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A MODEL FOR THE DEVELOPMENT OF THE BREADFRUIT INDUSTRY IN THE CARIBBEAN

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INTRODUCTION

The breadfruit, Artocarpus altilis (Park.) Fosberg (syn. A. communis J.R. and G. Forst, A. incisa L.F.), a native to the Indo-Malay peninsula and possibly the South-Western Pacific region, was introduced to the Caribbean since the 18th century. The seeded form, called breadnut or chataigne, was in Martinique since the 1750's and taken to Jamaica in 1782. The much more popular seedless fruits were introduced to St. Vincent and Jamaica in 1793, and then spread to neighboring territories (Leakey, 1977). Today the Caribbean is recognized as an area where breadfruit is an important food crop although production is small in comparison with that of the South Pacific territories, South East Asia and to a lesser extent, Central America.

CURRENT STATUS

The usefulness of the breadfruit as a starchy food is based on its high carbohydrate content which ranges from 20 to 28% in mature fruits (Leakey, op. cit.). The trees occur either in natural groves in gullies and abandoned estates or as single trees in small farmer holdings and in backyards. They are given minimal attention, if any, but generally grow well especially in high rainfall areas. There are indications that the number of trees and, consequently, production, have declined over the past three to four decades. For example, there were an estimated 2.3 million trees in Jamaica in 1958, which declined to 46,000 in 1987 and to half of this latter figure in 1988 after hurricane Gilbert. Thus, production also fell from 131,610 MT in 1958 to 5,600 MT in 1987. (Ministry of Agriculture, Jamaica, 1989; Leakey, op. cit.). Up-to-date information on breadfruit populations is not available for the entire Eastern Caribbean, but some decline is likely since there have never been any serious replanting programmes.

It is against this background of unplanned and declining production, and non-existent management that an export trade has developed firstly to regional markets, and more recently, to North America and Western Europe. Export statistics for certain territories are presented in Table 1. Consequently, breadfruit is now recognized as a non-traditional export crop and has been included in the diversification programmes of several territories. However, if this export trade is to survive and flourish, and if the tree's full potential is to be realized, then plans must be formulated in the very near future for the development of a breadfruit industry. It is to this end that a model for the development of the industry is being proposed. Furthermore, the model seeks to provide a framework within which

Table 1. Breadfruit exports from the Caribbean to extra-regional markets, kg

Territory	1985	1986	1987	1988	1989	1990
Jamaica	121,260	121,966	247,425	196,065	68,419	143,092
St. Lucia						
Dominica	-	310	-	-		
Trinidad & Tobago	-	2,309	3,662	-		

- Statistics unavailable.

recently initiated research activities on this neglected crop can be better focused.

THE MODEL

The major objective in designing this model of a breadfruit industry is to achieve and ensure long-term sustainability of higher levels of production of the crop. The model thus encompasses not only the production aspect, but also other components necessary to support production. The following components are included (Fig. 1):

- Crop utilization system
- Marketing system
- Production system
- Post-harvest handling system
- Institutional support system

CROP UTILIZATION

This aspect of the industry is being considered first because it is the factor which creates, and most directly affects, demand. By far, the most important use of breadfruit in the Caribbean is for human consumption. Available data on breadfruit consumption are presented in Table 2. It is unlikely that this picture of significantly low and declining levels of local breadfruit consumption has changed over the past two decades. This reduced importance as a staple, is directly linked to declining production and strong preference for other carbohydrate sources such as rice and white potatoes, especially in territories like Trinidad and Tobago where breadfruit is consumed mainly as a side dish. The first goal, therefore, is to stimulate higher levels of domestic consumption not only because of the need for greater self-sufficiency in food and because the local and regional markets are likely to remain dominant for some time yet, but also because through migration, they will influence significantly the demand in the export market.

Table 2. A comparison of levels of consumption of breadfruit, cassava, yams and sweet potato in Jamaica and Barbados.

