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PRODUCTION AND POST HARVEST ASPECTS OF THE INTEGRATED EXPORT SYSTEM

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INTRODUCTION

Barbados, as part of its diversification effort, has sought, over the past four years, to increase the market size for non-sugar commodities. The major thrust has been in the area of extra-regional exports.

In addition to yams and sweet potatoes which have been exporting for many years, crops like sweet pepper (*Capsicum annum*), eggplant (*Solanum melongena*), yam bean (*Pachyrhizus erosus*) and yardlong bean (*Vigna sesquipedalis*) are now being shipped during the winter season. Breadfruit is shipped May to September, and hot pepper and okra on a year-round basis.

Experience during this period has shown that the successful export of produce to extra-regional markets does not simply "happen"--it involves a very complex system, and each component of that system must be carefully planned if markets are to be successfully penetrated, and the market retained.

Ad hoc arrangements, such as attempting to fill an order from scattered plantings of existing crops intended for the local market, will usually fail. Timeliness of delivery and continuity of supply are key factors in the sophisticated extra-regional market system, and it is clear that these cannot be achieved if this ad hoc arrangement is employed, since the required quantity may be available the first week, but only half the next week, and none the third week and so on. This approach will eventually lead to loss of the market.

PRODUCTION SCHEDULING

A systematic approach based on precise production scheduling is of the utmost importance in the export system. When an exporter makes contact with a potential extra-regional buyer, the following information should be obtained:

- o Product to be shipped
- o Quality specifications (variety, size, etc.)
- o Quantity to be supplied
- o Period of supply
- o Type of packaging required
- o Weight required in each carton
- o Labelling required on cartons
- o Expected price to be paid for produce

The exporter must then decide whether it is feasible to export the crop for the price offered, taking into consideration costs of growing, local

transport, packaging, storage, freight and handling. If it is in fact feasible, then the first date of shipment should be decided.

Growers who have the necessary capability to produce according to the specifications should then be approached to grow the produce under contract. A definite planting schedule based on expected yields, time to maturity, and yield distribution over the harvest period must then be drawn up. This will ensure that an adequate acreage is grown to supply the buyer's requirements continuously over the specified period.

SELECTION OF GROWERS

Growers are not always over-enthusiastic about entering the export programme since prices offered are much lower than those which they are accustomed to receive on the local market. It is therefore often necessary to work with these growers to compile cost of production figures and to demonstrate to them that profits can be made as long as the recommended agronomic practices are adhered to so that high yields of good quality produce can be obtained. In addition, it must be pointed out to them that the volumes which they are able to dispose of on the export market are far in excess of those which can be marketed locally.

Contracts are important both from the point of view of the grower and the buyer. The buyer needs the contract since experience has shown that a grower may agree verbally to produce crops for the export market, but if prices are favourable on the local market when crops reach maturity, he will ignore the agreement and sell locally, thus upsetting the export schedule. On the other hand, the grower can safeguard himself by signing a contract which assures him a guaranteed price for a specified quantity and quality of produce.

The precise timing of planting, which is essential, means that selected growers should be large enough to have their own equipment and thus have control over the timing of their operations. If cultivation has to be done by contractors, delays of up to 2 months may be experienced causing the planting schedule, and ultimately the continuity of supply, to be severely affected. In addition, reduced quantities of produce may cause negotiated freight rates to increase which could in turn make the whole operation unprofitable.

This would suggest that an export programme is best based on a core of large growers who have more control over production, supported by a number of small growers.

IRRIGATION

It is desirable for growers involved in export to have irrigation facilities since the timely application of water is in most cases critical to production. With most crops adequate moisture is necessary for uniform germination and plant stands while with sweet peppers, for example, moisture stress during flowering and fruit development will reduce yields. Pepper flowers remain open for only about 24 to 30 hours, so short periods of adverse conditions, such as moisture stress, can affect fruit set and therefore yield. Flowers and young fruit may fall during long dry periods.

A regular moisture supply is also advisable to encourage uniform, vigorous plant development and adequate foliage. This helps to protect fruit from sunscald and bird damage which are two common causes of rejection of sweet peppers for export.

Dry conditions during harvest can result in the production of soft, flaccid fruit unsuitable for export. Irrigation should therefore continue during harvest to maintain fruit in a turgid condition.

WEED CONTROL

Weed control is extremely important if high yields of good quality crop are to be produced. Apart from competing with the crop for moisture and nutrients, weeds encourage insect attacks which will reduce crop quality and result in high rates of rejection.

