I. Identifying Scale-Appropriate Postharvest Technology

Lisa Kitinoja

An enormous amount of technically useful postharvest technology is described in this text and others, and new or improved technologies for handling and marketing horticultural crops are regularly reported on in technical and trade journals. Throughout the United States and abroad, postharvest extension specialists at universities and experi ment stations recommend potentially useful postharvest handling practices in newsletters, extension publications, videos, and via the Internet. Extension agents, farm advisors, postharvest consultants, and development personnel must be able to identify technologies that are cost-effective, feasible, and appropriate for their clients, as well as acceptable to consumers. With all the technologies from which to choose, how can extension professionals help their clientele deter mine whether any given postharvest technology will solve the prob

existing well-proven technical information. Often, postharvest losses take time to develop, and the specific cause of quality problems may not be fully understood by produce handlers along the chain. Other times, the handler may deliberately choose not to use a practice known to protect produce because of its cost or because consumers perceive the practice as undesirable. On occasion, a lack of reliable supplies, market information, or other infrastructural problems may make changes in handling impractical. Postharvest losses and changes in quality affect both the volume and perceived value of produce as it moves from the field to its final destination market, and any changes in practices will also have an affect. Part of any potential technical solution, therefore, is a consideration of the socioeconomic, cultural, and institutional constraints facing growers, handlers, and marketers when they attempt to make changes in the way they handle and market horticultural crops.

INFORMATION GAPS

Continuing use of some of these common improper practices can be traced to information gaps. Unless careful records have been kept of the handling practices undergone by a commodity between harvest and the final destination market, it can be difficult to determine the source of losses and quality problems. Even when moving through the simple direct marketing channel from grower or shipper to retailer, many people are involved in the postharvest handling, transport, and marketing of fresh produce. The effects of poor postharvest handling practices are cumulative, and losses can be caused by one or more events. However, identifying appropriate technical solutions can be impossible if the final handler is just guessing

Packing and packaging materials	Use of flimsy or rough packing containers. Lack of liners in rough baskets or wooden crates. Overuse of packing materials intended to cushion produce, causing interference with ventilation. Containers designed without adequate ventilation. Overloading containers. Use of containers that are too large to provide adequate product protection. Misuse of films for MA packaging, overreliance on MAP versus appropriate temperature management.
Cooling	In developing countries, general lack of the use of any methods of cooling during packing, transport, storage, or marketing of fruits or vegetables. In developed countries, use of inappropriate cooling methods, misuse of cooling methods, overcooling (chilling injury, freezing). Inadequate monitoring of temperature and chlorine levels in hydrocooler water.
Storage	In developing countries, general lack of storage facilities on the farm or at wholesale or retail markets, lack of ventilation and cooling in existing onfarm facilities. Poor sanitation and inadequate management of temperature and RH in larger-scale storages. Overloading of cold stores. Stacking produce too high for container strength.

Table 38.2. Factors affecting implementation of changes in postharvest technology

Identifying sources of losses	Difficulties in determining amount and causes of losses. Lack of knowledge D 2.700Tmɒ cau0Tmnsses.

about when and where the cause of losses occurred and who may be responsible. This task becomes even more difficult if the extension agent is unfamiliar with the location, crop, or cultural habits of the community.

Once the extension professional helps clients close these information gaps, it is often found that a simple change can solve a major problem. For example, quality problems at final destination could be traced to a packinghouse cooling system that is being overloaded, causing internal temperatures of produce to be higher than desired when produce is loaded for transport.

A variety of methods of postharvest loss assessment can be used to pinpoint the problem's source and to identify potential constraints to changing handling practices. Most involve direct observation of handling practices and the interviewing of key individuals regarding their standard postharvest practices. The United Nations Food and Agriculture Organization (FAO) has published loss assessment manuals for various commodities that

freight on additional packages (fig. 38.2).

