

ENVIRONMENTAL IMPACT ASSESSMENT

JAMAICA-CANADA AGRICULTURAL BUSINESS VENTURE

CIDA INC. PROJECT #K062267

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EXECUTIVE SUMMARY

Nightingale Farms Ltd, based in LaSalette, Ontario has entered into a partnership arrangement with the Christiana Potato Growers Cooperative (CPGCA) to promote the use of greenhouse, hydroponic and plasticulture technology in Jamaica. By establishing 2 demonstration farms in traditional farming areas, Nightingale Farms and CPGCA hope to stimulate farmers to grow high yielding, high quality fresh produce and root crops for the local and ethnic export markets. These technologies address some of the local constraints to traditional Jamaican farming methods. In addition, Nightingale Farms will invest in renovating and refurbishing CPGCA's under-utilized 36 year-old cold storage warehouse at Coleyville, Manchester, to receive, grade, rinse and distribute produce from the demonstration farms and contract farmers. Nightingale Farms will facilitate market access, importation of equipment and supplies to Jamaica and, in conjunction with the CPGCA, teach, train, organize and facilitate financing to growers to enable them to adopt these new farming methods.

The major project activities include:

- Acquisition of land at Mountainside, St. Elizabeth and preparation of land for mechanized farming and drip irrigation
- Mechanical laying of drip irrigation lines, mechanical planting and laying of plastic mulch
- Cultivation of Jamaican pumpkins, sweet corn, cantaloupes, honeydew melons, cucumbers, broccoli, cauliflower, tomatoes, sweet peppers, scotch bonnet and romaine lettuce at Mountainside.
- Cultivation of tomatoes, green, red and yellow sweet peppers, cucumbers and strawberries under 8 high tunnel greenhouses at CPGCA's Devon farm in Manchester. These will be added to existing greenhouses and rain-fed fertigation system.
- Renovation of the packing house, including interior repair and internal reconfiguration; roof repair, forced air cooling system repair; installation of sorting, rinsing and packing equipment; rehabilitation of a rain-water tank; building new staff bathrooms and installation of waste water treatment system.
- Operation of the packinghouse, including receiving, cooling, sorting, grading, rinsing and preparing produce for export or local markets. In the future, limited primary agro-processing may take place, in which root crops are made 'ready to cook' by peeling, preserving and vacuum packing them prior to export.
- Farmer training, outreach and demonstration programmes.

CIDA INC financed technical feasibility and market studies, and requested Nightingale Farms to conduct an Environmental Assessment and develop an Environmental Management Plan to mitigate negative environmental impacts. The analysis of environmental effects and their significance revealed no activities of public concern, or negative environmental effects that cannot be mitigated. Given the location and scale of the demonstration farms, impacts on biological and physical systems will be minimal, and ecosystem functions will not be compromised. Activities at the packing house will also be low impact. The main concerns relate to waste management (human, solid and waste water); employee health and safety and natural disaster vulnerability. Soil stability, erosion and fertility are also of some concern.

The existing operations at Coleyville and Devon demonstrate limited attention to waste management; however it is intended that this investment by Nightingale Farms will include installing waste management infrastructure. Disposal of rinse water containing soil particles, Benomyl and Imazalil (fungicides) and minimal pesticide residues should not pose a threat to ground water if disposed of in a tile field. Pesticide residues on the greenhouse crops should be lower than with traditional agriculture, given the reduction of pest and disease pressure offered by the sheltered greenhouse environment and to a lesser extent, with plasticulture. Once the rinsing system has been installed and effluent volumes and composition estimated, Nightingale Farms will have to liaise with NEPA to determine whether a license to discharge (trade effluent) will be required.

The major solid waste concerns are chemical bottles and general domestic waste which in Jamaica are traditionally left in the fields, and the plastic mulch and greenhouse plastic which have outlived their

usefulness. As there are no plastic recycling facilities in Jamaica, disposal of plastic is done at regular dumps. Initially black plastic mulch will be used, but Nightingale Farms should examine use of photo-degradable or organic mulch. The only feasible options at this point are for the plastic to be baled and collected by a commercial contractor, baled and stored at Coleville with the hope that recycling may be an option in the future, or buried. High temperature combustion as practiced in North America is not a considered option. The Pesticide Control Authority recommends triple rinsing and burying of pesticide containers. Nightingale Farms will follow PCA guidelines for disposal of chemical containers, and chemical handling in general. However, segregated storage for pesticides, fertilizers and fuels (for farm machinery) need to be built at Mountainside and reconfigured at Devon.

Organic waste will be recycled at both farms and at the packinghouse via vermi-composting. This will reduce the solid waste load going to the local dump. Volumes of organic waste will be reduced compared to traditional farming, due to the higher quality of produce under greenhouse and plasticulture.

There is some concern about the impact that greenhouse production at Devon may have on soil quality. At issue is the use of soluble fertilizers in the fertigation system which builds up salts and mineralizes the soil. The proposed use of hydroponic media and flushing of soil after crop will help allay this concern. There is also the potential for some soil erosion between rows and negative impacts on soil quality with plasticulture, however these can be mitigated by careful management. Plasticulture will have positive benefits, in that it reduces soil compaction, reduces water demand and reduces the need for herbicides for weed control, and results in less rotting and spoilage of produce.

The high pest and disease pressure in field production, (and to a lesser extent under greenhouse) as a result of natural factors and limited application of integrated pest management demands the use of at least 19 pesticides, most of which are WHO Class III (slightly hazardous) and IV (not hazardous under normal use). There are however a few Class II pesticides (moderately hazardous) and at least 6 have potential human health hazards and should be limited in use. Eight of the listed chemicals are moderately to highly toxic to aquatic fauna, although given the both locations' distance this is not cause for much concern, but should be used sparingly nevertheless. Three are toxic to birds and two to bees and should be applied with this in mind. Personal protective safety gear will be given to staff, who should be trained in chemical handling, per PCA guidelines. Supervisors will be responsible for ensuring that they personal protective safety gear are used as required. Nightingale Farms and CPGCA are aware of integrated pest management practices and partnerships with IPM experts at CARDI, UWI, RADA should be pursued to further reduce dependence on chemicals for pest and disease control.

A large unknown environmental impact depends on the extent to which farmers having seen the demonstration farms, will 'take-up' the technology and become contract growers. It is therefore difficult to predict the cumulative effects that an increase in farming activity will have but are likely to include:

- An increase in deforestation if yam production is stimulated, and there is an increase in use of the traditional 'yam sticks'
- Salinized/mineralized soil if large numbers of farmers adopt greenhouse technology and do not use hydroponic media, practice regular soil flushing, crop rotation or restorative practices
- Accumulation of plastics which cannot be recycled or disposed of easily.

These and other environmental impacts normally associated with agriculture in Jamaica should be addressed in the farmer training and outreach programme and will be outlined in a separate training plan. The Environmental Management Plan identifies mitigation activities with respect to:

- Waste reduction and responsible waste disposal
- Resource use
- Soil degradation
- Chemical use and handling
- Employee health and safety
- Environmental education/farmer knowledge
- Regulatory compliance

The project will be vulnerable to the effects of natural disasters, particularly tropical storms and hurricanes. Jamaican agriculture in general is frequently affected by the disruptive effects of flooding, landslides, road and infrastructure damage, and limited post-event financial assistance to farmers. There are limited advance and pro-active preparedness actions that can be taken to secure temporary farm structures. Some measures can be taken in advance of a hurricane; however, these may not be sufficient to mitigate against wind damage or uplift of the high tunnels and plastic mulch from hurricane winds or loss of crops. As these are cash crops in areas not susceptible to landslides or flooding, fields can be put back into production fairly quickly, given sufficient financial resources. There will however, be a disruption in supplies from both the demonstration farms and contract farmers, which will may curtail packing house activities for a number of months. In the event of catastrophic damage and prolonged electricity disruption, packing house operations will be affected; although disruptions in the municipal water supply will have less impact if the rain water tank is rehabilitated.

The emergency response plan addresses steps to be taken in the event of hurricanes and tropical storms as well as:

- Medical emergencies
- Pesticide Exposure
- Chemical spills
- Fire

Many environmental mitigation, employee health and safety and disaster preparedness activities can be built into the management system of the farm and packinghouse operation without considerable cost. The main up-front costs are associated with installing waste management infrastructure and sanitation facilities for employees. This amount is negligible compared with the overall investment. On going environmental monitoring and mitigation costs will be minimal, and should be considered part of regular farm/packinghouse operation expenses.

Parishes in which Nightingale Farms and CPGCA hope to exert some influence are predominantly rural parishes with higher than average levels of poverty (i.e. greater than the national average of 19.7%), and lower than average housing quality and sanitation. All 5 parishes are dependent on agriculture as a main economic driver. The project addresses some of the community concerns with respect to agriculture, particularly in Manchester, (identified by community consultations held in 2004). If there is significant uptake by farmers there could be positive economic benefits to farmers and rural communities including:

- a minimum three-fold increase in yields from greenhouses (compared to traditional farming)
- reduction in the use of chemical inputs, particularly pesticides with associated beneficial effects on human health and safety for the producer and consumer, as well as for ground water quality and reduced toxicity to non-target species.
- improved quality, reduced spoilage and waste of product with a greater percentage of the crop being marketable; more efficient use of resources, including water, labour and other inputs including fertilizers, and pesticides.
- fewer gluts, stable prices and less waste.
- an improvement in the quality of life for individual farm families and rural communities as a whole.

A possible cumulative effect could be increasing the motivation of rural communities to remain in farming and a curbing of rural-urban drift.

The issue of praedial larceny is to be taken into account as it does occur in the demonstration farm areas; however its significance and particularly violence sometimes associated with it should not be over-emphasized. The project can implement new measures proposed by the Jamaica Agricultural Society and adopt common-sense security measures to curb praedial larceny and as well as maintain good relations with surrounding communities.

The public consultation process to inform farmers about the project was more successful once CPGCA was brought in as the partner and the project integrated within their activities. Promising discussions have been held with government agencies, local banks regarding the possibility of financing arrangements for farmers, and with supermarket chains and hotels to identify local markets.

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ABBREVIATIONS

CARDI	Caribbean Agriculture Research and Development Institute
CEAA	Canadian Environmental Assessment Act
CIDA INC	Canadian International Development Agency Industrial Cooperation Program
CPGCA	Christiana Potato Growers Cooperative Association
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
HACCP	Hazard Analysis and Critical Control Points
JAMPRO	Jamaica Exports Promotion Agency
JAS	Jamaica Agricultural Society
JBRP	Jamaica Business Recovery Program
JOAM	Jamaica Organic Agricultural Movement
MOA	Ministry of Agriculture
MSDS	Material Safety Data Sheets
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NSWMA	National Solid Waste Management Agency
PCA	Pesticides Control Authority
PDC	Parish Development Committee
PIOJ	Planning Institute of Jamaica
RADA	Rural Agriculture Development Agency
RPPU	Rural Physical Planning Unit
SRC	Scientific Research Council
USAID	United States Agency for International Development
UWI	University of the West Indies
WHO	World Health Organization

1.0 INTRODUCTION

Nightingale Farms Ltd., based in LaSalette, Ontario, annually grows, packs and ships throughout North America, over 15 million pounds of fresh produce from over 1,000 acres. The company has an established relationship with Jamaican agricultural interests and has used temporary Jamaican farm labour for over 25 years. In 2005, Canadian food retail stores approached Nightingale Farms to develop a plan to source agricultural produce from Jamaica to serve the growing and highly profitable 'ethnic' market.

With the support of CIDA INC, Nightingale Farms Ltd. conducted a market feasibility study between January and March 2006 to examine the feasibility of sourcing produce from Jamaica, and to develop potential business relationships with local partners. The study determined there was export potential for Jamaican root crops (such as Jamaican yams and sweet potatoes), as well as an unfilled local market for fresh produce, particularly within hotels and supermarket chains. For this potential to be met however, the traditional constraints to Jamaican agriculture would have to be overcome to improve and maintain quality and consistent supplies as well as to ensure competitive pricing. Since 1996, domestic crop production has declined by 42.5%.¹ Currently, a large portion of fresh produce consumed in Jamaica is imported.

Jamaican agriculture has a number of characteristics that result in low, unpredictable yields, or poor, inconsistent quality. This renders a large portion of produce uncompetitive for domestic sale to bulk consumers such as hotels and supermarkets, or for export. Features of Jamaican agriculture include:

- limited available flat, fertile land for large scale production
- Highly fragmented, low technology, labour intensive, rain-fed small farms
- High pest and disease pressure and generally poor management of pests and diseases, including limited knowledge of integrated pest management (IPM)
- Poor post-harvest handling prior to sale
- Limited attention to value added agro-processing, packaging and labeling
- Limited adoption of internationally accepted food safety practices and standards such as HACCP certification
- High interest rates, lack of affordable financing and working capital for small farmers who have limited collateral to secure loans to expand or invest in new technology

Nightingale Farms, along with its local partner, is seeking to address some of these constraints incrementally by:

1. ***Establishing two (2) model farms, in central and southern Jamaica which already have established farming traditions.*** The first demonstration project will consist of 20 acres of vegetables grown in Mountainside/Hounslow, St. Elizabeth, while the second will be located in Devon, Manchester.

The identified crops are:

- a. fruit - including strawberries and cantaloupes (untraditional crops, currently grown on a small scale) for local markets
- b. vegetables - including tomatoes, cucumbers, peppers.
- c. root crops - including yellow yams and sweet potatoes, eddoes, coco, dasheen
- d. scotch bonnet peppers

The vegetables will be grown for the domestic market while root crops will be exported.

2. ***Demonstrating improved technologies and improved agronomic practices, including crop rotation and calendarization of production. The technologies to be introduced, include:***
 - a. high tunnel (greenhouse) and hydroponic/ non-soil medium technologies
 - b. plasti-culture and drip irrigation

¹ Planning Institute of Jamaica. Economic and Social Survey 2005.

These farming technologies are already in use on Nightingale Farms' Ontario operations and on a very limited scale, in Jamaica. It is recognized that climatic conditions and pest and disease pressures differ between Canada and Jamaica, so wholesale transfer of the technology will not necessarily give the best results. It is intended that the model farms will test, modify where necessary, and demonstrate the suitability of these farming technologies to local conditions, including the economic feasibility of introducing these new methods to Jamaican farmers.

3. *Entering into contract farming arrangements to supply local and export markets.*

Once knowledge is obtained on which crops are most suitable and profitable, surrounding growers will be able to watch, learn and decide if they want to become contract farmers with Nightingale Farms. Nightingale Farm will identify local and domestic markets and facilitate the sale of produce from contract farms.

4. *Establishing a centralized storage, grading and packaging facility to receive and prepare produce for export or local distribution.*

Nightingale Farms' stated program plan is to:

1. Teach, train, organize and help finance growers to adopt high efficiency farming methods and new technologies
2. Harvest, grade, pack, cool, distribute and market produce from a centralized packing facility
3. Provide distribution and delivery on a timely and consistent basis using refrigerated vehicles
4. Provide one-stop shopping for most products with a single phone call for all customer needs
5. Assist customers with promotion, presentation and marketing, using on-site training staff
6. Work closely with customers to better improve the products.

The Christiana Potato Growers Cooperative Association (CPGCA) is Nightingale Farms' local partner. The Co-operative is 46 years old, initially established to promote the production and marketing of Irish potatoes, a significant traditional crop grown in central Jamaica since the early 1900's. With the liberalization of the economy, Jamaican Irish potato farmers became less able to compete with cheaper imports. As a result, the CPGCA has re-focused its attention to promoting the development of the sweet potato industry via research, development, demonstration and supply of disease-free planting material. Based in central Jamaica, the cooperative represents farmers within a 50 km. radius encompassing 5 parishes — Manchester, St. Elizabeth, Trelawny, St. Ann and Clarendon.

The Co-operative's existing assets, namely land at Devon, Manchester; a large centrally located warehouse at Coleyville, Manchester; a farm store, farmer networks and a tradition of research, development will be utilized and enhanced by the project.

2.0 SCOPE AND METHODOLOGY OF ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Scope

Under Jamaican environmental legislation, the activities to be conducted under this project would not require an environmental impact assessment. CIDA has requested that an Environmental Impact Assessment be carried out for this project and an Environmental Management Plan be developed. The environmental assessment was conducted between June and August 2006. The level of effort budgeted for this activity was 10-man days.

The Terms of Reference agreed to between the Consultant and Nightingale Farms, was based on the project agreement between CIDA and Nightingale Farms. It is the consultant's understanding however, that the scope of the project as outlined in the original proposal to CIDA has been modified during the course of the feasibility investigation by Nightingale Farms Ltd. The original activities have been scaled down, in particular, the need to construct a new packing house in St. Elizabeth. Existing underutilized facilities owned by the Christiana Potato Growers Association will be renovated instead, and are thought to be sufficient for the long term. Environmental impacts which may have been envisaged as being associated with new construction have been minimized and are therefore not addressed in this EIA.

