Increasing Food Availability by Reducing Postharvest Losses of Fresh Produce

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Abstract

Qualitative losses (such as loss of caloric and nutritive value, loss of acceptability by consumers, and loss of edibility) are more difficult to measure than quantitative losses of fresh fruits and vegetables. While reduction of quantitative losses is a higher priority than qualitative losses in developing countries, the opposite is true in developed countries where consumer dissatisfaction with produce quality results in a greater percentage of the total postharvet losses. Providing consumers with fruits and vegetables that taste good can greatly increase their consumption of the recommended minimum of five servings per day for better health. Development of new cultivars with better flavor and nutritional quality plus adequate productivity should be given high priority in all countries. Strategies for reducing postharvest losses in developing countries include: (1) Application of current knowledge to improve the handling systems (especially packaging and cold chain maintenance) of horticultural perishables and assure their quality and safety; (2) Overcoming the socioeconomic constraints, such as inadequacies of infrastructure, poor marketing systems, and weak R&D capacity; and (3) Encouraging consolidation and vertical integration among producers and marketers of horticultural crops.

ESTIMATION OF POSTHARVEST LOSSES

Both quantitative and qualitative losses occur in horticultural crops between harvest and consumption. Our goal is to minimize these losses, and to do so we must: 1) understand the biological and environmental factors involved in postharvest deterioration, and 2) use the appropriate postharvest technology procedures that will slow down deterioration and maintain quality and safety of the commodities. Qualitative losses, such as loss in edibility, nutritional quality, caloric value, and consumer acceptability of the products, are much more difficult to assess than quantitative losses. 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.

Postharvest losses vary greatly among commodities and production areas and seasons. In the United States, the losses of fresh fruits and vegetables are estimated to range from 2% to 23%, depending on the commodity, with an overall average of about 12% losses between production and consumption sites (Cappellini and Ceponis, 1984; Harvey, 1978). Kantor et al (1997) estimated the U.S. total retail, foodservice, and consumer food losses in 1995 to be 23% of fruits and 25% of vegetables. Fresh fruits and vegetables accounted for nearly 20% of consumer and foodservice losses, which are due to product deterioration, excess perishable products that are discarded, and plate waste (food not consumed by the purchaser). The latter is often due to consumer dissatisfaction with product quality, especially flavor. Estimates of postharvest losses in developing countries vary greatly from 1 to 50% or even higher (National Academy of Sciences,

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1978). Only a few estimates based on actual surveys have been published (Table 1).

Based on the limited data available and my own experience, I estimate 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 (Table 2). I realize that many colleagues will disagree with my estimates and argue that losses in developing countries are much higher, but the only way to settle this argument is to collect data on postharvest losses. With the introduction of Universal Price Codes (UPC) for produce in the U.S. and other countries, we now have an opportunity to obtain detailed information about postharvest losses of produce items at the wholesale and retail levels. However, it is not clear at this time whether the major retailers will be willing to share such data. In any case, I believe that most people agree that 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 (return on investment evaluations).

BIOLOGICAL AND ENVIRONMENTAL CAUSES OF LOSSES

Biological (internal) causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavor, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown. The rate of biological deterioration depends on several environmental (external) factors, including temperature, relative humidity, air velocity, and atmospheric composition (concentrations of oxygen, carbon dioxide, and ethylene), and sanitation procedures. All these factors have been discussed by numerous authors (Bartz and Brecht, 2002; Bourne, 1977; Bourne, 1983; Coursey 1983; FAO, 1981; FAO, 1989; Gross et al, 2002; Harvey, 1987; Kader, 1983; Kader, 2002; Kitinoja and Gorny, 1999; Musa, 1984; Tindall and Proctor, 1980).

SOCIOECONOMIC FACTORS

Although the biological and environmental factors that contribute to postharvest losses are well understood and many technologies have been developed to reduce these losses, they have not been implemented due to one or more of the following socioeconomic factors (Kader, 1983).

Inadequate 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. This problem exists in many locations within developing countries. It is accentuated by lack of communication between producers and receivers, and lack of market information.

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 equitable.

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.

Wholesale markets in most of the developing countries are in desperate need of improvement in terms of facilities and sanitation. These are overcrowded, unsanitary, and

lack adequate facilities for loading, unloading, ripening, consumer packaging, and temporary storage. In several countries, there are plans to build better wholesale marketing facilities, but their implementation has been delayed more because of social and political than financial considerations.

Inadequate Transportation Facilities

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.

Government Regulations and Legislations

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.

