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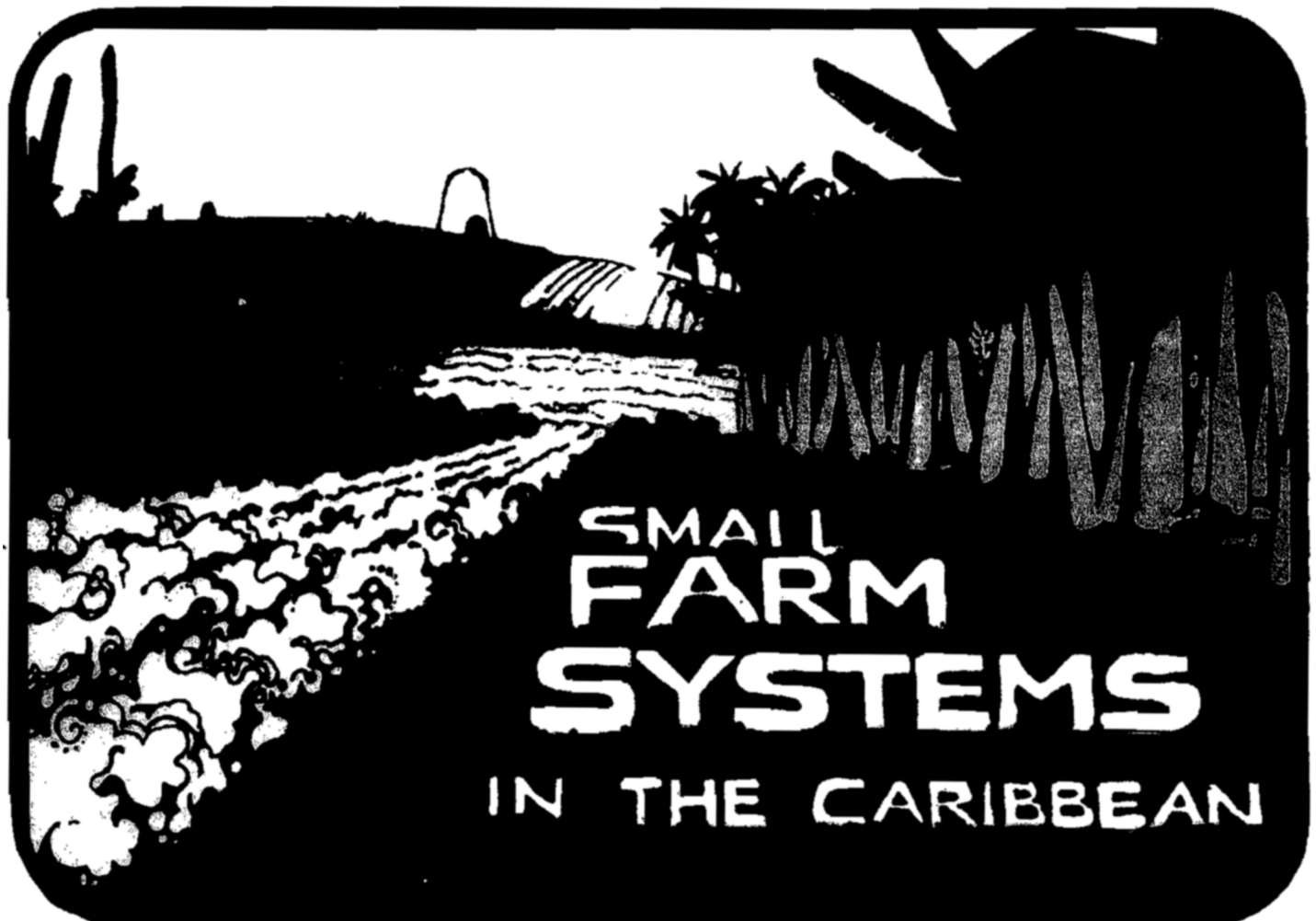
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Post Harvest Losses in Fruits and Vegetables, Their Extent and Methods of Control

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Post-harvest losses in fruits, vegetables, food crops and other perishable commodities, if effectively controlled, could feed millions of people now suffering from hunger and malnutrition in many parts of the world. Probably the heaviest losses occur in fruits and vegetables. Mature fruits and vegetables are highly susceptible to invasion by specific pathogenic micro-organisms. This is because they have a high water and nutrient content. After harvest they are no longer protected by the intrinsic factors which make them resistant during their development on the plant. Growth cracks and mechanical injuries during harvest, transport and storage are also responsible for the losses. The losses vary between various

types of fruits and in different seasons of the year. The losses in the soft fruits during the summer months in a tropical region would be far more than in winters in the same area. To meet the world's current and future food demand many developmental programs aimed at increased production and population control have long been initiated all over the world. In the recent years, the potential to control the post-harvest losses has also been recognised as an effective means of increasing the capacity of current level of production to feed the existing and the ever increasing population. There is now a better appreciation of the problem both among producer and consumer alike.

