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# POSTHARVEST TECHNOLOGY FOR MICRO-MARKETING OF HORTICULTURAL COMMODITIES

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## ABSTRACT

As more small farmers become adept at producing horticultural commodities, the need for training in postharvest technology becomes more critical. Many grain farmers in the U.S. who have no postharvest experience are turning to the production of small acreage of horticultural crops for local markets. While time spent in the marketing chain is minimized, there are numerous opportunities for the application of correct postharvest management practices that are essential for short term quality maintenance.

The major postharvest problems facing the inexperienced producers of horticultural commodities are temperature management, rough handling, and the ability to implement effective sanitation practices. This paper focuses on these problems and some of the solutions for limited resource farmers. Opportunities for on-farm value-added processing are emphasized.

## INTRODUCTION

The decline in profitability of grain crop production in the United States has stimulated much concern about alternatives. Horticultural crops are attractive to many farmers because of their high value compared to grains. The U.S. land grant university system, in recognition of these changes, has established numerous new positions for researchers and extension specialists to assist farmers with making this transition. Unfortunately, the intensity of management and the resources required to successfully produce and market horticultural commodities often are over-looked (King, 1984; Sanders, 1987). Many farmers, having become adept with production management, will produce a good crop, only to find they are unable to maintain quality after harvest. The lack of postharvest training among producers is a troublesome problem in many of the lesser developed countries as well (Mukai, 1987). This paper reports some of the experiences, both good and bad, of a postharvest researcher and extension specialist working with grain and tobacco farmers who have attempted to produce and market horticultural commodities. Postharvest research projects directed specifically to the problems of limited resource farms are described.

## DISCUSSION

### Micro Markets

Most large volume growers in the U.S., market their produce through brokers, chain stores, etc. Volume growers in the Caribbean almost certainly are considering the export market. When discussing fresh produce, the term "volume" usually means less profit per unit of production for growers. An

alternative to volume marketing is micro marketing. Sanders (1987) describes six categories of micro markets: ethnic, convenience, aristocratic, specialty restaurants, organic, and roadside markets. These categories are not mutually exclusive, i.e. a specialty restaurant may sell aristocratic, ethnic, or organic food. Growers who wish to supply these markets must have market contacts (buyers) to ensure that the crop can be sold. Buyers also can assist with deciding which crops are to be grown. Once these decisions are made, the grower must focus on cultural practices and postharvest considerations such as handling, packing, and cooling the product. Postharvest requirements are extremely critical because buyers want the best possible quality and are willing to pay for it.

Temperature Management

Refrigeration is recognized as the first line of defense against decay and senescence of horticulturai products (Mitchell, et al. 1972). Since many limited resource farmers, whether in the U.S. or the Caribbean, do not have access to refrigerated cooling facilities, alternative methods must be sought. The first consideration is to move any product out of direct sunlight immediately after harvest, a simple procedure that is often overlooked by both small-and large-scale farmers. The sun can literally cook harvested produce in the field, where pulp temperatures may exceed 45 C. In the shade, the pulp temperature usually remains at ambient or slightly above ambient temperature.

Quick removal of field heat is essential for long-term quality maintenance. This can be done on small lots without costly equipment. Graham (1987) described a procedure for dipping Caribbean-grown cucumbers in cold water (hydrocooling) prior to packing for export. This is probably the most effective way to remove field heat but growers must be concerned with the spread of decay in the water (see sanitation practices).

The performance characteristics of evaporative coolers for removal of field heat have been reported (Thompson, et al., 1981). A well designed system can cool produce within one or two degrees of the wet bulb temperature. While these work best in areas of low relative humidity, recent tests in South Carolina demonstrated their usefulness in more humid regions as well (Christenbury and Rushing, 1988). The reduction in weight loss observed in cooled products compared to controls (Fig. 1) is probably as important for quality as the cooling effect. Squash, cucumbers, and bell peppers lost significantly less weight on the cooler, however tomatoes were barely affected (Fig. 1), probably because of the better developed cuticle on tomato fruit. Evaporative cooling is not an alternative to mechanical refrigeration, but it can provide cooled air with high relative humidity, which can be of benefit for micro markets in which only a few days of storage is needed. A system can be constructed at relatively low cost and is adaptable to a variety of installations.