Unavailability of Needed Tools and Equipment

Even if growers and handlers of fresh horticultural crops were convinced of the merits of using some special tools and/or equipment in harvesting and postharvest handling, they most likely will not be able to find them in the domestic market. This is true of harvesting aids; containers; equipment for cleaning, waxing, and packing; and cooling facilities. Most of the tools are neither manufactured locally nor imported in sufficient quantity to meet demand. Various governmental regulations in some countries do not permit direct importation by producers of their needs. It is imperative that the tools that will enable handlers to use recommended technology for a given situation be available for them to use. In many cases, such tools can be manufactured locally at much lower cost than those imported.

Lack of Information

The human element in postharvest handling of horticultural commodities is extremely important. Most handlers involved directly in harvesting, packaging, transporting, and marketing in developing countries have limited or no appreciation for the need for, or how, to maintain quality. 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 on the Internet (numerous websites including: http://www.fao.org/inpho; http://www.postharvest.com.au; http://postharvest.ucdavis.edu; http://www.postharvest.ifas.ufl.edu; and www.postharvest.org) is an important step in the right direction, especially with the expanded access to the Internet worldwide.

Poor Maintenance

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.

STRATEGIES FOR REDUCING POSTHARVEST LOSSES

A systematic analysis of each commodity production and handling system is the logical first step in identifying an appropriate strategy for reducing postharvest losses (Bell et al., 1999; Kitinoja and Gorny, 1999; LaGra, 1990). Also, a cost-benefit analysis to determine the return on investment in the recommended postharvest technologies is essential (for information on how to conduct such analyses, see Kitinoja and Gorny, 1999). It is important to select the technologies that are appropriate for the size of each postharvest enterprise (Clarke, 1994; 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. The Agricultural and Food Engineering Technologies Service of FAO, in collaboration with the Global Forum for Agricultural Research (GFAR) and the Global Post-Harvest Forum (PhAction) recently embarked upon the development of a new global post-harvest initiative geared toward addressing the challenges faced by the sector in developing countries (Heyes, 2003; Rolle and Mazaud, 2003). 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.

VALUE OF POSTHAVEST RESEARCH AND DEVELOPMENT

Several authors have presented a strong argument in favor of devoting more resourses to postharvest research and development efforts in developing countries (Bourne, 1983; Mukai, 1987; Okezie, 1998). Although minimizing postharvest losses of already produced food is more sustainable than increasing production to compensate for these losses, less than 5% of the funding for agricultural research is allocated to postharvest research areas (Kader, 2003). In a more recent discussion paper, Goletti and Wolff (1999) stated that "while research on the improvement of agricultural production has received considerable attention and funding, until recently postharvest activities have not attracted much attention from international research organizations (CGIAR, FAO, ACIAR, IDRC, GTZ, CIRAD, NRI, USAID)." They identified the following five reasons to justify an increased commitment to postharvest research by the international agricultural system: 1) high internal rates of return, 2) international public good character, 3) effect on poverty, 4) effect on food security and health, and 5) effect on sustainable use of resources. Goletti and Wolff (1999) concluded that: "As the significant contribution of postharvest research to CGIAR goals such as poverty reduction, food security and sustainability becomes clear, and in the light of high rates of return, the very skewed allocation of funds to production versus postharvest topics cannot be justified. Since so far, relatively little has been invested in postharvest research, there is potential for large impacts as constraints and bottlenecks are removed. It would thus be desirable to re-examine current funding priorities and to allocated a larger proportion of resources to the postharvest area."

CONCLUSIONS

Minimizing postharvest losses of horticultural perishables is a very effective way of reducing the area needed for production and/or increasing food availability. Solving the postharvest food distribution problems in a given country will require cooperation and

effective communication among all the research, extension, and industry personnel involved. Postharvest horticulturists need to coordinate their efforts with those of production horticulturists, agricultural marketing economists, engineers, food technologists, and others who may be involved in various aspects of the production and marketing system. In most cases, solutions to existing problems in the postharvest handling system require use of available information and application of available technologies at the appropriate scale rather than conducting new research, or developing new technologies. Overcoming the socioeconomic constraints is essential to achieving the goal of reducing postharvest food losses.

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Tables

Table 1. Examples of estimated postharvest losses of fresh fruits and vegetables in developing countries.

Country	Commodities	Postharvest losses (%)	Reference
Egypt	All fruits	20	Blond, 1984
	All vegetables	30	
	Grape	28	
	Potato	18	
	Tomato	43	
Venezuela	Broccoli	49	Guerra et al, 1998
	Cauliflower	33	
	Celery	48	
	Leek	20	
	Lettuce	35	

Table 2. Estimated postharvest losses of fresh produce in developed and developing countries.

Locations	Developed Countries		Developing Countries	
	Range (%)	Mean (%)	Range (%)	Mean (%)
From production to retail sites	2-23	12	5-50	22
At retail, foodservice, And consumer sites	5-30	20	2-20	10
Cumulative total	7-53	32	7-70	32