If post-harvest losses in food crops and other perishable commodities were effectively controlled, millions of people now suffering from hunger and malnutrition in many parts of the world could be fed. Probably the heaviest losses occur in fruits and vegetables. Mature fruits and vegetables are highly susceptible to invasion by specific pathogenic micro-organisms, because they have a high water and nutrient content. After harvest they are no longer protected by the intrinsic factors which make them resistant during their development on the plant.

Growth cracks and mechanical injuries during harvest, transport and storage are also responsible for losses. These losses occur both in developing and developed countries but in different proportions. The losses also vary between various types of fruits and in different seasons of the year.

Many developmental programs, aimed at increased production and population control, have been initiated all over the world to meet the world's current and future food demand.

In the recent years, the potential to control post-harvest losses has also been recognised as an effective means of increasing the capacity of current level of production to feed the existing and the ever increasing population. There is now a better appreciation of the problem among producers and consumers alike.

Post-Harvest Losses Defined

Although the demarcation line between the production losses and post-harvest losses is not very clearly drawn, the errors in distinguishing between the two are not great. The post-harvest losses have been defined as losses which occur between the time the fruit or vegetable is separated from the parent plant and when it is eaten. Fruit falling on the ground and left as such are also regarded as production losses. The same fruit is, however, regarded as a post-harvest loss if no marker can be found. In contrast, if for any reason the crop is not harvested, it is regarded as a production loss.

Causes of Post-Harvest Losses

Production of horticultural crops is far from factory operations where everything can be planned beforehand. Agro-climatic con-

ditions and other environmental factors like temperature, relative humidity, level of fungus spores and the presence of other disease carrying organisms, storage conditions, and care during handling and transport determine the degree of post-harvest losses. These losses should not be regarded as the inevitable price which must be paid for produce, because proper application of the available techniques can reduce post-harvest losses to a very low level.

Various Types of Post-Harvest Losses

Growing quality fruits for export is much more than just planning trees and waiting for a rich harvest. A lot of skill is needed both in production and in the preparation of the produce.

As mentioned above, there could be many reasons to start the deterioration process. They can broadly be classified into the following categories:

Post-Harvest Losses Due to Physiological Factors

Generally, horticulture is the most important production sector in the Caribbean region, and therefore, the problem of post-harvest losses has to be given important consideration.

Fruits and vegetables continue their respiratory process even after they are harvested. The rate of respiration very much depends upon the environmental conditions prevailing after harvest. The respiration is mainly an oxidation process which increases the level of carbon dioxide and water and leads to the formation of energy. This chemical energy is required to perform the various essential catabolic and anabolic processes. After harvest, the respiration process in fruits and vegetables is not very efficient, as it is not backed up by the natural photosynthesis process through the leaves. The fruits and vegetables, therefore, give off energy in the form of heat, technically called "vital heat." Abnormal physiological processes lead to serious losses in food value or even non-parasitic diseases like bitter pit or scald of apples.

Adverse atmospheric conditions after harvest, *i.e.*, excessive cold or heat, could be responsible for chilling or heat injuries in fruits and vegetables. Rate of respiration can be controlled by keeping the temperature within safe limits. Temperature requirements vary considerably not only between species but even

in different varieties. There is a different safe temperature range for tropical and temperate fruits. Tropical fruits like pineapples, bananas, pawpaws, etc., may be injured at temperatures below 15°C, whereas apples, peaches, plums, etc., may be stored at temperatures lower than 5-6°C.

Post-Harvest Losses Due to Improper Handling During Transport and Storage

It is generally believed that fresh produce can't be handled or harvested without inflicting injuries, but with careful ground-work and precaution, the damage can be appreciably minimised. Frequently, the injuries appear in the form of abrasions, cuts or bruises. When the commodities are injured there is a marked rise in the evolution of carbon dioxide or uptake of oxygen. The cells very close to the injury point which are not killed in the process, respire much faster. This increase in the rate of respiration is said to be responsible for production of certain compounds which offer resistance against microbial attack.

The evolution of the ethylene gas from the wounded part could trigger ripening among the injured fruits and/or nearby sound fruits stored in the same box, room or hold.

During harvest, produce may get abrasion or cut injuries. Abrasion injuries result from friction between two fruits, fruit and the walls of a box, conveyor belt, etc. Cuts may result from contact with a sharp object or from fingernails of harvesters/handlers. Produce like ground provisions, which most of the time are cut from the parent plant, are left with open wounds. They are the most vulnerable spots for the hibernation of post-harvest pathogens resulting in various type of rots, etc. Injuries should, therefore, be kept minimum both in number and severity.

Bruises usually occur by impact or by compression. This results in the death of the outer cells which ultimately develop into brown patches, making the commodity very unattractive in appearance. While making a quality assessment, factors like appearance, size, shape, skin texture and blemishes are collectively taken into account.

Post-Harvest Losses Due to Pre- and Post-Harvest Diseases

Virtually every fruit and vegetable is susceptible to at least one of the post-harvest diseases initiated at a cut stem.

