in some cases, in bullock carts. In some cases, great portion is carried to the market without packaging, in bullock carts, but also in bamboo baskets. Traditionally, in these Hat Bazaars, products are left in the sun (or rain), in conditions that enhance ripening and senescence. In Sarlahi/Dhanusa, along the highway, a series of Hat Bazaars are organized during the week (twice a week in the same place). Considering the 50 km from Dhalkebar (Dhanusa district) to Nawalpur (Sarlahi district), the sequence of Hat Bazaars is the following, covering the 7 days of the week: (a) in Dhalkewar, Sundays and Wednesdays; (b) in Lalbandi, Mondays and Thursdays; (c) in Nawalpur, Tuesdays and Fridays; (d) in Bardibas, Saturdays. It often happens, during the main season when offer is high, that farmers (mainly the ones using bullock carts), move from one Hat Bazaar to the other, if not able to sell in the first they arrived. This is one of the detrimental factors, enhancing losses and quality deterioration, as consequence of excessive handling under if appropriate conditions. In general, packaging used to carry products from the farm to the roadside and/or local markets are suitable to the



local conditions and materials. In this sense 'doko' (the conic shaped bamboo basket for back carrying) is an ingenious packaging for hilly conditions, as the 'tokari' (circular shallow bamboo basket for head carrying) is suited for plain areas.

Primary traders repack the products for transportation to urban centres. After buying, products are dumped on heaps for sorting/packing. At this moment discounts are normally applied, to compensate rejects, representing a loss for the farmers. Some selection is done at this time, removing the damaged and decaying units. Depending on the type of fruit or vegetable, these are packed in 'bangha' or 'tokari'. In the case of tomato, for example, the basket is re-lined internally (all around) with newspaper and covered with jute bag material (gunny sack cloth) tightly stitched to the bamboo basket. It is a common practice to place green fruits at the bottom of the 'tokari' and the mature (ripen or ripening ones) on the top, expecting protection during transportation. First quality tomatoes are selected and accommodated around the upper board of the basket (place where it is partially opened at the market for inspection). Average weight of these tomato 'tokari' is 40.80 kg, ranging from 33.0 to 51 kg leaving room for exploitation when weighing is not available. The 'bangha' used for cabbage and cauliflower (as many other products) is a packaging unit using as base a 'tokari' that goes attached to a jute bag forming a sack that holds up to 150 kg, depending on the product. In the case of cabbage, 'bangha' weight averages 130.96, ranging from 121.5 to 150.0 kg. In the case of cauliflower the average weight is 114.13 kg, ranging from 100.0 to 125.0 kg. Packages prepared in this way are left in the open, waiting for the transportation that is normally done by bus (top of night buses). It is common belief that night bus tops are the cheapest mode of transport for vegetables. Since they change by volume, traders try to fill the packages as much as they can. Some transportation is also done by trucks, together with other goods, since there is not special transportation available for horticultural crops. Packages are carried on top of these buses and not always protected from rain (and /or sun). The excessive weight, mainly in the case of "bangha" (but also in "tokari") leads to mishandling during packaging, loading and unloading, damaging products in a great extent. Apples, for example, are transported by porters or by mules and goats from production area to Pokhara market. As with other fruits and vegetables, to accommodate maximum volume, traders do not care for minimizing losses that occur due to the packaging system (doko and gunny bags).

At Kalimati Market, as in other urban centres, these packages are unloaded and carried to the inside of the market in carts pulled by porters. Here, "banghas" are opened for selection and selling of the products in smaller amounts: shop retailer buys a complete "bangha". The temperature inside these sacks often builds up and even some fermentation starts. Retailers remove their goods from wholesale market in different ways: by porters; bicycle, by tempo (three wheel motorcycle); by Rickshaws, by hand-tractor; by car or by public buses. Products that are packed in "tokari" are carried out in the same baskets. Products packed in "bangha", as they are too big sacks, are normally sold loose and the buyer uses different types of sacks, bags, etc. to take them away. This leads again to rough handling due to inadequate stacking and transportation to the retail outlets. There are different types of retailers operating at this level: vendors ( ambulant); temporary road stall sellers; shop owners and contractors (servicing hotels, restaurants and other institutions). During selling hours products are exposed in the open, not always protected from sun and rain. In many cases, leafy vegetables are sprinkled with water to maintain freshness. At the



end of the day, products are kept inside a closed room, with no ventilation, in the majority of the cases.