Territory	Year	Per capita consumption (kg/yr)			
		Bread-fruit	Cassava	Yams	Sweet potato
Jamaica	1966	34.5	5.7	3.9	-
	1969	17.1	5.1	30.9	-
	1971	17.3	8.1	58.6	-
Barbados	1966	12.0	-	31.4	29.9
	1969	11.2	-	40.9	20.3
	1971	3.7	-	42.4	25.7

Source: Leakey (op. cit.).

Breadfruit is prepared mainly by washing, boiling, steaming or baking the fresh fruit. Since the crop is seasonal and also has a short shelf-life it is necessary to consider processing as an approach to minimizing the problem of availability. A number of products have been developed which also meet consumer requirements for convenience and these should be further explored for commercialization where possible. These include:

- * Frozen slices - work was initiated in Trinidad by Passam (1981) and continued more recently in Jamaica, where the effects of different methods of cooking, prior to vacuum packing and flash freezing, on long term eating quality were investigated (Scientific Research Council, Newmall, 1990).
- * Canned slices - breadfruit slices in brine have been exported from Jamaica (Swaby, 1981) and work has also been done in Dominica (Leakey op. cit.).
- * Dehydrated slices - (Reeve, 1974).
- * Flour - this is a traditional product used in making porridge. Commercial techniques for its production have been developed and it can be used in the manufacture of composite flours for a wide range of baked products (Swaby, op. cit.). It can also provide a basis for breakfast foods.
- * Snacks - work on breadfruit chips and extruded products has been conducted in Trinidad (Lewis, 1984) and Puerto Rico (Matthews, 1986).
- * Preserves - the male inflorescence is candied.

All the above products except preserves, utilize the mature unripe breadfruit. Utilization of the ripe fruit should be explored. The seeded form is consumed as a curried vegetable when immature and the mature seeds

as a snack mainly in Trinidad and Tobago, and Guyana. More widespread consumption should be encouraged.

Other forms of utilization which should be explored and encouraged where commercially viable include:

- * Livestock feed - this is a traditional use for ripe fruit. Fruits can also be utilized for preparing pellets or, as has been developed in Montserrat, as flour meal. Utilization of the wastes from processing and the ensilage of leaves should also be explored.
- * Industrial and other uses
 - Starch which may find use in textile manufacture, has been manufactured from the breadfruit in Brazil.
 - The tree trunks yield a light, strong, durable, termite resistant wood which is used in construction and furniture-making in some territories.
 - Bark cloth is a traditional product in the South Pacific, and may be considered for use in the handicraft industry in the Caribbean.
 - The latex has been used in the South Pacific traditionally for caulking ships and for chewing gum.
 - Various parts of the tree have been used for medicinal purposes in the treatment of conditions ranging from skin disorders and diarrhea to hypertension and sciatica.

THE MARKETING SYSTEM

The major initial objective of this component in the model is to secure a large market share for the fresh and processed breadfruit. A second objective, which caters for the possible expansion of foreign market demand beyond the production capability of exporting Caribbean territories, is the creation of the market perception that the Caribbean breadfruit is of the highest quality and therefore, a first choice that can command a premium price over breadfruit from elsewhere. Two major considerations in this regard are:

- * To promote utilization through proper marketing - this includes quality products which meet consumer requirements as far as possible, promotion inclusive of attractive and convenient packaging, proper merchandising in fresh produce markets and supermarkets and competitive pricing. With respect to the extra-regional markets demand should be stimulated not only within West Indian communities but also among other migrants who may be familiar with the crop and among the wider market. The important role that can be played by the tourist industry in the Caribbean, in promoting breadfruit utilization should not be ignored.

