VIEWPOINT

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Postharvest Research in a Developing Country: A View From Brazil

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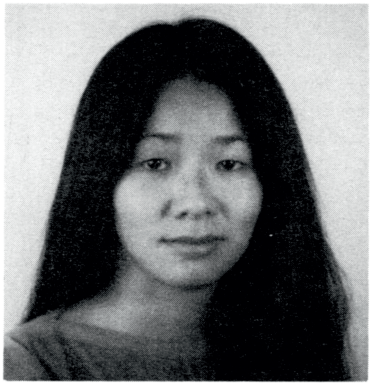
Despite the goal set in 1975 by the Seventh Special Session of the U.N. General Assembly for a 50% reduction in postharvest losses to be achieved by 1985, little postharvest horticultural research has been published by lesser developed countries (LDCs), where losses are assumed to be high (7, 9, 12). An exception is the work of the ASEAN Postharvest Horticulture Training and Research Center in the Philippines. Interest in postharvest research, however, runs keen among LDC researchers. A recent survey of foreign alumni of the Dept. of Horticulture at Michigan State Univ. showed that the course most cited as the one they "would take today" was postharvest physiology (1).

Horticultural production in Brazil, particularly of most vegetable crops, is still mostly small-scale, by traditional means, and usually for a regional market. Harvesting, selection, and packaging may be semimechanized at large farms, but manual labor predominates. Postharvest fungicide treatments are rare. When available, refrigerated storage is limited to use for temperate fruit crops, which still may undergo a 6-day unrefrigerated truck transport to the tropical north of Brazil. Wholesale marketing is directed to the traditionally busy Saturday morning retail market.

Researchers trained in developed countries (DCs) tend to blame a lack of advanced technology in LDC marketing channels for what are assumed to be high postharvest losses. First, less technology should not be confused with a lack of technology, for the indiscriminate adoption of sophisticated means never ensures a reduced loss. Second, LDC postharvest losses often are assumed to be higher than in DCs because much culling is highly visible in LDC marketplaces, where very inferior grades of produce are sold alongside better grades. Never flatly rejected or dumped in bulk as in U.S. terminal markets, Brazilian produce, when necessary, is continually culled and repacked at wholesale and retail even when >50% of the remaining lot may be rotten (see refs. 4 and 5). When a farmer cannot obtain any price during a market surplus, he empties the crate and donates his product to the poor, who circulate in marketplaces to salvage any edible or partly edible food. Inferior grades of produce that would not be marketed in DCs are a very important food supply for the large lower class in LDCs.



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Quality has no universal definition—just as North Americans become shocked at the imperfect appearance of produce and its rustic packaging in Latin America, foreigners in the United States are frequently appalled at the absence of flavor in some blemish-free produce. Loss, too, is perceived differently among societies (12). In LDCs, the produce culled at the farm level seldom is directed to a processing plant or left as refuse. Undersized, misshapen, damaged, and partly rotten produce is marketed at low prices, distributed to workers, or fed to animals (LDC farmers tend toward diversified production). When questioned what postharvest loss they experience, many Brazilian farmers responded that they "lose nothing" and "take advantage of everything." The definition of postharvest loss as produce intended but not suitable "strictly for human consumption" (3), or as occurring "after the moment of separation of the edible commodity of the plant that produced it by a deliberate human act with the intention of starting it on its way to the table" (7) perhaps should be altered for use in areas of the world where a greater distinction between "loss" and "waste" is felt. Surely many losses in DCs due to exigent grading would be viewed as wasteful in LDCs, and there are populations of the world who do not take their meals from a table.