Even when the overloading of containers and transport vehicles is a well-known cause

While field-packing is known to reduce losses by decreasing the number of times produce is handled, choosing to field-pack vegetables or to use a packinghouse will depend on many factors. The practical decision may be based on factors such as the amount of new investment required, what equipment and facilities are already owned or available, and the expertise of managers and packers. In the United States, another typical dilemma occurs when a choice must be made between performing a postharvest handling practice such as grading by using manual labor or with machinery designed to enhance efficiency. Which is a better choice for a given operation

leafy greens to prevent wilting is viewed as "cheating" since the leaves or water adds weight to the produce.

Other cultural factors that can affect whether handlers will adopt changes in postharvest technology include religious traditions, gender barriers, the local definition of losses, and traditional secondary uses for low-quality produce (e.g., animal feed, food banks). If agroprocessing is to play a role in reducing food losses, recommended technologies must result in high-quality, healthful foods that consumers find to be good-tasting and easy to prepare. Extension professionals must be aware of these many cultural factors in order to best identify scale-appropriate postharvest technology and before attempting to develop educational programs targeting specific clientele.

postharvest handling practices. Postharvest educational needs assessments undertaken in many countries point to a wide range of training requirements before local handlers are ready to make improvements in postharvest technology within their operations.

Extension workers worldwide have an opportunity to extend appropriate postharvest technology to a variety of clientele who can then use recommended practices to reduce losses, maintain produce quality, and increase profits. The final decision of whether to adopt any given improved postharvest technology will be made on an individual basis, and it depends on many factors that affect its ultimate usefulness. The more information extension workers have on the postharvest problem, the client's operation, and the local situation, the better they will be able to identify potential solutions. Involvement of clientele in postharvest loss assessment can assist extension workers in pinpointing the sources and causes of losses and in identifying potential constraints to changing practices required to solve the problem. Commodity assessments can help identify who (i.e., men, women, growers, traders, retailers) needs what kind of postharvest information to solve the problem. Market research can help identi

Kitinoja, L. 1991. Research and extension programs for improved postharvest handling practices in West Africa. In: Proc. Symposium on Sustain able Agriculture for Africa, Center for African Studies, Ohio State University. Columbus: Ohio

5. [illegible] to conduct the program. Compare the manpower, equipment, and facilities that will be needed with those that are currently available, and identify possible sources of funding, resource persons, tours, demonstration sites, and supplies.

6. [illegible] during implementation in order to determine whether objectives are being met and how the program might be improved. Include the program's stakeholders in the evaluation to enhance the chances that the results of the evaluation will be utilized.

More information on the topics of educational needs assessment, commodity systems assessment, extension methods and program evaluation can be found later in this chapter. For more detailed information on the extension program planning process, see Blackburn (1994); Van der Ban and Hawkins (1996).

EXTENSION METHODS

Working within any extension system, there are many extension methods available for conducting postharvest programs. Successful extension work is an art as well as a science. The relative effectiveness of any method depends on the level of interest and voluntary involvement of postharvest researchers, public and private extension workers, and industry clients. Always, the work of extension is to build new links and strengthen existing links between information generators and information users. These linkages help make postharvest researchers aware of industry problems, perspectives, and constraints, and also help increase industry awareness of the problem-solving assistance available from scientists. In this section of the chapter is a description and discussion of some of the methods most commonly used in postharvest extension programs.

APPLIED OR ADAPTIVE RESEARCH

Many common handling practices and conditions found in the horticultural industry cause increased product deterioration and marketing losses (see part I of this chapter). Some problems are relatively simple and can be studied easily by comparing existing postharvest technologies under controlled conditions. Other postharvest problems will require long-term study to determine the underlying cause of the problem and to develop a suitable technology.

Applied research studies in postharvest technology seek to identify the causes or magnitude of deterioration or losses and to develop and evaluate possible corrective measures. Adaptive research attempts to modify an existing technology to better fit the exact conditions in which it will be used in practice. While some research must be conducted in laboratories, and other research can be conducted in industry facilities, all research must use scientifically sound methods and procedures.

