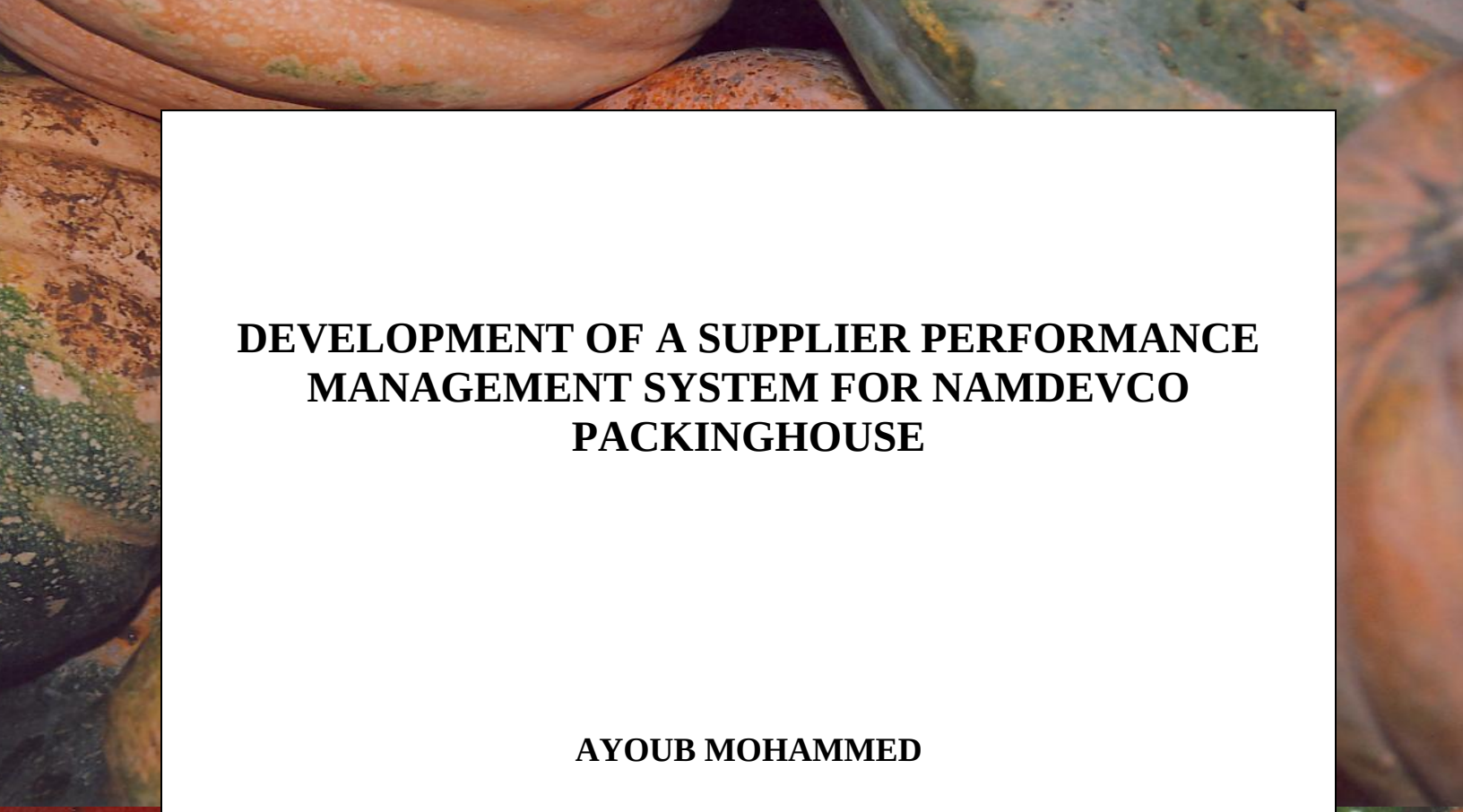

DEVELOPMENT OF A SUPPLIER PERFORMANCE MANAGEMENT SYSTEM FOR NAMDEVCO PACKINGHOUSE

AYOUB MOHAMMED

LEAD CONSULTANT
FRESH TECHNOLOGIES CONSULANCY SERVICES

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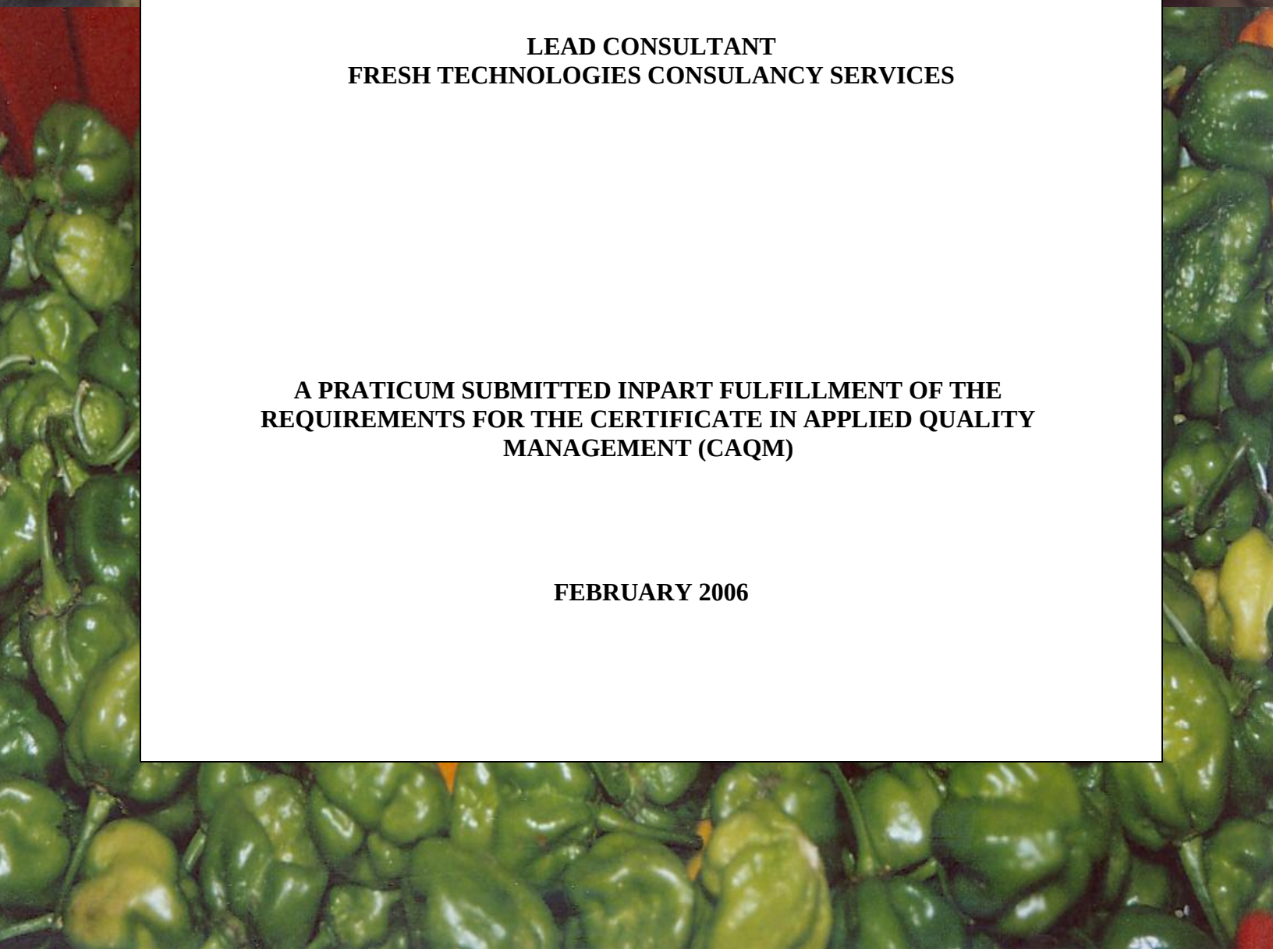


EXECUTIVE SUMMARY

1.0 INTRODUCTION

The National Agricultural Marketing Development Corporation (NAMDEVCO) was established in 1989. It replaced the Central Marketing Agency. The name change was seen as an important first step that reflected a greater role for the Corporation in becoming the chief state agency charged with the responsibility of marketing fresh fruits and vegetables (produce) produced locally as well as marketing of fresh fish. The Corporation is a statutory agency that falls under the purview of the Ministry of Agriculture Lands and Marine Resources. The line minister of that ministry has direct responsibility for the Corporation. The mission of the corporation is embodied in the mission statement "Taking our foods to the world". The Organizational chart of NAMDEVCO is diagrammatically outlined in Figure 1.

Government policies and decisions are relayed to the corporation via the Board of Directors. There are opportunities for the board to influence the direction of the Corporation by making suggestion to the line minister. Board membership reflects the many different stakeholders in the agricultural sector. It include a representative from farmers, a representative from the Ministry of Agriculture, the Corporation's chief executive officer, a representative from the Tobago house of assembly's department of agriculture. The Board chairman is normally a professional with a proven track record in agriculture and is drawn in most cases either from academia or business. There has also been a trend in the recent past to appoint someone with agri-business expertise since the thrust of the corporation is to seek out viable business opportunities for its primary stakeholders in the agricultural sector.

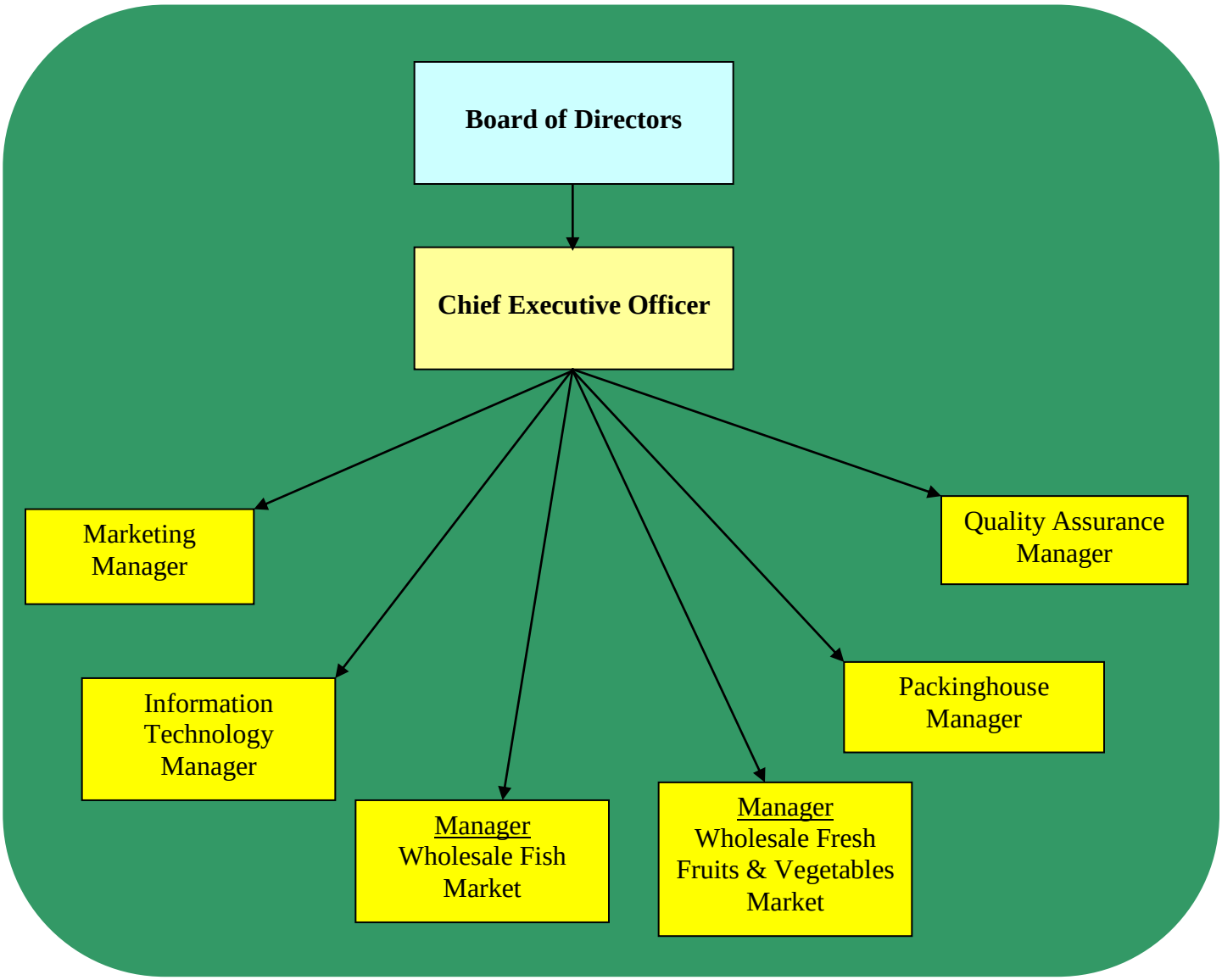


Figure 1. Organization Chart for the Agricultural Marketing Development Corporation (NAMDEVCO).