- * To improve availability - since this is a bulky, low-priced commodity, approaches must be found for it to compete more successfully for limited cargo space with higher valued items. One possibility is the marketing of smaller (1-1.5 kg) mature fruit to spread transportation costs while simultaneously attempting to increase the cargo space available. The fresh fruit is also subject to a short shelf-life which can encourage small consumer purchases. Therefore, rapid transportation to market is a necessity which should be combined with efficient storage. Some territories with significant production potential for example, Dominica and St. Vincent, do not have international airline connections and while this problem must be addressed, the advantages offered by processed products in terms of higher value, less bulkiness and longer storageability should also be exploited.

THE PRODUCTION SYSTEM

The objective of this component is to supply the market requirement for breadfruit in terms of quantity, quality and regularity, and to achieve this in the most cost-effective manner possible. Cost-effectiveness relates not only to higher farm revenues and competitive prices, but also to the long-term economic and social costs and the use of natural resources.

The major elements of this system are:

- * Location
- * Germplasm selection
- * Planting material supply
- * Cropping system
- * Crop management technology
- * Harvesting

Location.

The choice of a proper location is one of the major factors in the cost-effective production of any crop. Because of the requirements of breadfruit for high rainfall and properly drained conditions, and given the high price of flat land, in the Caribbean, upland or hillside cultivation of breadfruit is advocated. Such locations should be properly sheltered and measures to control erosion effected.

Germplasm Selection.

This is undoubtedly one of, if not the most important, factor determining success with perennial crops as the breadfruit, since it determines the extent to which the market requirements can be fulfilled. Important considerations in cultivar selection include:

- * Fruit characteristics - the end use is important; there is need for research to define the characteristics required for fresh versus processed forms.

- * Tree characteristics - this will influence the cropping system, plant population, management practices and harvesting; dwarf or relatively short trees will be preferred.
- * Generally desirable characteristics - high yield, early bearing, pest and disease resistance, adaptation to local physical conditions.

Though the breadfruit germplasm base in the Caribbean appears small, there is a wide range of germplasm in the South Pacific from which to select. However, the Caribbean germplasm should be assessed to identify desirable characteristics which must be preserved and negative traits which can be eliminated or minimized by new introductions. A number of accessions have been recently introduced to Jamaica and work on the local germplasm identification has been initiated at UWI.

Planting Material Supply.

This is a most important input for establishing a breadfruit industry as that being proposed, since it will allow intensive cultivation of desirable varieties and facilitate an overall increase in tree population. Several methods are available for vegetative propagation of breadfruit including the use of:

- * Suckers - the traditional method but this is not suitable for commercial purposes;
- * Root cuttings - a more commercially suitable method already employed in several territories but there is need for improvement in the technique and research is on-going at the UWI and CARDI.

Other possibilities which demand further exploration are stem cuttings since these have certain potential advantages over root cuttings, budding, grafting, and tissue culture.

Cropping Systems.

For upland cultivation an agroforestry system in which breadfruit is strip-cropped with forest species is being recommended. Large-sink plantings should be established on a phased basis with short-term intercrops during the establishment stage to provide a cash flow and for soil protection. Root crops should be avoided since, during harvest, breadfruit roots may be damaged. These intercrops can be removed when the breadfruit trees come into bearing. Mature trees which become unmanageable in terms of height, should be removed, and possibly used for timber, and the area replanted. Another suitable system is intercropping with other perennial crops as is done at present with bananas and coconuts. Both systems closely imitate the ecological systems in which breadfruit is grown in the Caribbean thereby minimizing the likelihood of serious pests and disease problems and facilitating easy implementation.

Crop Management Technology.