Collaborative and participatory research and development methods ensure that the postharvest information developed by extension specialists is useful and appropriate for their clientele. The skills needed in applied research include patience and attention to detail, careful planning, and willingness to listen to cooperators and clientele.

Public extension services face a unique challenge whenever they work with clientele associated with large, technically sophisticated companies involved in produce handling and marketing. This clientele may be unwilling to cooperate fully with postharvest extension specialists since their competitive outlook makes it undesirable to share the results of the applied research studies with others.

CONSULTATIONS

Requests for consultations most often originate with industry leaders or groups who want to improve their postharvest operations. Consultations are usually done in person, but they can also be handled by telephone, through the mail, or even by FAX or e-mail and can involve individuals, companies, or other groups such as grower cooperatives. Consultations generally deal with specific subjects (e.g., decay problems or cooling methods) and individual problem diagnosis. Despite the high time requirement associated with individual consultations, these continue to be an important extension method. Extension workers can use the time they spend with individuals to obtain informal information on needs and feedback on prior or ongoing extension programs, and to build linkages with clientele.

GROUP MEETINGS

Meetings with groups allow the extension worker to present information to larger audiences than through consultations. Regularly scheduled group meetings allow clientele the opportunity to feel connected and receive

wholesale or retail vendors (via ministries or departments of commerce or marketing), leaving no one to specifically target market intermediaries.

As with most extension methods, the language and socioeconomic status of the extension worker should match that of his or her clientele for best results. The use of nonformal and hands-on teaching methods whenever clients are illiterate would help increase participation and comprehension. When women are part of the target audience for postharvest extension programs, meeting times must be scheduled with the needs of women in mind. Locations of meetings for educational purposes must be accessible and provide some form of child care facilities. The marketplace is perhaps the best location for many extension activities related to postharvest handling practices. As a natural gathering place, wholesale and retail markets are excellent locations for information gathering, tours, and demonstrations of recommended postharvest technologies. Holding regular group meetings in local wholesale and retail marketplaces would also help to reduce the transportation costs associated with extension work and participation.

DEMONSTRATIONS

Extension workers can use demonstrations to show how to use a new practice, procedure, or facility or to illustrate the results of recommended postharvest technology. Demonstrations are often used to extend the results of applied or adaptive research. A hands-on or experiential learning approach can enhance program results, since many people "learn by doing." Careful attention to the equipment, facilities, and visual aids used in demonstrations can increase their effectiveness.

The message of any given demonstration should be simple and clearly presented to participants. One example is the effect of various temperatures on the postharvest life of selected produce; another is the effect of chlorine on the vase life of roses. In one short course offered in India by UC postharvest specialists during the hot (dry) season, Punjabi flower producers were enthusiastic about their training when they witnessed a large vase of wilting roses seemingly brought back to life when a dash of chlorine bleach was added to the vase solution.

An important component of any demonstration is a cost-benefit analysis, in which a comparison is made between the current handling practice and the new postharvest technology under consideration. A simple chart for comparing any two practices can be constructed and used to calculate the comparative costs and the expected benefits. Costs include required equipment, labor, supplies, and power; benefits might include increased volume of produce, higher quality grade, or better market price.

A summary worksheet is included as figure 38.3. For more details, please refer to Kitinoja (1999) and Kitinoja and Gorny (1999).

Research has shown that there is a strong correlation between the characteristics of an innovation and its rate of adoption (Rogers 1995). Table 38.5 lists the characteristics that are known to be important. Postharvest technologies that have these characteristics can be demonstrated successfully in extension programs.

SHORT COURSES

Extension audiences can benefit from intensive, broad coverage of specific subjects in short courses through classroom lectures, laboratory demonstrations, or tours. The Postharvest Technology Short Course offered annually in June by the University of California, Davis, is an example, with 5 days of classroom instruction followed by 5 days of tours. The University of the West Indies conducts short courses throughout the Caribbean on postharvest topics via their Continuing Education Program in Agricultural Technology (CEPAT). Other short courses are conducted by individual marketing firms for their own personnel, or by trade association specialists. The UC Postharvest Technology and Research Information Center (PTRIC) website on the Internet (http://postharvest.ucdavis.edu) is an excellent source of information on current postharvest course offerings, and it also has links to other sites.