A pilot yam growing project at Broadleaf (initiated in November 2005) which is part of the project described in the technical report was not included in the scope of this EA. Some activities to be supported by Nightingale Farms will essentially expand the current operations of the Christiana Potato Growers Cooperative Association, rather than being new undertakings.

Terms of Reference:

The EIA will address the three main components proposed by Nightingale Farms including:

- Establishment and operation of demonstration farms at Devon and Mountainside using greenhouse and plasticulture technology
- Rehabilitation of Coleyville packing house
- Operation of Coleyville packing house

The 'new undertakings' will be the establishment of the model farm at Mountainside (albeit on a site which has been farmed in the recent past) and the rinsing and packing operation at Coleville. Greenhouse technology is already in use at CPGCA's Devon farm.

The deliverables under the contract included:

Environmental Assessment report

- Detailed description of the purpose of the project and the proposed alternatives, project components, regulatory context, natural and socio-economic environment, public consultation process and results
- Analysis of potential environmental effects (including significance, cumulative impacts, potential effects of the environment on the project)
- Proposed mitigation measures

Environmental management plan

- Environmental policy/objectives
- Significant environmental aspects of the company's activities
- Legal requirements
- Proposed mitigation strategy and monitoring plan
- Performance indicators and evaluation processes
- Roles and responsibilities
- Emergency response plan
- Occupational health and safety
- Environmental training/awareness
- Costs relating to recommended mitigation

The results of the EIA were used to develop the environmental management plan for the model farms and packing house operation.

2.2 Methodology

The EIA was carried out by an environmental consultant with knowledge of Jamaican agriculture, experience in environmental management systems and CIDA/CEAA requirements. Work commenced in June 2006 and ended in August.

The Methodology closely followed CIDA's guidelines for environmental assessment under the Canadian Environmental Assessment Act (CEAA). The CIDA matrix of environmental issues was used with slight modifications to accommodate the project context and Terms of Reference.

The Consultant drew on documentation prepared for the project including a feasibility/market study conducted in March 2003, a technical report and discussions with the project principals. The final draft of the technical study prepared concurrently with the environmental assessment was not made available to the consultant until August. These studies and discussions provided background information about the project and planned activities. A site assessment was conducted at the three locations (Devon, Coleyville and Mountainside) and meetings held at CPGA's office in Christiana. The laws of Jamaica, as well as discussion with, or reference to regulatory bodies, ministries and agencies, and other persons engaged in similar operations were consulted for legal/regulatory and general information.

Environmental conditions were examined at the project site, and information on the natural environment and socio-economic conditions was extracted from published sources. There was particularly rich and current material for the Parish of Manchester which was utilized extensively.

Environmental impacts were identified by considering existing known impacts of agriculture in Jamaica, the peculiarities of the project location and through discussion with the project proponents. Other secondary sources such as publicly available research/information on chemical use and contamination, plasticulture/greenhouse use and attendant environmental impacts were consulted.

Significance was assessed as to whether the predicted outcome:

- was likely to occur
- could impact a large geographic location or sensitive ecological area
- could have long lasting effects
- could result in a permanent alteration to a physical or biological resource; or human health, safety or wellbeing.

Both positive and negative effects on the natural and human environment were considered. In keeping with the CEAA, cumulative environmental and socio-economic impacts were considered, particularly with respect to the possibility that a large number of farmers across 5 parishes could potentially adopt the practices demonstrated by the project. However, without knowing the numbers and location of such farmers, this could only be assessed in a very general way.

The environmental management plan (EMP) was developed to address the environmental impacts under the direct control of the project activities. In keeping with the Terms of Reference, the Ontario Environmental Farm Plan was reviewed, however for the scale of this project, the proposed activities, the regulatory context and (lack of) supporting resources available to farmers (e.g. recycling facilities, technical assistance, etc.) the plan is not directly transferable to the Jamaican situation. Jamaica-specific guidelines, particularly for pesticide use and management were drawn upon for the EMP.

3.0 DESCRIPTION OF THE ENVIRONMENT



Interior of greenhouse showing cucumber in the foreground with sweet potato as ground cover. Tomatoes and sweet peppers are also grown.

3.1 EXISTING OPERATION

3.1.1 Devon

CPGCA owns and operates a 15.25 acre demonstration farm at Devon, Manchester in central Jamaica. Devon is a rural farming community, which in the past was the centre of Irish potato farming. A variety of vegetables and root crops has traditionally grown in the area.

The site is currently utilized by CPGA for demonstration of greenhouse technology, and research and development on experimental plots for:

- tissue culture (sweet potato),
- integrated pest management,
- fertilizer management,
- irrigation,
- soil preparation,
- Irish and sweet potato production.

Only land under greenhouse is being utilized for commercial production.

The site comprises areas of fairly flat and gently rolling land in an area slated for bauxite mining. The property is accessible from the main road and is bounded primarily by road as well as a fence.

Elevation is approximately 2,736 ft or 833 m above sea level and because of the altitude and cloud cover, the climate is moist and cool. Most of the plateau highlands of Manchester upon which Devon sits, lacks surface water although there is an extensive network of underwater conduits due to the underlying white limestone foundation, (although there is evidence of a small stream in the general area on maps). The water table at Devon is, by CPGA sources, estimated at 3000ft, (app. 900m) although documented sources give an estimate of an average of 500m for the general area. The soil is predominantly Bonnygate Stony Loam, a friable brown/reddish brown clay loam on hard limestone which is highly susceptible to erosion and is thought suitable only for timber². The Devon property is located in the Gut/Alligator Hole Watershed Management Unit, which is considered to be one of Jamaica's least degraded watersheds.³

The predominant undisturbed vegetation is mostly mixed herbaceous woodland/ shrubland subsistence plantation and grasslands pasture, with some forested areas, though not likely to have been primary vegetation for that site. The site is near to the Devon Farm Settlement Forest Reserve and The Devon Great House which is of historical interest. It is not expected that project activities will have any impact on any of these sites. With the exception of earthworms, significant animal activity was not observed, however that may have been due to the time of the site visit in mid-afternoon. The area is not known for any rare or endangered species.

At the time of the site visit the property contained:

- one (1) 270 sq. meter, curved tubular steel frame high tunnel, with UV plastic roof and anti-viral netting. It currently houses sweet potato planting material. This has been in use since 2005.

² Cited in Parish of Manchester Sustainable Development Profile (Manchester PDC, 2004)

³ Source: NEPA Sustainable Watersheds Branch Brochure 2001

- one (1) 770 square meter greenhouse with (imported) wood frame, a UV plastic roof, anti-viral netting used for the production of tomatoes and sweet pepper, cucumber and sweet potato planting material and a drip irrigation system. This was supplied under a USAID-sponsored project in 2005.
- One 327,000 gal (app. 1.2 million liters) water storage pond for rainwater captured via guttering of the green house. The water from the pond is pumped through a sand filter and into four, 400 gal. (1,500L) elevated plastic storage tanks and used in the drip irrigation system in the greenhouses.
- Irrigation drainage system with canals and drainage pipes
- 2-3 acres experimental plots
- a small storage shed

There is no publicly supplied irrigation, hence the need for on-farm collection and storage of water. Water has traditionally been harvested and stored in concrete tanks for domestic use in this part of Jamaica for many years. Rain is harvested and stored on site in the pond. It is estimated that the pond filled to capacity can supply 2-3 months of water at current production levels.

Currently under construction, are two additional 770 sq. meter greenhouses to be built with local pine (from the nearby reserve) with permission from the Forestry Department.

Current production

CPGCA has planted and harvested crops of tomatoes, sweet peppers, cucumber and disease-free sweet potato planting material. The last harvest yielded 22,600lbs. (10,251 kg) of produce, not including sweet potato planting slips which are sold to farmers. Compared with traditional Jamaican farming practice, this represents a three-fold increase in average yield. The planting/reaping cycle under the greenhouse currently lasts approximately 9 months. By July/August most of crop is harvested.

With greenhouse production in this location, the major problems are fungal diseases as well as nematodes. These are currently being controlled fungicides including Champion, Kocide, Amistar, Humectin, Vermitec, Neem-X. The farm utilizes a fertigation system in which soluble fertilizers including calcium nitrate, magnesium sulphate, potassium nitrate, monophasic potassium sulphate, potassium sulphate, iron chelate, zinc sulphate and boric acid are added to the drip irrigation system. Pesticides are stored at the CPGA farm store at Christiana until used. The CPGA is registered by the Pesticides Control Authority as an approved vendor of restricted pesticides.



Existing high tunnel at Devon property currently used for sweet potato planting material. This design is more wind resistant; however it does not provide ideal growing temperature. The project will investigate the potential for using the best design features of both to come up with a wind resistant, cooler high tunnel that will be affordable to small farmers.

3.2 Christiana Potato Growers Cooperative Association Packing House (Coleyville)

Nightingale Farms proposes to renovate the existing CPGCA-owned packaging house at Coleyville, Manchester, approximately 5 miles (8km) from Devon and 45 miles (72.5 km) from Mountainside. Coleyville sits 906m (2975 ft) above sea level. It is located about a mile from the Gourie Forest Reserve managed by the Forestry Department and sits on the border of the Gut-Alligator Hole and Rio Bueno/White River Watershed Management Units. Both WMUs are considered amongst the least degraded in Jamaica. The land surrounding the warehouse is either bare, or is populated by tall grasses and a few trees. The soil in this area is Lucky or Union soil (clay loam).

The facility is accessible from the Christiana main road. The driveway into the property requires repair. The warehouse complex sits on approximately 7 acres of land and comprises three buildings. The oldest was built in the 1940s. CPGA currently leases one building to company which exports yams (Belle Tropics). The building currently in use by the CPGCA was built in 1969/70 and sections are in a state of disrepair. The area is cool with significant cloud cover which contributes to the growth of mould on the walls. It has never been used to full capacity as there has never been sufficient volume of produce.



Side view of CPGCA warehouse showing exterior of the smaller bays. Covered under sheds are the forced air compressors currently in use in the functional bays. Note mould on walls.

The facility is a 20,000 sq ft. structure of reinforced concrete with a zinc roof. Originally the building was divided into 6, 36 X 96 foot bays. The configuration was modified between 1986 and 1990 to maximize efficiency of the forced air compressors in keeping with the small volume of the building that was being used. The current configuration is twelve (12) bays - 8, 160 ton bays and 4, 800 ton bays. At present, only the smaller bays are operating and only 2 bays were in use at the time of the site visit. Forced air compressors, located in sheltered sheds outside of the main building are currently functional in 4 bays. The forced air system is said to be ideal for this kind of facility.

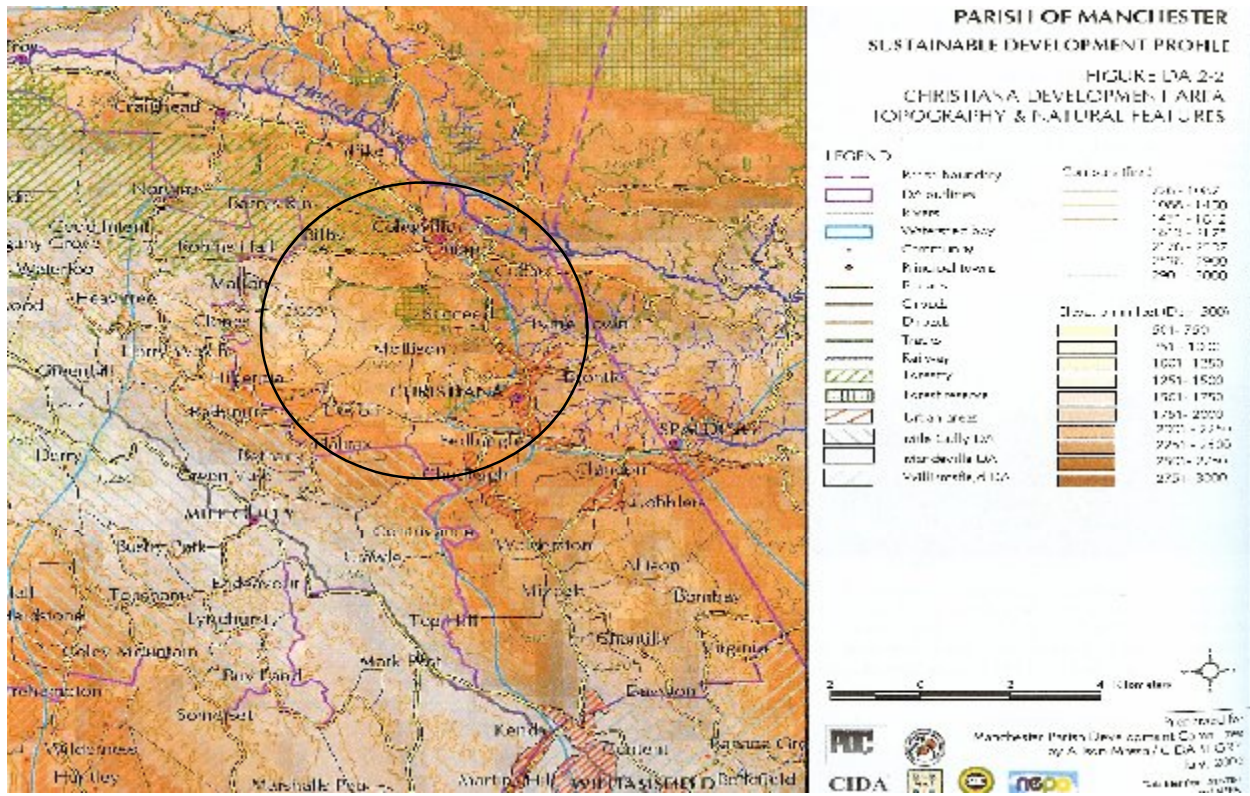
The large entryway is used by staff as an office and a back room used for meals.



One of the smaller bays in use.



Entrance to CPGCA packing house. At left are larger bays which are currently not in use. At back are minimal facilities for staff.



4.0 DESCRIPTION OF PROJECT AND SUMMARY OF ACTIVITIES

4.1 Proposed activities and proposed timelines

The initiative proposed by Nightingale Farms involves the following components:

- Demonstration of greenhouse and plasticulture technology and associated business model to local farmers
- Facilitating the acquisition of equipment and supplies to willing farmers
- Establishing relationships with farmers and educating them about the technology and potential to supply local and overseas markets
- Establishing local and overseas markets
- Establishing contracts with farmers to supply markets
- Providing storage and post-harvest handling facilities, including sorting, grading and transport to local and overseas markets.

It is intended that the model farms will be used to demonstrate new technologies to encourage local farmers to become contract farmers to Nightingale Farms as well as provide throughput for the packinghouse. A marketing infrastructure will be developed for local and export sales.

4.1.1 Acquisition of land in Mountainside/Hownslow, St. Elizabeth

Nightingale Farms/CPGCA have entered into a lease agreement for 12 acres of land in Mountainside/Hownslow, St. Elizabeth for the second demonstration farm project. The property is flat, lying at the bottom of the Santa Cruz Mountain range. The mountains descend fairly steeply from over 720m. Mountainside sits at an altitude of 72 ft or 22m above sea level. The water table here is estimated to be at 30 ft. While there was no visible evidence of surface water sources nearby, the Pondsider Lake, a large fish-stocked freshwater lake lies a few miles west of the site, towards Black River. There is an ample supply of ground water (most of St. Elizabeth sits on a wetland morass). The Black River Lower Morass was declared a RAMSAR site in 1998, with its most eastern boundary lies within a few miles of the site. Five (5) wells supply irrigation water to the area, which is available on this site.



Portion of the project site at Mountainside, St. Elizabeth. Site was previously under cultivation, now used as pasture. In foreground, evidence of plastic chemical bottles left in the field. Santa Cruz Mountains are in the background

The property is bounded by a farm road, and fencing with a few logwood trees and thorny scrub along the perimeter. The property is not on the main road but is accessible by car/SUV via a grassy single-lane track. At the time of the site visit, it was under pasture with grazing cows but was previously planted with peanuts and sweet potato by the owner who is a member of the Co-op. Cows are rotated throughout the property in order to provide manure/organic fertilizer.

The predominant vegetation in the area is dry grasslands/savannah and scrub wood-lands. The site has largely been cleared of trees, with the remaining vegetation largely thorny scrub common to the area, wild grass and a few logwood trees. Other than the presence of a number of rocks of various sizes (which will be removed and used for the foundation of a house), the plot is suitable for mechanized farming, and contains irrigation infrastructure from a public scheme developed in the 1970s. The predominant

soil is Newell loam which is friable with good drainage. It is described as small hard black shot in a brown to light brown matrix, suitable for vegetables, peanuts and pasture. The technical report describes it as a sandy loam with good organic content with a pH of 7.0 and top soil depth of 18 inches.