A number of facilities fall under the direct responsibility of NAMDEVCO. These include:

- The wholesale fishing depot, at Port-of Spain and Carli Bay, Couva.
- The wholesale markets at Debe, Macoya and Port of Spain.
- The NAMDEVCO packinghouse at Piarco.

This practicum focuses its attention on the NAMDEVCO packinghouse

2.0 THE NAMDEVCO PACKINGHOUSE

The NAMDEVCO packinghouse was commissioned in 2000. It was the culmination of at least twelve (12) years from project conceptualization to realization. Following the collapse in oil prices in the mid 1980's a number of new initiatives had to be found in order to meet the demand of the Trinidad and Tobago's economy for valuable foreign exchange. The medium term macro economic framework developed by government in 1989 identified non traditional agricultural export as part of its strategic plan to boost its foreign exchange earnings. At around the same time a number of small entrepreneurs had already started to seek new opportunities in exporting fresh fruits and vegetables. The main products that were exported then were: Hot peppers, the culinary herb cilantro also called culantro or "shado beni", papayas, pumpkins, dasheen leaves. Some exporters targeted the external markets for fisheries products as well. Many of the local exporters failed in their early efforts at exporting non traditional fresh fruits and vegetables. High levels of rejects and sub standard quality were the major factors impeding growth in this sector. It was soon realized, that most of the local exporters were not equipped with the

technical knowledge and proper facilities in order to meet the postharvest technological requirements of the export trade in fresh fruits and vegetables.

In his keynote address to the 1st regional workshop on fresh fruits and vegetables held in 1992, Mr. Oscar Alonzo the then board chairman of the Tourism Development Company suggested that cold storage facilities close to the Piarco international airport would solve the problems that were faced by exporters. The idea was developed and became the responsibility of the NAMDEVCO who had the responsibility from design to management of the facility.

The packinghouse is a state run service facility that seeks to assist fresh produce marketers in meeting the quality requirements of the higher end produce market. The packinghouse primary aim is to ensure that all fresh produce meets the specific postharvest treatments and storage requirements demanded by its clientele. Its clientele include a number of different kinds of entrepreneurs:

- Persons involved in regional markets for fresh fruits and vegetables.
- Persons who target the higher end of the local markets for fresh fruits and vegetables including supermarkets and hotels.
- Persons involved in extra regional markets (mainly U.S.A and Canada).
- Persons interested in the lucrative but highly specialized fresh cut fruits and vegetables market often referred to the minimally processed or convenience fresh food market.

In the context of its strategic plan 2003-2008 NAMDEVCO has identified the packinghouse as one of its key facilities if it is to realize the full potential of its mission 'Taking our foods to the world". As part of meeting its objectives the packinghouse has been set certain targets that it must realize over the next three (3) years in order to become profitable. These include:

1. Increasing its customer base by customizing its customer service.
2. Improving the efficiency of its present operations.
3. Become involved in value added products namely fresh cut (minimally processed fruits and vegetables).
4. Become a facility that is run on the principles of Hazard Analysis Critical Control points (HACCP). The management of the corporation has identified HACCP certification as a major goal if it is to meet the other targets listed before.

The organizational chart of the packinghouse is given in Figure 2.

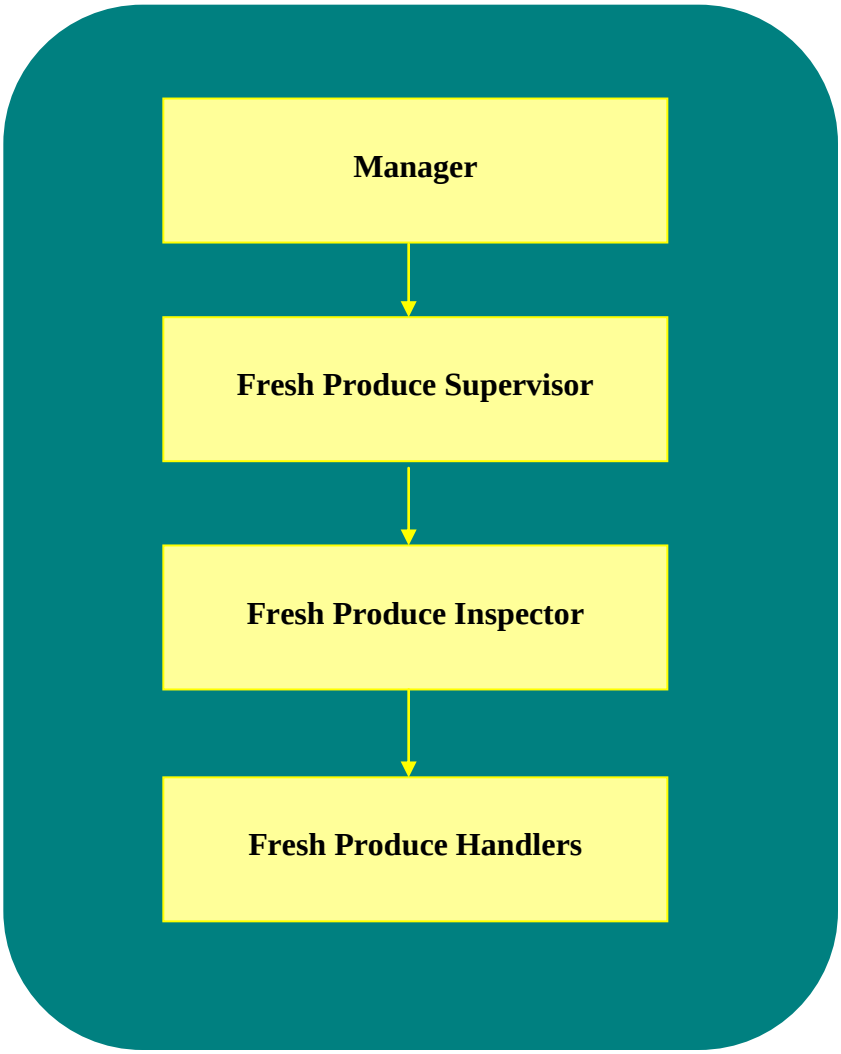


Figure 2. Organization Chart for NAMDEVCO Packinghouse

The packinghouse is run by a manager who accounts directly to the chief executive officer. The manager is in charge of the overall day to day operations of the packing house as well as has responsibility for budgeting, resource management and ensuring the annual targets are met by the facility. In addition the facility has on its staff two inspectors and one supervisor. They are responsible for ensuring the quality of the fresh fruits and vegetables demanded by customers who use the facilities are met. There are fourteen employees who are hired as produce handlers who are directly involved in all the day to day postharvest handling operations conducted at the packinghouse. The supervisor and the inspectors work closely with the produce handlers in ensuring produce quality is maintained.

3.0 PROBLEM STATEMENT

Poor quality fresh fruits and vegetables continue to plague the operations of the NAMDEVCO packinghouse. The levels of rejects for pumpkins and hot peppers, two of company's flagship products are between 15-30%. It is postulated that by analysing the impact of poor quality on suppliers, exporters and packinghouse efficiency a supplier chain management system can be developed to the benefit of all the major stakeholders.

4.0 RATIONALE

No packinghouse facility will realize its full potential if it does put in place a proper supplier management system. In fact a lot of the failures of the early efforts at exporting non traditional fruits and vegetables were in part due to poor quality fresh produce supplied to the exporters, compounded by poor postharvest handling or packinghouse

operations by the exporters themselves. Numerous studies have shown, that losses due to poor handling, along the marketing chain is between 35-75 %. The packinghouse is quite clearly equipped to meet the stringent requirements of international markets, poor quality supplies continue to plague its efficiency and profitability.

A supplier management system for the packinghouse will only be able to be implemented if those who use the facility are convinced of the impact of poor quality on its operations. A key first step is to show the impact that poor quality produce is having on its operations. Following which a systematic system of supplier performance, appraisal and improvement can be developed.

Given the culture of fresh produce handling in Trinidad and Tobago, supplier management system will be a challenge. Apart from cocoa and at one time sugar cane, most farmers pay very little attention to maintaining the quality of the fresh fruits and vegetables that are taken to local market. A comprehensive supply chain management must of necessity take into account the present culture of production field handling and postharvest handling since the new approach takes a systems approach from production to consumption.

Given the nature of the fresh produce trade, exporters seek out multiple growers in order to meet their quota. Because of the use of multiple suppliers, there is a plethora of problems associated with the quality of the produce on arrival at the packinghouse. While basic data has been collected on the quantity of produce received and rejected at the

packinghouse little effort has been made to analyse this data. Data analysis is important if any interventions are to be made on improving the present system. The packinghouse has set a standard that rejects should not exceed 5% of pumpkins and hot peppers received . To date this guideline has not been met by most suppliers. When one examines the operations of the packinghouse, no comprehensive supplier performance system is in place at this time. It is believed that the development of a supplier management system, will go a long way in improving the quality of the produce received at the packinghouse and provide an impetus for gaining market share of these very important markets.

5.0 SCOPE AND OBJECTIVES OF THE STUDY

The study seeks to examine the quality of hot peppers and pumpkins received at the packinghouse which are destined for international markets mainly North American markets. Given the importance of these two crops in the context of export of non traditional exports, it is necessary to have a better understanding of the quality problems that exists. The data that is to be collected and analysed will be used to impress upon suppliers and exporters of the need of ensuring that much is need to improve the quality of the supplies that reach the packinghouse.

The objectives of the present study are as follows:

1. To quantify the percentages of rejected pumpkins and hot peppers received at the packinghouse.
2. To categorize the rejects and express the results using Pareto charts.

3. Use the Pareto charts to identify the major categories of produce rejects and propose appropriate interventions to improve the system.
4. Evaluate the impact of poor fruit quality on packinghouse efficiency.
5. Evaluate the impact of poor quality fruits on exporter cost.
6. Evaluate the impact of poor quality on supplier income.
7. Propose an evaluate intervention strategies to improve the quality using a Plan, Do Check and Act quality improvement model.
8. Use the results obtained, the results of the intervention and best practices available for the crops to develop a supplier management system for the packinghouse for these two commodities.

6.0 IMPORTANCE OF PUMPKIN AND HOT PEPPERS AS NON TRADITIONAL EXPORT COMMODITIES

The tropical pumpkin (*Cucurbita maxima* Duch.) is an important member of the Cucurbitacae family. Other members of this family include squash, watermelon, cucumbers and bitter melon. Tropical pumpkin is also referred to as calabaza on the foreign markets. The crop is an important part of the local diet and is an extremely important export crop on both regional and international markets. In 2004, Trinidad exported over 22000 tonnes of pumpkin which translates into substantial foreign exchange earnings. Having found a niche on foreign markets, the projection is for increased export earnings in the foreseeable future.

While no international codex standard have yet been published for tropical pumpkins

buyers have established certain guidelines. These are listed below:

1. Fruits must not exceed 25-27lbs each
2. They must be free from rots
3. Free from worm holes and worm
4. Free of soil and other organic debris
5. Must be free of cracks
6. Free of bacterial contamination that may compromise human health especially *E.coli* 0157:H7 and salmonella
7. Free from other pathogens that may compromise food safety such as nematodes.
8. Free from bruising with slightly bruised fruits cured before shipping.
9. Free from internal mould and other microbial growth

Hot peppers out of Trinidad are shipped to four major North American markets: Toronto, New York, New Jersey and Miami. Over the last 10-15 years a number of different exporters have targeted this market with varying degrees of success. In 2003 Trinidad exported approximately 2 millions lbs of hot peppers. At the time of writing this practicum, figures for 2004 were not available. What is quite evident is that more new players are interested in capturing a share of this market.