Short courses may be from 2 days to about 2 weeks long. They may be used to refresh the audience with previously learned information and to provide updated or new information on a subject. When the course meets for several days or more, the extension specialists can prepare demonstrations of the use of postharvest practices, and-cli

Figure 38.3 Worksheet: Comparison of costs and benefits.

Does one practice cost more than the other for materials, power, equipment, labor, storage, transport, marketing, etc.? Calculate the difference based on expected yield, hourly labor costs, expected volumes to be handled.

	Current practice	New practice
1. Cost of equipment	$_____	$_____
2. Cost of supplies	$_____	$_____
3. Cost of labor	$_____	$_____
4. Cost of power	$_____	$_____
5. Other	$_____	$_____
Total direct costs	$_____	$_____

Benefits

Base these figures on expected yield, quality, amount of produce at various grades, and predicted market prices. Use either wholesale or retail prices or a combination if you will sell both ways.

	Current practice	New practice
1. Expected sales (wholesale)		
Highest grade	$_____	$_____
Second grade	$_____	$_____
Lowest grade	$_____	$_____
Subtotal: Sales (wholesale)	$_____	$_____
2. Expected sales (retail)		
Highest grade	$_____	$_____
Second grade	$_____	$_____
Lowest grade	$_____	$_____
Subtotal: Sales (retail)	$_____	$_____
3. Total expected sales	$_____	$_____
4. Comparative advantage		
(Total sales – Total direct costs)		
Which practice is most profitable?	$_____	$_____

Recovery of Invested Capital (ROIC)

How long will it take to pay for your investment in the new practice or technology?

1. Actual capital outlay for new practice = $_____
(Difference in total direct costs for new equipment, facilities, power costs, supplies, and labor requirements when compared to current practice)

2. Interest rate (if capital is borrowed)
= _____% per annum; or _____% per month
cost of capital at three months = $_____; or at six months = $_____

ents can see for themselves the results of certain technologies.

Effective short courses require much planning, considerable professional involvement and input, proper facilities, and follow-up to evaluate their effectiveness. A good mix of extension methods should be used to maintain interest. The use of visual media (slides, videotapes, or CD-ROM) and group exercises or discussion helps keep participants involved. Printed materials, including a syllabus and a list of current references for further information, are generally provided to each participant in a short course.

WORKSHOPS

Workshops can improve the skills in postharvest technology of individuals or groups. For example, one might conduct a specific workshop on harvesting, cooling, or careful handling. Often, a workshop will focus on a single commodity and provide written materials, as well as use visual aids and include discussions. Workshops can last for 1 or more hours, and can meet only once or as a series over a period of time. Organized meetings and workshops in California have led to changes in practices within the apple industry, where growers have learned the importance of harvesting earlier and storage operators have learned to monitor and maintain low levels of CO_2 in storage. These simple changes in postharvest practices have resulted in a decreased incidence of internal browning in Fuji apples.

The scheduling of workshops can be a sensitive issue, since clients may be too busy to attend during a time that is optimal for the extension worker in terms of demonstrating pertinent postharvest handling practices for a certain commodity.

TOURS

Figure 38.4 Interview and observation schedule for postharvest tours.

Small Scale Postharvest Handling of Organic Horticultural Crops
Interviews and Observations

Site _____
Date _____
Commodity _____

Use the following outline to take notes as you ask questions about the commodity system during field visits and market tours.