It is documented that only the top 15 cm/6 inches of clay loam soil in St. Elizabeth is considered to be fertile. The red clay soil below is considered totally infertile⁴. This has implications for soil conservation and fertility management. To counteract this, crop rotation with animals is traditionally practiced (cows and donkeys) and crops are 'dry mulched' with Savannah grass to conserve water and add organic content to the soil.

4.1.2 Establishment of demonstration farm - Devon, Manchester

Nightingale Farms/CPGA intend to install an additional 8, 8.54m x 61m high tunnel greenhouses at Devon, covering a total of just over 1 acre (4,168m²). While these do not offer the precision of conventional greenhouses for environmental control required for northern climates, they sufficiently modify the environment to enhance crop growth, yield and quality and provide the benefits of wind and rain protection and pest and disease prevention which are of greater concern in Jamaica. Greenhouses improve the working environment compared to field production, and produce is cleaner and freer from defects and damage. High tunnels are better able to withstand hurricanes than greenhouses as the roof can be pulled down, or the structure moved altogether. Nightingale Farms and CPGCA may experiment with designs to identify the most suitable structure for the local environment, taking into account temperature, pests and diseases and natural hazards. The life span of the high tunnels is about 4-7 years.

The crops to be grown at Devon under greenhouse will include:

- Tomatoes – 3 bays
- Green peppers – 1 ½ bays
- Cucumbers – 1 bay
- Red/yellow peppers – 1 bay
- Strawberries – 1 ½ bays

The soil at Devon is highly erodable, and despite the current success with the greenhouse at Devon, it is documented that the soil in that area is not really suitable for crops⁵. It is also infested with nematodes. To counteract this, Nightingale Farms and CPGA will use hydroponic/non-soil media under the greenhouses, starting with 'coco-peat' (coconut husk fibres). This will be imported, although attempts will be made to identify local suppliers with acceptable quality. They will investigate other local alternatives, such as sawdust, peat and vermiculite. CGPA has found that with sweet potato as ground cover, sweet peppers seem not to be affected by nematodes. This approach, which takes maximum advantage of the greenhouse, will be investigated further.

Fertigation lines will be installed under each greenhouse to be fed by the rain-water pond. The existing water tank will be expanded by 4 ft vertically, providing an additional 140,000 gals (530,000 L). Soluble fertilizers similar to those already in use will be applied at rates ranging from 0.9 -16.4 lbs / 1000 gals. Lechate of fertilizers from hydroponic media is estimated to be 20-25%. This may contribute to salination of the soil which will require mitigation measures. Both phosphates and nitrates contribute to eutrophication of surface and coastal waters. At the end of the crop, phosphoric acid will be used to flush the fertigation system to prevent salt build up in the lines. Even if the soil will not be used again, it is advised that the soil be flushed, or left fallow and exposed to rain to flush away the salt build up. Given lack of surface water and water table, eutrophication effects should be minimal.

The predominant pest problem, fungus, and other pests will be controlled by the following pesticides listed in the technical report:

⁴ Social Development Commission – St. Elizabeth Parish profile (1997)

⁵ Manchester Parish Sustainable Development Profile

- Dithane, Bravo and Amistar (fungicides) - WHO Class IV toxicity⁶, approved for use in Jamaica by the Pesticides Control Authority.
- Aliette (fungicide) – WHO Class IV –approved for restricted and managed use⁷
- Pegasus (Insecticide) and Actara (insecticide) – WHO Class III toxicity⁸, approved for general use
- Champion (Copper Hydroxide) – (fungicide) WHO Class III toxicity, approved for restricted use
- Ridomil – WHO Class IV fungicide approved for minor use.
- Vermitec and Kocide (copper hydroxide) fungicides - WHO Class II toxicity,⁹ approved for restricted use
- Neem-X – a WHO Class IV approved insecticide.
- Malathion (insecticide) – WHO Class IV toxicity, approved for minor use¹⁰.
- Dimethoate (fungicide) – WHO Class II toxicity, approved for restricted use.

The WHO hazard classifications rate to oral toxicity, (LD50) and carry a range of human health and environmental risks. (See appendix 1). Despite the fact that the majority of pesticides used are classified in the less toxic Class III and Class IV range, they will require prudent management. It is expected that with the use of high tunnel technology, the use of pesticides can be reduced compared with traditional farming. However, given the confinement of the greenhouses, additional safety precautions will need to be taken by staff when applying these chemicals.

Additional activities at Devon may include

- Planting lychee, neem and cedar as agro-forestry demonstration
- Development of an organic demonstration plot

CPGCA is working with the Jamaica Organic Agriculture Movement (JOAM) and has submitted a funding proposal to do research on organic sweet potatoes, legumes, tomatoes and sweet peppers. Although this activity would not fall under the Nightingale Farms investment, it may open the possibility for future production and marketing of organic produce from Jamaica.

Waste management of both farm-based, domestic (e.g. plastic bottles, food containers) and human waste is currently less than desirable. There are no on-site sanitary facilities for workers. There is limited municipal collection of waste, no proper long term facilities for storage (other than plastic garbage bags), or burying. CPGCA is investigating the best method for human waste disposal. Pit latrines are commonly used as sanitation solutions in areas with little piped water. A pit latrine, ventilated improved pit latrine, or double ventilated pit latrine are proposed options.

Subsequent to the site visit, a vermi-compost heap (using earthworms) was established at Devon, as well as a traditional compost heap. CPGCA is building up worm-stock for use in the next crop to break down organic waste that comes out of the greenhouse production, and will experiment with ways to break down both crop waste and old plant material. This is preferable to burning, which is commonly used as a method of waste disposal in Jamaica.

It is estimated that up to 20 people will be employed at Devon at peak production, once all the greenhouses are being utilized.

4.1.3. Establishment of demonstration farm – Mountainside

This will include:

- Preparing the land for mechanical planting
- Repair/replacing existing irrigation infrastructure and commission existing irrigation system
- Refurbishing of dilapidated concrete building for use as office/chemical storage

⁶ WHO Class IV toxicity (unlikely to present acute hazard in normal use)

⁷ This means that its use is restricted to specific applications

⁸ WHO Class III toxicity (slightly hazardous)

⁹ WHO Class II (moderately hazardous)

¹⁰ This means that importation can only be done by the end user and is specific to the registrant. (it cannot be sold)

- Rehabilitation of pit latrine for worker restrooms
- Rehabilitation of existing shade house

The crops proposed for the Mountainside site by the technical study include:

- Jamaican pumpkins
- Sweet corn
- Cantaloupes and Honeydew melons
- Cucumbers
- Broccoli
- Cauliflower
- Tomatoes
- Sweet green peppers
- Red/yellow sweet peppers
- Scotch bonnet peppers
- Romaine lettuce

The Newell clay loam present at Mountainside was tested by Nightingale Farms and found to be a sandy loam, friable with good drainage and good organic content, with a PH of 7.0. This makes Mountainside suitable for most of the crops proposed. However, care will have to be taken in crop rotation and irrigation management in order to manage pest and diseases and maximize yields. The more suitable crops for the site are:

- pumpkins which require light, well drained soils, pH 6.0 -7.0. It is however sensitive to water and it is important to regulate irrigation to avoid excessive moisture or water stress. It is not recommended however, to be planted in fields in which muskmelons, watermelons, pumpkins, squash, cucumbers or other cucurbits have already been planted.
- peppers – which do well in well-drained, moderately fertile soils with pH between 6.0 and 7.0. Neutral pH gives maximum yields. Peppers however, should not be rotated in fields in which eggplant, tomato, pepper, potato, or strawberry have been planted to reduce risk from Verticillium wilt and other diseases.
- strawberries – which require full sun, fertile soils such as sandy loams, silt loams or well-drained clay loams. Although they do best in slightly acid soils (pH 6.5), they can be grown in soils with up to pH 8, before developing lime-induced chlorosis, or yellowing between the veins of the youngest leaves. Nitrogen and potassium are nutrients needed in the greatest quantities for good strawberry production. Even soil moisture with drip irrigation is better than sprinkler irrigation, which wets foliage and fruit and increases rot.
- cauliflower - which does best on a well-drained, loam soil well supplied with organic matter. Sandy loams are preferred for early crops. Maximum yields result from pH to 6.0 - 6.8 soils. No crucifer crop, or related weed, should be present in the field for at least 3 years.
- broccoli – does best on well-drained, loam soil well supplied with organic matter. Sandy loams are preferred. Soil pH should be 6.5 or higher. No crucifer crop, or related weed, should be present in the field for at least 3 years.

This farm will be highly mechanized compared with traditional Jamaican farms. Plastic mulch will be used with drip irrigation and machines used to till the soil, lay the mulch and irrigation tape; plant seeds or planting material. The soil surface will be prepared to be free from impediments to machine use, including trash, stones and tree stumps. The property contains a wide range of stones, likely to be of limestone origin which must be removed. These will be used by a relative of the land owner as foundation for a house. Unusable irrigation hose and plastic litter from will be removed and disposed of.

Equipment to be used will include:

- Rainflo bedder, drip and plastic layer combo unit

- Plastic planter and planter water wheels
- Diesel offset tractor
- Rototiller

Rototilling will be done prior to laying mulch to create a smooth, lump free surface to ensure a tight union between the plastic and the soil. This prevents movement in the wind which may cause the plastic to tear, eliminating the benefits. 12 acres of 0.6-inch irrigation tape will be laid along the beds, fed by 2 inch layflat from two hydrants. Three fertilizer injector manifolds will also be installed. The mulch and irrigation tape will be laid mechanically on the prepared soil surface and anchored using the weight of the soil on the edges. Black plastic which does not increase soil temperature but provides excellent weed control, and is the least expensive, will be used. Mulch applicators generally consist of a plastic roll holder, two furrow openers, and two land wheels followed by two furrow closers mounted on a tool bar. The furrow openers create a trench on either side of the mulch. The two land wheels follow the furrow openers and hold the plastic in the furrow. The two furrow closers refill the trench, firmly anchoring the plastic. A 15 to 23cm (6-9") border of plastic is usually buried leaving 76 to 91 cm (30-36") of mulch exposed.

A plug mix planter or a water wheel planter, considered the most efficient means of planting or transplanting will be used.

This machinery will require diesel which will be bought as needed at the nearby gas station. As a rule, fuels will not be stored on site.

According to the technical study, pests and diseases will be managed by the following pesticides:

- Karate – (insecticide, WHO Class II toxicity, approved by PCA.
- Fusilade – (herbicide), WHO Class III toxicity, approved by PCA.
- Selecron – (insecticide), WHO Class II toxicity , approved for restricted use.
- Decis – WHO Class II pesticide, approved for restricted use.
- Xentari – (insecticide), WHO Class IV pesticide approved for general use.
- Admire – WHO Class IV toxicity. Approved for minor use.
- Kocide – (see 4.1.2)
- Bravo – (see 4.1.2)
- Dithane – (see 4.1.2)
- Pegasus – (see 4.1.2)
- Ridomil – (see 4.1.2)

Although the field is not currently under production there is evidence of poor waste management from previous activities, such as discarded chemical bottles, plastic drink bottles, styrofoam and irrigation hoses which have been left on the field. Given the inaccessibility from the main road it is unlikely that there is municipal collection of waste.

There are no usable sanitary facilities for staff on the property, which is expected to employ 40 persons at peak and 10-12 permanently. Nightingale Farms propose to rehabilitate an existing pit latrine. A dilapidated building on the site is to be renovated for chemical storage/office use.

4.1.4 Renovation of Christiana Potato Growers Cooperative Association Packing house

The original expectation of Nightingale Farms in early stages of the project was that a new warehouse/packing facility would have to be built to handle the volume of produce. However, the partnership with CPGA and the agreement to utilize their facilities has eliminated the need for new construction. Although the existing condition and physical configuration of the building is not up to acceptable standards of food handling, the macro-structure will be sufficient to meet Nightingale Farms' needs. Any modifications required will be done within the existing footprint of the building and would not require major demolition or construction work.

Renovation work will include:

- Rehabilitation of existing roads/driveway (gravel base)
- Fixing the roof
- Refurbishing the cooling system
- Refurbishing and reconfiguring the interior for efficient work flow/storage capacity
- Improving drainage and waste water disposal system
- Rehabilitating existing water tank
- Removing and replacing an electricity pole

○ *Rehabilitate existing roads/driveway (gravel base)*

Approximately 10 loads of ¾ inch crushed gravel will be used to rehabilitate the existing drive way. This material is readily available.

○ *Fix roof and replace zinc*

The roof is to be repaired and damaged zinc sheets removed and replaced.

○ *Refurbish cooling system and electrical system*

The four bays currently in use each have a 10hp compressor, fans and condenser which make up the forced air cooling system. The other four larger bays do not have functioning cooling units. New compressors and condensers will be needed to upgrade these bays. If refrigerants are needed these will be non-ozone depleting as the Government of Jamaica does not allow ozone depleting substances to be imported.



Section of building which will need extensive roof repair.

There is sufficient electricity supply for the expansion of the packinghouse operation. Permission has been granted to relocate a light-pole which will potentially block access of trucks to the loading bay.

○ *Refurbish and reconfigure interior for efficient work flow/storage capacity and occupational health and food safety*

Although the structure is sound, the building has suffered from poor maintenance and damage from natural disasters. The existing exterior walls are overgrown with mould as a result of the ambient humidity and the interior walls were never rendered. Seams between the cement blocks are therefore exposed which is not compatible with food safety and ease of cleaning. Interior walls will be rendered so that they can be painted with anti-fungal paint and periodically washed. Interior and exterior walls will be cleaned, de-moulded and painted. Some walls are lined with washable zinc which will be retained. Where necessary, screening of open areas will be installed to eliminate birds, insects and vermin.

The internal configuration of the warehouse has to be changed to allow for an efficient receiving bay area, sorting, packing and grading; storage and on-loading for transport and distribution. There is currently insufficient lighting, and staff have no proper washroom or eating facilities. These conditions will be rectified. For the facility to meet Ministry of Agriculture packing house standards, washroom and sanitation facilities will have to be upgraded and proper bathrooms provided for staff. The new rest room will likely be installed within the existing footprint of the building, near to existing drainage infrastructure.

Nightingale Farms and CPGCA eventually intend to pursue HACCP certification of the plant. All modifications to the building will be done towards this meeting the standards for HACCP certification. The diagram below shows the projected layout of the packinghouse once renovations are complete.

CPGCA Renovations

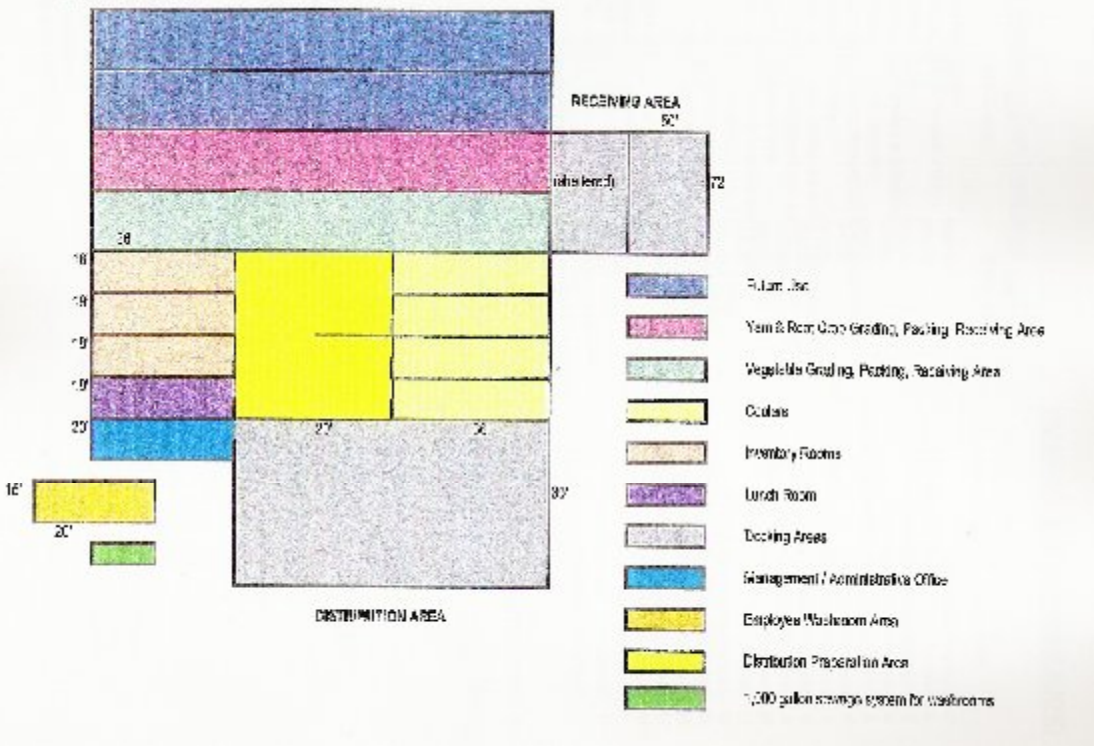


Figure 1-Renovation plan for packinghouse- Diagram taken from Nightingale Farms technical report

Improve waste disposal system:

- Sewage and waste water drainage and disposal

Waste management of solid and liquid waste is already an issue and the drainage and waste disposal infrastructure will have to be upgraded. Pipes coming out of the building lead into an open culvert which appears to lead underground to the roadway. The drainage system appears to serve both the packing house and the building utilized by Belle Tropics, although waste water from Belle Tropics was seen bypassing the existing drainage infrastructure.