In Barbados, in general, the large growers who rotate their vegetable plantings with sugarcane have been more successful in the production of crops for export. Small farmers have usually had their land in vegetables continuously and hence the land is in poor condition with very high weed populations. These small growers have been encouraged to irrigate their fields after cultivation, then to apply pre-plant herbicides such as paraquat or glyphosate to destroy the initial weed population. This treatment may then be followed by the application of a pre-emergent herbicide. If this is not done, and the crop is planted immediately after cultivation, the first irrigation results in severe weed competition particularly if the crop is direct-seeded.

CROP RECOMMENDATIONS MANUAL

When growers have been selected, they should be supplied with Production and Post-harvest Handling Manuals which explain in detail the specific variety of crop to be used, the expected yield, seed treatment, seeding rate, planting method, irrigation and fertilizer requirements, weed control, insect and disease control, harvest method, post-harvest handling and on-farm sorting of produce.

It is important to realize that even growers who have been producing vegetables for a number of years will need these manuals since producing a crop for the export market is vastly different from producing it for the local market where consumer taste is less sophisticated.

If the export market is to be successfully penetrated, crops must be offered on that market at competitive prices. These prices can only be achieved if management is efficient and high yields of good quality produce can be attained. Close monitoring of growers by extension agronomists will assist in this respect.

Some growers tend to neglect their export crops because they are receiving prices which they consider to be low, but these prices in most cases allow growers to produce at a profit as long as crops are well managed.

Thinning of Crops: Most crops, even when planted with the precision seeder, will require some thinning. However, growers, particularly small

growers, appear reluctant to thin crops since it involves destruction of plants. This is most often seen with okras where as many as five plants may be seen growing at one station. This leads to severe competition, weak plants and reduced yields.

Windbreaks: In Barbados, crops are badly affected by hot, dry and often salt-laden, winds. The use of temporary windbreaks such as sorghum, corn or sugar cane at intervals in fields has been recommended. This practice has been observed to conserve moisture and result in better crop quality. The frequency of windbreaks must coincide with the number of beds which can be covered with tractor mounted crop protection equipment, e.g., if a boom sprayer covers 5 beds in a pass, the windbreaks may be put on every 11th bed, allowing 2 passes to the boom sprayer between windbreaks. The growth of crops on beds directly adjacent to windbreaks has in some cases been retarded by the windbreaks, but it is generally agreed that the advantages of windbreaks outweigh these disadvantages.

Crop Protection: Timely spraying of crops against pests and diseases is important for high yields and good quality. With okras and hot peppers for example, sucking insects attack the fruit, causing bumps or galls which make the fruit unmarketable. The insects must be controlled early before they move from the leaves on to the fruit. Pest control using chemicals such as the pyrethroids, which have a short residual period, should be continued during the harvest period to maintain crop quality.

Aphid attacks on sweet peppers can cause considerable problems in the packhouse since the honeydew and sooty mould which result from these attacks are difficult to wipe from fruit and consequently productivity decreases and packing costs increase. Aphids (*Aphis gossypii*) are easily controlled if the recommended spray programme is diligently followed and populations are not allowed to build up.

Corn ear-worm (*Heliothis zea*) is another pest which has caused serious problems on sweet peppers in the Barbados export programme. This pest must be controlled early which means that growers must scout fields frequently, so as to detect the first signs of the problem. If not controlled promptly, the pest will enter through the calyx of the fruit, bacterial soft rot will follow, and the entire fruit will collapse. The rotting may occur on the farm, at the packhouse or worst of all, after the produce reaches the buyer. If this occurs, there is a good possibility that the market will be lost.

Some farmers tend to spend less on crop protection chemicals in order to reduce their cost of production. This is not wise, since increased returns are obtained not by spending less on inputs, but by increasing yields, and this is achieved by efficient management.

Maturity and Harvesting: A good quality crop can be completely ruined if harvesting is not carefully supervised. With sweet peppers for example, the stage of maturity is important. Only mature green fruit should be harvested for export. These should be fully green, shiny and firm enough that they do not yield to moderate pressure from the fingers. If immature fruits are picked, they lose water rapidly after harvest and become flaccid and unmarketable by the time they reach the buyer.

