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MEMORIAS
COMPTES-RENDUS
PROCEEDINGS



Caribbean Food Crops Society

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(fabrication), dépendront de nombreuses variables à effets réciproques, lesquelles ne seront pas obligatoirement favorables en un endroit donné. Le contexte général d'opération sur petite échelle, et par conséquent de bas revenus, est, en soi, un obstacle. Afin de fournir une plus grande capacité laquelle, à son tour, rendra accessibles les moyens d'acquérir les systèmes essentiels de transformation, une reorganisation ou une nouvelle localité est indispensable, par le biais d'une action soit volontaire, soit involontaire.

Les conditions de base pour les industries de fruits et légumes aux Caraïbes sont fondées sur les actifs suivants:

- 1) Un climat idéal tout le long de l'année (pour la production de fruits et légumes)
- 2) De l'eau en abondance (dans la plupart des zones)
- 3) Des matériaux d'emballage à bon marché
- 4) Un potentiel infini pour la fabrication de récipients en verre

L'énergie est potentiellement une menace sérieuse, mais qui peut être maniée avec succès en ayant recours au bois, suivant la tradition du Tiers Monde comme un supplément aux combustibles actuels.

Technological Criteria for Locating Small-Scale

Fruit and Vegetable Processing Factories

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INTRODUCTION

Generalizations about the Caribbean States and Territories are fallacious, in view of the diversity of regional life, and disparities in infra-structural preparation. Nevertheless, if technology has indeed been identified as the key to mankind's progress (Burkart, 1979), then processing and fabricating technology is the new development frontier in most of Caribbean agriculture. At this secondary production level, technological criteria will dictate the rate and extent of advances, notwithstanding economic and political exigencies. The prerequisite of success is a thorough investigation of the indigenous, largely unexploited, resource base and its supporting systems and services that range from non-existent to adequate throughout the region.

Advances in fruit and vegetable processing technology will be predicated on numerous, interacting variables, and not all of them will be favourable in a given instance. The best compromises will be an eclectic integration of the old empiricism with modern scientific approaches. Such an undertaking pre-supposes finite objectives and

a domestic technical capability to develop, adapt and apply novel methodologies in pursuit of those objectives. It pre-supposes also a post-colonial revision of perspective; for whereas, previously, the production motive was the exportation of raw commodities and their return as goods with increased value, it is or should now be retention and conservation of the total food resources. Any technology that contributes to this end, within the limits of affordable cost, appropriate technology.

Indeed, the high cost of the simplest technology is itself an encumbrance to industrializing the local food supply. Quite often, horticultural projects are unavoidably small in scale, with consequently low returns from inadequate financing. This operating context has the potential to obstruct progress in fruit and vegetable processing, because existing factories must necessarily be of appropriately low capacity, and therefore are unable to generate enough revenue for acquiring, operating and maintaining suitable equipment and skilled employees. Whether by re-organization or re-allocation, through voluntary or involuntary action, fruit and vegetable processing industries will require a level of funding that will provide barely adequate processing systems (e.g., refrigeration, dehydration, packaging) and competent personnel. Though these, technology will find useful expression.

DISCUSSION

The Indigenous Resource Base

Climate. Climate is the primary, distinguishing feature of the freest vegetable-producing regions, and the most important elements are temperature, rainfall and humidity (Thompson, 1949). The Caribbean experiences favourable growing conditions yearlong, although to varying degrees, different weather patterns from place to place have substantially influenced farming practices. Specific processing requirements will therefore differ with the crop specialties.

The Caribbean outdoors is a natural dehydration system that can be economically applied to fruit and vegetable processing under controlled conditions.

Raw products. One goal of regional horticultural industries is to replace assorted imports of a high quality with local substitutes. The latter could be of comparable quality. Technology cannot create a superior product from inferior produce.

Phenotype and cultivation history are widely acknowledged to be the earliest determinant of quality of horticultural produce. It should be expected, therefore, that the best fruits and vegetables will derive from those systems of primary production that incorporate modern science and technology (e.g., genetics, fertilization and irrigation) in the production mechanism.

Tropical diurnal temperatures, by their influence on moisture loss and respiratory heat accumulation, are especially inimical to good vegetable quality which becomes objectionable at a 5-10% reduction of weight (Ryall and Werner, 1972). Excessive heat in the micro-environment of the harvested produce may also result in a prematurely cooked texture in the surface tissues.

Once a wholesome supply of raw commodities has been assured, maintaining a high quality after processing will depend on conditions of handling, holding and trans-

porting the produce during the post-harvest, preprocessing interval. In communities with limited means, deleterious physiological changes may be retarded or arrested by substantially shortening the time between harvesting and processing. Locating the factory within the environs of the growing district would be one way to accomplish this, while simultaneously effecting economies, as a consequence of reduced transportation needs. Proximity to the production site would also obviate the need for elaborate raw-product storage space, since the processing operations could be sustained directly from the field.