Although greenhouse production will reduce the volume of water required for washing, root crops must be free of soil for export. Rinse water will therefore contain varying amounts of soil (particulates) as well as chemical residues. It is estimated that the facility will use 500-1000 gals/day for rinsing produce.

After packing, the floors and walls of the packing house will have to be washed to comply with Ministry of Agriculture packinghouse guidelines. This will likely be done with a pressure washer, with bleach used as a cleaning/disinfecting agent. It is not known what volumes of water will be required and at what frequency.

The existing drainage and waste disposal system for waste water is inadequate for the scale of post-harvest treatment proposed by this project (1.15-6.9 million lbs of produce/year). Options being considered include a 1000 gal septic tank for sewage and grey water, and a sand filter with a tile field for rinse water. The tile field option would require a 250 sq. ft (at 2 ft depth) of land (preliminary estimate), which is available on the site.

- Solid waste:

Although CPGCA contracts a commercial contractor to remove waste from the packinghouse, solid waste practices on the site are poor, with food and drink containers scattered about and thrown into the storm

drain. Belle Tropics staff may be contributing to this litter. Construction waste that will be generated will have to be disposed of by using a reputable commercial waste disposal contractor. Staff will have to be made aware of their responsibility to dispose of waste properly in garbage receptacles provided.



Section of existing drain between the CPGCA packinghouse and Belle Tropics packing house on property. This appears to be a storm drain into which effluent (grey water) from both buildings drain. CPGCA building is to the left.



Continuation of storm drain filled with solid waste. This drain appears to lead to the road below.



○ *Rehabilitate existing water tank*

The plant currently receives potable water from the National Water Commission's Christiana/Spaldings water supply scheme. While it is reasonably reliable, prolonged heavy rains result in high turbidity which forces a discontinuation of supply, which could disrupt the plant's schedule when it is operating. A concrete water storage tank exists which may be rehabilitated as a back-up water supply for the plant in the event of water supply disruption. This would involve rendering interior walls and the sides, and replacing/fixing pipes leading out of the tank. The tank appears structurally sound.

4.1.5 OPERATION OF THE COLEYVILLE PACKING HOUSE

Prior to operation, the packing house must be certified by the Ministry of Agriculture. The renovation of the packing house as planned by Nightingale Farms will comply with Ministry of Agriculture packing house requirements. (See Appendix 2).

Table 1 lists the equipment which will be installed in the packing house. These items are available in painted steel and stainless steel. Stainless steel is preferred.

Table 1- Packing house equipment

Equipment for rinsing, grading and packing of fresh produce and root crops	
<ul style="list-style-type: none">▪ Receiver belt▪ Washer and Absorber combo▪ Waxer (for liquid wax)▪ Packaging belt conveyor▪ Rotary packing table▪ Stainless steel wash basins▪ Wooden dryout and curing racks	<ul style="list-style-type: none">▪ Floor stapler▪ Circulating fans▪ Forklift▪ Box holder rollers▪ Hand pallet trucks

Nightingale Farms estimates 600,000 lbs of (272,160 kg) produce will be harvested per year from Hounslow/Mountainside¹¹. Based on past yields out of the Devon greenhouse, it is estimated that at peak production, between 312,500 - 375,000 lbs (141,520-170,100 kg) in total will be harvested per crop year¹². Total throughput from pilot farms and contract farmers based on Nightingale Farm projections is estimated at 1.1-6.9 million lbs (500,000 – 3.13 million kg).

Fresh produce will be graded, rinsed and packed for local sales. Some fresh produce (e.g. melons and cucumbers) need to be cooled and rested prior to sale to prolong shelf life. Root crops for export will be processed differently as they have to be treated according to specifications of the importing country. Export specifications for yams and sweet potatoes are as follows:¹³

Yams tubers must be free from:

- adhering soil particles, chemical residue and foreign matter
- defects such as growth cracks, cuts or bruises
- disease and decay from fungi and bacteria and nematode damage
- minor roots on the external skin

If stored under conditions of high moisture and temperature, yam roots will begin to grow – so they should be stored at 12.5-15 degrees C and 90% relative humidity to delay sprouting. Yams are exported in slatted trays/boxes in layers of 1-2 tubers deep for large yams and 2-4 for smaller yams.

Prior to export, yams must be cleaned with cut or damaged ends dipped in a mixture of 1000ppm Imazalil and 500ppm Benlate (Benomyl) solution to prevent spoilage during transport to Canadian and European markets. Under natural conditions, Imazalil is not likely lead to resistant strains of fungi compared with other fungicides.

Sweet potatoes should be:

- red skinned with white flesh,
- round, oval or elongated with no unusual outgrowths
- skin intact, free from cuts and bruises and chemical residue.

Sweet potatoes are not treated prior to export, but washed free of soil and packed in sawdust or coconut fibres in cardboard boxes.

In the future, limited agro-processing may include peeling/ready-to-cook packaging of root crops, and pumpkins for export as a ready to cook product. This would involve rinsing, grading and peeling root crops, and packaging them with preservatives for export.

Refrigerated trucks will be used to transport the packed produce to points of departure for export. This may be done by sea or air. Prior to export, all produce must be inspected by the Ministry of Agriculture Plant Quarantine Produce Inspection Unit.

¹¹ Nightingale Farms Marketing and Feasibility Plan

¹² Pers. Com. Alvin Murray, General Manager, CPGCA

¹³ Ministry of Agriculture

- Organic waste management

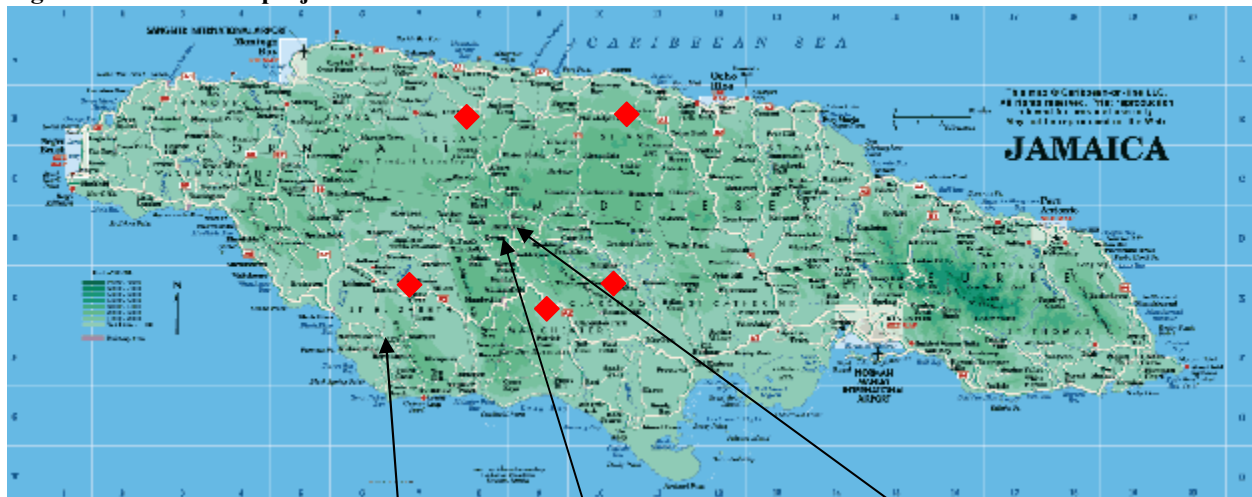
The estimated waste stream from rejected produce is expected to be 1-5% of throughput. The estimated volume of the Mountainside pilot location alone of 18,700lbs/week would result in 187-935 lbs or vegetable waste per week. If projections for throughput from contract growers hold, up to 350,000 lbs. of organic waste will need to be disposed of by year three. Nightingale Farms feels that given the improved quality in greenhouse production, most of this “waste” would still be fit for human consumption, and they propose to provide local charities with produce that does not meet market standards. If there is sufficient volume of rejects which can be used for secondary processing such as canning or making sauces, this will be pursued. The considered option for all ‘unusable’ organic waste at this point is vermi-composting. Vermi-compost can then be sold or used at the Mountainside property to enhance soil fertility. If plans for primary processing materialize, the resulting increased waste generation (vegetable skins) as a result of preparing ‘ready to cook’ products could be treated with a bio-digester. The Scientific Research Council (SRC) could assist in installing a concrete anaerobic biodigester which would produce biogas which can be captured and used as a fuel source (e.g. for heating water). Sewage can also be treated with this method. However, until these plans materialize and the organic load can be determined, it is too early at this point to know whether this option will be feasible.

4.1.6 FARMER DEMONSTRATION AND EDUCATION PROGRAMMES:

The project will be incorporated within the existing activities of the CPGCA. Farmers will be recruited from within the membership of the Christiana Potato Growers Cooperative Association. Although the CPGCA has a listed membership of 17,100 farmers only approximately 4,000 are considered active.

Given the reach of the CPGA, and the central location of the packing house, farmers from Manchester as well as four adjoining parishes – St. Ann, Clarendon, Trelawny and St. Elizabeth will be targeted. CPGCA intends to establish a grower training centre which will provide a venue for training, as well as documentation/information for interested farmers. A training plan is currently being developed. Through proactive engagement of farmers, CPGCA will encourage visits and tours of the demonstration farms by local farmers.

Figure 2- Location of project activities



◆ - parishes with CPGCA member farmers

Christiana – Location of CPGCA office.
Coleyville packinghouse located slightly west of Christiana

Devon

Mountainside



5.0 LEGAL/REGULATORY FRAMEWORK AND RESPONSIBLE AUTHORITIES

5.1 Responsible authorities with jurisdiction over activities considered integral to the project include:

- **Ministry of Agriculture and Lands (MOA).** The Ministry of Agriculture is responsible for produce inspection and issuing of phyto-sanitary certificates. All agricultural exports must be packed in MOA approved and registered packinghouses. Guidelines are provided by the MOA which cover requirements primarily concerned with sanitation, health and safety. (See Appendix 2). These guidelines however, do not address the issue of disposal of packing house effluent. All produce must be inspected by MOA officers before they can be exported. The Ministry also imposes standards and requirements for packing, labeling and time-frame for inspection prior to export. All agricultural businesses are required to be registered with the Rural Agricultural Development Authority (RADA), a statutory agency under the MOA. This registration is required before registering with JAMPRO (below).
- **JAMPRO (Jamaica Export Promotions Agency).** JAMPRO is the national certifying body for Jamaican exporters, and also facilitates marketing, promotion and incentives for exporters. All exporters are required to be registered with JAMPRO. This registration number is required to ship goods out of Jamaica.
- **National Environment and Planning Agency (NEPA).** This project would not require an environmental impact assessment, nor a permit from NEPA. Under the trade effluent discharge regulations of the NRCA Act, however, it may be necessary for the packinghouse to apply for a license to discharge waste water. This would depend on the quality of the rinse water, (including BOD/COD, particulate matter, chemical residues) and the waste treatment proposed. Not all packing houses in Jamaica currently operate with a NRCA license to discharge.
- The **Jamaica Bureau of Standards (JBS)** may have jurisdiction over future activities if proposed agro-processing activities expand and fall within the definition of processed foods under the Processed Foods Act. If the packing house seeks HACCP (hazard analysis and critical control points) certification, the Bureau of Standards will be the certifying body. The Bureau (in conjunction with CARDI, JAS, MOA/RADA, PCA, RPPU and SRC) is also piloting a National Programme for the Certification of Agricultural Produce in 5 parishes including St. Elizabeth and St. Ann. All growers or legitimate traders of agricultural produce have the right to apply for the mark, once the Bureau is satisfied they have fulfilled the requirements of the program.

5.2 Relevance to Canadian Environmental Impact Assessment Act:

The construction activities to be undertaken by the project fall under the CEAA exclusion list with respect of physical works as follows:

- maintenance or repair of existing physical work – the repair of the packing house at Coleyville, or the building on the Mountainside site will not trigger the need for an environmental assessment for those activities
- construction of a building with a footprint of less than 100m² and a height under 5m – the latrines to be constructed fall within this limit and will not be releasing polluting substances into a water body.
- there are no water-bodies within the vicinity of the plant at Coleyville into which waste water will be discharged
- there is no proposed modification to an existing irrigation structure that would not involve the likely release of polluting substance into a water body

5.3 Relevant Jamaican legislation

The main pieces of legislation pertinent to this project include:

- a) **Natural Resources Conservation Authority Act (NRCA Act 1991)**. The Act empowers the NRCA (now National Environment and Planning Agency (NEPA)) to issue permits for any new development, construction or enterprise anywhere in Jamaica. Under Section 9, designated or Prescribed Activities require a permit from the NRCA and the agency may request the preparation of an Environmental Impact Assessment of the proposed activity (Section 10 of the Act). This project is not a new development and will not require a permit.

The Act also governs the issuance of licenses for the construction or modification of any work causing the discharge of trade or sewage effluent into the environment. Although preliminary inquiries to NEPA have indicated that this project may require a license to discharge trade effluent, not all Ministry of Agriculture approved packing houses have licenses. It will be necessary for Nightingale Farms to complete a project information form (PIF) for preliminary review by NEPA. They will then determine whether a license to discharge is required.

- b) **Agricultural Produce Act**. The Agricultural Produce Act outlines the requirements, standards and handling of agricultural produce for export, and empowers the Ministry of Agriculture to inspect produce as necessary.
- c) **Prevention of Praedial Larceny Act (1983)** empowers agricultural wardens to prevent and prosecute acts of praedial larceny. Praedial larceny provisions have been included in the amended Agricultural Produce Act (2004) as below.
- d) **Agricultural Produce (Amendment) Act (2004)** requires that every person carrying on the trade or business of growing or rearing agricultural produce should be registered with the Rural Agriculture Development Authority. Produce which has been sold must be accompanied by a receipt from a registered farmer who is issued a unique registration number. This would apply to contract arrangements between Nightingale Farms/CPGA in that the contract farmer would be required under this new law to issue a receipt for produce purchased by Nightingale Farms/CPGCA.
- e) **Pesticides Control Act (1975)**. The Pesticides Control Act (1975) establishes the Pesticides Control Authority (PCA) to ensure registration of all pesticides and authorizes persons to trade in and apply restricted pesticides. The PCA provides guidelines for pesticide handling and disposal. Some designated pesticides are approved for minor and special use in which use is restricted to a specific end user or for a specific application/crop respectively. The operation of the CPGCA farm store is governed by this Act.

5.4 Legislation with minor relevance to the project

- a) **Watershed Protection Act (1963)** which gives authority to designated officers to ascertain whether crops cultivated on land in watershed areas are the most suitable for land and to advise the conditions under which such crops should be cultivated.
- b) **Country Fires Act (1942, amended 1995)**. This act governs the use of fire which is often used by farmers as a means to clear land. Under the Act it is illegal to set fire to any crops or trash unless notice is given to the nearest police station and occupants of adjoining property within ½ mile. A permit is needed if an area to be burned is in a prohibited area. The Act also describes conditions for burning.
- c) **Rural Agricultural Development Authority Act (1990)** empowers persons authorized by RADA to enter upon any land (only with the consent of the occupier of the land) to inspect the condition of land and any improvement work to ascertain:
 - whether crops being cultivated are suitable

- conditions under which such crops are to be cultivated
- the expediency of any improvement work.

d) **Land Development and Utilization Act** (1966 amended 1997) governs designation of agricultural land and responsibilities of occupiers to maintain such lands consistent with its designation as agricultural land. Under the Act if such responsibilities are not discharged by the occupiers the land can be designated as idle land.

e) Legislation which may be applicable to the project (once further details are known):

The following legislation may apply to the project once more detailed implementation plans have been finalized:

f) **Factories Act** (1943 with amendments to 1973). Not all packing houses are registered under the Factories Act. Depending on the type of equipment commissioned at the packing house at Coleyville and the number of employees, this facility may fall under the Factories Act. Under the Act, a factory is any premises used for the making of any article or the altering, repairing, ornamenting where:

- acetylene, steam, water, wind, electric, internal combustion or other mechanical power is used, or
- where ten (10) or more persons are employed in manual labour;

The Act outlines responsibility of Factory owners. Its regulations govern occupational health and safety. (This legislation is currently being reviewed to improve occupational health and safety concerns). The Act requires registration of every factory with the Ministry of Labour.

g) **Processed Food Act (1959)**. If the project intends to engage in activities beyond the washing, grading, peeling and packaging of produce, the Processed Food Act may apply. Under the law, "processed" refers to preheated cooked, canned, preserved, condensed, evaporated, fermented, distilled, carbonated, dehydrated, milled, frozen or otherwise processed. This law is up for revision.

h) **Public Health Act** (1985) empowers Parish Councils to enforce regulations with respect to public health and communicable diseases, including areas where food is handled. The Environmental Control Division in the Ministry of Health establishes conditions under which air, soil and water pollution are established. The Regulations include inspection and prevention of contamination of food intended for human consumption, including control and destruction of pests and vermin. Under the Public Health Act and the Food Establishment Regulations, it is mandatory that all persons who work in a food handling establishment or any facility, which involves food at any stage of processing or delivery, be in possession of a permit. Ministry of Agriculture guidelines do not speak to the need for food handlers permits for packinghouse staff.

i) **Pesticides Control Act Draft Regulations** - The Pesticides (Maximum residue levels in crops, food and feeding stuff) Jamaica Regulations (Draft 2005). These draft regulations, if promulgated, will establish maximum levels of pesticide residue on crops, food and feeding stuff. The regulations will establish and empower PCA to enforce maximum pesticide residues levels on a variety of crops, including those proposed under this project.