Production Management
Choice of cultivars _____
Cultural practices _____
Field sanitation _____

Harvest Practices
Maturity indices _____
Containers/tools _____
Handling methods _____

Preparation for Marketing
Sorting/grading _____
Sanitation _____
Quality control practices _____
Pest management _____

Packaging/Shipping Containers
Packing methods _____
Packaging materials _____

Cooling/ Temperature Management
Cooling methods _____
Temperature/RH control _____

Transport
Vehicle cooling _____
Loading methods _____

On-Farm Storage
Structures _____
Temperature/RH control _____
Pest control _____

Marketing
Pricing policies _____
Customer relations _____
Finding new markets _____

Uses for Surpluses
What happens to produce you can't sell? _____

often published in two or more types of publications to reach a broader audience and achieve the maximum effect. For example, the scientific details of a study might be reported in a professional society journal, the semitechnical aspects published in a university or government report, and a popular report of the study, showing its relevance to the postharvest industry, might be published in an extension newsletter and one or more trade publications. Following are examples of types of publications (see also the reference list in chapter 1):

[illegible]. These include articles on applied research published in professional societies' publications and in university and government technical reports. They are written in a scientific style, primarily for the benefit of professional researchers and extension workers; few industry representatives read these publications.

[illegible]. This type of publication addresses a single specific subject or development in a direct, simple style. The UC Postharvest Technology Research and Information Center produce fact sheets are examples, where information is provided regarding recommendations for maintaining postharvest quality of an individual commodity (fig. 38.5).

[illegible]. These publications extend current information on ongoing projects to cooperators, research sponsors, industry personnel, and others. An example might be results of a just-completed preliminary study on the effects of a questionable, presently used industry practice. They are usually brief reports, no more than a few pages long. Their main advantages are timeliness, brevity, and directness, and they keep interested persons informed about ongoing results.

[illegible]. These periodical publications extend information to broad audiences on a regular basis, typically four to six times a year. A good newsletter is an effective route for extension of brief, pertinent reports and articles to the postharvest industry and to fellow extension and research workers. The University of California Perishables Handling Quarterly has been an effective informational tool since its founding as a newsletter in 1962. Issues usually contain a review article on a specific subject related to postharvest handling, brief articles on recent research results, book reviews, and a list of recent postharvest publications and reports. The University of Florida postharvest newsletters for industry, Packinghouse Newsletter and Handling Florida Vegetables, is another effective newsletter. The horticultural industry also has its own postharvest newsletters, mostly intended for internal communication.

[illegible]. Articles in trade magazines and newspapers are most effective for extending information to industry handlers, who read them regularly. Magazines and bulletins produced by grower-shipper associations include The Western Grower and Shipper, published by the Western Growers Association; the monthly PMA Bulletin, published by the Produce Marketing Association; and Fresh OuC BT /T1hy the Produce Mark231 231

. Videotapes and CD-ROM programs are becoming increasingly popular methods of extension as costs of production decline and computer technology makes production and editing feasible on a small scale. The United Nations Food and Agriculture Organization (FAO) is currently producing a series of postharvest publications on CD-ROM, which will be available worldwide in several languages. The University of California markets a wide selection of slide sets and videos related to recommended postharvest handling practices. Examples include the slide set

why they are using the postharvest practices they are currently using.

- **Overlooking investigation.** Researchers may overlook what they cannot see—they observe physical things and activities but not social and cultural settings and relationships (patron-client relations, factions, informal organizations, traditions, norms, indebtedness, interest rates, control of assets, decision-making practices). The more you understand about the local conditions for postharvest handling, the better chances will be for identifying the most appropriate changes.
- **Overlooking seasonal investigation.** Investigators focus on only one moment in time—cyclical and periodic events such as crop rotations and weekly markets may be overlooked; trends and seasonal changes can be easily missed. Sometimes market price fluctuations can be the key to understanding when certain postharvest practices can be used to best effect (and profit).

COMMODITY SYSTEMS ASSESSMENT METHODOLOGY (CSAM)

This postharvest loss assessment method sets the stage for productive postharvest extension work by assessing the technical, socioeconomic, cultural, and institutional factors related to handling a given commodity in a specific locale. The end products of CSAM encompass both traditional loss assessment and cost-benefit analysis and lead to productive extension program and project development.