The water supply. Man operations in fruit and vegetable processing require large volumes of water. Washing and rinsing alone (Table 1) may account for one-half the total consumption (NCA, 1971). Sources of processing water are municipal reservoirs, and in the case of the rural Caribbean, wells and surface catchments. Regardless of source, the water should meet potable standards. Its composition will vary with depth and will determine the degree of treatment necessary. Shallow wells are characteristically softer than deep wells, but are more likely to be biologically contaminated. Deep wells quite possibly will contain minerals, e.g., sulfur, calcium, magnesium sulfates, chlorides, and bicarbonates that have implications for texture and odor of processed fruits and vegetables.

A copious supply of water is desirable for hydro-cooling, the practice of rapidly dissipating field and respiratory heat from harvested fruit and vegetable matter by immersion or spraying.

Water, in one or more of its three states, is an indispensable heating, cooling and cleaning medium in a fruit and vegetable processing factory. Its usage is variable within and between plants. Nevertheless, the magnitude of its demand warrants the consideration of reliable and perhaps independent sources, where low seasonal rainfall consistently limits the flow, or when high residential and tourist requirements are apt to be given priority.

TABLE 1*
USE OF WATER IN WASHING FRUITS AND VEGETABLES.

Product	Function	Water Used Gal/ton
Green beans	tank and spray	52
	flume	108
Beets	primary wash flume	100
Carrots	primary wash flume	90
Corn	washer and silker	212
Fruits	spray	385
Peas	wash and flume	1200
Potatoes	spray	2500
Tomatoes	wash	1320

* Ref.: excerpted from National Canners Association, 1971.

Energy. Energy is vital to fruit and vegetable processing, an industry that is sixth in the United States in total consumption (Unger, 1975). Conventional processing energy, mostly in the form of heat, is directly and indirectly provided by fossil fuels. Unfortunately, their availability is now becoming quite tenuous, and their cost, prohibitive. As a result, serious attention is currently being given to the rejuvenation of old technologies, e.g., wind power (Price and Weeks), minihydroelectric plants (NRAES, 1978) and solar energy (Canner Packer, 1977; Lemaire, 1978), some if not all of which are still feasible in the Caribbean. Steffgen (1974) proposed a wastes-to-fuel conversion industry, utilizing animal feedlot manure, crop production for fuel, and urban and industrial refuse. Many bio-gas plants are already functioning throughout the developing nations (McDowel, 1979).

The sale of wood is re-emerging as a viable business in most rural communities of New York State. Nine-tenths of the Third World depend on it as a chief source of fuel (NRAES, 1977). It has for a very long time been the mainstay of the baking industry in some parts of the Caribbean. So has bagasse, in providing a fraction of the energy requirement for extracting and refining sugar. In consideration of the future cost and availability of fossil fuels, rural, Caribbean, fruit and vegetable processors need to be mindful of an adjacent, inexpensive source of renewable energy, viz. wood, to fuel the operations.

Packaging materials. The simplest function of a package is to protect fruit and vegetable matter from environmental hazards, until the time when it is consumed. Packaging materials vary from a thin film of wax to rigid containers. They are another consideration when establishing a fruit and vegetable processing industry.

Many indigenous materials, e.g., palm fronds, coir and bamboo, are already fabricated into useful items in the non-agricultural sectors. They can be woven into durable packages for transporting some fruits and vegetables. Other materials, e.g., dried grass and corn husks, can act as packing material to absorb mechanical shock during transport. As the stage of processing is advanced, rigid containers, e.g., tin and glass, will become necessary. The Ball Plan (Ball Brothers Food Technology, Inc., Muncie, Indiana) recommends glass, where national incomes are low, because of the advantages connected with re-use. It is noteworthy that the Caribbean is abundantly enriched with silica, the basic component of glass, whose purity sometimes exceeds 99% regionally.

FOOD PROCESSING WASTES

Liquid effluent. Inasmuch as millions of gallons of water are used in fruit and vegetable processing, millions of gallons of waste-water are discharged. This effluent often contains solute that is capable of contaminating the environment. With exceptions (e.g., Figure 1), the organic fraction of this solute will be readily amenable to biological amelioration under tropical conditions. The inorganic fraction tends ultimately to accumulate with time wherever these discharges terminate.

Solid waste. Solid waste is a voluminous by-product of fruit and vegetable processing. Much of it may be converted directly to an adequate form of utilizable heat by dehydration and low-temperature pyrolysis (Table II). The Caribbean environment would be an advantage in evaporating the moisture without elaborate drying facilities.

TABLE II*
Proximate Analysis of Grape and Apple Press- Cake

	%	
	Apple	Grape
Moisture ^a (105°C)	76	69
Soluble carbohydrates ^b	35	29
Crude fiber ^b	26	18
Ash ^b	1	6

^a Wet weight basis. ^b Dry weight basis.

Gross Heat of Combustion of Fuel Items

Items	Btu/lb
Grape press-cake (dried at 105°C)	8.367
Apple press-cake (dried at 105°C)	7.960
Grape pyrolyzate	10.564
Apple pyrolyzate	11.506
Grape charcoal briquet	11.470
Apple charcoal briquet	11.522
Commercial briquet	12.832

* Ref.: Walter and Sherman, 1976.