Importers demand a high quality product given that they pay premium prices for the product. The quality criteria demanded by importers are as follows:

1. Must be dark green in colour with an intact green stem
2. Hot peppers must be whole
3. Glossy appearance indicative of fruit freshness
4. .Free from soil
5. Free from decay
6. Free from disease
7. Free from injuries
8. Free from sunburn foreign matter off odour
9. Free from banned pesticides

Given that one of the major regional producers of tropical pumpkin and scotch bonnets hot peppers in the English speaking Caribbean – Jamaica, has lost its North American market Trinidad has the potential to take a greater share of that market once held by Jamaica. It must be borne in mind that international trade in fresh produce requires adherence to very strict quality standards. These quality considerations often reflected by such appeals as “safe food from farm to table” and “food safety begins on the farm”.

Gaining market share in this highly competitive market will be enjoyed only by those who meet the requirements on the international market especially as it relates to food safety and adherence to product standards.

The photographs shown reflect the standard for pumpkins and hot peppers demanded by the North American markets.

IDEAL EXTERNAL FRUIT QUALITY DEMANDED BY NORTH AMERICAN IMPORTERS.

EXPORT QUALITY HOT PEPPERS

7.0 UNIT OPERATIONS.

In order that a supplier management strategy be developed one must first understand the processes involved in each unit operation. This understanding will serve as the basis for supply chain management, will assist quality improvement strategies and serve as the basis for a systems approach to fresh produce management.

Three unit operations are involved from production to storage of pumpkins and hot peppers :

- Production (Field practices)
- Harvesting, field handling and transportation.
- Postharvest handling (packinghouse operations).

In the past, the linkages between these three unit operations were not studied in the context of developing a systems approach to marketing fresh produce. With the new emphasis on food safety and produce quality, it has become incumbent on all countries that seek a share of this highly competitive market to develop systems approach for fresh produce management.

7.1 Field practices (Production)

The key processes that are carried out during production of both hot peppers and pumpkins are given in following process flowchart:

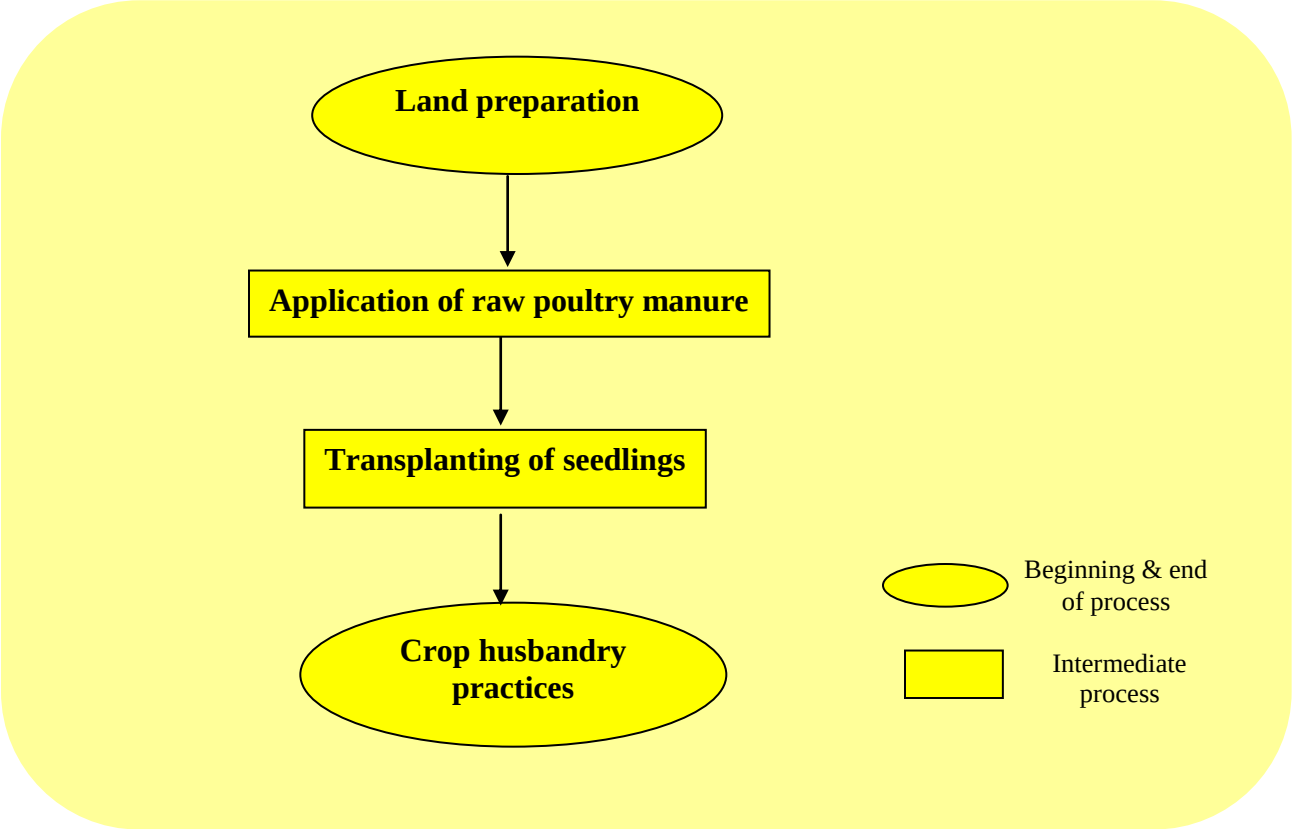


Figure 3: Unit operations during production of pumpkins and hot peppers

The first step that commences production is land preparation. This include land clearing, bed formation, drainage and the addition of soil ameliorants. Most growers are now installing overhead irrigation sprinklers in order to meet the crop water requirement. Raw manure is then broadcasted onto the field. Pumpkins are planted either as seedlings or by direct seeding. Hot peppers are grown from seedlings.

Normal crop husbandry practices including irrigation, fertilizer application, pest and disease control etc. Both pumpkins and hot peppers matures in 3- 3 ½ months and is

ready for harvesting at this stage. Hot peppers will be harvested for approximately six to eight months whereas pumpkins will be harvested within 2- 3 months.

7.2 Harvesting and Field handling.

The key steps involved in this part of the operation, differs markedly for pumpkins and hot peppers.

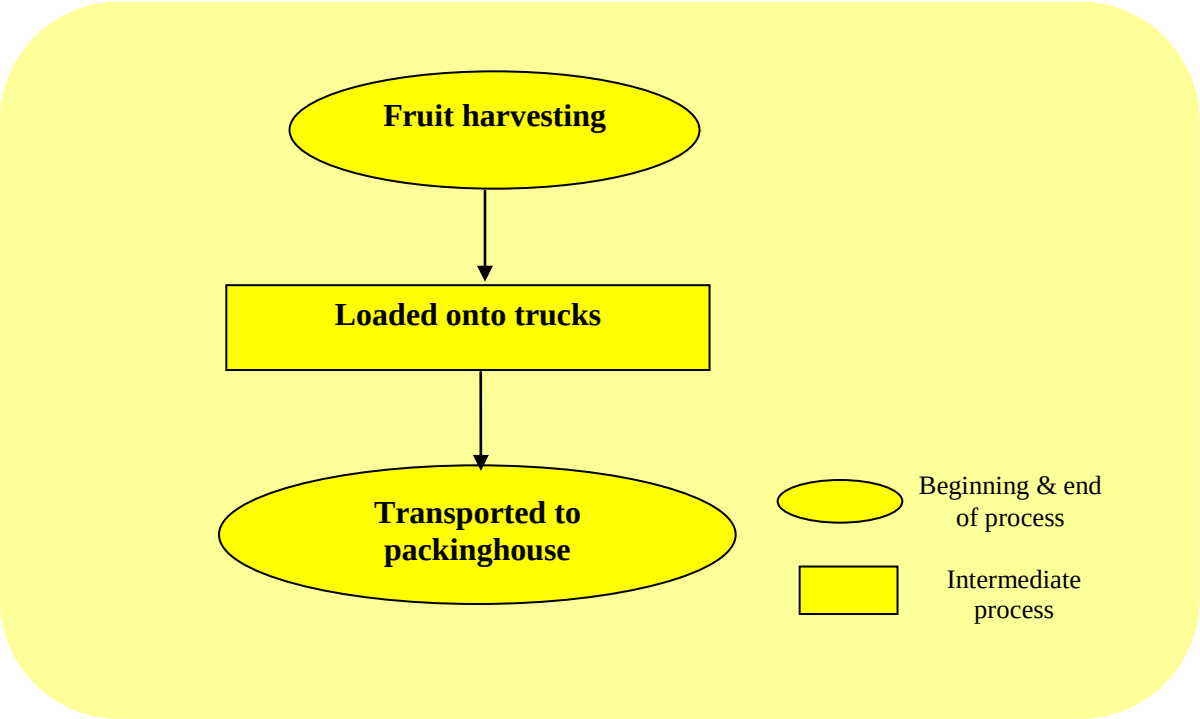


Figure 4: Unit operations during harvesting field handling and transportation of pumpkins

A number of indices are used to assess the maturity of pumpkins. The extent to which these indices are adhered to depends very heavily on the level of experience of the workers involved in the harvesting operations. Under the present system fruits are harvested and thrown to a packer located on a truck. The “catcher” collects the fruits and

places them on the truck. In most cases the fruits are not padded and rough handling is quite commonly observed. The fruits are then transported out of the field to the packinghouse. The steps involved in the field handling of hot peppers are:

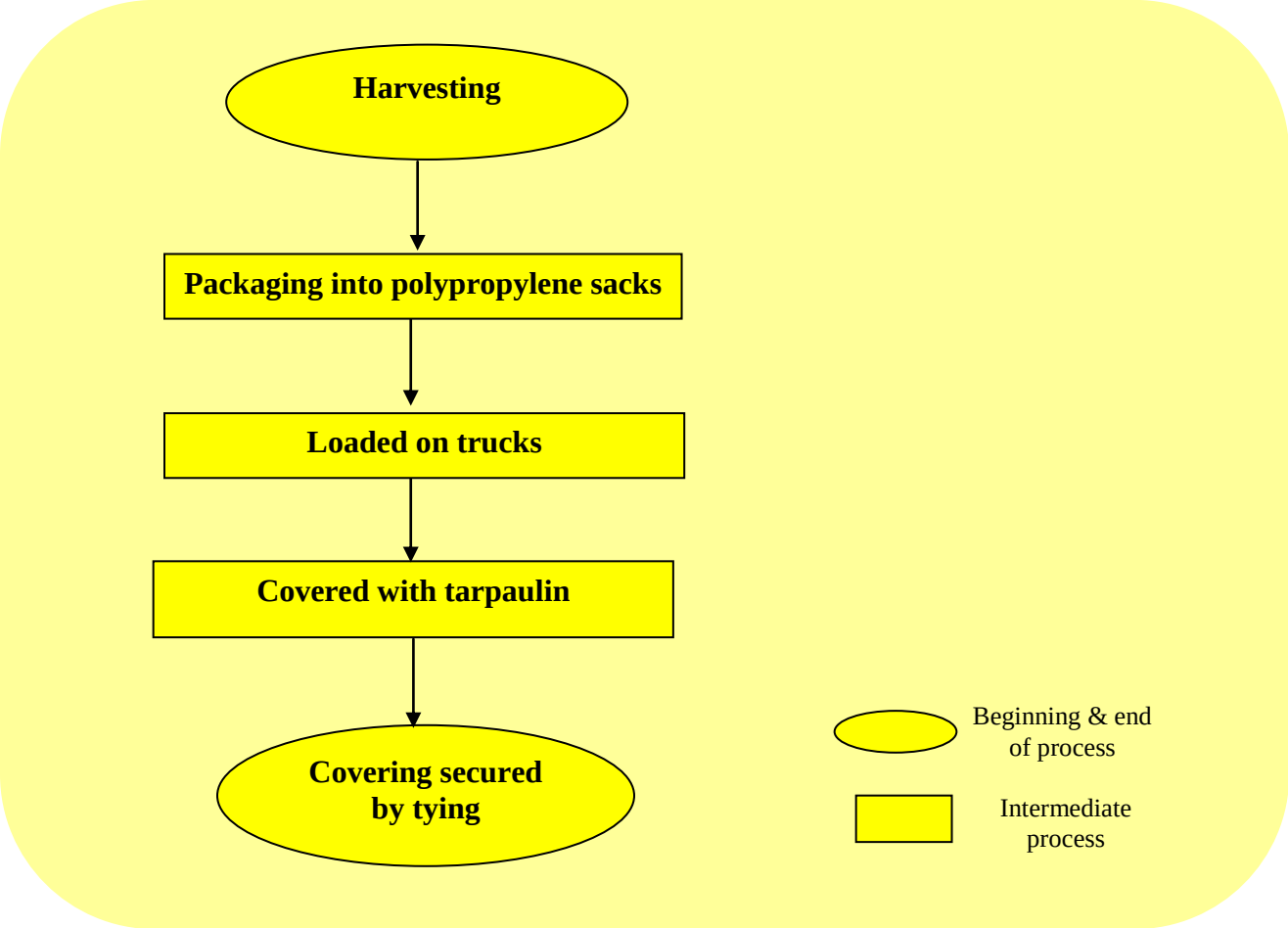


Figure 5: Unit operations during harvesting, field handling and storage of hot peppers

Fruits are harvested at mature green. At this stage they are dark green. They are placed in sacks, tied to prevent spillage and stacked two to three layers high on flat bed trucks.