The commodity system is made up of 26 components that together account for all the steps associated with the production, postharvest handling, and marketing of any given commodity. The method was developed over the course of many years and was tested extensively in the Caribbean before being introduced worldwide to field personnel via an excellent training manual (LaGra 1990). The manual includes sample data collection instruments and detailed explanations of each of the components. Ideally, teams of people work together while investigating a commodity system—for example, a horticultural production researcher might be teamed up with a marketing specialist and an extension agent. CSAM can help build links between agencies and individuals, close information gaps, and help people solve problems while focusing on usable postharvest technology.

Sample CSAM questions

Table 38.6 is a list of system components and sample questions for investigating the commodity system. The team begins by considering these questions in relation to any commodity of interest, and then adds any other information that is pertinent to the situation. Some of the questions can be answered directly by extension personnel or others who are knowledgeable about the commodity, or information can be found in available literature. Other questions may require the data collection team to observe actual postharvest handling practices and ask questions of those people who harvest, handle, and market the product. Information on the costs and expected benefits of various postharvest technologies can be collected directly or estimated from applied or adaptive research studies.

Expected outcomes of CSAM

CSAM can assist a postharvest loss assessment team to determine the sources of postharvest losses (when, where, and who within the marketing chain is responsible); the causes of those losses (what handling or marketing practices are responsible); and the economic value of the losses compared to the costs of current and proposed postharvest practices. Once this kind of information has been collected, extension educators can target the responsible handlers with appropriate information on cost-effective, improved postharvest technical practices.

In the occasional situation where there is no existing appropriate technical solution for the handling or marketing problem uncovered using CSAM, the problem can be passed

EXTENSION PROGRAM DEVELOPMENT

Postharvest extension work requires knowledge and skill in planning, implementing, and evaluating educational programs. Extension workers need to use creativity and initiative in program approaches, teaching techniques, and extension methods. They also must be highly self-motivated and must seek to involve clientele throughout. Using informal and formal needs assessments, extension workers must seek out postharvest handling problems and the groups that face

16. Cooling	When and how is produce cooled? To what temperature? Using which method(s)? Are methods appropriate for the product?
17. Storage	Where and for how long is produce stored? In what type of storage facility? Under what conditions (packaging, temperature, RH, physical setting, hygiene, inspections, etc.)?
18. Transport	How and for what distance is produce transported? In what type of vehicle? How many times is produce transported? How is produce loaded and unloaded?
19. Delays/waiting	Are there any delays during handling? How long and under what conditions (temperature, RH, physical setting) does produce wait between steps?
20. Other handling	What other types of handling does the produce undergo? Is there sufficient labor available? Is the labor force well trained for proper handling from harvest through transport? Would alternative handling methods reduce losses? Would these methods require new workers or displace current workers?
21. Agroprocessing	How is produce processed (methods, processing steps) and into what kinds of products? How much value is

it is expected that each year will bring new ideas and innovations.

In the United States, Cooperative Extension personnel are invited to attend the University of California Postharvest Technology Short Course. In Europe, the Natural Resources Institute (NRI) regularly offers postharvest training courses. If local extension capabilities in postharvest in-service training are limited, it is possible to work with a variety of development agencies to design and fund training programs. The FAO and the World Bank announce currently available programs on their websites. The U.S. Agency for International Development (AID) regularly funds postharvest training projects in developing countries through the Farmer-to-Farmer Program via Winrock International and through voluntary agencies such as Agricultural Cooperatives Development Institute/ Volunteers in Overseas Cooperative Assistance (ACDI/VOCA), in which postharvest extension specialists are invited to participate as speakers and resource persons.