Problems in assessing postharvest losses in LDCs

To develop lines of appropriate postharvest research, it is first necessary to identify when, where, and how much is being lost. Guidelines for loss assessment of perishables in LDCs cannot be so generally established as Harris and Lindblad (8) did for grains, because horticultural produce decays in hours and days in the tropics rather than in weeks, and because its production and market changes occur more rapidly than they do for grains. It is moreover difficult to establish guidelines, as has been recommended (7), because LDC practices and traditions can vary more locally than in DCs. People in LDCs can be more settled; where the technology appears simple, the practices can be quite varied. To emphasize this point, one notes as an example that Brazilian postharvest training manuals (6) of the type the Food and Agricultural Organization (FAO) (7) has recommended be prepared, are hardly in use because the information, when relevant to the user, is so basic.

A statistically valid loss assessment of perishables in LDCs may well be impossible, even if adequate funds were available to conduct such a study. Loss assessment researchers who have tried to plan randomly selected visits have often treated a region as homogenous in traditions and practices when it is not. Other problems arise when surveying farms according to their area size or production capacity. The same farm area may be managed by one owner or 20 sharecroppers, while officially registered as one property, and x hectares may be seeded once per year or x/2 hectares may be seeded in two

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separate seasons. Additionally, farm size cannot be correlated with a use of advanced technology. Small farmers in cooperatives may have access to sophisticated equipment; the largest carrot producer in a region we studied seeded, harvested, graded, and packed his product manually, whereas his neighbors all used some form of mechanization.

Due to the participation at all marketing levels of many sharecroppers, small farmers, and intermediates, the routes of food flow in an LDC may be numerous within a region, which adds to the impossibility of assessing losses statistically. In one study (13), more than 400 tomato samples were assessed for losses at the farm, collection point, and wholesale and retail levels (the method of assessment was not described). Total loss from farm to retail was calculated considering that the percentage of losses at earlier levels of marketing did not enter each later level. Yet, in some localities of that same region, most tomatoes go straight from the farm to retailers at farmers' markets located within all wholesale terminals in Brazil, and do not pass through a collection point or wholesale dealer (11). Produce also passes from one wholesale terminal to another in Brazil, emphasizing that the market structure is not a single channel, but a web of channels. To have calculated total loss correctly, the volume of tomatoes arriving at each level of marketing and the route of marketing for each lot would have had to have been considered.

Postharvest losses in LDCs can be misleading if data are based on only one season. In our region, retail losses of tomato range from about 5% due to a moth larva in the dry winter to 30% or 50% at times during the wet summer. The large losses are due to splitting of the skin after shrinking and swelling of the fruit on the plant (strong sun followed by rains), and subsequent pre- or postharvest infection by *Alternaria* and/or bacteria. Cabbage losses at wholesale may be nil all winter, and suddenly may reach 50% for some dealers at the start of the rainy season due to bacterial soft rot. Tropical hailstorms during the mild winters can interrupt the production of beautiful vegetables, with slight bruising of the produce or complete crop destruction. Most studies emphasize the difficulty in sampling lots representatively for losses, but, in LDCs, even the day of sampling can be of primary importance. Production is infrequently centralized in the climatically safest regions, and produce is highly susceptible to fast deterioration after harvest because of the inavailability of refrigeration.

Useful estimates of loss and loss cause analysis

In LDCs, loss can be defined and loss evaluation carried out only after an investigation of the production and marketing system of the region of study. Thus, the method of loss evaluation will be location-specific, and should be developed by researchers who understand the commodities, people, land, and traditions.

Useful estimates of loss may be obtained from experienced participants in the marketing system (producers, wholesale and retail dealers, transporters, and cooperative and extension workers). Although arrived at subjectively, these estimates may be much more accurate than assessments that appear to be based on statistically valid sampling.

In our experience in Brazil, an investigation of the production and marketing system of perishables for a full year or for each season of market availability is essential for the development of a sensible method of loss evaluation and cause analysis for a given region. Visits to representative farms with knowledgeable extension workers provided much basic information (the extension service and research institutions in some countries function quite independently, often resulting in misoriented research). By interviewing farmers and participants in the marketing channels, new research needs, as well as reasons for conserving some traditional postharvest practices, were identified. We found these people to be our most accurate source of information for loss estimation, as they are with the commodities every day and have a personal interest in reducing losses. We supplemented their quantitative estimates with an analysis of the types of losses.