The majority of markets accept only green or red peppers, and will not buy "turning" fruit. Under local conditions and using the varieties California Wonder, Gilroy King, Florida VR2 and Keystone Resistant Giant, fruits which are fully red have been generally too soft for export. In addition, anthracnose damage is often a problem with these ripe fruits.

Mechanical damage from jewellery, fingernails, and secateurs is another problem often experienced during harvest. With sweet peppers in particular, where fruit may be borne in clusters, careless use of secateurs can result in extensive fruit damage and consequent rejection at the packhouse. In fact, in the Barbados programme 50% of a grower's supply of high quality fruit had to be rejected one week because of mechanical damage during harvest. The damage, although seemingly minor, will in most cases lead to bacterial soft rot by the time the produce reaches the buyer.

Efficient methods of harvest are important in order to reduce costs of production and increase profitability. With crops like okra and hot pepper, where harvesting is labour intensive, use of a picking bag worn over the shoulders is beneficial since it allows both hands of the picker to be free, and speed of harvest can be considerably increased. The bag may also be divided into 2 sections thus allowing preliminary sorting of the fruit to be done in the field.

Harvesting is best carried out during the cool morning hours when fruits are turgid. In addition, field heat is lowest at this time and refrigeration costs to remove this heat can be kept to a minimum.

POST-HARVEST HANDLING

Efficient handling of produce after harvest is important if the necessary high quality required for the export market is to be achieved. Growers are encouraged to erect temporary covered sheds adjacent to fields so that the crops can be placed under shaded conditions from the time they are harvested until they are transported to the packhouse.

Ventilated plastic field boxes are the most suitable containers for transport of most types of produce. These allow for adequate air circulation and are easily stacked to avoid damage to produce. However, it is important not to pack boxes tightly, particularly in the case of sweet peppers and eggplant which are easily bruised by excessive pressure. Sanitation of these field boxes is important. A regular wash with a bleach solution should prevent the build up of disease organisms which could contaminate produce.

Covered, well-ventilated transport is also essential to maintain produce quality. Growers do not fully appreciate the far reaching effects of high temperatures and have been reluctant to improve their handling and transport methods. Consequently, pulp temperatures of over 90°F have been recorded for eggplants destined for export.

Produce must be cleaned, graded and packaged promptly on arrival at the packhouse so that the packed produce can be cooled without delay. During the first years of export, sweet peppers were cooled in field boxes on arrival from the grower, then packed and returned to the cold storage. This was found to be unsatisfactory since considerable condensation and subsequent

spoilage occurred when the cooled fruit was packed under ambient conditions.

Graders can cause further damage to produce if they are not well trained and supervised. Jewellery, fingernails and secateurs as well as throwing, and dropping of produce can cause damage which although not immediately noticeable, will show up later as spoilage at the buyer's end.

Lack of adequate cooling facilities often leads to the use of refrigerated vehicles for removal of field heat from produce. However, this method is not fully satisfactory since forced air circulation is necessary for the adequate removal of field heat. Refrigerated vehicles do not provide this and are designed only to maintain the cold chain during transit.

Cooling rooms may also be used for storage of produce by adjusting the air flow after the initial cooling period. It is probably advisable to have a number of smaller cold rooms rather than one large room since crops vary in their storage temperature requirements, and gases, such as ethylene, which are produced by some crops, may adversely affect the quality of others.

Humidity is another important factor in storage. A balance must be struck between conditions which will cause desiccation of produce and those which will encourage fungal attacks. Sanitation is important in this respect, and cold storage facilities should be disinfected at regular intervals.

Correct stacking of cartons for cooling is important. Spaces should be left between rows of cartons and around the cartons to allow adequate passage of cool air through the produce rather than around it.

SUPPORTING RESEARCH FOR EXPORT PROGRAMME

A continuing research effort is necessary to solve the variety of problems which cause high rejection rates in the export programme.

In Barbados, viruses, bacterial spot (*Xanthomonas vesicatoria*) and bird damage are the most severe constraints to the production of high quality sweet peppers. Some preliminary research has been done by CARDI with regard to the virus problem, and two varieties Florida VR2 and Gilroy King which showed some tolerance to viruses were grown on a commercial scale during 1985. However, the use of hot water and sodium hypochlorite seed treatments followed by in-field spraying with copper and maneb formulations has not in most cases controlled bacterial spot adequately. Further research is required in this area.