Educational needs assessment

A common complaint raised against extension systems is that programs are related more to the interests of the extension worker than to the needs of the clientele. During the 1980s many evaluations pointed to ineffective extension programs, underutilized postharvest facilities, and disillusioned clientele. In order to avoid this situation, extension workers must regularly use educational

needs assessment to find out what clients need to learn in order to solve the current postharvest problems they face. Needs assessment may be formal, involving surveys and literature reviews, or they may be informal, based on thorough dialog with representative clients. If mail or telephone surveys are undertaken, following the methods described by Dillman (1978) can greatly increase response rates.

Finding resources

Extension workers will no doubt be required to locate sources of funding for their applied research and extension educational programs. Grant writing skills can be developed by taking courses that are offered at many colleges and universities worldwide. Most libraries have access to the *Foundation Directory* and the *Foundation Grants Index* in printed or electronic form. Both of these references contain thousands of entries describing foundations that offer grants to eligible organizations. In addition, *The National Data Book* lists over 30,000 foundations that have awarded a cash grant during the most recent fiscal year, and the *Catalog of Federal Domestic Assistance* lists grants given by U.S. government agencies.

/Grants Index /Tm1 1 Tf 0 Tc 10 0 0 105<</MCID 25380</hsa1.2

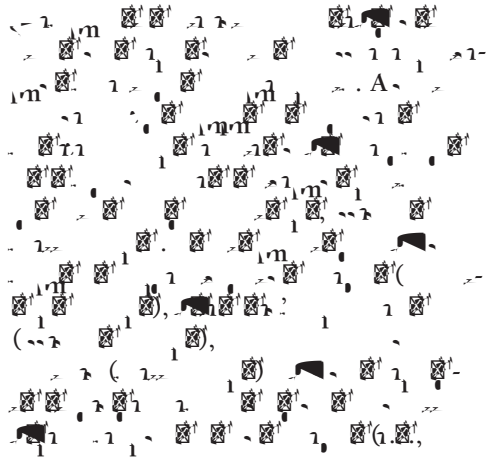
An entire field is dedicated to agricultural communication, including nontechnical writing for newsletters, extension manuals, fact sheets, and multimedia. Some of the most recent literature on agricultural communication is available via the University of Illinois at Champaign-Urbana and the Illinois Cooperative Extension Service. Back issues of this publication (Agricultural Communications) and a bibliography of literature on extension methods can be accessed free of charge via the Internet (http://www.ag.uiuc.edu). The Department of Agricultural Education at the Ohio State University publishes the quarterly newsletter Agricultural Communicator that offers updates on extension methods, writing techniques, and multimedia productions. The editors also review books and short courses dealing with professional skill development.

Marketing extension programs

Even the best postharvest extension programs will be less effective than they can be if people don't know about them. Marketing extension programs requires planning ahead, developing high-quality promotional materials, and getting the word out via direct mail, posters or brochures, word-of-mouth, or the Internet. The four P's of marketing (product, place, promotion, and price) have been interpreted for postharvest extension programs in table 38.7. Similar to quality program planning, where the needs of the clientele determine the objectives of the extension effort, the more an extension worker knows about the target audience, the more likely it is that the program will be marketed to those who will benefit most from participation.

Program evaluation

Extension workers must be willing to do the work associated with evaluating their ongoing projects and extension programs in order to determine what is working well and what needs to be changed. Evaluation requires gathering information during implementation to determine whether the program has met its objectives. Figure 38.6 illustrates Bennett's model (1979) and the seven levels of evidence related to a program's theory of action, which can help an extension worker focus the evaluation on the key aspects of the program. A theory of action attempts to understand causal linkages between the program inputs and activities and the program's intended outcomes. It is important to focus attention and resources during evaluation on higher-level outcomes, such as actual or intended practice changes, rather than counting the number of participants and assuming they learned and used the postharvest technologies offered during the program. According to Patton (1986, p. 171):



program are housed throughout California, at the campuses of UC Davis and UC Riverside and at the Kearney Agricultural Center in Parlier. The specialists represent seven aca demic departments, including vegetable crops, pomology, food science, agricultural

projects would stagnate. Much of the success

ological variables in rural development. 2nd ed.