7.3 Packinghouse (Postharvest Handling Operations)

As is the case with field handling operations the postharvest handling operations or packinghouse operations are quite different for both crops. The important handling steps at this stage of the operation for pumpkins is given in the following flow chart.

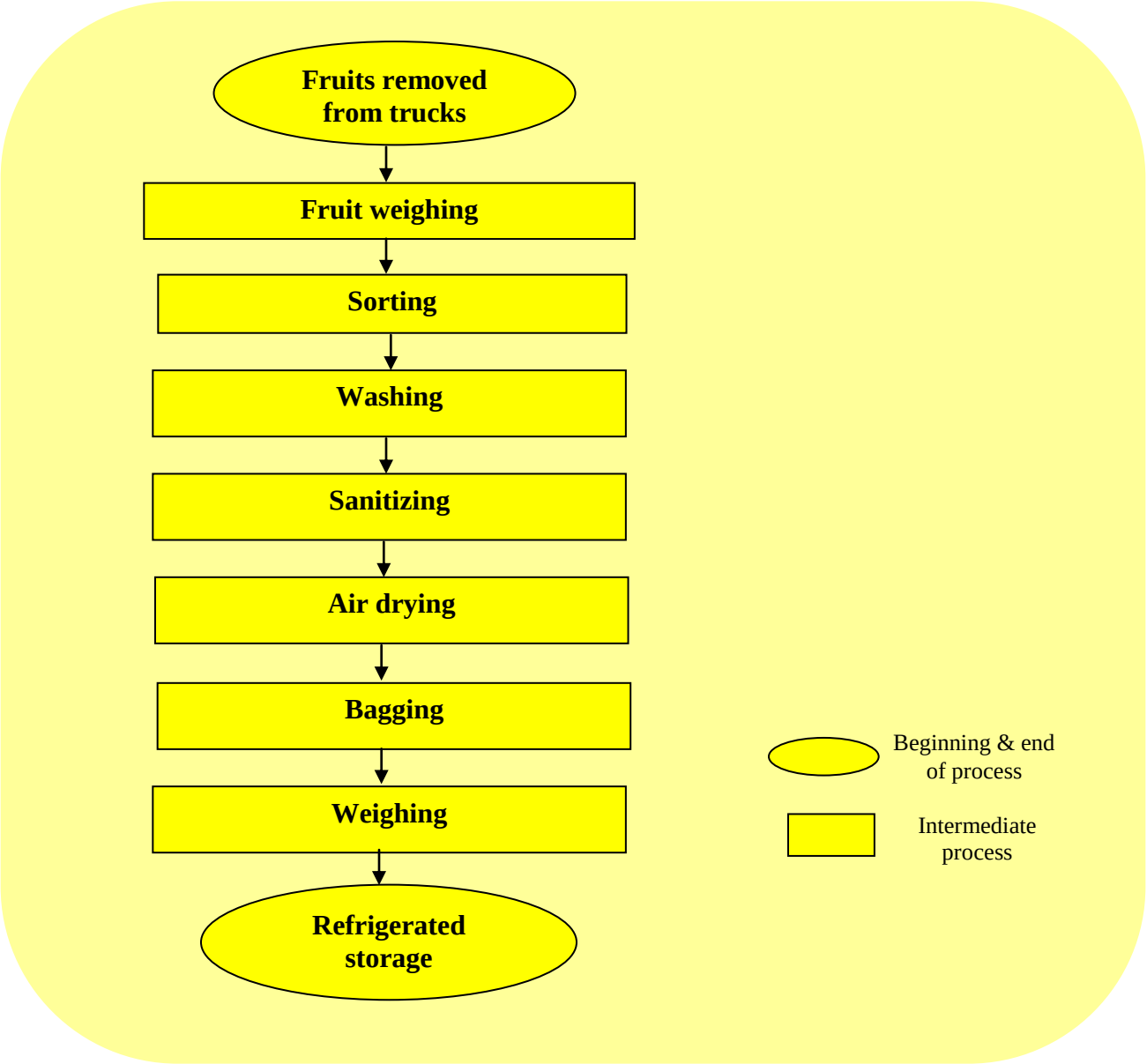


Figure 6: Flow chart of unit operation during packinghouse operation for pumpkins.

Fruits are removed manually from loaded trucks and transferred to high density polyethylene gondolas. They are taken into a receival bay where they are weighed and then transferred into the packinghouse. The first step in the operation is fruit sorting. At this stage rejected fruits are culled, placed into a separate gondolas and removed into an area outside of the main packing area. Suppliers return at some later time and collect their rejects. Suppliers are only paid for acceptable fruits by the exporters. Selected fruits are then washed with clean running water and a mild soap solution. Fruits are then placed in a sanitizing food grade dip before being placed on a conveyor belt where they are air dried by a forced air dryer. They are then weighed, bagged placed in refrigerated storage at 13°C. Once they have been cooled to an internal core temperature of 12-14°C they are then placed in pre-cooled reefer and sea freighted to destination markets.

A pictorial flow chart of the processes involved in pumpkin packinghouse operations is given to assist an understanding of the processes involved.

PICTORIAL 1:
FLOW CHART OF POSTHARVEST PROCESSES FOR PUMPKINS DESTINED FOR EXPORT

ARRIVAL OF PUMPKIN AT PACKINGHOUSE IN 3 TON FLAT BED TRUCKS

PUMPKINS BEING TRANSFERRED GONDOLAS

PUMPKINS BEING SORTED AND WASHED

PUMPKINS PLACED IN SANITIZING DIP

FORCED AIR DRYING OF PUMPKINS

PRE COOLING IN WALK IN CHILLERS

The processes involved in the unit operations in the postharvest handling operations for hot peppers are:

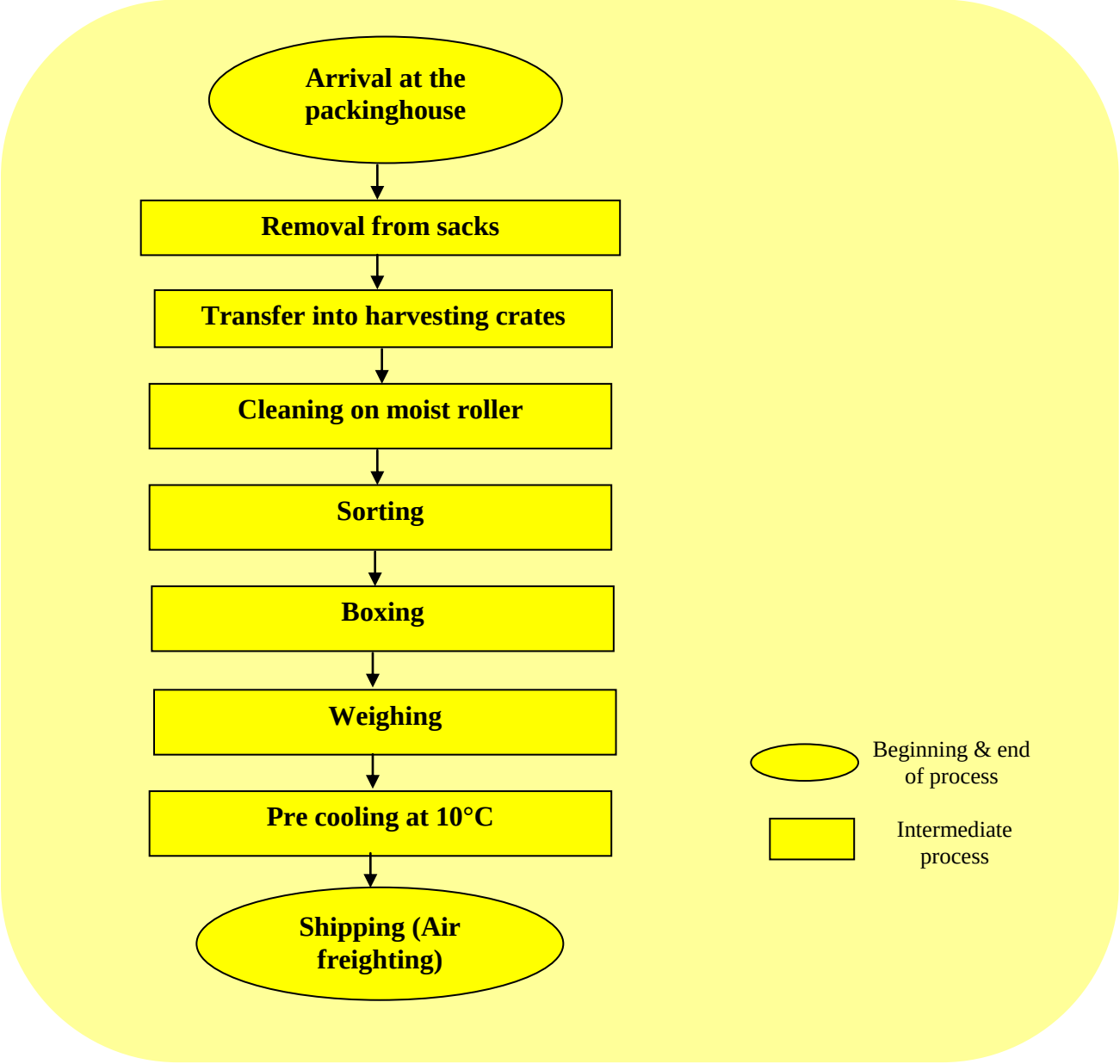


Figure 7: Unit operations in the packinghouse operations of hot peppers destined for export.

A pictorial flow chart of the processes involved in hot pepper packinghouse operations is given to assist an understanding of the processes involved.

PICTORIAL 2:
FLOW CHART OF POSTHARVEST PROCESSES FOR HOT PEPPERS DESTINED FOR EXPORT

ARRIVAL AT THE PACKINGHOUSE IN SACKS

TRANSFER TO HARVESTING CRATES

CLEANING IN ROLLER BRUSHES

SORTING

BOXING

WEIGHING (ADJUSTED TO 8 LBS PER BOX)

PALLETIZED AND SENT TO CHILLER FOR PRE COOLING

8.0 METHODOLOGY EMPLOYED FOR DATA COLLECTION OF PUMPKINS AND HOT PEPPERS.

Data were collected along the postharvest unit operations for both pumpkins and hot peppers. Given that the processes involved are different for both commodities the data collected reflected that difference.

The data collected were used for the purpose of evaluating the impact of poor quality on some aspects of postharvest handling operations. This is a critical first step for several reasons. First, while some data has been collected prior to this practicum, this is the first attempt at evaluating the impact of produce quality. Secondly, the data collected and analysed can be used to assist any strategy for supplier improvement, especially if the data can be used to impress suppliers, exporters and the packinghouse management of the economic benefits of ensuring good quality.

