

Handling of Horticultural Perishables in Developing vs. Developed Countries

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Abstract

The basic requirements for maintaining quality and safety of horticultural perishables (fruits, vegetables, herbs, ornamentals) between harvest and consumption sites are the same in developing and developed countries. However, the extent of adoption of the specific harvesting and postharvest handling technologies varies greatly among countries and within each country, depending on scale of operation, intended markets, and the return on investment (cost/benefit ratio) of each technology. Although labor costs are lower in developing countries, labor training, productivity, and management are generally better in developed countries. Availability and efficient use of the cold chain is much more evident in developed countries than in developing countries. Unreliability of the power supply, lack of proper maintenance, and inefficiency of utilization of cold storage and refrigerated transport facilities are among the reasons for failure of the cold chain in developing countries. Cost of providing the cold chain per ton of produce depends on energy costs plus utilization efficiency of the facilities throughout the year. There is great variation among and within countries in the extent of compliance with quality standards and food safety regulations, which is associated with the extent of participation in the global marketing of fresh produce. Successful exporters of fresh produce from developing countries must follow the required quality standards and safety regulations such as avoiding microbial contamination, and requirements for traceability, of the importing companies and/or countries. Strategies for improving handling of horticultural perishables in developing countries include: (1) Application of current knowledge to improve the handling systems of horticultural perishables and assure their quality and safety; (2) Removing the socioeconomic constraints, such as inadequacies of infrastructure, poor marketing systems, and weak research and development capacity; and (3) Overcoming the limitations of small-scale operations by encouraging consolidation and vertical integration among producers and marketers of each commodity or group of commodities.

INTRODUCTION

The basic requirements for maintaining quality and safety of horticultural perishables (fruits, vegetables, herbs, ornamentals) between harvest and consumption sites are the same in developing and developed countries. However, the extent of adoption of the specific harvesting and postharvest handling procedures and technologies varies greatly among countries and within each country, depending on scale of operation, intended markets, and the return on investment (cost/benefit ratio) of each procedure or technology.

Kader (2005) estimated that worldwide about one third of all fruits and vegetables produced are never consumed by humans. The general difference between developed and developing countries is that more of the losses occur between production and retail sites in developing than in developed countries. However, more can and should be done to reduce postharvest losses in all countries. It is not economical or practical to aim for 0% losses, but an acceptable loss level for each commodity-production area and season

combination can be identified on the basis of cost-benefit analysis. In this article I briefly discuss the similarities and differences between developed and developing countries in various aspects of the handling systems used to maintain quality and safety and reduce losses of fresh horticultural crops.

HUMAN RESOURCES

The human element in postharvest handling of horticultural commodities is extremely important. Although labor costs are lower in developing countries, labor training, productivity, and management are generally better in developed countries. Effective training of workers and their supervisors along with delegation of responsibility and authority to the supervisors are more common in developed countries than in developing countries. The tendency in many operations in developing countries to limit authority for making any changes in the procedures to the owner or very few trusted persons often leads to poor management and problem-solving expertise among the supervisors and reduced productivity of the workers.

Many packing houses and storage facilities for handling fresh produce in developing countries have poor logistics and product flow as a result of poor design and/or stage-wise construction with inadequate planning for future expansion. Suboptimal product flow results in reduced efficiency of the workers and may increase the opportunities for cross-contamination with microorganisms when incoming products are handled in the same area as final products.

Most handlers involved in harvesting, packaging, transporting, and marketing in developing countries have limited or no appreciation for the need for, or how, to maintain quality and safety of produce. An effective and far-reaching educational (extension) program on these aspects is needed critically now and will continue to be essential in the future. The availability of needed information in books (e.g., Bartz and Brecht, 2002; Kader, 2002; Thompson, 2003; Gross et al., 2004; Sapers et al., 2006; Wills et al., 2007; Nunes, 2008; Yahia, 2009) and on the internet (e.g., <http://postharvest.ucdavis.edu>; <http://www.fao.org/inpho>) is an important step in the right direction, especially with the continuing expanded access to the internet worldwide.

MAINTAINING THE COLD CHAIN

Regardless of growing region or scale of operation, temperature and humidity management procedures to maintain quality of fresh produce include: harvesting during the coolest part of the day possible, and keeping produce in the shade while accumulating it in the orchard or field; transporting produce to packing house and/or direct-marketing outlet as soon as possible after harvest; protecting produce on display from exposure to direct sunlight; shipping packed produce to the market in refrigerated transit vehicles, and maintaining proper temperature and relative humidity in display cases and cold storage rooms.

