Technology Transfer

Introducing Storage Concepts to Growers in Less-developed Countries

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Summary. Under most circumstances, some type of storage, from ephemeral to long-term, is an asset in the marketing of horticultural products. However, attempts to transfer developed country (DC) storage technology to the less-developed countries (LDCs) can be futile unless two conditions are met: 1) There must be a prior extension program to introduce the concept of what produce storage involves and what benefits can be expected from its proper use; and 2) the storage techniques introduced must be appropriate for the area. In many circumstances it may be necessary to start with very simple "old-fashioned" methods. Stages of development in LDCs are described, together with suggestions as to appropriate storage methods for each stage and how to prepare for them.

Domestic extension methods are under constant, although usually minor, refinement. Until very recently, minimal attention has been given by foreign aid agencies (U.S., European, and international) to the real extension challenges involved in transferring DC postharvest concepts to LDC growers of horticultural crops. Mukai (1986, 1987), who addresses this problem with regard to efforts to improve postharvest horticulture in Brazil, stresses that not only is direct technology transfer often not appropriate, but efforts to devise local modifications can be complicated by considerations of local politics, a situation not confined to Brazil. In no field has this failure of technology transfer been more obvious than in the introduction of storage technology. Most particularly, there is a dearth of literature on how to introduce storage methods into situations where direct transfer of DC technology is not appropriate.

It is gratifying, therefore, to note two recent publications, available from the Postharvest Inst. for Perishables (Univ. of Idaho, Moscow, ID 83843), dealing with much of the interdisciplinary coordination that is necessary even to plan LDC distribution of fruits and vegetables (Schermerhorn, 1986; La Gra and Dechert, 1990). The latter includes cold storage in its in-depth treatment of necessary interdisciplinary coordination. However, all such publications known to me presume that some knowledge of the requirements of market channels exists. Often this is lacking; thus, well-meaning efforts will be wasted until some concept of the requirements for fruit and vegetable distribution, and of storage as a marketing tool, is established.

It is helpful to recognize the stages by which LDC agriculture develops from completely undeveloped to a degree of development making possible acceptance of DC storage technology. I have described three such stages (Grierson, 1975). At each of these stages some storage technology is possible, but not necessarily such as to be considered "cold storage: by DC horticulturists.

Subsistence economy. This can be defined as a closed-cycle economy in which the grower's family consumes what it produces, attempting to sell only occasional surpluses. For such subsistence farmers, the simplest, most reliable form of storage is to feed edible trash and surplus crops to animals, which thus become on-the-hoof storages (and incidental suppliers of valuable fertilizer), later returning such surpluses in the form of milk, eggs, meat, wool, leather, etc. This concept is an ancient one; nevertheless, I was astonished to have a very senior agricultural official in the government of an Asiatic country express gratification at the "novel" idea of including an animal husbandry component in a nationwide horticultural marketing project. Such ancillary use of animals is not limited to LDC practice. British and European farmers still use animals (most commonly sheep) to glean, and thus "store on the hoof," the bountiful forage left in the fields after harvesting vegetable crops, particularly crucifers. Have we grown so specialized that this is now a "novel concept"? Moreover, animals so used sometimes can provide their own transportation to market. Nevertheless, I have yet to encounter a horticultural overseas project the planning of which included such use of animals. Occasional progressive subsistence growers can be introduced to the simple, nonrefrigerated storage methods described below under "local marketing."

Local marketing. This is the situation in which fruits and/or vegetables are being grown primarily as cash crops to be sold periodically at a local market. In such circumstances, harvesting is apt to be casual, transportation crude, and market facilities minimal. Good practice usually is limited to careful handling and perhaps manual sizing. Refrigerate storage is usually out of reach for individual farmers, but, depending on local crops and climate, various forms of "common storage" can be both practical and beneficial. These start with intelligent use of: 1) shade; 2) moisture; 3) day/night temperature differential; 4) natural air movement; and 5) evaporative cooling. An initial extension program is needed to teach the growers (some of whom may be very intelligent, even if illiterate) that fruits and vegetables are alive and must be kept that way. They must be taught to distinguish between those whose outer layer of cells is alive (most fruits, vegetables, and root crops) and

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those whose outer cells are dead (such as onions, mature cucurbits, and nuts). From there on it is simple to show them how moisture-loving crops such as roots and tubers can be stored in moist, dark "clamps" (earthen storages) or hillside, ventilated "cave storages" and how to use airy, well-ventilated sheds for dry storage of crops such as onions or pumpkins. In all cases, instructions on basic sanitation and rat control must be included.