6.0 ANALYSIS OF ENVIRONMENTAL EFFECTS AND THEIR SIGNIFICANCE

The significance of the potential environmental impacts of this project are summarized in the Environmental Impact Matrix

Most of the project undertakings have no significant environmental impact and no obvious public concerns. Activities with potential significant negative impacts can be managed with mitigation measures. A large unknown, indicated by the number of “potential significant negative effects unknown” result from not knowing if, where, and how contract farmers may respond to increasing demand for produce and yams especially, which traditionally have had significant environmental impact.

Table 2 - Environmental Impact Matrix – Nightingale Farms Ltd. (Jamaica)

Description of codes					
Blank	A	B	C	D	E
No significant environmental effect and there is no significant public concern	Significant positive environmental effect	Significant negative environmental effect that can be mitigated	Potential significant negative environmental effect unknown	Significant public concern	Significant negative environmental effect that cannot be mitigated

Project Undertakings	Environmental issues																												
	Physical						Biological								Non-physical/socio-economic components														
	Groundwater quality	Surface water flows/quality	Soil stability/ erosion	Soil fertility/productivity	Natural hazards/ disaster vulnerability	Climate/micro-climate	Air quality (dust, odors)	Vegetation	Mangroves & Wetlands	Coastal water quality	Fish stocks	Aquatic wildlife & habitats	Terrestrial wildlife	Forest resources	Biodiversity	Ecosystems functions (terrestrial/aquatic)	Rare species	Protected areas	Employee health & safety	Quality of life	Employment/Business opportunity	Traffic/ road deterioration	Water supply	Electricity supply	Noise	Public cleanliness/litter	Aesthetics	Cultural/historical sites	Cumulative Effects
Preparatory phase																													
Building rehabilitation/ refurbishing																										B	A		
Construction of pit latrines																													
Drainage/waste water system installation																													
Entrance road repair & retaining wall			A		A																								
Rehabilitate water tank																							A						
Electricity upgrade																													
Equipment installation and compressor repair																													
High tunnel/ greenhouse construction (Devon)					B									B															
Land preparation and planting (Mountainside)			B	B																									

Project Undertakings	Environmental issues																													
	Physical						Biological										Non-physical/socio-economic components													
	Groundwater quality	Surface water flows/quality	Soil stability/ erosion	Soil fertility/productivity	Natural hazards/disaster vulnerability	Climate/micro-climate	Air quality (dust, odors)	Vegetation	Mangroves & Wetlands	Coastal water quality	Fish stocks	Aquatic wildlife & habitats	Terrestrial wildlife	Forest resources	Biodiversity	Ecosystems functions (terrestrial/aquatic)	Rare species	Protected areas	Employee health& safety	Quality of life	Employment/Business opportunity	Traffic/ road deterioration	Water supply	Electricity supply	Noise	Public cleanliness/litter	Aesthetics	Cultural/historical sites	Cumulative Effects	
Farmer education/ training																				A	A									A
Contract farming and transport to packing house		C	C				C						C					C		A	A									C
Sales and marketing																														
Facilitate financing																				A	A									
Accidents and malfunctions																														
Chemical spills	B					B													B											B
Fire			B		B	B	B							B					B									B		B
Windstorms/hurricanes			B		B																									B

6.1 ENVIRONMENTAL IMPACT OF PROPOSED ACTIVITIES

Introduction and utilization of greenhouse and plasticulture technology

Greenhouse technology and plasticulture have a number of advantages compared with traditional agricultural practice, primarily due to a reduction of chemical inputs required for pest and disease control; improved labour efficiency; reduced soil erosion and reliance on soil quality, and improved produce quality. These are counterbalanced however, by negative environmental effects due to increased soil degradation and plastic waste generation and disposal. The negative impacts cannot be eliminated but can be carefully managed by implementing mitigating and monitoring measures. Mitigation measures are outlined in the environmental management plan. Nightingale Farms/CPGCA also intends to take proactive, environmentally friendly measures such as water harvesting and recycling of organic wastes.

The table below summarizes the major activities and environmental impacts of project activities. The comparison is made between traditional Jamaican farming practice and the new methodologies to be introduced by Nightingale Farms.

Table 3 – Environmental impact of greenhouse and plasticulture technology at Devon and Mountainside

GREENHOUSE vs. TRADITIONAL AGRICULTURAL PRACTICE	ENVIRONMENTAL EFFECT
<p>Activity</p> <ul style="list-style-type: none"> ▪ land preparation ▪ use of hydroponics/sterile non-soil media ▪ water harvesting at Devon ▪ use of sterile planting material (tissue culture) ▪ pest and disease control including of integrated pest management ▪ planting under greenhouse ▪ harvesting ▪ vermin-composting 	<p>Positive or not significant</p> <ul style="list-style-type: none"> ▪ reduced potential for erosion, (wind and water) and siltation - wind and water erosion are minimized as less soil is exposed ▪ reduced water demand ▪ reduced disease pressure leading to reduced chemical use (pesticides/herbicides) - reduced potential for surface/groundwater contamination/eutrophication and human toxicity ▪ reduced wastage - produce is less subject to rejection due to decreased pest and disease damage. ▪ reduced post-harvest water demand - crop is cleaner ▪ less organic waste; more saleable product ▪ recycling of organic waste for use on-farm to restore soil fertility ▪ more pleasant working conditions
<p>Activity</p> <ul style="list-style-type: none"> ▪ disposal of greenhouse/high tunnel (life-span 4-7 years) ▪ disposal of chemical containers ▪ fertigation with soluble fertilizers ▪ pest and disease control 	<p>Negative and significant (can be mitigated)</p> <ul style="list-style-type: none"> ▪ Non- biodegradable solid waste – limited municipal garbage collection, and no suitable landfill for disposal. No recycling facilities in Jamaica for plastics. Impact can be mitigated in the sense that it can be disposed of responsibly and not contribute to litter. Care and maintenance of tunnels can improve lifespan, thus reducing accumulated plastic waste over time. ▪ Soil deterioration - increased pH as a result of heavy use of soluble inorganic fertilizers. Soil may become saline if not allowed to leach - limited opportunity to provide organic nutrients to the crop under production. Soil can be monitored to track salinity/pH, and leaching done in between crops to flush salts out. ▪ Chemicals used, though moderately to practically non-toxic, still have potential impacts on human health if not applied correctly. Training and provision of protective gear, and use of chemicals only where necessary can help eliminate impacts. Implementation of IPM can reduce chemical usage.

PLASTICULTURE vs. TRADITIONAL AGRICULTURAL PRACTICE	ENVIRONMENTAL EFFECT
<ul style="list-style-type: none"> ▪ Land preparation and planting (mechanization) ▪ Use of plastic or biodegradable mulch ▪ Harvesting ▪ Crop rotation 	<p>Positive or not significant</p> <ul style="list-style-type: none"> ▪ reduced pesticide use due to reduced disease pressure ▪ reduced use of herbicides for weed control (particularly with black mulch) ▪ reduced potential for surface/groundwater contamination/eutrophication via fertilizer leaching. As rain runs off the mulch, plant nutrients are not lost through leaching as the water is not in contact with the fertilizer. ▪ reduced soil compaction. Soil under plastic mulch remains loose, friable and well-aerated. Roots have access to adequate oxygen and microbial activity is excellent ▪ reduced water demand as soil moisture is conserved (less evaporation) ▪ reduced post-harvest water demand - produce from a mulched crop is cleaner as there is limited contact with soil. ▪ reduced wastage - produce is less subject to rot because of less contact between plants or fruit and decay/soil organisms- ▪ less organic waste; more saleable product ▪ crop rotation reduces pest and disease pressure
<ul style="list-style-type: none"> ▪ Use of plastic mulch ▪ Pesticide application ▪ Irrigation/fertigation ▪ Disposal of plastic mulch 	<p>Negative and significant (can be mitigated)</p> <ul style="list-style-type: none"> ▪ Pesticide contamination - pesticide run-off from uncovered soil in middle strips. Pesticides applied on plastic-mulched fields may roll into the middle with possible runoff from the field, raising the possibility of pesticide residues in soil/ground water. May be mitigated by careful application, taking weather forecast into account and implementing IPM. ▪ Soil degradation - all nutrients have to be applied via the drip system which may limit use of organic fertilizer and result in over reliance of NPK. Soil may become saline if not allowed to leach naturally. ▪ Non-biodegradable solid waste - limited municipal garbage collection, and no suitable landfill for disposal. No recycling facilities in Jamaica for plastics. May be mitigated by investigating organic or biodegradable mulch.

Human waste disposal:

There are currently no waste disposal facilities for staff at either location. The increased number of workers that will be employed raises the risk of communicable disease (between workers and via food handling) and environmental contamination. These risks will be mitigated by installing latrines/washrooms with access to clean water at all project sites (Devon, Mountainside and Coleyville).

Chemical use:

The environmental management plan sets out precautionary and mitigation measures with respect to chemical use and waste management in accordance with Pesticides Control Authority guidelines. According to project documents, at least 19 chemicals will be used in the growing of crops. All have been approved by the Pesticides Control Authority for agricultural use. Although it is expected that the use of greenhouse technology and plasti-culture may reduce chemical use compared with traditional agriculture, several of these chemicals should nevertheless be used sparingly and alternatives used if possible. Pesticide use must be done within a framework of integrated pest management. The following chemicals with potential human health hazards should be limited in use and protective gear mandatory during application:

- Malathion
- Dimethoate
- Vermitec
- Marathon
- Decis
- Karate

Bravo and Ridomil have some potential for groundwater contamination. These will be used at Mountainside where the water table is higher, so should be used sparingly. Malathion will be used at Devon. This too should be used sparingly and carefully during application in the greenhouse in particular. It too has the potential for groundwater contamination which is less an issue at Devon, but more importantly, has human health risks.

Eight of the listed chemicals are moderately to highly toxic to aquatic fauna. Given the distance of both farms to surface water, this should not be a significant issue. Three are toxic to birds and two to bees. When applied under greenhouse, this is not a significant risk. Six of the chemicals have no available information on ecological hazards or persistence.

Disposal of rinsate containing Benomyl and Imazalil residues are not likely to pose a threat to ground water if disposed of in a tile field. Benomyl binds to the soil while Imazalil breaks down within hours.

An analysis of the chemicals proposed is found in Appendix 1.

Waste generation

If mitigation measures are implemented, the significance of waste generation and management will be reduced. The proponents intend to build sanitary facilities according to approved practice for the area. Compost heaps are proposed to handle on-farm organic wastes. Solid waste management practices however, will have to be improved over current methods. Proponents should follow PCA recommendations regarding pesticide container rinsing and disposal.

Packing house activities

Activities at the packing house at Coleyville include building rehabilitation and preparatory activities as well as on-going long term operations (including storage, rinsing, packaging and distribution). The environmental impacts are shown in Table 4.

Table 4 - Environmental impact of packing house operations

Packinghouse operations	Environmental effect
Building rehabilitation <ul style="list-style-type: none"> ▪ Re-roofing/replacement of zinc roof ▪ Cleaning, de-moulding, rendering and painting walls ▪ Construction of retaining wall ▪ Installation of waste water system ▪ Repair of compressors and electricity upgrade ▪ Rehabilitation of water tank 	Negative and significant (can be mitigated) <ul style="list-style-type: none"> ▪ Generation of waste construction waste in an area poorly served by municipal waste collection. Can be mitigated by contracting responsible commercial waste contractor to remove waste to approved dumpsite.
Packing house operations <ul style="list-style-type: none"> ▪ Rinsing ▪ Peeling ▪ Grading ▪ Packing 	Negative – but not significant <ul style="list-style-type: none"> ▪ Generation of organic waste (can be composted) Negative and significant (but can be mitigated) <ul style="list-style-type: none"> ▪ Waste water generation with soil and pesticide residues ▪ Generation of domestic and packaging waste

Increase in farming effort (response by contract farmers or others exposed to the technology)

Given the reach of the CPGA across five parishes, and the uncertainty of knowing the extent and geographic uptake of the new technologies to be introduced, or the response to the increased demand for root crops and vegetables, it is difficult to predict where and what specific environmental impacts might be, and their significance. It is expected that production will be intensified in existing farm areas, rather than undergo a spatial expansion. Nightingale Farms estimates that by the end of year 3, 425 acres will be under production.

A concern however, is whether farmers might expand yam production especially in ecologically sensitive areas such as the Cockpit Country in Trelawny. Estimates in the literature for the demand for yam sticks for traditional yam cultivation, range between 6-12 million yam sticks per year.¹⁴ It is documented that yam cultivation has a severe impact on northern forests in Manchester/Cockpit Country. In parts of Manchester, clearing usually by burning is evident and appears to be increasing, especially around Mandeville¹⁵. Additionally, terracing which was traditionally practiced on steep slopes and erodible soils under the auspices of the Christiana Area Land Authority appears to be a waning practice.¹⁶

Agriculture is a major contributor to non-point source coastal pollution in Jamaica. In general, the expected environmental impact resulting from an overall increase in farming as a result of successful marketing and increased demand for produce could include a mix of the following well-known environmental impacts of farming in Jamaica:

- increased soil erosion as a result of improper land clearing, poor farming practices and farming on marginal or unsuitable land.
- deforestation due to land clearing and use of timber for yam sticks
- poor local air quality due to burning
- siltation of rivers and streams as a result of soil erosion
- pesticide/chemical contamination of rivers and streams due to poor chemical management. Most research on chemical contamination of surface and coastal waters however, have concentrated on chemicals used in the growing of coffee. There is less research and no consistent monitoring of pesticide residues.
- eutrophication of rivers and streams due to soil erosion and groundwater contamination by fertilizers
- poor on-farm waste disposal of farm and domestic waste

As noted in the environmental impact matrix, the true extent of the cumulative impact due to an increase in farming, is at present, unknown. Possible cumulative effects of increased farming could however include:

Negative:

- significant increase deforestation if yam production takes off to meet new demand and there is an increased use of yam sticks
- salinized/mineralized soil if large number of farmers adopt the greenhouse technology
- accumulation of plastic which cannot be disposed of or recycled easily
- increased erosion and deforestation

Positive

- cumulative reduction in pesticide and herbicide use over time and a potential reduction of groundwater/surface water contamination
- utilization of marginal land with hydroponic technology

The primary mitigation method to prevent or reduce environmental damage is for Nightingale Farms/CPGA to integrate environmental education within the demonstration and outreach program. Such a program would have to address environmentally friendly farming practices for:

- proper land clearance without the use of fires and excessive use of herbicides
- chemical management, including integrated pest management
- alternatives to yam sticks such as bamboo or mini-sett yam technology
- soil conservation and fertility management
- waste management, including vermi-composting

¹⁴ 12 million quoted by NEPA sources in Sustainable Development Profile; 6 million quoted by the Nature Conservancy (<http://www.nature.org/wherework/caribbean/jamaica/work/art8666.html>). This figure however, has been disputed by the Forestry Department.

¹⁵ Manchester PDC - Sustainable Development Profile

¹⁶ NEPA source quoted in the Manchester Sustainable Development Profile

- PCA guidelines for pesticide application and proper disposal of containers

Nightingale Farms may also consider imposing certain minimum standards to be practiced by contract growers, such as use of bamboo yam sticks or mini sett yams. This however would require personnel to monitor compliance by contract farmers. They should also facilitate importation of biodegradable or organic mulch, or provide the option of centralized storage of plastic waste.