Availability and efficient use of the cold chain is much more evident in developed countries than in developing countries. Unreliability of the power supply, lack of proper maintenance, and inefficiency of utilization of cold storage and refrigerated transport facilities are among the reasons for failure of the cold chain in many developing countries. Cost of providing the cold chain per ton of produce depends on energy costs plus utilization efficiency of the facilities throughout the year.

Maheshwar and Chanakya (2006) reported that about 30% of the fruits and vegetables grown in India get wasted annually due to gaps in the cold chain, such as poor infrastructure, insufficient cold storage capacity, and poor transportation infrastructure; the solution is to develop and use an integrated cold chain infrastructure covering major production areas, processing units and distribution centers.

In many developing countries, some good facilities that were built a few years ago are currently “out of order” or not functioning properly because of lack of maintenance and unavailability of spare parts. This problem is especially true of public-sector

facilities. Any new project should include in its plan adequate funds for maintenance to ensure its success and extended usefulness (Kader, 2005).

Appropriate postharvest technologies when used effectively can greatly enhance profitability, but no single technology is a substitute for the many integrated steps involved in proper postharvest management for assuring quality and safety of horticultural crops (Kader, 2006). Effective use of the cold chain between production and consumption sites is the most important strategy for maintaining quality and safety of horticultural perishables in developed and developing countries.

QUALITY AND SAFETY STANDARDS

Grade standards identify the degrees of quality in a commodity that are the basis of its usability and value. Such standards, if enforced properly, are essential tools of quality assurance during marketing and provide a common language for trade among growers, handlers, processors, and receivers at terminal markets. Some production areas enforce minimum standards concerning produce quality, maturity, container marking, size and packing requirements. This provides orderly marketing and equity in the marketplace and protects consumers from inedible and poor quality produce.

Standards of quality and consumer preferences and purchasing power vary greatly among countries and cultures. For example, elimination of defects from a given commodity before marketing is much less rigorous in developing countries than in developed countries. This, however, is not necessarily bad, because appearance quality is often over-emphasized in developed countries. Another difference is the consistency of quality within a package; placing good quality units on top and lower quality units below is much more common in developing countries than in developed countries. Discouraging fraud in packing produce via establishing and enforcing mandatory, simple minimum quality standards can greatly improve quality of fruits and vegetables reaching the consumers and increase trust between buyers and sellers in developing countries.

Sanitation procedures to minimize potential contamination with plant and human pathogens include: training workers on their role in assuring food safety; washing produce with clean and disinfected water, then removing excess moisture if needed; sorting out and properly discarding decaying produce; and cleaning harvest containers daily, and cleaning reusable shipping containers, display and storage facilities periodically with water, soap, and disinfectants. Consumers in developing countries deserve the same protection as those in developed countries against food contamination with pesticide residues above legal limits, mycotoxins, and/or microbial contamination. A major effort is needed to inform producers and handlers of fresh produce about good agricultural practices, good handling practices, and other food safety assurance procedures.

The degree of governmental controls, especially on wholesale and retail prices of fresh fruits and vegetables, varies from one country to another. In many cases, price controls are counter-productive. Although intended for consumer protection, such regulations encourage fraud and provide no incentive for producing high-quality produce or for postharvest quality maintenance. On the other hand, regulations covering proper handling procedures and public health aspects (food safety issues) during marketing are, if enforced properly, very important to the consumer.

There is great variation among and within countries in the extent of compliance with quality standards and food safety regulations, such as “Global Good Agricultural Practices”, which is associated with the extent of participation in the global marketing of fresh produce. Successful exporters of fresh produce from developing countries must follow the required quality standards and safety regulations (avoiding microbial contamination, traceability, etc.) of the importing companies and/or countries.

STRATEGIES FOR IMPROVING HANDLING

Recommended procedures regarding maturity and quality include: harvesting at the proper maturity stage relative to intended use and marketing practices and periods;

eliminating produce with serious defects, and inspecting produce quality and condition when it is received; separating out produce that must be sold immediately, and placing it on display first; and rotating produce when replenishing displays.

Procedures for minimizing mechanical damage include: handling produce with care during harvesting and hauling to the market or produce stand; using suitable materials-handling equipment; avoiding drops, impacts, vibrations, and surface injuries of produce throughout the handling system; using shipping containers that will provide adequate protection for the commodity from physical injuries; and stacking containers so that the pressure comes on the structure of the package, not on the produce.