With eggplant, two problems--greening and scabbing of fruit--have become increasingly prevalent over the past 2 years, causing phenomenal rejection rates. Preliminary observations of a number of varieties indicates no varietal tolerance, and while the greening would appear to be caused by early insect damage at the flower stage, the scabbing problem remains unsolved. Workers elsewhere have suggested mite damage as a possible cause, but there was no evidence of mites in the crops when the problem occurred. Further investigations are being carried out by CARDI after discussion with members of staff of the Crop Science Department of the University of the West Indies.

In conclusion, it must be emphasized that the change from sugar production, or even vegetable production for the local market, to production for the extra-regional export market is a major one and education of those involved in all the steps of the system is an obsolete necessity. Growers must also realize that their responsibility does not end when they deliver produce to the packhouse. The results of poor agronomic practices may not show up immediately but could cause the loss of a market. Therefore every effort should be made by growers to follow recommendations which will result in the production of the quality and quantity of crop which the market requires.

APPENDIX I

Summary of Production and Post-Harvest Handling Recommendations for Sweet Peppers for Export

VARIETIES

California Wonder #3
California Wonder 300
Keystone Resistant Giant
Gilroy King

YIELD

Varies with management but 22,000 kg/ha obtainable during 6-8 weeks harvest period.

SEED TREATMENT

Hot water treatment at 52°C for 30 minutes or treat with Sodium Hypochlorite solution (1 qt per 1 gallon water to treat 1 lb seed). Rinse and allow to dry.

SEED RATE

2.7 - 3.5 kg/ha - direct seeded.
1.4 - 2.0 kg/ha - transplanting.

GERMINATION

8 - 10 days

SPACING

2 rows per 152 or 168 cm bed. Space plants 23 - 30 cm apart in the row.

SEASONALITY

Can be grown all year round with irrigation, but bacterial spot is more prevalent in wet weather. Fruit set is reduced at day temperatures above 32°C or nights below 15°C.

DURATION OF CROPS

Varies slightly with variety but harvest can usually begin 10-12 weeks after sowing.

FERTILIZER

500 kg/ha 12:12:17+2 at planting and rotavated into the seed bed.
Side dressings of 250 kg/ha 22:0:22 or ammonium sulphate at six weeks and just before harvest.

A complete foliar feed (20:20:20) with most insecticide/fungicide sprays.

Trace elements by foliar application.

Some growers have reported the beneficial effect of the biostimulant "Ergostim" when applied in addition to adequate fertilizer rates.

Apply 680 kg/ha before flowering and after fruit set. Do not apply with copper fungicides.

IRRIGATION

Enough moisture for germination and continued vigorous growth. Moisture stress during flowering and fruit development will reduce yields.

Continue irrigation during harvest to maintain turgidity of fruit.

WINDBREAKS

Are a distinct advantage in protecting the crop from excessive moisture loss caused by hot, dry winds.

WEED CONTROL

Apply bensulide (Prefar) at 16.9 litres/ha as a pre-emergent to clean soil.

INSECT CONTROL - SOIL INSECTS

Apply carbofuran (Furadan 10G) at 33.5 kg/ha or ethoprop (Mocap) at 22.4 to 33.6 kg/ha.

Caterpillars

Malathion (Malathion, Maladrex 5E) at 1.4 litres/ha
or acephate (Orthene 75S) at 1.1 kg/ha
or carbaryl (Sevin 85WP) at 0.8 kg/ha

Thrips

Oxydemeton-methyl (Metasystox R 25E) at 1 litre/ha

Aphids

Acephate (Orthene 75S) at 1.1 kg/ha
or malathion (Malathion, Maladrex 5E) at 1.4 litres/ha

Flea Beetles

Thiodan (Thionex 3E) at 1.4 litres/ha

Corn Earworm

Methomyl (Lannate) at 1.1 litres/ha
or mevinphos (Phosdrin) at 0.8 to 1.1 litres/ha for
quick knockdown during harvest

or any of the pyrethroid insecticides at recommended rates.

INSECT CONTROL - DURING HARVEST

Permethrin (Ambush 50E) at 280 ml/ha
or decamethrin (Decis 2.5E) at 140 ml/ha
or fenvalerate (Belmark 10E) at 0.7 litres/ha
or cypermethrin (Sherpa) at 0.3 litres/ha

DISEASE CONTROL

Damping Off

Avoid overwatering. Use captan (Captan) at 9 kg/ha.

Bacterial Leaf Spot

Use a copper fungicide mixed with maneb at manufacturers recommended rate.