Effects of environment on the project

Natural hazard vulnerability:

Drought

St. Elizabeth is one the driest areas in Jamaica, and drought is a common occurrence. The availability of irrigation water will allow for farming to continue in drought conditions. Devon is vulnerable to drought conditions; given the dependence on rain-harvesting, prolonged drought would have a potentially severe impact on farm production.

Earth movements and landslides

Given the topography at Mountainside, the area is not prone to landslides, but may be prone to wind erosion from middle rows if the soil is left bare and there is minimal soil moisture as a result of drought. At Devon, despite the erodable nature of the soil, the area is not prone to landslides.

Pest and disease pressure

Although the climate in the hot and dry, given the proximity of the mountain range, a morning dew descends which contributes to fungal diseases. The major cropping period is November to April which are the cooler (though drier periods). Nematodes are also a problem for the cucurbit crops, as well as wire worms and white grubs for root crops. The sweet potato weevil, a traditional pest is now under control, however the potato leaf beetle has emerged as a new significant threat and not much is known about it.

Tropical depressions, storms and hurricanes

Jamaica is vulnerable the effects of severe weather such as tropical storms and hurricanes.

Tropical systems are organized systems of clouds and thunderstorms with a defined circulation. They are classified as follows:

- | | |
|-----------------------|---|
| • Tropical depression | wind speeds of under 38 mph (61km/hr) |
| • Tropical storms | wind speeds of between 39-73 mph (63-119km/hr) |
| • Hurricanes | maximum sustained wind speeds >74mph (119km/hr) |

Potential consequences of these severe weather events include flood damage and wind damage to crops in the field and to the greenhouse structures. Mountainside is said to be not prone to flooding although portions of St. Elizabeth are prone to flooding after prolonged rain. Devon is not prone to flooding. Given the distance from the coast and elevation, storm surge associated with these systems is not a concern. Damage to be expected from hurricanes is shown in Table 4.

Table 5- Potential damage from tropical storms and hurricanes

Hurricane category	Expected Damage	Concern to project
Tropical depressions and tropical storms <73mph 117.48 6km/hr	<ul style="list-style-type: none"> ▪ Can result in extensive flooding, damage to roads, landslides, particularly if slow moving ▪ Minor wind damage 	<ul style="list-style-type: none"> ▪ Flooding of crops in the field ▪ Damage to roads with impact on delivery to packinghouse ▪ Turbidity in water supply
Category One hurricane 74-95 mph 119-153 km/hr	<ul style="list-style-type: none"> ▪ No real damage to building structures; damage primarily to unanchored mobile homes, shrubbery, and trees, poorly constructed signs. ▪ Low-lying coastal roads inundated 	<ul style="list-style-type: none"> ▪ Damage to signs at Devon ▪ Damage to roads with impact on delivery to packinghouse ▪ Damage plastic mulch ▪ Some crop loss at Mountainside ▪ Damage to experimental plots and compost heaps ▪ Turbidity in water supply ▪ Damage to roads
Category Two hurricane 96-110 mph 154-177km/hr	<ul style="list-style-type: none"> ▪ Some roofing material, door, and window damage of buildings. ▪ Considerable damage to shrubbery and trees with some trees blown down. ▪ Considerable damage to mobile homes, poorly constructed signs, and piers. Coast roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Evacuation of some shoreline residences and low-lying areas required 	<ul style="list-style-type: none"> ▪ Damage or loss of greenhouses ▪ Loss of plastic mulch ▪ Crop damage and loss ▪ Damage to roads ▪ Damage to experimental plots and compost heaps ▪ Potential temporary loss of electricity and water
Category Three hurricane 111-130 mph 178-209 km/hr	<ul style="list-style-type: none"> ▪ Some structural damage to small residences and utility buildings with a minor amount of wall failures. ▪ Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed ▪ Low-lying escape routes cut by rising water 3-5 hours before arrival of hurricane center. Coastal flooding destroys smaller structures; larger structures damaged by battering of floating debris. Terrain continuously lower than 5 ft above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences within several blocks of the shoreline may be required. 	<ul style="list-style-type: none"> ▪ Damage or loss of greenhouses ▪ Potential for damage to latrines, smaller buildings at Devon and Mountainside ▪ Damage to roads and infrastructure ▪ Potential damage to staff homes; staff dislocation ▪ Crop loss ▪ Potential loss of electricity and water for days/weeks
Category Four hurricane 131-155 mph 210-249 km/hr	<ul style="list-style-type: none"> ▪ More extensive wall failures with some complete roof structure failures on small residences. ▪ Shrubs, trees, and all signs are blown down. ▪ Extensive damage to doors and windows. ▪ Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of structures near the shore. 	<ul style="list-style-type: none"> ▪ Potential for damage to latrines, smaller buildings at Devon and Mountainside ▪ Potential for damage at Coleyville packing house , CPGCA offices ▪ Potential for trees at Mountainside to blow onto crop area ▪ Damage to staff homes; staff dislocation ▪ Damage to roads; infrastructure; air/sea transportation disrupted ▪ Crop loss ▪ Potential loss of electricity and water for weeks/months
Category Five hurricane >155mph >249 km/hr	<ul style="list-style-type: none"> ▪ Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. ▪ All shrubs, trees, and signs blown down. ▪ Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. 	<ul style="list-style-type: none"> ▪ Damage to latrines, smaller buildings at Devon and Mountainside ▪ Damage at Coleyville packing house (roof), CPGCA offices ▪ Damage to staff homes; staff dislocation ▪ Damage to roads and general infrastructure ▪ Crop loss ▪ Air/sea transportation disrupted ▪ Potential loss of electricity and water for weeks/months

Some of this damage can be mitigated, particularly damage associated with weaker systems (Depressions, storms and Category 1-2 hurricanes.) High tunnels are not built to withstand high gusts of wind typical of hurricanes, however in advance of a storm the covering can easily be pulled back in the event of high winds. Damage to the crop and high tunnels by winds below 60 km/hr can be prevented and is addressed under the Emergency Response Plan. High tunnels placed perpendicular to the wind receive most damage – in the event of a hurricane wind direction is unpredictable, so they may be subject to damage if not pulled down and secured. Posts should be driven at least 24 inches into the ground to prevent uplift of the structure by high winds. Plastic mulch is also liable to be destroyed and blown away, particularly if care has not been taken to keep it secured by the soil.

Greenhouse design must also take into account rain load – to be able to withstand the intensity of heavy rains which do occasionally occur. High tunnels are better able to withstand rains because of their curved roofs. CPGCA intends to investigate a hybrid structure which can offer the maneuverability and mobility of the high tunnels as well as the enhanced climate control of the greenhouse.

In the event of excessive amounts of rain, plasticulture may reduce the potential for drowning of crops to a certain extent, since the water is shed from the row area and runs off the field; however this may exacerbate soil erosion from the middle rows.

Tropical storms and hurricanes would have an impact on crops in the field but would not be expected to inflict long term damage, but will certainly result in a disruption of supplies. Given a return to normal conditions, crops could be harvested within the next crop year. The project will be particularly vulnerable to infrastructure damage (roads); electricity and water supply disruption. To a limited extent, air transportation may be temporarily affected which may have implications if shipments are ready when a storm occurs. Mitigation of these impacts are largely beyond the control of Nightingale Farms, except for the back –up water supply provided by the tank at the Coleyville packing house.

Potential effects of accidents/malfunctions:

The more likely accidents and malfunctions would be chemical spills/contamination. Fire is also a potential, though unlikely threat, particularly if burning is actively discouraged by farm management. Chemical spills could result in skin, eye irritations and other symptoms of pesticide exposure; ecological damage due to toxic exposure of birds, bees and perhaps domestic animals and persistence in the environment if large amounts of chemicals are released. The mitigation plan outlines an emergency response plan to deal with these possibilities.

7.0 GENERAL SOCIO-ECONOMIC CONDITIONS and COMMUNITY CONCERNS

Agriculture employs a large portion of the population, (particularly unskilled labour) and is a main plank of the Government of Jamaica's National Industrial Policy. The project will take place in one of the country's most productive traditional agricultural areas. Communities in Manchester have traditionally grown banana, coffee, pimento, Irish and sweet potatoes, citrus, yams, ginger, vegetables, peas, and corn. St. Elizabeth, known as the 'bread basket of Jamaica' is well known for watermelons, cantaloupes, tomatoes, scallion, and thyme. Trelawny is well known as 'yam country', famous for its annual Yam Festival.

Because it is difficult to predict the location and number of farmers who might eventually become contract farmers, or adopt the technology being introduced by Nightingale Farms, predicting the environmental and socio-economic impact of the project can only be done generally. At a broad level, it is possible to describe the general socio-economic conditions of the parishes within the CPGCA's sphere of influence, with more detailed information on the parishes of Manchester and St. Elizabeth in which project activities will physically take place.

As indicated in Table 4, the parishes in which Nightingale Farms and CPGCA hope to exert some influence are predominantly rural parishes with higher than average levels of poverty (i.e. greater than the national average of 19.7%), and lower than average housing quality and sanitation. All 5 parishes are dependent on agriculture as a main economic driver.

Table 6- Socio economic indicators of selected parishes

Indicator	St. Elizabeth	Manchester	Clarendon	Trelawny	St. Ann
Main economic activities	Agriculture, bauxite mining, fishing	Bauxite mining, agriculture	Bauxite mining, agriculture, agro-processing manufacturing	Tourism, agriculture	Tourism, bauxite mining, agriculture
Population (2005 est.)	149,400	188,900	243,600	74,700	171,300
% of population in rural areas	85.6%	66.5%	69.7%	79.4%	73.3%
% of population below poverty line	20%	24.4%	27.2%	31.3%	37.0%
Housing quality	54.8 – lower than national average	58.2 – lower than national average	62.1-lower than national average	56.4 – lower than national average	59.6 – lower than national average
Sanitation	61.6% use pit latrines	52.1% use pit latrines	44.4% use pit latrines	67.6% use pit latrines	55.1% use pit latrines
Age distribution (% of population between 15-64 years)	56.9%	55.1%		55.3%	56.5%

Source: Survey of Living Conditions 2003 (PIOJ). Population figures from ESSJ 2005 (PIOJ)

In general, the farming population in Jamaica is an ageing one, despite the fact that the majority of the population lies within the productive years of 15-64 years of age. Farming is thought to be difficult and unattractive to young people as described in an excerpt from an on-line article below with reference to farmers in Manchester:

"The older, more dedicated farmers have either retired, died, moved on to lighter activities, or some just cannot be bothered. Many of those who have changed occupation report that they find it difficult to bring younger blood on board, mainly because of a lack of their interest in farming, and their reasoning that crops take too long to mature, and so they can't get a sale.

Some crops take longer, but the other factors can readily be addressed by means of diversification, variation, and proper management. As long as all the farmers are growing the same crops at the same time, there will be a 'glut' on the market, prices will always be low, and there will be waste." - Rose Dewar - Agriculture in Jamaica in need of a revival (<http://www.go-localjamaica.com>) (May-02-2006)

Socio-economic conditions and public concerns within the project area

The major economic activity of the Devon/Coleyville/Christiana area is farming. Devon is comprised mainly of low density homesteads. 95% of the farmers in the community farm more than one acre¹⁷. 30% are leased from the bauxite companies or the Government of Jamaica. From the main road, the quality of the housing stock appeared to be quite high with most being substantial concrete structures.

Throughout Manchester, future land use conflicts may arise between agricultural land use and bauxite mining. It is estimated that 90% of the land is covered by bauxite. With green house technology however, it may be possible for reclaimed bauxite lands to be converted more readily for more productive post-mining agricultural use, particularly when used in conjunction with hydroponic techniques which will be less reliant on soil quality.

According to the Manchester Sustainable Development Profile, community concerns with respect to agriculture in the Christiana Development Area (including Devon, Christiana and Coleyville) include:

- the decline of agriculture and particular produce such as Irish potato, cabbage, corn
- high cost of production and transportation
- difficulty selling produce
- praedial larceny (in particular, produce)
- limited impact of Jamaica Agricultural Society and RADA
- over-production of some crops

Some of these concerns can potentially be addressed by the project activities. Community profiles examined revealed that the population has some awareness of environmental issues including the effects of poor environmental management on health and well being; the dangers of bush fires, soil erosion, degradation and loss of nutrients; the need to plant trees and the impact of poor management of garbage. Some communities understood and practiced appropriate mitigative actions. However, in some cases because of inadequate infrastructure such as garbage collection, residents burn garbage as a primary means of waste management.

Due to the lack of surface water and the depth of the water table, publicly provided water is rare in rural areas of Manchester. Although pipes are reportedly in place at Devon, water supply is irregular, and occasionally residents must purchase water from the Rapid Response Unit of the NWC. As a result, a large portion of the population relies on pit latrines for sanitation and rain for agriculture. This solution, while not ideal, is accepted by NEPA as an appropriate waste disposal method, despite some evidence of sewage contamination of Manchester Rivers.

The community surrounding the Mountainside/Hounslow site comprises small farms and residences fairly widely dispersed. Farming is the primary economic base with most farmers cultivating tomatoes, carrots, dasheen, pineapples, cantaloupe, melon, cucumber, sweet potato, zucchini and pumpkin, thyme, sweet pepper. The area is also known for goat rearing. The introduction of plasticulture technology to the area is not new, as a proximate plot to the project site is a USAID-funded demonstration plot with plastic mulch being used.

St. Elizabeth has a good network of major and minor paved roads and in some areas, irrigation infrastructure. Nevertheless, water supply is an issue, as is poor sanitation and waste management. In both areas, there is inadequate garbage collection and disposal and many resort to burning or dumping. Unfortunately, there is no comparable information on community concerns in the literature for St. Elizabeth. They are very likely however, to be similar to those from Manchester.

Praedial larceny

The perception of the significance of praedial larceny varies across the stakeholders, as there are mixed views about of the severity of praedial larceny. The severity appears to be localized, (for example, the CPGCA has not been plagued by praedial larceny to date). Community meetings documented in the Manchester sustainable development profile mentioned praedial larceny as a critical issue in some

¹⁷ Manchester PDC. Sustainable development profile (2004)

communities but not in others¹⁸. In many cases praedial larceny is a crime of opportunity rather than part of organized criminal activity. It is often driven by price fluctuations as a result of scarcity of produce, and high value crops and livestock are usually targeted. With more even production cycles and consistent prices, over time this could be minimized. There is occasional violence associated with retribution by farmers or community residents for praedial larceny if the offenders are caught (locally known as vigilante or jungle justice). The more sensational incidents are highly publicized.

Precise data on praedial larceny is difficult to obtain as larceny is the generic term used in police reporting that covers theft of various items. It is however, assumed to be under-reported, as it tends not to be a priority of local police. The Jamaica Agricultural Society (JAS) estimates the cost of praedial larceny to the sector is \$J4 billion (approximately C\$68.4million) or 25% of overall earnings in agriculture. The JAS has also claimed that the parishes of Manchester and St. Elizabeth have reported high incidences of praedial larceny.

Efforts are being made by the JAS to counter praedial larceny. A new system launched by the Jamaica Agricultural Society in 2005, which was incorporated into the amended Agricultural Produce Act, involves the introduction and use of an agricultural produce receipt book which will demonstrate proof of legitimate purchase of agricultural produce. The JAS is the sole distributor of the receipt books which features a unique registration number for each farmer. Farmers must register with RADA and obtain an agricultural produce receipt book at their JAS parish offices. The Island Special Constabulary Force will work with the JAS to disseminate information regarding the books at farmers meetings to be held in all parishes and investigate praedial larceny incidences.

The concern regarding praedial larceny with respect to this project is two-fold:

- The potential for losses from the demonstration farms – neither location is totally enclosed by fencing designed to keep people out, and both are easily accessible to vehicular traffic. It will also be expensive to put up impenetrable perimeter fencing to restrict access.
- The potential for Nightingale Farms/CPGCA to receive stolen goods at the packinghouse.

Nightingale Farms/CPGA may need to insist on the use of JAS receipt books with their suppliers, in order to minimize the potential that they will receive stolen goods. They will have to make it widely known that they will buy only from contract farmers, and/or legally registered farmers. Stringent management systems of inventory control, receiving control at the packinghouse, staff supervision and general security measures, and common sense precautions such as not leaving harvested crops in the fields overnight will have to be incorporated into day to day operations. CPGCA should ensure it develops and maintains close ties/good will with the local communities and police in both demonstration farm locations in the hope they will discourage 'would-be thieves' or support the investigating of any instances of praedial larceny if they arise.