Siting a fruit and vegetable factory is therefore critical, not only from the standpoint of resource inputs but also of waste outputs and their implications for surrounding water, land and vegetation.

OTHER CRITERIA

Technological considerations have been isolated for the purpose of focusing attention on natural assets and liabilities, when planning a factory for processing horticultural crops. They cannot by themselves portend success or failure. Other criteria, e.g. labour supply, market potential, legislation, regulation, and the cost of capital are qualifying, albeit meaningless factors in the absence of an adequate technological basis. The foremost criterion, however, will be the social consequences of the decision to proceed, or not, to advance horticultural industries by technological means, into the secondary, stages of production where the real social and monetary rewards accrue.

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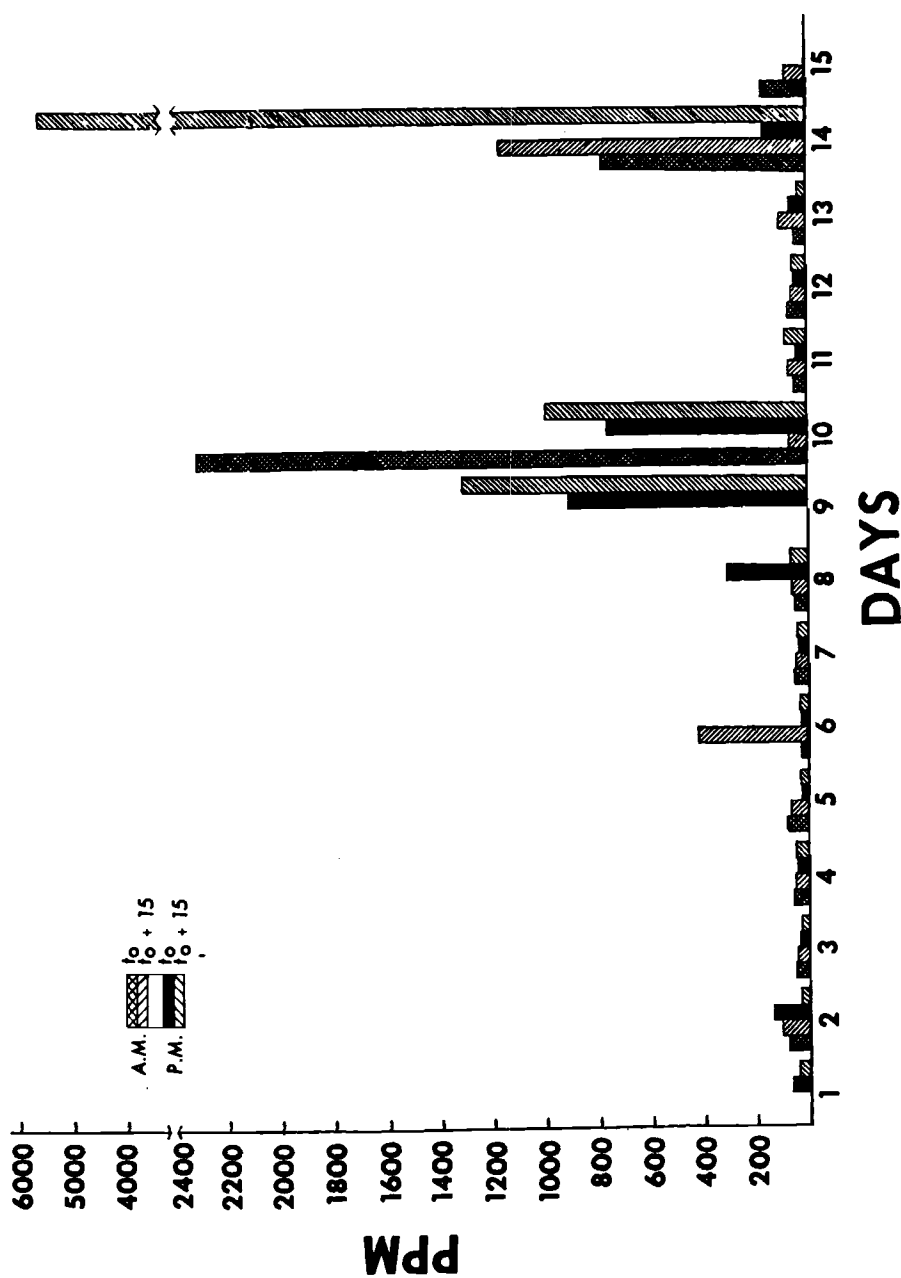


Figure 1. Petroleum-based lubricant profile of a confluent discharge from can-cooling retorts, during a 15-day interval in 1977, sampled daily at 10:00 a.m. (t_0), 10:15 a.m. ($t_0 + 15$), 2:00 p.m. (t_0) and 2:15 p.m. ($t_0 + 15$).