In most developing countries, roads are not adequate for proper transport of horticultural crops. Also, transport vehicles and other modes, especially those suited for fresh horticultural perishables, are in short supply. This is true whether for local marketing or export to other countries. The majority of producers have small holdings and cannot afford to own their own transport vehicles. In a few cases, marketing organizations and cooperatives have been able to acquire transport vehicles, but they cannot do much about poor road conditions (Kader, 2005).

Strategies for improving handling of horticultural perishables in developing countries include: (1) Application of current knowledge to improve the handling systems of horticultural perishables and assure their quality and safety; (2) Removing the socioeconomic constraints, such as inadequacies of infrastructure, poor marketing systems, and weak research and development capacity; and (3) Overcoming the limitations of small-scale operations by encouraging consolidation and vertical integration among producers and marketers of each commodity or group of commodities.

The terms “value chain” and “supply chain” are used interchangeably to include production, collection, processing, wholesaling, and retailing as well as support functions, such as input supply, financial services, transport, packaging, and advertising. A systematic analysis of each commodity production and handling system is the logical first step in identifying an appropriate strategy for reducing postharvest losses (Kitinoja and Gorny, 1999; LaGra, 1990). Also, a cost-benefit analysis to determine the return on investment in the recommended postharvest technologies is essential. It is important to select the technologies that are appropriate for the size of each postharvest enterprise (Kitinoja and Gorny, 1999; Kitinoja and Kader, 1995; Persson, 1986). Marketing companies and cooperatives are essential for handling produce and reducing postharvest losses by providing facilities for accumulating, preparing and transporting produce to markets; by coordinating marketing activities; and by distributing profits equitably to members.

Mrema and Rolle (2002) indicated an evolution of priorities within the postharvest sector of developing countries from a primarily technical focus geared towards the reduction of losses, to a more holistic approach designed to link on-farm activities to processing, marketing, and distribution. However, the major constraints continue to be high postharvest losses, poor marketing systems, weak research and development capacity, and inadequacies in policies, infrastructure, and information exchange. Goletti (2003) listed the most relevant issues for developing countries as follows: the need for a regulatory framework that promotes growth while safe-guarding welfare; for adequate market information to be given to all participants involved; for further investment in postharvest research; and for participation in international agreements that promote trade and food safety.

MARKETING SYSTEMS

Growers can produce large quantities of good-quality fruits, ornamentals, and vegetables, but, if they do not have a dependable, fast, and equitable means of getting such commodities to the consumer, losses will be extensive. Kader (2005) pointed out that this problem exists in many locations within developing countries and is accentuated by lack of communication between producers and receivers, and lack of market information. Singh (2006) indicated that market access for small producers depends on

understanding the market, organization of the firm or operations, communication and transport links, and an appropriate policy environment. In general, the number of intermediaries between producers and consumers is much larger in developing countries than in developed countries; this situation often results in lower prices to the producers.

The globalization of sourcing horticultural products, concentration in developed country retailing, and the increasing scope and complexity of public and private standards challenge the ability of developing country producers to access global horticulture markets (Humphrey, 2006). The competitiveness of small-scale producers is undermined in current horticultural markets by the increasing coordination costs relating to quality, traceability and food safety.

Marketing cooperatives should be encouraged among producers of major commodities in important production areas. Such organizations are especially needed in developing countries because of the relatively small farm size. Advantages of marketing cooperatives include: providing central accumulation points for the harvested commodity, purchasing harvesting and packing supplies and materials in quantity, providing for proper preparation for market and storage when needed, facilitating transportation to the markets, and acting as a common selling unit for the members, coordinating the marketing program, and distributing profits among members (Kader, 2005).

The entry of modern retail, both international and domestic players, into developing countries and transition economies is bound to continue having major impacts on these countries' agrifood systems (Vermeulen et al., 2008). Large-scale supermarket retail and wholesale operations demand large volume and low price produce that meets stringent quality and safety standards (Vermeulen et al., 2008). Given the small unit size of many producers in developing and transition economies the ability to ensure timely delivery of products of the right quality and quantity to intermediaries and processors is paramount. Grouping small-scale farmers into co-operatives, farmers' organizations or business units can help with this (Vermeulen et al., 2008).

Collective action in agricultural markets is facilitated by institutional arrangements that effectively resolve the inherent tension within groups as well as between farmers and other economic agents (Ton, 2008). Strategies of producer organizations are to by-pass middlemen, to meet quality requirements in modern markets and to effectively use postharvest technologies.

Alternative distribution systems, such as direct selling to the consumer (roadside stands, produce markets in cities, local farmers' market in the countryside, etc.) should be encouraged. Production should be maintained as close to the major population centers as possible to minimize transportation costs.