8.1 Data collected and analysed for pumpkins were as follows:

1. An assessment of the total rejection rate for ten forty feet reefer containers.
2. Determination and quantification of specific causes of rejection.
3. The impact of varying reject rates on packinghouse operation and exporter income
4. Determination of bacterial load and its impact on spoilage.

8.1.1 An assessment of total rejection rate for on a container load basis

This was done by recording the total weight of pumpkins received at the packinghouse for filling either a 20’ or 40’ reefer container. The total quantity of pumpkins that met the

requirement for export was recorded at the end of the postharvest unit operation. These two sets of data were then used to calculate the mean rejection rate per shipment using the following formula.

$$\text{Percentage rejection per container} = \frac{\text{Weight of fruits rejected on arrival per shipment}}{\text{Total weight of pumpkins received per shipment}} \times 100$$

8.1.2 Determination of specific causes of rejection

Rejects fell into one of the following categories.

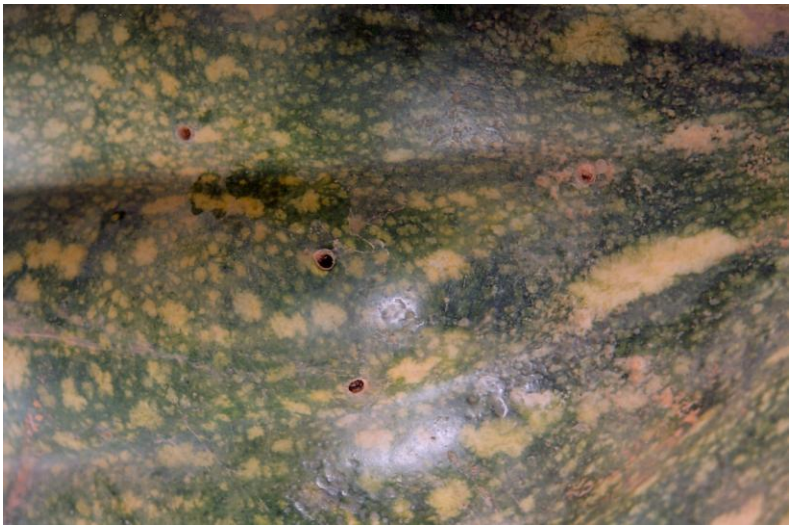
- Bruising damage.
- Pumpkins with holes and /or presence of worms.
- Pumpkins with damaged stems (calices).
- Pumpkins with early symptoms of rotting.
- Pumpkins that were too large.

Two Gondolas with rejected fruits were chosen at random after sorting operations. The pumpkins were categorized based on the rejection categories and each category expressed as a percentage of the total. Twenty replicates of two gondolas each were used for this aspect of the investigation.

To provide a clearer picture of the rejection categories a pictorial reference guide is presented below.

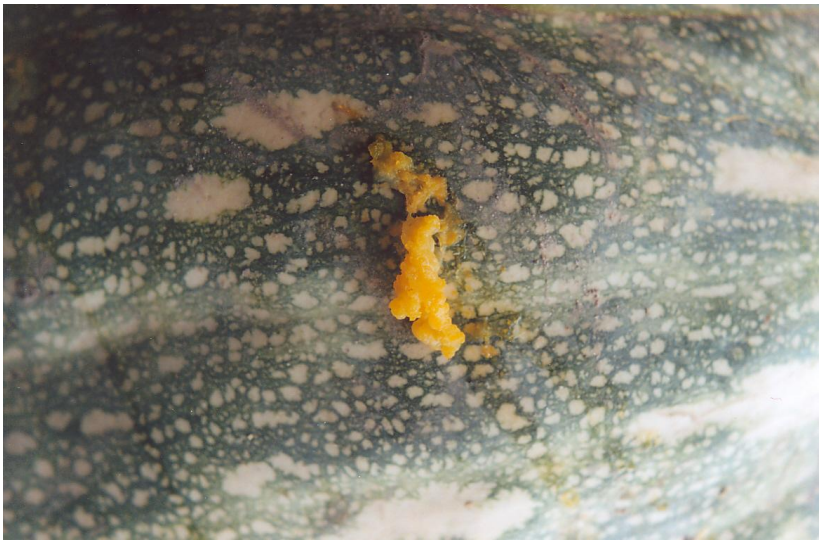
PICTORIAL 3:
REFERNCE GUIDE - PUMPKIN REJECTION

BRUISING DAMAGE



WORM HOLES

PRESENCE OF WORMS



PRESENCE OF FRASS: INDICATIVE OF WORM DAMAGE

DAMAGED CALICES (FRUIT STEM)

FRUIT ROTTING

8.1.3 Impact of rejection on packinghouse efficiency

The total time taken for all the processes in the postharvest unit operations from off loading to refrigerated storage were determined and presented graphically for four different reject rates: 15%, 19%, 21%, 25%.

8.1.4 Determination of bacterial load

Preliminary studies were conducted on the role if any that the presence of bacteria especially *Escherichia coli (E. coli)* might have on fruit quality the significance of this measurement will be a critical factor when considering the selection of suppliers.

Data on bacterial presence is reported as coliform forming units per gram (CFU/g). It is graphically represented against percentage spoilage and its concentration against time. Microbial determination has become a critical non visible quality consideration in the export trade in fresh produced and no country interested in this market can ever afford to pay attention to.

8.2 Data collected for hot peppers

In the case of hot peppers the following data was collected and evaluated:

1. Number of boxes of fruits per 8hr shift at different rejection rates

   In order to ascertain the impact of rejection rates on packinghouse efficiency, the number of boxes of hot peppers packaged in an eight hour shift was times and plotted against the % of pepper rejects.

2. Quantification on a percentage basis the different categories of hot pepper rejects

   Rejects are sorted, placed in harvesting crates and removed from the packinghouse. Twenty replicates of 2lbs of hot pepper each were randomly removed and the reject places in pre-determined categories. Each category was weighed and expressed as a percentage of total weight of rejects.

The following is a pictorial representation of some rejection categories for hot peppers.

PICTORIAL 4:
REFERNCE GUIDE – HOT PEPPER REJECTION

COMPRESSION DAMAGE

STEM DAMAGE

RIPE FRUITS

9.0 RESULTS FOR PUMPKINS

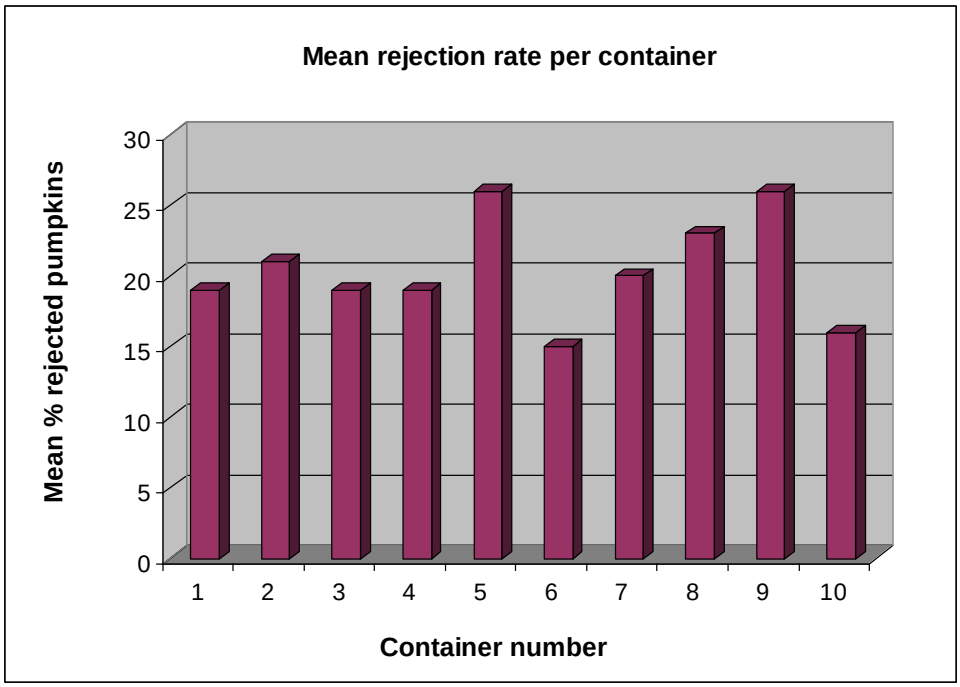


Figure 8: Mean rejection percentages for 10 container shipments (June - December 2006).

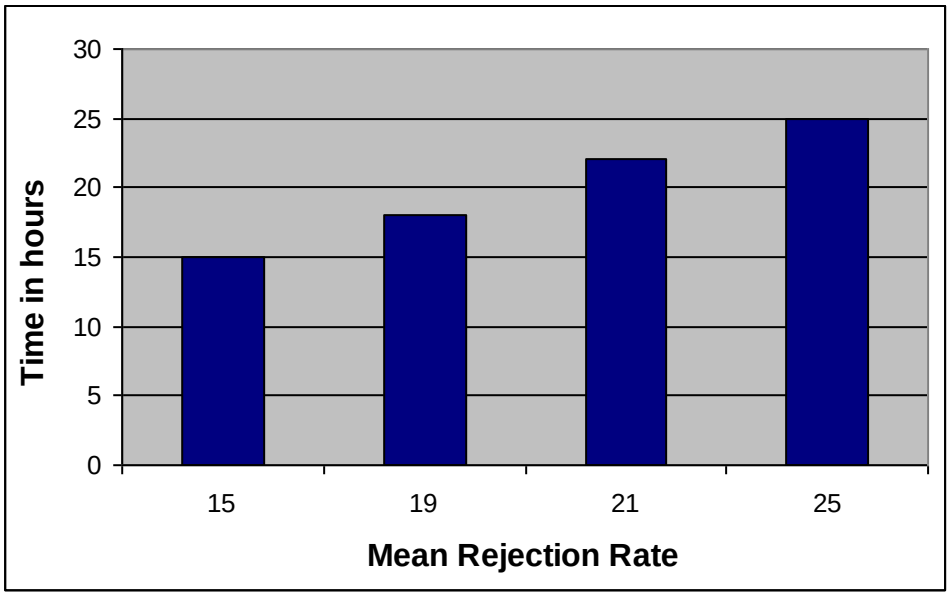


Figure 9: Total time to fill a forty feet reefer container at different reject rates.