A quality evaluation, at the wholesale and retail markets, will demonstrate normally (taking a few examples) the following symptoms'- in oranges: mechanical damages (cuts and crushing); decay;- in apples: mechanical injuries; sun scald; weight loss (mealy fruits); decay;- in potatoes: insect damages; immature tubers; mechanical injuries; decay; greening;- in cauliflower: colour alterations from yellowing to browning ( and to purple, in some cases); dark zones with physical damages resembling bacterial rot; dehydration; loose curds presenting separation of the florets; abnormal odour;- in cabbage: deteriorated outer leaves; yellowing; cracking; wilting;- in tomato: insect damages; skin rupture; deformation (compression); rotting; immature underdeveloped fruits; wilting(mainly small fruits).

### **Packaging and transportation**

All the above mentioned causes of losses are directly related to the packaging/transportation system being used, mainly from origin markets to the urban centres: tokari and bhanga, carried on top of buses, leading to rough handling condition, are the main responsible for the extent of the losses and for the quality reduction. The "tokari", being internally revested with paper and covered by jute bag, does not permit throughout ventilation that would dissipate field heat, heat of respiration (10,000 Btu/ton/day at 25 degrees in the case of tomatoes) and ethylene. The "bangha", with its big volume, does not permit throughout ventilation either, with the same effects. The exposed surface, on the other hand, during transportation on top of buses, seems to enhance moisture loss, due to the rapid air movement, developing and the volatile originated by respiration. Products requirements, from the point of view of its physiology are important to be considered during the post-harvest phase, aiming to reduce losses and maintain quality and nutritional value. Being " living products", respiration plays important role in the post-harvest behaviour of all horticultural products. Respiration rates are directly influenced by temperature, by the presence of ethylene and by mechanical injuries. Rate of respiration doubles or triples for each 10 degrees Celsius rise in temperature and normal physiology does not develops in temperatures above 28-30 degrees. Building up of ethylene in the ambient (in the packaging), being the vegetable hormone responsible for ripening and senescence, has accelerating effect on respiration. As a consequence, the building up of CO<sub>2</sub> can be detrimental in some cases. Mechanical injuries are responsible for similar increases in respiration rate, easily doubling it, as demonstrated by many authors.

The recent introduction of plastic crates and group transportation has brought in important improvements. The system is cheaper than the traditional ( in almost 40%), the losses are reduced, and the price for the produce is 20-25% higher (better quality).

### **THE SMALL MARKETING INFRASTRUCTURE PROJECT INTERVENTIONS**

It is in this context that HMG/N requested assistance from UNCD. This Project has recently been implemented through UNOPS and FAO. This Project consists of the following four components:

- \* Development of marketing infrastructures;
- \* Formation of market users committed and training of users group in market



- operation and management;
- \* Development of a market information network and
- \* Introduction of an improved packaging system.

The general objectives of the Small Marketing Infrastructure Project are to improve the marketing infrastructures/services for fresh horticultural produce. The immediate objectives are to establish a self-managed marketing network consisting of physical facilities supported by an information network, improved packaging, and the establishment and training of market users' groups/committees. In this view, the Project has developed an integrated strategy for pilot-scale interventions on improved handling and marketing of fresh produce, associated with the implementation of the collection centres/rural markets. As part of this "Strategy", it is considered a must to have the main "actors" participating in all steps, from the preliminary evaluations (situation analysis) to the proposition/ testing of improvements up to the implementation of the infrastructures through local artisans.

The main participants in this strategy will be the leader framers, traders and local artisans, i.e., the basic participants in the future market. The focus is to integrate the "hardware" (infrastructure) and the 'software' (technical assistance in marketing) with the "humanware" (market users) through people participation at all steps, from the situation analysis, planning implementation and evaluation/replanning. These aspects, together with the training of local artisans when constructing the market will permit an organized apport of knowledge which should be reflected in the sustainability of the project interventions.

This project is, therefore, a step toward implementation of a sector-wide network for improving the marketing system for fruits and vegetables in Nepal.

## CONCLUSIONS

Both farmers and traders can benefit from an organized market in which minimum infrastructure is available and where organized market information is provided and clear rules and regulations are established to carry out the transaction procedures.

Observations made in the marketing chain provide significant evidence that handling from harvesting, and the packaging/transportation system are important elements in quality reduction (and losses) production. Mechanical injuries are the outstanding factor and derive from handling procedures (in the field, at local market and at terminal markets) conditioned by the packaging/transportation system. Physiological disorders due to abnormal respiration (excessive ripening and senescence) are also related to the packaging/transportation system.

Traders and organized farmers need to co-ordinate and get together over production planning, packaging and transportation, looking for improvements and scale economy. Extension Agents have important role to play as animators and coaches, utilizing proper methodology and group dynamics: there is plenty of room for improvements.

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