CONCLUSIONS

The keys to successful handling of horticultural perishables are the same in developed and developing countries, but the extent of adoption of the necessary harvesting and postharvest technologies to maintain their quality and safety can vary greatly among countries and within each country, depending on the intended market and the return on investment (ROI) of these technologies. Availability and cost of labor, scale of operation, availability and dependability of electric power and its cost, and extent of utilization of facilities and equipment per year are important factors in determining ROI of harvesting and postharvest technologies. Availability and efficient use of the cold chain for handling fresh horticultural products is much more evident in developed countries than in developing countries. There is also great variation among and within countries in the extent of compliance with quality standards and food safety regulations, which is associated with the extent of participation in global marketing of fresh produce.

Literature Cited

Bartz, J.A. and Brecht, J.K. (eds.). 2002. Postharvest physiology and pathology of vegetables. Second edition. Marcel Dekker, New York, 744p.

- Goletti, F. 2003. Current status and future challenges for the postharvest sector in developing countries. *Acta Hort.* 628:41-48.
- Gross, K., Wang, C.Y. and Saltveit, M.E. (eds.). 2004. The commercial storage of fruit, vegetables and florist and nursery stocks. USDA Agr. Handb. 66 (<http://www.ba.ars.usda.gov/hb66/index.html>).
- Humphrey, J. 2006. Horticulture: Responding to the challenges of poverty reduction and global competition. *Acta Hort.* 699:19-41.
- Kader, A.A. (ed.). 2002. Postharvest technology of horticultural crops. 3rd ed. Univ. Calif. Agr. Nat. Resources, Oakland, Publ. 3311.
- Kader, A.A. 2005. Increasing food availability by reducing postharvest losses of fresh produce. *Acta Hort.* 682:2169-2175.
- Kader, A.A. 2006. The return on investment in postharvest technology for assuring quality and safety of horticultural crops. *J. Agric. Invest.* 4:45-52.
- Kitinoja, L. and Gorny, J.R. 1999. Postharvest technology for small-scale produce marketers: economic opportunities, quality and food safety. Univ. Calif. Postharvest Hort. Series No. 21.
- Kitinoja, L. and Kader, A.A. 2002 Small-scale postharvest handling practices: a manual for horticultural crops. Univ. Calif. Postharvest Hort. Series No. 8E. 4th ed.
- LaGra, J. 1990. A commodity systems assessment methodology for problem and project identification. Postharvest Institute for Perishables, Moscow, Idaho.
- Maheshwar, C. and Chanakya, T.S. 2006. Postharvest losses due to gaps in cold chain in India - a solution. *Acta Hort.* 712:777-783.
- Mrema, G.C. and Rolle, R.S. 2002. Status of the postharvest sector and its contribution to agricultural development and economic growth, p.13-20. In: Proc. 9th JIRCAS Intl. Symp. 2002. Value-addition to agricultural products, Ibaraki, Japan.
- Nunes, M.C.N. 2008. Color atlas of postharvest quality of fruits and vegetables. Blackwell Publ., Ames, Iowa.
- Persson, P.O. 1986. Refrigeration and the world's food supply - especially in developing countries. *Int. J. Refrig.* 9:144-149.
- Sapers, G.M., Gorny, J.R. and Yousef, A.E. (eds.). 2006. Microbiology of fruits and vegetables. CRC Press, Boca Raton, FL, 634p.
- Singh, S. 2006. Horticultural supply chains and small producers in South Asia: governance, participation, and strategies. *Acta Hort.* 699:399-406.
- Thompson, A.K. 2003. Fruit and vegetable harvesting, handling and storage. Blackwell Publ., Oxford, UK, 460p.
- Ton, G. 2008. Challenges for smallholder market access: a review of literature on institutional arrangements in collective marketing. *Stewart Postharvest Review* 5:1, 6.
- Vermeulen, S., Woodhill, J., Proctor, F. and DeInoye, R. 2008. Chain-wide learning for inclusive agrifood market development: a guide to multi-stakeholder processes for linking small-scale producers with modern markets. International Institute for Environment and Development, London, UK and Wageningen University and Research Centre, Wageningen, the Netherlands.
- Wills, R.B.H., McGlasson, W.B., Graham, D. and Joyce, D.C. 2007. Postharvest - An introduction to the physiology and handling of fruit, vegetables and ornamentals. Fifth edition. CAB International, Wallingford, UK.
- Yahia, E.M. (ed.). 2009. Modified and controlled atmospheres for the storage, transportation, and packaging of horticultural commodities. CRC Press, Boca Raton, FL, 589p.