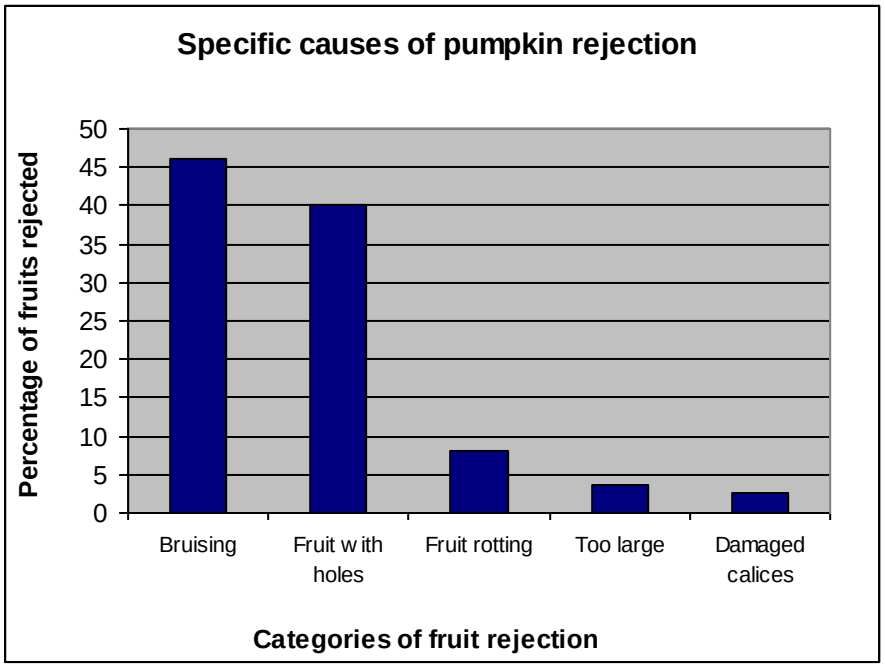


Figure 10: Specific causes of fruit rejection

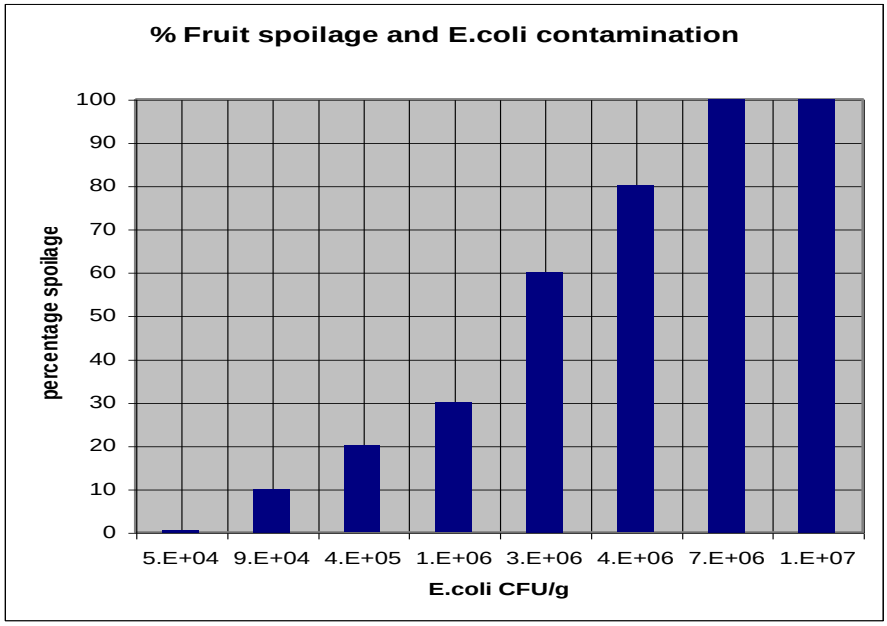


Figure 11: *E. Coli* contamination and fruit spoilage.

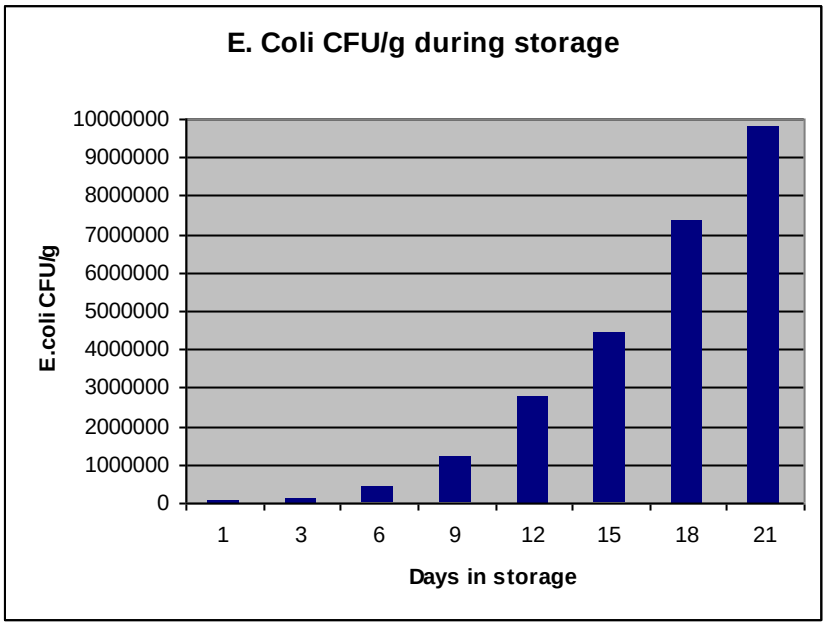


Figure 12: *E. Coli* leveles during storage.

IMPLICATIONS OF RESULTS

From the results it is evident that a lot of improvements are needed in the production, harvesting and field handling and transportation of pumpkins received at the packinghouse destined for export markets. All of these operations fall within the range of activities that are done by the supplier and therefore the use of data is the best way of convincing both exporters and suppliers of the need for drastic improvements.

When the reject rate of ten shipments were compared, the data indicated a mean rejection rate of between 15-29%. When individual suppliers were examined the rejection rate ranged between a low of 6% to a high of 45%. When the data is translated to the amount of pumpkin needed to fill a forty feet reefer container the following picture presents itself.

Cost of poor quality to the packinghouse

At 15% rejection it will require 57,500 lbs of pumpkin to fill a forty feet reefer with 50,000lbs of pumpkins, at 20 and 25% rejection rates it takes 60,000lbs and 72,500lbs of pumpkin respectively to fill the same forty feet reefer container with 50,000lbs of pumpkins. This rejected fruits is now the responsibility of the packinghouse staff to repackage and store temporarily outside of the packinghouse and therefore represents an additional labour cost to the packinghouse.

When the mean rejection rate is at 15% it takes 15 hours to completion of packinghouse postharvest unit operations. At 19%, 21%and 25% mean rejection rates the time taken for the same unit operations are 18, 22 and 25 hours respectively.

These figures can now be used to calculate the cost of labour as it relates to the unit operations from off loading to refrigerated storage.

Number of produce handlers : 14

Hourly rate per worker : $14.50

The cost of the entire postharvest unit operation can be calculated based on the percentage reject based on the following formula:

Cost of operation = Number of workers x hourly rate per worker x Time for completion of unit operations

At 15% rejects cost of packinghouse unit operations = $3045

At 21 % rejects cost of packinghouse unit operations = $3654

At 25% rejects cost of packinghouse unit operations = $5075

The packinghouse has set as its objectives for 2006 to prepare four forty feet reefer containers per week for 50 weeks in a calendar year. The total cost per annum based on these percentage rejects can now be calculated.

Annual labour cost for unit operations = Cost of postharvest unit operations per container load x number of containers per week x number of container per annum

Using the figures calculated above and assuming four containers per week for fifty weeks per year the total labour cost at 15%, 21% and 25% rejection are $609,000, $730,000 and $1,015,000 per annum.

At 15% rejection the savings on labour cost alone works about to be in the vicinity of $121,000 when compared to the annual labour cost on postharvest

Categorizing specific causes of rejection

The results also provide the basis for intervention strategies aimed at reducing the specific causes of rejection. Two of the major causes of rejection, bruising and worm holes account for a total of 86% of the total rejects that arrive at the packinghouse. The other causes accounts for 14% of the total rejection recorded at the packinghouse. Having

regards to the fact that one is dealing with biological material, one expects some degree of variation from the classic Pareto 80:20 rule. However the results come very close and can be used to determine where the greatest efforts should be spent in improving quality.

Severe bruising is a problem that continues to plague the operations of the packinghouse fruit arrivals at the facility. Numerous scientific investigations have shown time and again that bruised fruits are susceptible to microbiological contamination and subsequently spoilage. The major cause of bruising relates to the manner in which the fruits are transported from the field to the packinghouse. At the point of harvest bruising is rarely seen therefore it is really not a production problem. During off loading operations at the packinghouse severe bruising is observed. Additionally fruits which are at the bottom of the tray and those on the sides of the tray show the greatest damage due to bruising.

Overstacking of transport vehicle lack of padding on the base and sides of the transport vehicle means that during transportation the weight of the entire load is borne by the fruits on bottom and those at the sides of the truck. Vibration during transportation is primarily responsible for bruised pumpkins during transportation.

Wormholes are directly linked to poor field sanitation. Worms are really the larvae of insects that feed on the developing fruits. They are known to lay their eggs in raw poultry and other kinds of animal manure. These eggs hatch and the young larvae bore into the flesh of the developing pumpkins. Poor weed control is also another source of concern. The adult insects use taller weeds as an alternative host while the pumpkin plant is still

young. They start laying as soon as the pumpkins reaches close to full maturity.

Both of these problems can be significantly reduced by developing a supplier management system, this issue is addressed in Section 12 of this practicum.

Importance of bacterial analysis

The presence of high levels of bacteria especially *E. Coli* in the pulp of pumpkins can have significant implications to the continued international trade in this commodity. Most developed countries have now developed very strict guidelines that are to be followed by exporters. The presence of *E. Coli* indicates that somewhere along the chain of unit operations from production to shipping the pumpkins are becoming contaminated with some king of sewage. Research conducted prior to this investigation has shown that the two major sources of bacterial contamination in pumpkins are poor quality irrigation water and the use of raw poultry manure.

From the results it is also clear that at 13C the bacteria has the ability to grow quite rapidly and during the first 6 days showed a six fold increase when compared to the day of harvest. The implication on destination market is that if the fruits are tested which would normally be 7-10 days after harvest in Trinidad, there is every possibility that they will be rejected resulting in loss of market. Any intervention to supplier performance must take this fact into account since the cost of reentering a foreign market far outweighs the cost of getting right the first time. In the past Trinidad has suffered because of the same problem of bacterial contamination for a once promising crop namely the

culinary herb “shado beni” also traded as cilantro. The country has never recovered from that loss on market and that market is now dominated by Puerto Rico and Mexico.

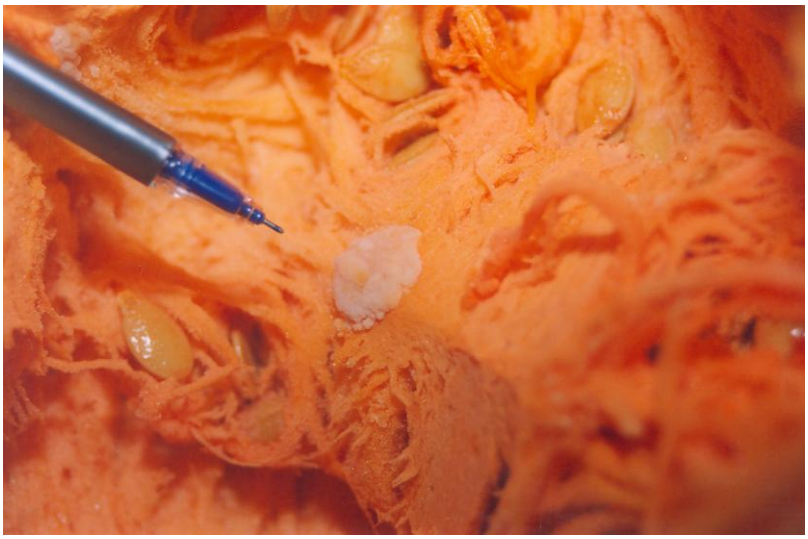
This study has also shown that there is some kind of relationship between the presence of E Coli and spoilage as storage time increases. This relationship has never been investigated before and may very well serve as a marker in ascertaining the extent to which spoilage might occur on arrival on foreign markets.

Very often exporters complain that the pumpkins they ship are in very good condition but on arrival importers complain they the entire shipment is spoilt. More often than not this results in mistrust on the part of exporters and importers. What is often not realized is that the conditions under which the crop was grown would have been grown was unacceptable from a food safety stand point. The addition of raw manure as indicated by high pulp *E. Coli***,** may be the chief culprit responsible for spoilage, which is only observed some time after the shipment has left Trinidad.

Raw manure also has another important implication. It releases excessive nitrogen which is taken up in the fruit. High nitrogen is also known to causes tissue collapse. This observation must be taken into consideration when developing a supplier management system.

The following photographs show the initial stages of fruit collapse and internal microbial growth.

FRUIT SPOILAGE (LEAKING OF ROTTTED FRUITS)



INTERNAL MICROBIAL GROWTH.