Public consultation process:

Experience has shown that a challenge in projects with external (foreign) financing is that expectations are raised as to what stakeholders will get out of the project. Initial meetings held with potential stakeholders (farmers) by Nightingale Farms were not successful in selling farmers on the idea behind the project, or generating immediate support. In particular, they were resistant to payment of fees to join the growers group. However, once the CPGCA was identified as a potential partner and the project became integrated into their on-going program of activities, there has been an on-going program of communicating about the existing greenhouse project and the proposed expansion to farmers. CPGCA has used various media including:

- an article in the Manchester PDC Newsletter (July 2006), circulated throughout the parish
- farmers 'planting day' where farmers were given the opportunity to plant seedlings in the greenhouse (July)
- participation at Denbigh, the annual national agricultural trade show (Aug 2006)

¹⁸ Manchester PDC. Sustainable development profile (2004)

- attending Jamaica Agricultural Society farmers meetings (particularly in Manchester)

CPGCA is assisting a farmers co-op in Clarendon to establish a demonstration plot. Further consultations will take place at the CPGCA annual general meeting in October. Already there has been interest in the project generated with visitors to Devon enquiring how they can transfer the technology to their farms.

There has been consultation with potential customers such as Supermarket chains and hotels. The National Commercial Bank has been approached to discuss the possibility of the bank working with CPGCA to facilitate low-interest loans to farmers to implement changes in farming practice. There is also on-going consultation with, and positive feedback from Government Officials, particularly within the Ministry of Agriculture and Bodles Research Station.

SIGNIFICANT SOCIO-ECONOMIC IMPACTS

Introduction of new farming technology

The project can potentially lead to a change in farming practice, if Nightingale Farms/CPGCA are successful in demonstrating the value of the new technology to farmers. The potential adoption of greenhouse technology in particular, could have far reaching benefits including:

- changes in farming practice which could result in increased yields, quality and income/profits. A precedent has already been set by the USAID – funded post-hurricane Jamaica Business Recovery Programme (JBRP) in 2004-2005. This included introduction of greenhouses (of which CPGCA was a beneficiary) and plasticulture. According to JBRP literature and CPGA, growers experienced up to three times the tomato yield under tree house compared with field production. With an average of 1,500 plants per crop under a 600 sq. m greenhouse, growers reaped 13,500lbs (10-15 lbs/plant) compared with 4500-6000 lbs (3-4 lbs/plant). JBRP estimates that with even better nutrition and production practices, this yield could increase even further. JBRP documentation indicates that farmers were receptive to the new technologies introduced.
- reduction in the use of chemical inputs, particularly pesticides as a result of the preventing pest infestation in the first place, coupled with integrated pest management principles. This would have beneficial effects on human health and safety for the producer and consumer, as well as for ground water quality and reduced toxicity to non-target species.
- reduced spoilage and waste of product with a greater percentage of the crop being marketable; more efficient use of resources, including water, labour and other inputs including fertilizers, and pesticides.
- calenderized farming will produce different produce at different times, resulting in fewer gluts, stable prices and less waste. The practice of crop rotation will reduce pest and disease pressure, restore soil fertility and reduce the need for increased chemical inputs over time, resulting in less expenditure on inputs.
- an improvement in the quality of life for individual farm families and rural communities as a whole. This could have a spin-off effect of increasing the motivation of rural communities to remain in farming and curb rural-urban drift. This could be a possible cumulative effect of the project over time.

The extent to which this uptake will occur is difficult to predict. On the one hand, the experience of JBRP was positive, however this was achieved with intensely focused project resources and its sustainability is yet to be tested. The positive potential for significant socio-economic impact is real, however, this will only occur if the following conditions are met:

- Farmers must be willing to make a dramatic change in the way they manage their farms. Greenhouse and plasti-culture with their associated water, nutrient and pest and disease management needs require attentive management and consistent monitoring.
- Credit is available at reasonable rates and conditions. This change will demand new investment in the technology which many farmers may not be able to afford unless credit is available. Many farmers may not be able to collateralize loans even if available due to the issue of land tenure and ability to prove ownership. Nightingale Farms, while investigating means to facilitate favourable credit terms cannot guarantee same, nor can it guarantee that farmers will meet loan criteria and conditions.
- Marketing and distribution is successful and post-harvest quality and price are competitive.

It is said however¹⁹, that this technology will not help subsistence and very small farmers, who represent a substantial portion of the farming community.

¹⁹ CPGCA General Manager, pers. comm..

8.0 ENVIRONMENTAL MANAGEMENT PLAN

8.1 INTRODUCTION

This environmental management plan represents the proposed mitigations strategies for environmental impacts identified in the Environmental Assessment Report.

8.2 NIGHTINGALE FARMS/CPGCA ENVIRONMENTAL, HEALTH AND SAFETY POLICY

(adapted from Nightingale Farms Health and Safety Policy)

Nightingale Farms Ltd. and Christiana Potato Growers Co-operative Association (CPGCA) will make every effort to provide a safe, healthy working environment and manage the environmental aspects of all joint-venture activities. Commitment to environmental protection, health, safety and compliance with the law must form an integral part of this organization from the owners to the managers.

Nightingale Farms and CPGA as employers are ultimately responsible for our workers' health and safety and environmental protection. Every reasonable precaution will be taken to protect workers, reduce waste and minimize environmental pollution. All supervisors and workers must be dedicated to the continuing objective of reducing risk of injury and minimizing the impact of activities on the natural environment.

Supervisors will be held accountable for the health and safety of workers under their supervision and ensure that workers are in compliance with the environmental management plan. Supervisors will be responsible to ensure that machinery and equipment are safe and that workers work in compliance with safe work practices and procedures and the environmental management plan. Workers will receive adequate training in their specific tasks to protect their health and safety. Every worker must protect his/her own health and safety by working in compliance with the law and with safe work practices and procedures established by Nightingale Farms Ltd./CPGCA.

8.3 COMPATIBILITY WITH NATIONAL/INTERNATIONAL REGULATION AND CODES OF PRACTICE

This environmental management plan will be consistent with the following regulations, guidelines, and codes of practice:

- Ministry of Agriculture Packing house requirements (Appendix 2)
- Pesticides Control Authority safe handling and proper use of pesticides (Appendix 3)
- NEPA trade effluent discharge standards (Project Information Form) (Appendix 4)

Nightingale Farms and CPGA will work towards ultimately achieving HACCP certification for the Coleyville packing house.

8.4 LEGAL REQUIREMENTS

1. Packinghouse approval from Ministry of Agriculture
2. Export registration with JAMPRO
3. License to discharge trade effluent (where necessary)
4. Registration with the Ministry of Labour and Social Security in compliance with Factories Act (where necessary if packing plant meets the definition of a factory)

8.5 DIRECT ENVIRONMENTAL ASPECTS OF COMPANY'S ACTIVITIES

1. **Waste generation**

- Waste water (from packing operations)
- Sewage (from pit latrines and bathrooms)
- Solid waste, including office waste, farm waste, domestic waste (from on-farm activities, construction activities, administrative activities and other general day-to-day activities)
- Organic waste (from sorting, grading and processing)

2. **Resource Use**

- Water (rinsing operations, farms)
- Electricity (packing house)
- Fuels (farm machinery, vehicles)

3. **Soil degradation/instability** (Devon and Mountainside)

4. **Chemical Use**

- pesticides/fungicides (farm/greenhouse and post harvest)
- herbicides (farm/greenhouse)
- fertilizers farm/greenhouse)
- cleaners and disinfectants (greenhouse/packinghouse)

5. **Employee health and safety**

- Sanitation
- Chemical handling
- Equipment handling
- General working environment

8.6 INDIRECT ENVIRONMENTAL ASPECTS OF ACTIVITIES (contract growers)

- Deforestation/removal of vegetation
- Soil erosion
- Soil mineralization/depletion
- Increased solid waste

8.7 MITIGATION MEASURES

1. Environmental aspect - Waste generation Mitigation measure – Waste reduction, responsible on-site management and disposal

Waste water (from packing house operation)

Determination of the most effective way for effective disposal of waste water is affected by the following:

- there are no clear guidelines for the proper disposal of packinghouse waste water from the Ministry of Agriculture and NEPA
 - there is no municipal waste water infrastructure in Coleyville
 - existing waste water infrastructure at the plant is inadequate

Waste water from the packing house will potentially contain:

- soil particles
- chemical residues from pesticides and rinsing solution (Benomyl and Imazalil)
- detergents and chlorine from washing down operations (equipment and plant interior).
- sewage/grey water from bathrooms to be constructed at Coleyville

An on-site, secondary disposal method such as tile field is recommended. The advantages are:

- Low tech, low maintenance and affordability
- Availability of land at the packing house site

- Low concentrations of chemical residues expected in the rinse water
- Low organic and pathogen load
- Proposed pesticides and fungicides are of low toxicity and generally not persistent in the environment. Use of a tile field will facilitate breakdown and dissipation of residues by the soil.
- Low water table with limited potential for groundwater contamination
- No water bodies in the vicinity of the plant.

Nightingale Farms/CGPA will engage the services of a waste water specialist to:

- project the volume of waste water that will generated, based on industry standards and projected volumes of produce to be handled by the packing house. Currently, projections are 1.15 million lbs of produce in year one, increasing to approximately 7.0 million lbs. in year three. A processing schedule will be done to estimate the maximum throughput per day/week.
- map existing drainage infrastructure and new drainage required for the packinghouse operation (rinsing, wash-down and sewage)
- determine whether sewage disposal and rinse water disposal methods are compatible and can be accommodated in one system, or whether separate systems are needed.
- design a suitable on-site waste disposal solution (perhaps one which can be 'scaled up' as volumes increase) which will satisfy NEPA's trade effluent requirements. If a license to discharge is required, the waste water specialist should shepherd Nightingale Farms/CGPA through the process.
- construct and install a waste treatment system which will provide a secondary level of treatment

For Devon and Mountainside Nightingale Farms/CPGCP will:

- install ventilated improved double pit (VIDP) latrines (i.e. composting toilets) to reduce potential for groundwater contamination at Devon and Mountainside. Water will be made available for sanitary purposes (hand-washing and bathing) perhaps from a dedicated tank. The small volume of water used for this purpose and effluent quality will not require disposal infrastructure.

Solid waste

Solid waste will be generated at both farm sites as well as the Coleyville packing house. Waste from the Coleyville/Devon area waste goes to a NSWMA approved dump (which is not managed as a landfill). Waste generation will therefore be minimized and recycled where possible to reduce the costs and environmental impacts associated with waste disposal. Solid wastes will be disposed of responsibly, both on-site to minimize litter and reduce waste collection costs, and off-site by contracting with a registered commercial waste removal firm (which is currently being done by CPGCA). Other strategies will include:

- On farm waste which cannot be collected and /or recycled will be buried rather than burned.
- Compost heaps will be established on both farms for organic wastes
- Chemical containers will be disposed of in compliance with PCA recommendations.

A main concern will be waste from plastic mulch as well as the eventual disposal for greenhouse material (netting and plastics). At present there are no recycling facilities for plastics (as there are in Canada). Nightingale Farms/CPGCA will investigate use of bio-degradable or organic mulches and use these where feasible. It may also be prudent for the packinghouse to house used plastics until suitable recycling or disposal methods are identified.

Wastes will be treated as follows in Table 4.

Table 7- Waste Management

Solid waste	Source/Location	Likely constituents	Waste treatment/disposal
Office waste	CGPA office and training centre	Paper, plastic/glass drink bottles, styrofoam, cardboard,	<ul style="list-style-type: none"> ▪ Commercial collection by approved waste removal company
Packaging	Coleyville Packing house	Plastics, cardboard, old palletes, sawdust, coconut fibre	<ul style="list-style-type: none"> ▪ Garbage skips/containers for temporary storage prior to collection ▪ Commercial collection by approved waste removal company ▪ Compost (organics)
Construction waste	Colleyville Packing house	Zinc, empty paint cans, wood, old metal parts	<ul style="list-style-type: none"> ▪ Commercial collection by approved waste removal company.
Organic farm waste (spoilage, remnants from crop, hydroponic medium)	Devon and Mountainside	Spoilt produce, old plant material Coconut fibres	<ul style="list-style-type: none"> ▪ Composting/vermi-composting on site
Organic waste – rejects from packing house	Colleyville Packing house	Spoilt produce, skins	<ul style="list-style-type: none"> ▪ Rejected (but edible) produce to charities/food banks, children’s homes ▪ Composting/vermi-composting ▪ Biodigester if feasible on expansion of agro-processing generates peelings, etc.
Domestic waste	Devon and Mountainside	Paper, plastic (PET)/ glass drink bottles, styrofoam, cardboard,	<ul style="list-style-type: none"> ▪ Encourage workers to bring reusable containers from home ▪ Burial on farm
Chemical containers	Mountainside and Devon	HDPE plastic bottles	<ul style="list-style-type: none"> ▪ Triple rinsed, crushed and buried on farm as recommended by PCA ▪ Triple rinsed, crushed and removed to approved dump
Plastic mulch	Mountainside	Polyethylene	<ul style="list-style-type: none"> ▪ Use of photodegradable or biodegradable/organic mulch ▪ Baling and storing at Coleyville prior to commercial removal ▪ Burial on farm
Old greenhouse material	Devon	Polyethylene UV plastic Anti-viral netting	<ul style="list-style-type: none"> ▪ Commercial removal to approved dump

2. Environmental Aspect - Resource Use

Mitigation measure – Conservation, responsible use and proper maintenance

- Water – staff will be trained to conserve water during rinsing and irrigation operations. Water will be harvested at Devon for use in the greenhouses. Where feasible, rain water will be harvested at Coleyville as a back-up water supply for the municipal system.
- Electricity – lighting will utilize energy efficient fixtures. The forced air system will be maintained regularly to ensure energy efficiency.
- Fuels – refrigerated trucks and farm machinery will be periodically and regularly maintained to enhance fuel efficiency. Where feasible, only full loads will be transported.

3. Environmental Aspect - Soil degradation/instability

Mitigation measure – Minimize soil degradation and soil erosion

- Hydroponic, non-soil medium will be used at Devon. This will eliminate need to treat some pests and diseases (e.g. nematodes) and will avoid the risk of soil mineralization.

- Where soil is used inside the greenhouse, the soil will be irrigated. Soil under greenhouse does not experience leaching effect of rains that removes excess sodium. Salt buildup can occur, making greenhouse soil more difficult to work with. This can be overcome by monitoring the electrical conductivity (EC) of the soil. If the EC is higher than 4 mmhos / cm, sprinklers will be used to irrigate soil at the end of each crop to eliminate excess salt. The amount of water to be applied through sprinklers will depend on the EC level and type of soil. High tunnels may be moved periodically where feasible to allow crop rotation and soil to lay fallow to regain fertility. Soil under plasticulture will be exposed to natural leaching effect of rain.
- Crop rotation calls for a change in botanical family after each crop cycle. This is complicated by the demands of the market that may call for a continuous supply of one crop, leading to build-up of soil-borne pests and diseases, in addition to high soil salinity. Chemical and physical characteristics of soil will be monitored by means of soil and foliage nutritional analysis. Crop protection records will be analyzed and the information on pest and disease pressures incorporated into the production plan.

4. Environmental Aspect - Chemical Use

Mitigation measure – Identify and use least toxic chemicals, reduce use hazardous chemicals, and ensure responsible storage, application and disposal.

Identify and use least toxic chemicals

Where possible the least toxic chemicals for pest and disease control, cleaners and disinfecting will be used, as long as they do not compromise quality. Nightingale Farms/CPGCA will liaise with chemical suppliers and consult industry publications to identify less harmful alternatives to pesticides, cleaners and disinfectants. Natural pesticides (e.g. Neem-X, Xentari) and less toxic pesticides will be the first treatment option. Priority will be given to using chemicals with the lowest toxicity ratings.

Reduction of chemicals

While the introduction of greenhouse technology will reduce the pest and disease load and the chemical requirements compared with traditional farms, where applicable the following alternatives to chemicals will also be used:

- compost/organic waste to regenerate soil, using vermi-compost particularly at Mountainside
- integrated pest management practices (IPM) recommended by CARDI, RADA or any other technical advisors. Priority will be given to biological control methods where feasible.
- pesticides will only be applied when pests are at an economic threshold level, and only using recommended doses.

Chemical storage

CPGCA is a registered pesticide purveyor and thus must comply with PCA requirements. Pesticides will continue to be stored at the farm store on the CPGCA premises in Christiana and will be dispensed as needed from that location. CPGCA will use PCA guidelines as outlined in Appendix 3.

Fuels (diesel) for farm machinery will be purchased as needed and not stored on-site as a general rule. Chemicals (fertilizers, pesticides and fertilizers) will be segregated and stored in well ventilated locations where accidental mixing (including fumes) can occur. The storage area will have a concrete floor with a bund to prevent spillage. Fire extinguishers will be kept in close proximity.

5. Environmental Aspect - Employee Health and Safety
Mitigation measure – Ensure employees are aware of safety and appropriate emergency response procedures and are provided with the appropriate personal protective gear.