Where a local market exists with some sort of "market authority," it may be possible to set up basic storage for short-term holding. When climate, topography, and local materials are suitable, it may be possible to start a storage program without electricity by using native materials for construction and insulation, and by using evaporative cooling or day/night temperature differential to lower the temperature of the harvested product. Again, let it be emphasized that such methods are not that far behind us in the DCs. In 1954, I was in a sawdust-insulated "million box" lemon storage in Ventura County, Calif., that ran at a constant 54-56F (12.2-13.3C) solely by virtue of a thermostatically controlled (originally hand-controlled) ventilation system. Similar storages can be set up as evaporative coolers powered by gasoline or diesel motors (Grierson, 1987).

Setting up such a market storage is easier than managing it. Initially, the only practical management system occurs when the same person who owns the storage buys and sells the produce to be stored.

Distant marketing. Here we approach the situation in which the complex methodology such as is detailed in the CSAM report (La Gra and Dechert, 1990) can be put to use, but not until some critical psychological barriers are overcome. For this, an effective prior extension program is essential.

For the small LDC grower, the production of crops for distant markets introduces a number of new, sometimes mind-boggling, concepts. First is the strange concept of giving family-grown produce to someone else to transport and/or sell. This has many psychological, sociological, and economic ramifications that still need to be studied. What is pertinent, and critical, is that everyone involved must understand that the considerable costs of storage can be justified only for carefully handled, properly graded and suitably packaged produce. This is something that cannot be taken for granted. The concept must be understood thoroughly before a cold storage program is begun. Here again we have a situation in which direct transfer of DC technology is often unsuitable. Grades and standards always are characterized by demands of the particular buying market and economic and ecological limits for that growing area (Grierson and Ting, 1978). What is common to all storage situations anywhere is that only marketable sizes of sound produce with good storage potential can repay the expense of storage.

When the situation merits cold storage, only a basic storage should be attempted at first; current DC practice may not be appropriate. Many storage projects have failed because the limitations (reliability, cost, and type of current) of the local electricity supply have not been considered. An example is a Caribbean project involving hydrocooling and refrigerated local marketing of vegetables on which I was consulted. The local electricity supply was unreliable, with frequent periodic shutdowns. The motors ordered were for

U.S.-style 220-V, 60-Hz current instead of the local 440-V, 50-Hz power supply, and the cost of the electrical power input exceeded any possible profit on sale of the produce. This was not a viable project on electrical considerations alone and should never have been started. Sometimes local skills and materials can be used to considerable advantage. An excellent example was a storage developed from a ruined 300-year-old Mexican monastery whose meter-thick adobe walls needed no further insulation. Often, DC labor-saving methods may be inappropriate. When asked for recommendations for "modernizing" a large cold storage in Pakistan, my advice was to make no major changes. This was despite its apparently archaic appearance, with multiple slatted floors, narrow stairways, and purely manual methods. Air distribution and temperature maintenance were excellent. The laborers who carried the boxes up and down those narrow stairways and stowed them carefully on slatted racks were paid 40 rupees a day (less than U.S.\$2). No system of forklifts and palletized handling, or even mechanized delivery belts, could work more cheaply, and usable storage capacity inevitably would be reduced.

Above all, advanced storage techniques such as CA storage or hydrocooling should not be contemplated until the local economy has been shown to be capable of using simple, basic cold storage to the full.

But, who today is training the postharvest extension workers needed to prepare the way for such developments in LDCs? And where is the body of literature to guide them? There is a need for extension services specifically oriented toward laying the groundwork for LDC growers to take the first steps that are necessary before improved storage and marketing technologies can be incorporated successfully into their local economies. For this, some concept of elementary market channel requirements needs to be introduced routinely into the training of graduate students in postharvest technology.

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