If you have any mechanical refrigeration for room cooling, it can be modified for forced-air cooling with minimal investment. There are numerous bulletins that describe the principle of forced-air cooling (Hardenburg, et al., 1986). Used equipment, such as the fan, switches, etc. may be utilized and scraps of plywood may form the frame for the fan. We constructed such a unit for less than US$30.00. The time to cool certain commodities can be reduced to less than 10% of the time required to cool in common room storage

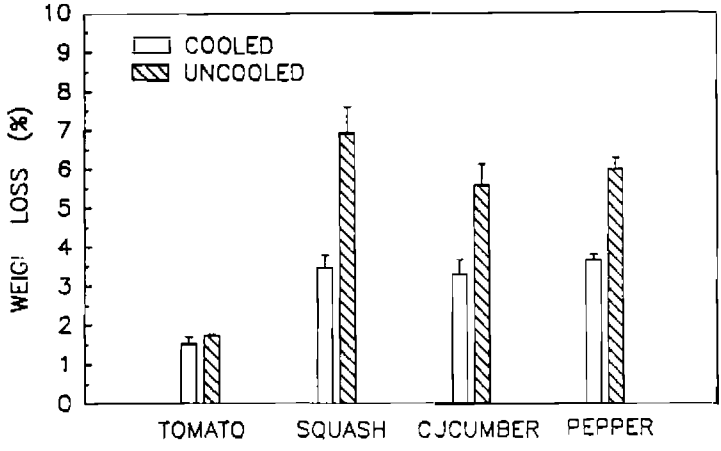


Figure 1. Effect of evaporative cooling on the weight loss of vegetables.

Table 1. Effect of pH on chlorine availability.

| pH | chlorine available |
|---|---|
| 6.5 | 95% |
| 7.0 | 75% |
| 7.5 | 50% |
| 8.0 | 25% |

without forced-air (Mitchell et al., 1972).

Icing, especially slurry-icing, is an extremely effective cooling method and is used in the U.S. on vegetable farms of all sizes, from large commercial operations to the small family farm. Items that are chilling sensitive, such as squash, cucumbers, and nearly all tropical fruits, should not be iced. Sweet corn, broccoli, and leafy greens typically are iced for transit (Hardenburg et al., 1986).

The general recommendation on temperature management is to cool to the lowest safe temperature and keep it there. When this cannot be done, one must use every feasible method to reduce the product temperature to the lowest possible level.

Sanitation Practices

Exposure of horticultural commodities to water, e.g. dumping, hydrocooling, washing, rinsing, etc., sets the stage for proliferation of decay organisms. Water should be chlorinated to about 100 ppm free chlorine, which is 500-fold dilution of common household bleach (5% NaOCL). Other sources of chlorine include calcium hypochlorite, commonly used in swimming pools, and chlorine gas, which is quite dangerous if used improperly. The ability of chlorine to disinfect is dramatically affected by pH (Table 1). Failure to adjust the pH of dump tank water has been the source of costly decay problems in the U.S. fresh market tomato industry, a situation that is rapidly being corrected. Hypochlorites tend to raise pH, while chlorine gas will lower pH. This means that an initial pH adjustment is nearly always necessary following the first addition of chlorine. Commercial packinghouses of all sizes should have on hand the means to measure the pH and chlorine content of water and should do so routinely (Rushing, 1986 a,b).

While water contamination is probably the most troublesome source of decay problems, there are other areas of concern. Packinghouses should be cleaned at least once a day. Fruit and vegetables should not be left on the floor, under machinery, etc. until they rot. A single rotten item may be the source of millions of decay-causing spores which may in turn infect other commodities. This is true for decay or damaged plant material in the field as well. Grierson and Wardowski (1987) reported on the impact of good sanitation practices on postharvest losses of subtropical fruits and vegetables.

Rough Handling

The hand that harvests a fruit or vegetable can, in one brief moment, negate all other factors to deliver a high quality product to the consumer. Damage such as cuts, bruises, scratches, punctures, stem plugs, etc. causes the respiration rate to increase, detracts from the appearance, and provides a point of entry for pathogens. All steps in the handling system should be analyzed for potential problems. Sharp edges on field crates, packingline equipment, etc. should be eliminated. Containers should be moved or dumped gently to reduce bruising. Everyone who works in the postharvest sectors, especially harvest workers, must be made aware of the cost of their mistakes.

During the hot days that prevailed in South Carolina during the summer of 1987, I observed bruise marks on nearly 40% of the tomatoes passing over a

commercial packingline on one particular afternoon. The bruises fit the pattern of a picker's thumb and two fingers. These fruits deteriorated rapidly. A combination of picker negligence, hot weather, and turgid fruit (grown on plastic mulch with drip irrigation) seemed to be the source of the trouble. Every horticultural crop has special harvesting and handling considerations that must be identified.