10.0 RESULTS FOR HOT PEPPER

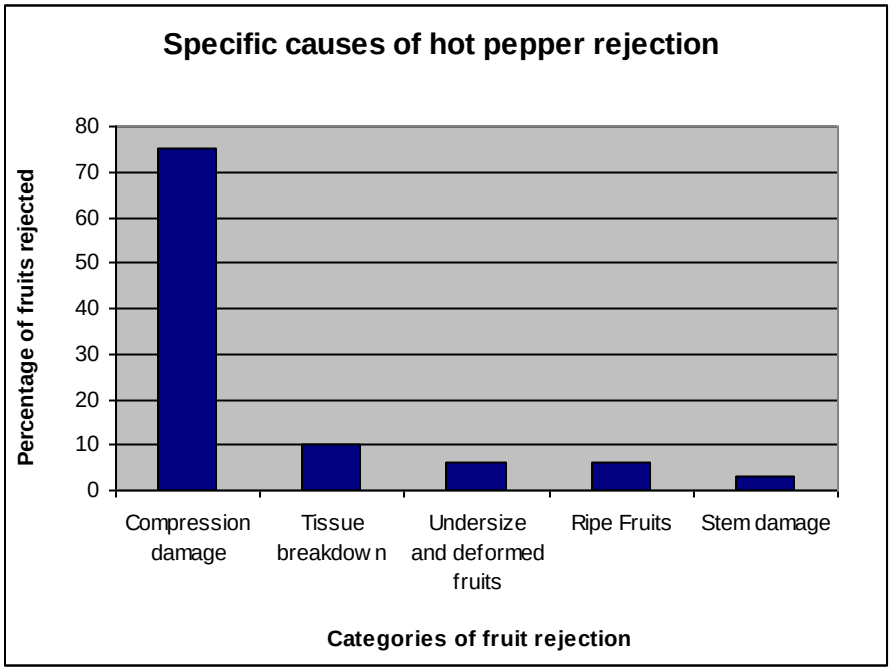


Figure 13: Categorization of Hot Pepper Rejection

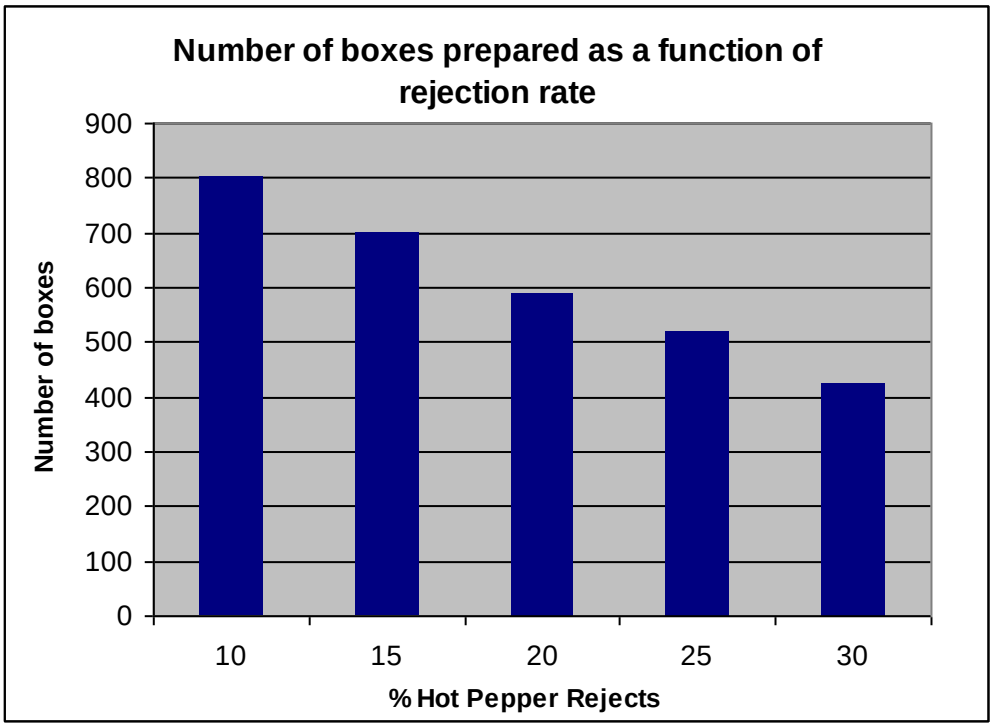


Figure 14: Number of boxes prepared as a function of rejection rate.

IMPLICATION OsF HOT PEPPER RESULTS

As was the case with pumpkins the percentages of fruit rejection were high and directly affected the efficiency of postharvest handling operations, exporter profitability and supplier income. At a 10% rejection rate the mean number of boxes that can be prepared for shipment in an 8 hour shift amounts to 800 boxes. This figure drops to 700, 590, 520 and 425 boxes when the rejection rate increases to 15%, 20%, 25% and 30% respectively.

Cost of poor quality to packinghouse unit operations

If the cost of postharvest unit operations were compared for an 8 hour work day the impact of poor quality becomes even clearer.

Assumptions

Number of hours: 8

Number of produce handlers: 9

Hourly rate: $14.50

Rejection rate (%)	Unit cost of labour per box
10	$1.31
15	$1.49
20	$1.76
25	$2.00
30	$2.49

Savings to the exporter

Consider an exporter who uses the packinghouse and receives hot peppers at different rejection rates. The rate that the packinghouse charges the exporter for hot peppers is on the weight of peppers received from the supplier.

The table below gives the amount peppers which would be needed to fill an order of 800 boxes at 10, 15, 20, 25 and 30 % rejection.

Assumptions:

8lbs per box = 6400lbs of peppers needed for 800 boxes

Handling charge per lb: $0.30

Rejection rate (%)	lbs of peppers needed	Cost to exporter
10	7040	$2112
15	7360	$2208
20	7680	$2304
25	8000	$2400
30	8320	$2496

If an exporter makes one shipment per week of 800 boxes per shipment for 50 weeks in a given calendar year then his savings can also be calculated from what it will cost him using the same rejection rates as given earlier.

Assumptions:

40,000 boxes per annum

320.000 lbs of hot peppers per year

Packing charge : $ 0.30 per lb

Rejection rate (%)	lbs of fruit needed	Packinghouse charges
10	352,000	$105,000
15	368,000	$110,400
20	384,000	$115,000
25	400,000	$120,000
30	416,000	$124,800

Using the current rejection rates there is saving of approximately $5000.00 for every 5% reduction in rejection that the exporter receives if 10 % is used as the current lowest rejection rate.

Loss of income to the supplier

Farmers who supply hot peppers to the exporters also suffer a loss if income because they are only paid for peppers accepted by the packinghouse. Using the same example above on a per annum basis and the present price of $4.00 T.T per lb for hot peppers by the exporter, the economic loss to the supplier (farmer) can also be calculated.

Assumptions:

Supplier paid for 320,000 lbs of hot peepers at $4.00 TT per lb

Total income: 1,228.000

Rejection rate (%)	lbs of fruit supplied	lbs of fruit rejected per annum	Loss of earnings
10	352,000	32000	$128,000
15	368,000	48000	$192,000
20	384,000	64000	$256,000
25	400,000	80000	$320,000
30	416,000	96000	$384,000

When a supplier supplies the packinghouse with poor quality fruits, there is significant loss of income when one looks at the loss he or she suffers on a per annum basis. At 10% rejection the loss of earnings is approximately $124,000. When compared to a 20 % reject rate which is quite common for a number of suppliers using the assumption as stated earlier he can lose as much as $256,000 annually.

Specific causes of fruit rejection

The results established that compression damage and tissue breakdown (fruit softening) were the major causes of hot pepper rejection, cumulatively responsible for 85% of the rejects arriving at the packinghouse. Both these problems are due to poor field handling,

harvesting and transportation to the packinghouse.

The common practice is to harvest hot peppers and field package them into mesh bags or polypropylene bags. The bags are then tied and placed directly on top of flat bed trucks to be transported to the packinghouse. In some cases the bags are stacked two to three layers high covered with a tarpaulin tied and then transported to the packinghouse.

HOT PEPPERS ARRIVING AT THE PACKINGHOUSE IN POLYPROPYLENE SACKS

Such a practice results in severe compression and concomitantly bruising damage which may manifest itself as cracked fruits and bruised fruits. Of greater significance is the immediate unseen impact of compression damage.

In many cases the peppers do not appear as having suffered from the impact of compression damage. The damage is only seen on destination markets where there are severe and substantial quality losses often resulting in loss of income to the exporter.

In some cases fruits are harvested late on evenings and left overnight on the field or at some location and transported the next day to the packinghouse. The overfilled tied bags allow for heat build up, and results in tissue breakdown of the hot peppers. Researchers have also found strong correlation between tissues breakdown and the use of raw animal manure due to excessive nitrogen during the production of the crop.

Having analysed the problems associated with poor quality pumpkins and hot peppers on arrival at the packinghouse, an attempt was made to test some strategies and measure their impact if any on product quality improvement using the Plan, Do, Check and act model for quality. From what was observed the problems were mainly due to poor production, field handling and transportation in both products.

11.0 INTERVENTIONS TO REDUCE THE IMPACT OF POOR QUALITY HOT PEPPERS AND PUMPKINS

The results of this present study in addition to published scientific investigations identify the root causes of the major causes of rejects for both commodities. The major concerns that must be addressed are as follows:

- The continued use of raw poultry manure since its impact on spoilage and worm of pumpkins.
- Poor field handling, overstacking and lack of protection of pumpkins during transport.
- Poor field packing and transportation of hot peppers
- General poor field sanitation.

Using the principles of plan, do, check and act an approach was developed to addressing these concerns.

At the planning stage six suppliers of each commodity together with their field staff and the supervisor of the packinghouse participated. The programme was developed and coordinated by the author of this practicum. By consensus, it was agreed that the following programme would be followed:

1. All workers and suppliers would attend three visits at the packinghouse to get a first hand view of the operations with an emphasis on understanding rejects. This was decided since the majority of the workers (88%) never saw the operations of the packinghouse.
2. Some field advice and supervision would be conducted during harvesting, field packaging and transportation. This would serve as a training tool instead of formal classroom type training.
3. Pumpkins would not be overstacked. The base and sides of the truck would be padded and every two layers of pumpkins would be separated by foam padding.
4. Only properly composted manure would be added to the planting holes three weeks before planting and no more applications thereafter.
5. Hot peppers would be transported in high density polyethylene harvesting crates no polypropylene sacks would be allowed.
6. Hot peppers would be harvested early on morning and moved immediately to the packinghouse.

Visits were made at the time of field handling to ensure adherence and provide guidance where needed. Generally there was good adherence to the procedures agreed to.

Impact of intervention

Pumpkins

Using the new procedures as outlined above fruit rejection rate fell to 7% .This represented a marked improvement in what previously obtained with only a few fruits with minor bruises, worm holes were completely eliminated The major cause of rejects were pumpkins that were above 27lbs and these were used to make "veggy packs" by another company using the services of the packinghouse.

It took 11 hours to fill the forty feet reefer container with 50,000lbs of pumpkins a savings of 3 hours on labour cost for postharvest unit operations demarcated between off loading and refrigerated storage. Using the same formula to calculate savings to the packinghouse the following economic benefit is realized.

Assumptions:

11 hours to fill container

Labour: $14.50 per hour

Number of produce handlers: 14

Cost per 50,000lb container load = $2233.00

When compared to a 15% rejection rate the savings to the packinghouse in labour cost at 7% fruit rejection is $812 per container. Compared to 21% and 25% fruit rejection the saving to the packinghouse is $1421 and $2842 respectively.

The potential saving cost if one were to use the target of 200 container per year shows the true economic worth of the intervention. The postharvest unit operations cost at 7 % for 200 containers will be $446,600 at 15% rejection the same target will cost $609,000 at 21% will cost$730,800 and 25% rejects will cost $1,015.000.00.

Hot peppers

Training, supervision, and adoption of improved practices led to a substantial improvement in the quality of hot peppers. This augers very well for the case of instituting a supply management system for this commodity destined for export. When peppers were harvested early on mornings placed in harvesting crates and expeditiously transported to the packinghouse the benefits became almost immediately apparent to all who took part in the exercise.

At the completion of a 8 hour work shift the rejects expressed as a percentage of total weight of hot peppers received showed a drop in rejection to 5.5%. For an 8 hour work day at a rejection rate of 5.5% the packinghouse was able to prepare 925 boxes of hot peppers ready for export. Significant savings in time occurred because the non value adding step of transfer from bags to crates was eliminated and the time spent on sorting to

remove rejects was reduced resulting in a more efficient work flow of the processes involved in the postharvest unit operations demarcated for investigation.

Using similar assumptions as given earlier, the benefits to all stakeholders can be calculated.