Appropriate loss reduction research

Without a careful survey of the practices and structure of a postharvest system, exaggerated loss estimates and wrongly assumed causes of losses misdirect research. An illustration was a study undertaken by a Brazilian institution to compare the transport of tomatoes in corrugated cartons of 10 kg with the traditional 22- to 26-kg wooden crate. Tomato was chosen for testing apparently because of reports that emphasized its large market volume and high postharvest losses, although the causes of the losses never were analyzed. The commonly marketed Brazilian tomato is an oblong fruit that remains relatively firm at the red stage ('Santa Cruz'). Despite harsh compaction in the crate, it does not suffer great amounts of physical damage, and often is marketed half-red or less mature at retail. This packaging research did not address the true causes of the high summer losses, which are due to a physiological field problem followed by microbial infection. Considering that the wholesale terminal facilities in Brazil do not always protect commodities during unloading in heavy rains, and that corrugated cartons would withstand neither the high stacking nor the harsh handling during rapid manual loading and unloading, the transport of tomatoes in such containers would not be feasible for a commodity of large marketing volume. It might be preferred by certain retailers or institutions for the sanitary aspect of a nonreturnable container whose cost could be passed to the consumer; however, the large lower class in LDCs cannot afford any food cost increases.

Current words in the postharvest literature may be ethylene, hydrocooling, and CA storage, but what is to be the orientation of research in developing areas of the world? Basic food supply as well as exportable commodities must receive attention. Because most perishable vegetables are still regionally grown and marketed in Brazil, produce usually arrives at retail within 24 hr after harvest. Thus, postharvest treatments, storage, and refrigerated transport are less essential than in DCs, where production is often centralized and concentrated in the nonwinter months.

The FAO (7) suggestion that refrigeration should not be seen as a panacea for all problems should be heeded, particularly by countries in major development after the 1973 oil crisis. Simple technologies, such as for storage (2) and processing units (14) are in use. Traditional practices may be modified rather than replaced by expensive equipment. For example, plastic bagging at retail has recently replaced wrapping in newspaper in our region; during slow hours of marketing, hypochlorite rinses given by small grocers before prepackaging carrots and cabbage could reduce high losses due to bacterial soft rot, instead of trying to resort to refrigeration.

As an alternative to developing storage facilities, planting can be better planned in LDCs—for example, with government loans that give farmers an incentive to grow certain commodities for expected periods of short market supply. On a national basis, Brazil's extension service adopted a plan in past years to coordinate the production of onions and potatoes suited to different regions and seasons. Thanks to breeding research, many vegetables are now produced during the entire year in the São Paulo–Rio de Janeiro–Belo Horizonte triangle, where 40% of the population lives, and stimulation of production during the more difficult months is needed.

FAO (7) has recommended that LDCs establish national programs to reduce losses of perishables, but LDCs lack trained personnel, and it has not been uncommon in these countries to see large sums of money allocated for programs and commissions that then attempt to create researchers out of inexperienced individuals, simply because the money is there for hiring. Instead, ongoing local research should be supported and expanded, particularly in view of the location-specific nature of postharvest work. As the need arises, research could be coordinated on a national basis. Federal planning and direction is essential, however, to organize and facilitate wholesale distribution.

In developing postharvest horticultural research in LDCs, consideration should be given to what are tolerable levels of losses for each commodity in a given marketing system, according to the different causes of losses, the major criteria of quality, and the economic level of the society that the system serves. The object is not to aim at once for a technologically sophisticated system with near zero losses, but to conserve the best qualities of the system while intelligently guiding and introducing loss reduction measures as the market and its products evolve.