The important casual organisms responsible for deterioration of quality are fungi, bacteria and viruses. In the case of vegetables, bacteria are mostly responsible for serious nutritional and quality losses. The deterioration can be checked by proper chemical treatment, etc. However, chemical treatment will only help if the pathogen has not penetrated deep into the host tissue. The moment rotting takes place, the level of ethylene generation increases, which causes healthy fruit to ripen prematurely and may transfer pathogens to them. Deep seated, latent pre-harvest infections initiated during the development of fruits in the plantation are hard to eradicate. Knowledge of the time and mechanism of infection of the crop is essential for the development of an effective program for controlling a post-harvest disease.

Heating the surface of some fruits to a few degrees below the injury threshold has been shown to eradicate or delay the development of incipient infections. It is a relatively simple, low cost method, leaving no chemical residues. Brief hot water treatment does not increase refrigeration loan substantially because only surface cells of produce are heated.

Measures to Reduce Post-Harvest Losses

Efficient Marketing System

All factors remaining the same, the shorter the time between harvest and consumption, the lower the post-harvest losses. An efficient marketing system suiting the local conditions has to be built and every link in the long marketing channel has to be given

very careful consideration. Speed is the most important single factor which affords access to increasingly remote markets and consumer centers. Side by side, a suitable fruit processing line has to be developed which could preserve the marketable surpluses, culls and varieties not suitable for export or home consumption.

Improvement in Post-Harvest Handling Technique

With the application of modern technology in grading, packing, transport and warehousing, a big breakthrough in the conservation of fruits and vegetables has been possible. Even rural commercialisation is carried out in packing plants located in the production zone. It is now possible to transport highly perishable commodities like grapes, lettuce, bananas, strawberries and avocado pears to distant markets without an appreciable loss. This, however, requires installation of modern, sophisticated equipment requiring heavy capital investment. In some cases the cost of transport and handling, etc., far exceeds the cost of production. Post-harvest manipulations can only affect metabolic transformation of chemical compounds already present, but any imbalance will result in unsatisfactory post-harvest qualities.

Temperature management is very important and is the first step towards the conservation of fruits and vegetables. Cooling or removal of field heat is a very effective means of achieving the goal. By lowering the temperature, the rate of respiration is considerably reduced as is the onset of post-harvest diseases.

Care During Preparation for the Market

The exporting technique or post-harvest treatment used very much depends on the geographical position and the requirements of the market.

Production and marketing of produce can't be considered in isolation. Protection of the produce should start right in the field, i.e., immediately after harvest, and continue until the fruits are consumed. Grading and standardization are important reference factors in the world market. Sorting fruits by maturity and size, and removing injured ones are therefore very important.

Fruits mature in a relatively short space of time and if they are harvested ripe they may have a very short post-harvest life. Some fruits, like apples, oranges, etc., are waxed to seal in the freshness and natural flavour and to give a good sheen.

The produce should be stored in clean, lined bins or bins with a smooth surface. Overfilling should be avoided. Fruits exposed to the sun can attain a temperature many degrees above the air temperature. The temperature attained depends upon the surface, storage conditions and colour of the produce. If a tarpaulin is to be used to cover the fruits during transport, it should be clean, a light colour, and placed in a way to allow circulation of the air so as to avoid warming the commodities. Occasional wetting of the tarpaulin is also recommended. Field sanitation is equally important. If flowing water is not used for washing, water quickly gets polluted and in a short time develops a high concentration of fungal spores which can further inoculate the injured fruits.

Excessive and indiscriminate dumping of fruits must be avoided at all costs as it leads to excessive injury. The grading or sorting room should be well lit so that the workers can clearly see all the fruits and remove the injured and defective ones. During packing, the fruit should be immobilized so as to avoid transit motion. This can be achieved by wrapping the fruit and carefully packing it in the cartons, packing trays, padding, etc. Precautions to safeguard fruits against impacts or compression should be followed.

Determination of Losses

It has been very difficult to build any reliable data on the magnitude of the post-harvest losses. This is because it is so very different in extent under various conditions and can vary from shipment to shipment and from fruit to fruit over a period of time.

The estimates are obtained by applying a variety of methods. In doing so, terms like assessment, measurement and estimates have often been used. Assessment is completely subjective, while measurement is an objective determination of the samples selected. Estimation, on the other hand, is the interpretation of measurement from which all losses can be extrapolated. The losses can be measured in monetary terms at various steps of the marketing chain. They can also be measured and expressed by percentage of units or loss of weight. The loss is deemed to have

occurred only after the unit is considered unfit for human consumption. There are many factors like socio-economic level of consumers, visual assessment of quality factors like moisture loss, consumer appeal, etc., which determine whether the fruit is fit or unfit for human consumption.

An assessment by the National Academy of Science, Washington, D.C., and the Food and Agriculture Organisation of the United Nations of the extent of post-harvest losses in fruits and vegetables in some developing countries, reveals that in some cases the post-harvest losses are as low as 5%, whereas in others they are as high as 50%.

The study further establishes the magnitude of the problem and the urgent need to take effective control measures to check the post-harvest losses in fruits and vegetables.