The major considerations are:

- * Plant population - populations of 200 to 270 trees ha⁻¹, with spacings as close as 6m x 6m are envisaged for pure stand plantings, while 100 to 150 trees ha⁻¹ should be suitable for permanently intercropped breadfruit cultivation. Root suckers should be removed as they arise.
- * Tree size control - this is especially important given the plant populations recommended. Approaches include the use of dwarf cultivars, encouragement of a low-bearing habit, training and pruning. Some pruning trials have already been initiated by the Caribbean Agricultural Research and Development Institutel. The effect of subsequent regrowth on canopy architecture and the effect of routine pruning on production costs need to be evaluated.
- * Pest and disease control - pests are generally not a problem in the Caribbean. Mealybugs have been reported as a pest in the French West Indies (Paris et al., 1974 and). The fruitfly is a problem in Australia (Drew, 1976) and this should be regarded as a quarantine risk. Similarly, disease problems are not widespread in the Region, but some are of potential importance. A breadfruit decline, mainly in mature trees, has been observed in Jamaica and Montserrat and research studies are being conducted at the UWI, to determine the causative agent(s) and suitable methods of control. Other diseases include root rot in Trinidad and Grenada, anthracnose on fruits, red root rot (Stump rot) caused by the pathogen Ganoderma philippi which is present in Jamaica. Indications are that most of these problems can be controlled by enforcement of proper plant quarantine regulations and by cultural and chemical control.
- * Fertilizer - traditionally, nails are inserted in unthrifty trees, supposedly to supply iron. The effects of trace element deficiencies need to be examined and fertilizer requirements determined.

Harvesting.

Currently breadfruit is harvested by shaking the tree and allowing the fruit to fall to the ground; this method results in high post-harvest losses. Improved methods such as the use of fruit pickers need to be encouraged.

Research activities are in progress at the Cave Hill Campus, UWI (Worrell, 1991) to determine maturity indices for the breadfruit using indices such as skin colour, degree of expansion of the polygons on the

¹Andrews, personal communication.

skin surface, surface texture and latex flow. There is need to extend this study to all commercially important varieties or types.

Furthermore, fruit to be exported should be harvested on the same day of shipment, preferably in the early morning kept in the shade and transported from the field as soon as possible to minimize field heat and prolong shelf-life.

POSTHARVEST HANDLING SYSTEM

The aim of this component is to get fruit of the best quality to market, and to prolong storage and shelf-life. Therefore, marketeers and relevant organizations must put operations and facilities in place to meet these objectives. At present the major post-harvest operations are washing, drying, sorting, grading and packaging. A pre-cooling step, using air or water, is sometimes included², and as expected small fruits cool faster. There is need, however, to avoid chilling injury.

Low temperature storage has been shown to prolong shelf-life beyond the normal 3 to 4 days. According to Worrell (op. cit.) the best results are obtained under conditions of low temperature and high humidity since this reduces weight loss and darkness of the skin. Sankat (1991) has also shown that controlled atmosphere storage can be successfully used to prolong shelf-life but this method is expensive. Modified Atmosphere Packaging using films has been found by Worrell (op.cit.) to be not only cheaper but also effective since storage life can be prolonged to 3 weeks. There is need for these studies to continue since the ability to prolong storage will increase availability of the fruit and make possible cheaper shipment by sea.

INSTITUTIONAL SUPPORT SYSTEM

The banana industry in the Caribbean has developed as an important contributor to, and in the case of some Eastern Caribbean territories, the major source of foreign exchange earnings because of the level of institutional support it receives. Any other crop which is targeted as an important export crop must have similar support, and since the development of the non-traditional export crops such as breadfruit, is driven more by our need to diversify our agricultural sector rather than by the market this support system must be indigenous.

The development of a breadfruit industry will require support in the following areas:

- * Market information - producers, processors, marketeers need to be aware of new market opportunities, prices, consumer requirements;

²Campbell, personal communication.

- * Input supply - access to suitable land and planting material supply are two immediate requirements;
- * Credit - this is especially important for the initial establishment phase;
- * Infrastructure - international transportation and post-harvest facilities are two of the most pressing requirements in some Eastern Caribbean territories;
- * Research and extension - all of the foregoing components of the model point to the need for intense research to generate the kind of information for the development of sound strategies in every area of the industry. Such information generation must be linked to an extension service which would function to disseminate information to end-users and to relay research needs back to the researchers.

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