In the California melon industry, cantaloupes are usually transported in bulk from the field to the packinghouse. The truck is emptied by opening a trap door and letting the melons roll down a long (approximately 10 meters) ramp to a conveyor, where some of them split as they strike the bottom. When we went to the cull line, we found that most of the physical damage was a result of improper dumping.

Another example of rough handling is the practice of overpacking cartons. That commonly occurs in the U.S. sweet potato industry. While sweet potatoes are more durable than most horticultural commodities, they still may be damaged in transit. The carton, not the commodity, should support the weight of cartons stacked on top.

Rough handling is a management problem, and therefore may be easier to overcome for the micro market than for the large commercial farmer. In small farming systems, the manager can take the time to work with each individual employee to ensure that correct handling practices are performed.

Value-Added Processing

Almost any postharvest procedure that increases the worth of a commodity is referred to today as "value-added processing." The value-added industry in the U.S. amounts to about 700 billion dollars (U.S.) annually, most of which is spent beyond the farm gate (Liska, 1988). To increase returns to limited resource farmers, the U.S. Cooperative Extension Service is encouraging them to become involved in postharvest procedures, thus eliminating some of the middle-men who are pocketing profits. Typically, a product that is worth x dollars at the farm gate is worth 2x after packing. At the retail level, the price is 5-6x what the farmer was paid due to the cost of cooling, shipping, etc. and the losses that occur along the way. The farmer, who nurtured the crop for weeks or months, receives only a fraction of what the consumer ultimately pays. By selling directly to micro markets, or by actually operating a micro market, producers can bypass conventional channels to increase their own revenues.

To direct-market horticultural commodities, some value-added procedures may be required. Packing is an essential practice for some items. When feasible, field packing is recommended because the amount of bulk transport and resulting injury is reduced. If light washing is necessary, products may be wiped clean with a damp cloth using chlorinated water. Field packing should not have to be done while squatting on the ground. A simple packing stand has been described that is relatively inexpensive, portable, versatile, and requires no special accommodations (Grierson and Wardowski 1987). If packing is to be followed by precooling to remove field heat, containers must withstand the rigors of the cooling method.

Packaging has a different meaning than simply packing. Packaging implies

that the product is placed in family or individual-sized portions. While packaging may be unnecessary for some micro markets, such as roadside stands, it may be essential for others, such as aristocratic or convenience food. Fresh cut, ready-to-eat, prepackaged vegetables are increasingly popular in the U.S. (Zind, 1988). The same principle is applied throughout the Caribbean, where heads of lettuce or cabbage are cut in half and individually wrapped for retail sale. Innovative packaging cannot replace temperature management, but in many case it can delay senescence and improve the appearance of the product (McGregor, 1987).

Initiation of ripening of selected commodities can be done on the farm prior to delivery to a micro market. I have worked with two different small farms in South Carolina, one produces kiwi-fruit, the other a fall tomato crop, to build ripening rooms on the farm. A source of ethylene and a closed room are the main requirements. Certain safety measures in the use of ethylene are required.

Educational Effort

Extension effort on postharvest management is essential to assist limited resource growers of agronomic crops to shift to production of horticultural commodities. Knowledgeable, intensive management is the key to success. Last year I observed, in a Barbados grocery, that grapefruit and tomatoes (both chilling sensitive) were displayed in a refrigerated counter. On an unrefrigerated isle counter were broccoli and cauliflower, both of which should be cooled to near 1°C. Obviously the problem originated with a produce manager who was unfamiliar with appropriate storage temperatures. Similar situations can be found throughout the U.S. Today's emphasis on quality has made the produce business even more competitive than before. Everyone who handles the product should be informed of the appropriate procedures to ensure quality maintenance.

CONCLUSIONS

The basic principles of postharvest management that apply to volume handlers of horticultural commodities also apply to those who deal with micro markets. The finest quality is obtained by practicing good temperature management, minimizing rough handling, and implementing effective sanitation practices. Small-scale handlers may be in a better position to carry out these procedures than volume dealers because fewer people are involved in the system, thus the educational process is simplified.

Limited resource farmers have viable options with regard to value-added processing of their crops. These options are dependent on which markets can be identified. An understanding of the importance of management is a prerequisite for anyone who considers doing business in postharvest horticulture.

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