Savings to the packinghouse

At 925 boxes per day the cost of produce handlers labour charge for postharvest unit operations is now $1.12 per box. Compared to the charge at 10%, 15%, 29%,and 25% the cost per box is reduced by 19,37,64and 88 cents respectively. At 160000 per year which is the target for 2006 the savings on labour cost gives a better appreciation of the intervention. At 5.5% rejection rate it will cost the packinghouse $179,200 per annum compared to $209,000, $238,000, $281,000 and $320,000 at !0%,15%,20% and 25% rejection.

Savings to the exporter

If an individual exporter can receive supplies at 5.5% rejection he or she also stand to benefit. Consider 800 boxes at 8 lbs per box it means he would pay a handling charge for 6752 lbs of peppers to the packinghouse at $ per box0.30. It will now cost him$2025.60 per shipment compared to the higher handling cost at higher rejection rates given in a subsequent section of this practicum.

Supplier income

Given that suppliers are paid by exporters for the peppers selected for export, lower rejection rates means higher income per delivery.

12.0 A SUPPLIER PERFORMANCE MANAGEMENT SYSTEM FOR PUMPKINS AND HOT PEPPERS

The results of this study and previously conducted scientific investigations all add credence to a supplier management system for pumpkins and hot peppers. Given that the processes employed at the packinghouse meet the most stringent postharvest handling requirement for fresh produce, the onus is now on developing supplier performance systems for the facility. Having regard to the fresh produce trade being one based solely on quality supplier performance systems benefits farmers (suppliers), exporters and other fresh produce marketers and fresh produce exporters.

The major components of a supplier performance strategy are:

- The criteria to be used in selecting suppliers
- The techniques by which these requirements are communicated to the suppliers
- Assessment of supplier performance over time and communicating feedback
- The expansion of the NAMDEVCO farm certification programme to facilitate these new demands on exporters.

Supplier selection strategy

Given the nature of the fresh produce industry in Trinidad, there will always be many potential suppliers for a given commodity. In the context of the Trinidad situation that pool of suppliers present both opportunities and potential problems. Extremities of lack of water and flooding means that any given time only a few suppliers might be in a position to supply the market.

Many exporters have now embarked on a programme of contracting growers and pre arranged prices. Missing from that arrangement is a holistic approach to supplier management. The strategies developed by the packinghouse will serve all suppliers in exporters and the packinghouse in good stead.

The key components of the selection strategy are as follows:

All suppliers of pumpkins and hot peppers destined for international markets must be willing to become part of the programme.

Supplier selection pre-requisites

- All operations on individual holdings must conform to the principles of Good Agricultural Practices (GAP).
- Suppliers must agree to have their produce tested for microbial testing two weeks before harvesting.
- All suppliers on the programme must meet the record keeping requirements

instituted by the Extension staff of NAMDEVCO.

- During the first phase which should be in place by May 2006, all suppliers presently contracted should be coerced to become the first persons on the programme.
- NAMDEVCO Extension staff must have ready access to all farms on the programme to offer advice and take corrective actions before these problems become wide spread.

Adoption of Good Agricultural Practices (GAP)

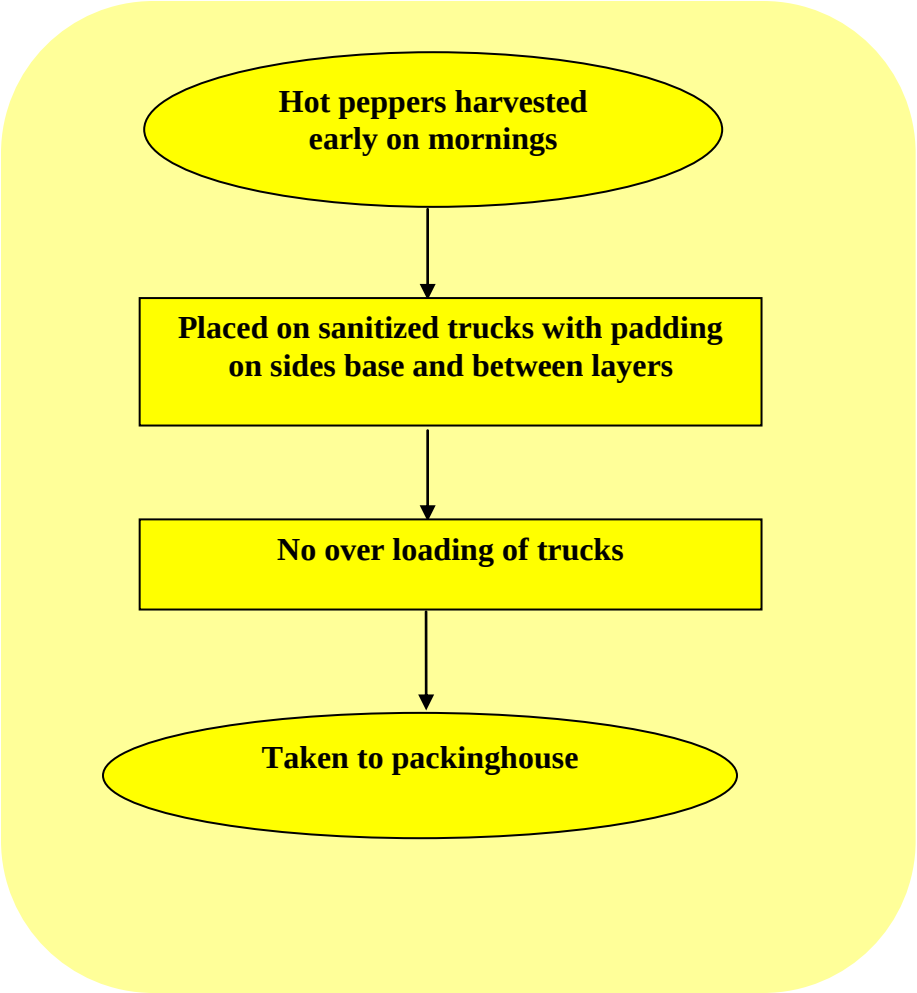
GAP has become the important pre requisite best practices protocol used by countries seeking market share in the international fresh produce business. Mexico, Puerto Rico, Guatemala and Chile all enjoy good market share on the North American markets because of the adoption of GAP by their farmers. HACCP and more recently the food industry latest standard ISO 22000:2005 have placed tremendous emphasis on pre-requisite programmes (PRP'S). GAP is the best system in ensuring that on farm food safety requirements are met. If the packinghouse is to realize its goal of becoming HACCP ready and as it has signaled its intention to become ISO22000:2005 registered GAP will be even more critical in achieving that goal.

Requirements for suppliers of pumpkins and hot peppers to the packinghouse

Product technical requirements: These requirements have been listed earlier in Section 6.

Delivery requirements for pumpkins: This is an important requirement since it was determined that most of the rejection was due to poor delivery. The requirement differs for pumpkins and hot peppers.

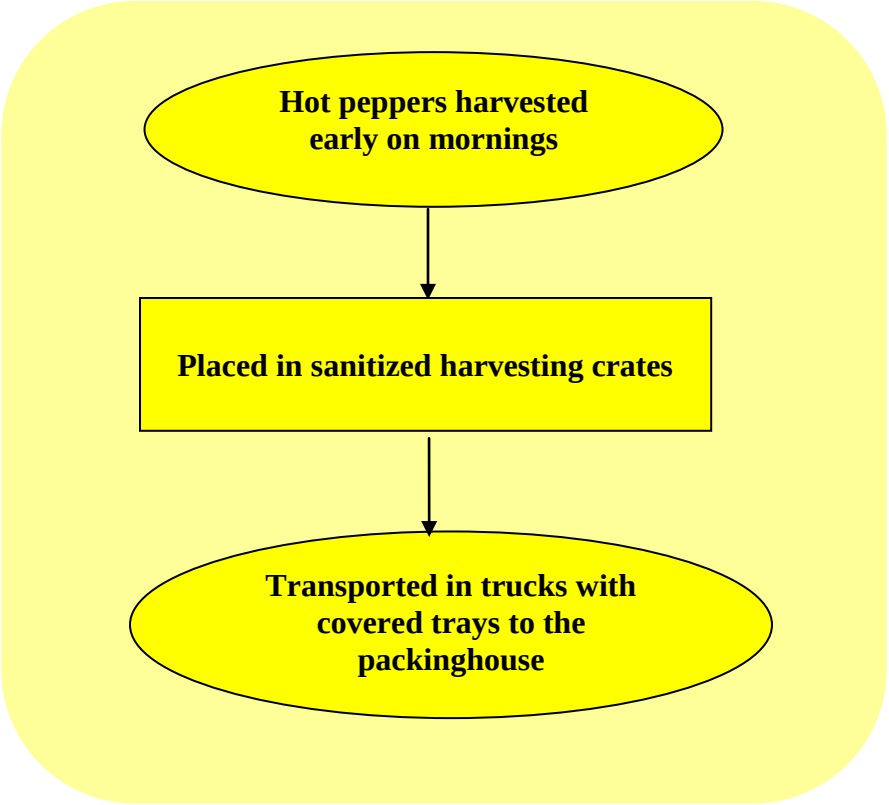
For pumpkins:



A second option for pumpkin delivery is to place fruits directly into gondolas on the field. This option will become important as exporters seek to target the more lucrative end of

the pumpkin market for fancy grade pumpkins. Field packaging in gondolas is the most appropriate method for this segment of the market.

Delivery requirement for hot peppers



Traceability requirement

All suppliers must establish a record keeping system with the following records:

- Pesticide application records
- Manure and water testing record
- Manure and water sources record

- Microbial count on product record
- Worker health and hygiene record

Order requirement

- Hot peppers are not to exceed 30 lbs per crate
- Pumpkins are not to exceed 7,000 lbs per truck load

Communicating the requirements to suppliers

A number of strategies are needed to continuously improve and upgrade supplier adherence to requirements:

- At the commencement of the programme all selected suppliers and their staff must visit the packinghouse to see first hand the processes involved in exporting pumpkins and hot peppers.
- A photographic guide of product acceptability and produce rejects as developed by the author of this practicum, and used to great effectiveness thus far, should be given to all suppliers and their field supervision staff**.**
- Training of suppliers and their staff both on farm and informally**.**

Supplier feed back and improvement strategies

These strategies should not be used as punitive measures but should be viewed as assisting the supplier in meeting the requirements demanded by the packinghouse and exporters. The following strategies are recommended:

On farm compliance report

Submitted by the NAMDEVCO extension staff to all suppliers. This report should be done monthly and should indicate areas for improvement and areas where compliance was achieved.

Packinghouse produce report assessment

The report should be done on each delivery using a scoring system for the following categories:

- Compliance to product delivery requirement
- Core temperature of pumpkins
- Core temperature in the middle of hot pepper harvesting crates
- % produce reject

Challenges to overcome in the implementation a supplier performance system

The approach outlined above is not without it fair share of barriers to overcome. Perhaps the biggest hurdle is changing the culture of fresh produce handling that presently obtains among farmers. The approaches that are being recommended are new to most of the farming community and will take some time to implement.

To compound the challenges, most farmers and their staff lack basic training in the modern requirements of an export based agricultural systems. Other countries in Latin America, South and Central America, have also faced similar challenges. Their approach

was to use a supplier management system to bring in their early adapting farmers first. With support from state agencies the less trained farmers were brought on board later.

Perhaps the greatest incentives that facilitated acceptance was an improvement in farm income from supplier management systems. It would be naïve to think that farmers will accept a programme if there are no economic benefits to them. The supplier performance management system proposed here has been tested earlier and the economic benefits to farmers (suppliers) have been established. The pilot project presented earlier indicated the benefits to suppliers of adopting the new approach. In fact it was the main seller of the new approach.

Farm certification

NAMDEVCO is farm certification programme in place. This programme ensures that suppliers to the Caribbean market meet the requirements for pesticide compliance for regional trade. The new supplier performance management system is envisage to expand the certification programme for all farms using the packinghouse. It will now include the following additional responsibilities.

- GAP assessment
- Microbial testing of produce, water and manure: The cost of which will be shared by supplier and the Corporation.
- Advice on compliance.

13.0 CONCLUSION

In 1988 the perishable handling quarterly published by the University of California Davis indicated that in the future, quality will be king in the fresh produce industry. The facts of this trade suggest that the future is well and truly here. No country seeking to capture mak