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LETTERS

NEEDED: A BETTER WORD THAN "ORNAMENTALS"

We often use the noun "ornamentals" to describe plants used in landscapes, around homes and other buildings, in parks and public gardens, and along streets and highways. However, "ornamentals" can be perceived quite differently by others outside our profession and with serious consequences.

We talk with administrators, legislators, mayors, members of commissions, and others who influence important decisions about funding but know little about horticulture. We cannot compete for attention, and, more importantly, for funds for programs that are "ornamental." What a disservice it is to our profession, to our friends, and to ourselves when we use an imprecise word to describe the essential, functional uses of plants in cities—such as screens, shade, pollution control, food, and nutrition—which influence quality of life, rates of crime and vandalism, community pride, and aspirations of growing children.

We must use terms that tell precisely what we mean, emphasizing the professionalism of our work. "Urban plants" describes all kinds of plants in urban areas—be they woody or herbaceous; fruit, vegetable, or flower crops; trees or sodgrass; managed or wild. Urban plants are plants for people, and everyone, even cost-conscious administrators, understands how plants and parks enhance vitality of cities, property values, tax bases, and impressions of visitors. "Landscape" and "nursery crops" are also useful terms.

We in horticulture can do ourselves and our constituents a favor by being more precise, aware of horticultural terms like "ornamentals," which mean one thing to us, but something very different to others. Perhaps ASHS should take the lead in renaming some of its Working Groups. Correct language will help us as we seek support to quantify experimentally the beneficial effects of horticultural plants on urban environments and the people who live there.

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Letters to the editor, with the writer's name and address, should be sent to: ASHS Editorial Office, Lincoln C. Peirce, Science Editor, Dept. of Plant Science, Nesmith Hall, Univ. of New Hampshire, Durham, NH 03824. Letters may be edited for purposes of clarity or space.

CORRIGENDA

• In the article "Interaction between an Indigenous Endomycorrhizal Fungus and Mineral Nutrition of *Rosa multiflora* Understock" by D.R. Paterson, Ruth A. Taber, H.B. Pemberton, and D.R. Earhart (*HortScience* 21:312–313, Apr. 1986), the last line of data in Table 1 was printed incorrectly. The correct version of Table 1 is as follows.

Table 1. Influence of VAMF and nutrient solution concentration on fresh and dry weight and % VAMF infection (percentage) of *R. multiflora* understock.

Steiner solution concn	Fresh wt/4 plants (g)			Dry wt/4 plants (g)			Infection (%)		
	VAMF			VAMF			VAMF		
	Dead	Live	Avg	Dead	Live	Avg	Dead	Live	Avg
0.01	25	33	29 B[z]	7.2	9.2	8.2 B	7	85	46 A
0.1	54	64	59 A	13.4	17.3	15.3 A	0	16	8 B
Avg	39 b	48 a		10.3 B	13.3 A		4 B	51 A	

[z]Mean separation between VAMF treatments or between concentrations by F test at 5% (lower case letter) or 1% (upper case letter).

• In the article " 'Advantage', 'Pilgrim', and 'Companion' Celery" by Shigemi Honma, M.L. Lacy, and H.H. Murakishi (*HortScience* 21:1073–1074, Aug. 1986), H.H. Murakishi's name was spelled incorrectly.

• In the article " 'Ice Formation in Woody Plants Under Field Conditions" by E.N. Ashworth and G.A. Davis (*HortScience* 21:1233–1234, Oct. 1986) literature citations 1 and 4 were printed incorrectly. The correct citations are as follows:

1. Arny, D.C., S.E. Lindow, and C.D. Upper. 1976. Frost sensitivity of *Zea mays* increased by application of *Psuedomonas syringae*. Nature (London) 262:282–284.
4. Ashworth, E.N., J.A. Anderson, G.A. Davis, and G.W. Lightner. 1985. Ice formation in *Prunus persica* under field conditions. J. Amer. Soc. Hort. Sci. 110:322–324.