Viruses

Avoid planting close to tomatoes and cucurbits. Wash hands thoroughly after smoking of handling tomatoes. During transplanting, seedlings may be dipped in a solution of milk.

HARVEST

Only fruits which are full-sized, firm and shiny in appearance. Fruit should be removed from the plant with secateurs and not by pulling or twisting them. Avoid damage to fruit by fingernails and jewellery.

All damage or decayed fruit should be removed from the field.

POST HARVEST HANDLING

Place fruit in ventilated field boxes and place in shade. Transport in covered byt ventilated vehicle.

ON-FARM SORTING OR PRODUCE

Peppers should be:

- o well developed;
- o fresh;
- o of good quality;
- o sound - without cracks or damage caused by disease, insects, sunscald, mechanical or other means;
- o clean and reasonably free from foreign matter;
- o free from excessive spray residua.

APPENDIX II

Summary of Production and Post-Harvest Handling Recommendations for Eggplant for Export

VARIETIES

Black Beauty)
Florida Market) - Oval fruit

Long purple - long, slender fruit

YIELD

Depends on variety, management and harvest period. Under good management yields of 22,400 to 28,000 kg/ha can be achieved.

SEED TREATMENT

Hot water treatment at 52°C for 30 minutes.

SEED RATE

1.4 kg/ha if direct seeding
840 gm/ha if transplanting.

GERMINATION

5-7 days after seeding but judge stand at 14 days

SPACING AND PLANTING

Plant 2 rows 60 cm apart per 166 cm bed. Spacing within the row should be 41 cm.

SEASONALITY

Can be grown all year round with irrigation.

DURATION OF CROP

May be harvested 12-15 weeks after direct seeding.

FERTILIZER

A compound fertilizer such as 12:12:17+2 at 500 kg/ha at planting and a top dressing of 250 kg/ha 12:12:17+2 8 weeks after germination.

A complete foliar feed such as "Nutrex" at 3-week intervals if nutrient deficiency symptoms are apparent.

Trace elements may be applied by foliar application along with pesticide mixtures.

The Biostimulant "Ergostim" has been reported by growers to have beneficial effects. Apply at 618 ml/ha before flowering and after fruit set. Do not apply with copper fungicides.

IRRIGATION

Eggplant has a high moisture requirement and responds well to irrigation. Moisture stress during flowering and fruit development will cause reduction in yield.

WINDBREAKS

Young plants extremely susceptible to wind damage so windbreaks are recommended.

WEED CONTROL

Use DCPA (Dacthal) at 11 kg/ha to direct seeded plants at 4-6" in height. Earlier application will cause brittle branches.

INSECT CONTROL

Flea Beetles

Endosulfan (Thionex 3E) at 2.1 litres/ha
or acephate (Orthene 75S) at 1.1 kg/ha
or cartap (Padan) at 1.1 kg/ha
or permethrin (Ambush 50E) at 0.6 litre/ha (0.3 l/ha during harvest)
(or any of the other pyrethroids at manufacturers rates).

Caterpillars

Carbaryl (Sevin 85WP) at 1.7 kg/ha
or permethrin (Ambush 50E) at 28l ml/ha
or any of the other pyrethroids.

Leaf Miners

Dimethoate (Roger 40, Perfekthion) at 1.4 litre/ha
or acephate (Orthene 75S)
or oxydemeton-methyl (Metasystox R) 25E at 1 litre/ha

Mites

Rogor or Metasystox as for leaf miners
or dicofol (Kelthane 3E) at 1.4 litre/ha
Some literature states that Kelthane should not be used on eggplant, but no phytotoxicity has been experienced locally.

DISEASE CONTROL

Phomopsis vexans or
Diaporthe vexans
(Phomopsis blight)

Apply dithiocarbamates, Benlate, Daconil at manufacturers' recommended rates.

Sclerotium rolfsii

Ensure proper drainage. Harvest early. Apply nitrogenous fertilizer. PCNB at manufacturers' recommended rates.

HARVEST

Pick at immature stage when skin is firm and shiny. Fruit should be cut cleanly with secateurs. Fingernail damage should be avoided.

POTS-HARVEST HANDLING

Shade fruit - if not, skin will become dull and fruit will shrivel.

PRELIMINARY SORTING

Fruit should be:

- o fresh;
- o dark violet-black;
- o free from soil;
- o shiny;
- o well developed;
- o sound - without cracks, damage, rots or spray residue.

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