▪ **Training**

All staff will be trained to safely handle chemicals and handle emergencies involving chemical spills, fire, accidents and damage as a result of natural disasters. Pesticide training will be based on the Pesticides Control Authority Training guide. Staff will also be trained in the safe handling of machinery and the use and maintenance of irrigation/fertigation equipment.

▪ **First aid**

A fully stocked first aid kit will be kept at all project locations (Mountainside, Devon and Coleyville). (See emergency response plan).

▪ **Medical care**

Because of the risk of tetanus/lock jaw on farms, any deep tissue lacerations must be seen by a doctor. Employees with known allergies to insect bites will also be seen by a doctor.

▪ **MSDS**

MSDS (Material safety data sheets) are provided by chemical suppliers and are kept at the CPGCA offices. Summaries of the chemicals, their effects on human health and treatment on un-due exposure will be kept on the project site in accessible areas, particularly in the event of chemical spills or exposure.

▪ **Protective gear**

Protective gear as recommended by the Pesticides Control Authority will be provided on each farm and will include:

- Coveralls for pesticide application
- Boots (hard plastic/rubber)
- Unlined gloves (heavy duty plastic/rubber)
- Cartridge respirators
- Goggles
- Hat

▪ **Staff Facilities (sanitary/changing, eating)**

Workers at the Coleyville plant will be provided with changing rooms and bathrooms with clean water and eating facilities. Staff on the farms will be provided with latrines and clean water and shower facilities. Staff facilities will follow employer obligations for occupational health and safety under the current Factories Act, and the new Occupational Health and Safety Act, when promulgated.

6. Indirect Environmental aspects of activities (general increase in farming)
Mitigation measure - Environmental education and demonstration

Mitigation measures

Nightingale Farms Ltd. CPGCA will promote the following good agricultural practice on its demonstration farms and in its farmer outreach program by highlighting the following:

- use of bamboo yam sticks
- tissue culture (sweet potato and mini sett yams)
- safe chemical storage, use and disposal

- crop rotation and agronomy
- integrated pest management
- solid waste management
- composting/vermi-composting
- soil conservation
- soil/nutrient management (including periodic soil testing)
- greenhouse building (including responsible use of local lumber)

DISASTER PREPAREDNESS

The major natural hazard vulnerability will be potential damage from tropical storms. Jamaica is susceptible to tropical depressions, tropical storms and hurricanes during the Atlantic hurricane season which begins on June 1 and ends on November 30. The Atlantic is currently in a prolonged period of greater than average storm activity. The following pro-active steps will be taken to mitigate against potential damage from storms and hurricanes

- hurricane straps will be installed on the roofs of all buildings during renovation. All renovated buildings will be able to be secured (strong doors and windows which can be locked from the outside) in the event of a hurricane.
- a designated person will be identified to manage/coordinate disaster preparedness activities.
- an emergency response plan will be developed and reviewed/updated annually (see Initial Emergency Response Plan).
- emergency items will be acquired before the hurricane season. These include boots, raincoats, flashlights, plastic bags, nails, hammers, boards and other tools.
- drainage infrastructure at Devon and Coleyville will be maintained and kept free from debris/solid waste at all times
- to protect the greenhouse against wind damage, where feasible, fast growing trees or herbaceous barriers (e.g. corn and king grass) will be planted will be planted not less than 20m away from the greenhouse.
- any trees with the potential to fall down and cause damage to crops, or those near to electricity lines will be limbed at the beginning of each hurricane season.

9.0 ENVIRONMENTAL MONITORING PLAN

ENVIRONMENTAL ASPECT	PERFORMANCE INDICATORS/TARGETS	IMPLEMENTATION AND MONITORING PLAN	FREQUENCY/TIMING
Waste reduction and responsible disposal	<ul style="list-style-type: none"> ▪ 100% recycling of organic waste (on farm and at packinghouse) ▪ All garbage properly contained in receptacles (No evidence of chemical containers/litter or domestic waste on farm) ▪ Treatment of waste water according to approved standards ▪ Minimum use of non-biodegradable plastics 	<ul style="list-style-type: none"> ▪ Ensure compost heap is of sufficient volume for waste generated ▪ Install garbage receptacles ▪ Ensure garbage containers are sufficient for volume of waste generated ▪ Monitor health of worms in compost heap ▪ Identify burial site for on-farm disposal of chemical containers and domestic waste ▪ Train workers on waste management practices ▪ Monitor collection of garbage by commercial contractor ▪ Install waste water treatment per specialist's recommendations and NEPA requirements ▪ Monitor rinse water effluent ▪ Investigate feasibility of using non-biodegradable or organic mulch ▪ Investigate possibilities for recycling plastic 	<p>On-going</p> <p>Immediately</p> <p>On-going</p> <p>On-going</p> <p>Immediately</p> <p>On-going; on new hiring</p> <p>Monthly</p> <p>First three months</p> <p>Yearly</p> <p>First three months and on -going</p>
Resource Use (water, fuel, electricity)	<ul style="list-style-type: none"> ▪ Water efficiency per industry standards ▪ Energy efficiency per industry standards ▪ Fuel efficiency per manufacture's standards ▪ Collection and use of rain water 	<ul style="list-style-type: none"> ▪ Establish target for water usage based on use per unit flow-through of produce ▪ Establish target for electricity consumption ▪ Monitor water consumption via water bill ▪ Monitor electricity consumption via electricity bill. Use electricity at off-peak hours if possible. ▪ Install energy efficient lighting and equipment ▪ Rehabilitate tank and modify plumbing to use rain water in non-critical areas (e.g. toilets, sinks, washdown) ▪ Regular maintenance of forced air system ▪ Regular maintenance of refrigerated trucks, tractors and farm equipment ▪ Train staff to monitor leaks, conserve energy and water 	<p>First three months of operation</p> <p>Monthly/bimonthly per billing cycle</p> <p>Immediately</p> <p>Immediately</p> <p>According to manufacturers specifications</p> <p>On-going</p>
Soil degradation	<ul style="list-style-type: none"> ▪ Maintain soil pH at no less than 5.5 ▪ Maintain organic content of soil ▪ Maintain nutrient and micro-nutrient levels 	<ul style="list-style-type: none"> ▪ Soil PH testing to monitor salt buildup. with hand held pH-EC meter, (1 part soil to 2-3 parts water) ▪ Flush irrigation lines with water (Devon) ▪ Expose to rain and/or leave fallow (Mountainside) ▪ Practice crop rotation as recommended for each crop ▪ Soil nutrient testing ▪ Incorporate compost/nutrients in the soil (Mountainside) 	<p>After each crop year</p> <p>After each crop year</p> <p>Per technical recommendations</p> <p>After each crop</p> <p>As determined by soil tests</p>

ENVIRONMENTAL ASPECT	PERFORMANCE INDICATORS/TARGETS	IMPLEMENTATION AND MONITORING PLAN	FREQUENCY/TIMING
Chemical handling	<ul style="list-style-type: none"> ▪ Compliance with PCA chemical use and storage guidelines ▪ Zero incidence of chemical spills ▪ Use only as needed at economic damage threshold levels. ▪ Least toxic chemicals as first option 	<ul style="list-style-type: none"> ▪ Training of staff in chemical handling ▪ Chemicals transferred to farm from CPGCA farm store as needed (just in time delivery) ▪ Provide segregated storage areas for different chemicals ▪ Monitor pest levels ▪ Date of application amounts of chemicals recorded ▪ Review of chemical use records 	<p>Immediately/on hiring As needed</p> <p>Immediately Daily/weekly On application</p> <p>Quarterly</p>
Employee health and safety	<ul style="list-style-type: none"> ▪ Zero incidents of accidental exposure to chemicals ▪ Zero on-farm accidents requiring medical attention ▪ Minimal exposure to hazardous chemicals ▪ Compliance with occupational health and safety legislation/regulations (Factories Act) 	<ul style="list-style-type: none"> ▪ Train staff in mechanical and chemical handling, interpretation of MSDS sheets, emergency and accident response including chemical clean-up. ▪ Post emergency response plan at accessible location at each site. ▪ Ensure chemical cleanup kit is stocked ▪ Check first aid kit supplies/expiry date ▪ Ensure all chemicals have MSDS sheets and are available on farms ▪ Ensure fire extinguishers are present on farm on at packinghouse ▪ Provide personnel protective safety gear ▪ Provide shower/washing up area for farm staff ▪ Supervisors monitor use of safety gear 	<p>Immediately and on new hiring</p> <p>Immediately</p> <p>Annually, or after each accident On purchase</p> <p>Immediately</p> <p>Immediately Immediately</p> <p>On-going</p>
Environmental education/farmer knowledge	<p>All contract farmers aware of :</p> <ul style="list-style-type: none"> ▪ use of bamboo yam sticks ▪ tissue culture (sweet potato and mini sett yams) ▪ safe chemical storage, use and disposal ▪ crop rotation and agronomy ▪ integrated pest management ▪ solid waste management ▪ composting vermi-composting ▪ soil conservation ▪ soil/nutrient management (including for periodic soil testing) ▪ responsible use of local lumber for greenhouse building 	<ul style="list-style-type: none"> ▪ Training sessions with farmers ▪ Demonstration of good agricultural practices ▪ Visits to contract farms 	<p>On-going</p> <p>Randomly</p>
Regulatory Compliance	<ul style="list-style-type: none"> ▪ All legal requirements met and licenses/approvals current 	<ul style="list-style-type: none"> ▪ Apply to the Ministry of Agriculture for packing house approval ▪ Apply to JAMPRO for exporter registration ▪ Complete application for license to discharge trade effluent 	<p>On completion of packinghouse renovations After consultation with waste water specialist</p>

10.0 EMERGENCY RESPONSE PLAN

This emergency response plan outlines steps to be taken to minimize the impact of accidents and natural disasters on human health and the environment. The major likely emergencies will likely involve the following scenarios:-

- Minor injuries, bites, sprains
- Major injuries (deep tissue lacerations, broken bones)
- Chemical exposure (personal)
- Chemical spills (environmental)
- Fire
- Severe weather - Hurricanes/weather related emergencies

The plan covers steps to be taken in the event of:

- Medical emergencies
- Pesticide Exposure
- Chemical spills
- Fire
- Hurricanes/wind storms

Roles and responsibilities:

- Nightingale Farms and CPGCA will ensure that the emergency response plan is up to date and understood by all staff.
- CPGCA will be responsible for ensuring that all hurricane emergency items, first aid equipment, fire extinguishers, chemical clean up kits and protective gear and emergency contact information are available to staff in accessible locations, and that contents are complete and up-to-date.
- CPGCA will ensure that a designated person is identified (local doctor/hospital) to be called in the event of medical emergency.
- CPGCA will appoint designated responsible person(s) to coordinate and manage the pre- and post emergency response.

MEDICAL EMERGENCIES

A stocked first aid kit with the following will be kept in an accessible location at all project locations for use during emergencies involving minor cuts and lacerations, bites, sprains etc. The kit will be stocked with the following items:

- contact information of nearest medical facility, and emergency response (fire, ambulance etc)
- bottled water to be used as eyewash in the event of chemical exposure
- anti-histamine syrup, calamine lotion or anti-inflammatory cream in the event of insect stings/bites
- roll of gauze and tape/safety pins
- band-aids and bandages of assorted sizes
- anti-bacterial soap and cream
- hydrogen peroxide
- vinyl gloves
- chemical MSDS
- smelling salts (for fainting)
- pain killers
- first aid book

The emergency response for medical emergencies is based on the following steps:

1. Knowledge of nearest medical facility for emergencies
2. Assess severity of the injury
3. Contact designated person to transport patient to nearest medical facility
4. Treatment of minor injuries on spot
5. Immediate medical assistance for major injuries

i. Minor injuries, stings, bites:

- Assess severity of the injury
- Treat minor injuries on spot with first aid kit.
- Refer injured person for medical assistance in the event of chemical exposure, allergies, deep wounds, sprains, etc.

ii. Major accidents

- Assess severity of the injury
- Contact medical help as soon as possible.
- Contact designated person to transport injured to nearest hospital
- Contain bleeding if necessary. Monitor breathing until help arrives or as patient is transported to the nearest medical facility.
- Treat related minor injuries on spot with first aid kit.

PESTICIDE/CHEMICAL EXPOSURE

1. **Prevent additional contamination:** Move the person away from the spill area or move containers of pesticide away from the person. Remove any contaminated clothing. Wash any body areas in contact with the pesticide, using soap and water, as soon as possible. If pesticides get in the eye, open eyelid and wash with a gentle stream of water for 15 minutes.
2. **Check victim is breathing:** If victim is breathing but inhaled pesticides, take victim to an open area where he/she can get fresh air. Loosen tight clothing. **Perform artificial respiration if not breathing. This takes precedence over all other first aid procedures.**
3. **Get medical aid:** Call for medical aid immediately. Provide as much information as possible about the pesticide by keeping the container and label handy. Provide the history of exposure and poisoning symptoms
4. **Keep victim at rest, warm and comfortable:** The victim should be kept calm, preferably lying down, until medical help arrives. Continue any first aid treatment. Rinse mouth with plenty of water.

Note: Additional first aid procedures for handling specific types of poisoning resulting from pesticides on skin, in eyes, inhaled or swallowed can be found on MSDS sheets.

CHEMICAL SPILLS

A spill clean-up kit will be located near pesticide storage or display areas. At a minimum, the kit will contain:

- **Safety Equipment:** Unlined rubber or plastic gloves, unlined boots, coveralls, and a cartridge respirator suitable for pesticides).
- **Absorbent Materials:** Absorbent material such as kitty litter, sand, vermiculite, or sawdust.
- **Decontamination Materials:** Soap and bleach should be available for decontaminating the spill site. Do not use bleach unless it is specified on the label or the Material Safety Data Sheet (MSDS) sheet.
- **Clean-up tools:** Clean-up tools include a long handled broom, dustpan, and shovel. Garbage bags and a plastic bucket or garbage pail with lid are required for containing waste, and a spray bottle to moisten dusts.

In the event of a pesticide spill, the designated responsible person will apply the following procedure:

1. Don protective clothing for personal protect against pesticide contamination. At a minimum, wear unlined rubber or plastic gloves, long-sleeved shirt, long pants, and shoes and socks. Wear a respirator if necessary to prevent inhalation of pesticide vapours.
2. Isolate the area from other people and animals.
3. Eliminate the source of the spill if possible.
4. If the spill is indoors, ensure there is maximum ventilation by opening all possible windows and doors to prevent build-up of vapours.
5. Contain the spread of the pesticide to prevent further contamination of the environment. Put down a barrier to prevent spilled liquids from spreading. Use absorbent material in pesticide spill kit.
6. Place leaking containers inside new plastic containers to prevent additional pesticide from spilling. Put smaller containers that are leaking into larger containers.
7. Read the label. Product labels may contain information on how to respond to a spill and should be consulted first for specific precautions
8. Decontaminate the areas as directed by Material Safety Data Sheets. Decontaminate all equipment used in the cleanup using the same procedure.
9. Do not wash away spilled pesticides. This will contaminate a greater area, make decontamination more difficult and present a greater risk to the environment due to run off.
10. Put the pesticide clean-up materials and pesticide residue into a sealed plastic container. Label the container with the name of the pesticide. Contact the chemical supplier or the Pesticides Control Authority for disposal instructions.
11. Change Clothes/Wash: After the spill is cleaned up, remove safety equipment, shower, and change clothes if it is possible that they were contaminated during cleanup. Remove contaminated clothing. Thoroughly wash skin with soap and water. Read product label for treatment. Get medical attention.

Collecting Dusts/Granular pesticides:

- Moistened dusts with a fine mist before removal to prevent dust from floating into the air during clean-up.
- Do not use a vacuum cleaner to collect spilled dust.
- Collected pesticide from the spill may still be good for use and does not require disposal. For example, a granular pesticide spilled onto a dry, hard surface could be collected and used.

FIRE

General

Fire Extinguishers rated for chemical and electrical fires will be kept near to where pesticides are kept, and at Coleyville. Farm and office staff will be trained in use of fire extinguishers. Emergency numbers (the local police, fire department, and ambulance service) will be posted in visible locations, including on fire extinguishers.

In the event of a fire:

- Assess the severity and source of fire. If fire can be contained with water (e.g. a 'bush' fire on the farm) use hoses and/or buckets to contain the fire.
- Use the fire extinguisher if water is not available, or it is not safe or practical to do so (small chemical or electrical fire)

- Contact the fire department if fire cannot be contained as above, involves chemicals, electricity and is spreading rapidly.
- If fire is spreading rapidly or involves burning of potentially hazardous materials with fumes, evacuate area immediately.

Fires Involving Pesticides/Chemicals

Fires involving pesticides are hazardous because chemicals can be released as vapours into the air and spread by water used to fight the fire. The following procedure will be used in the event of a pesticide/chemical fire:

- Notify the fire department immediately. Make it clear that pesticides are on the property and provide as much information as possible on the specific pesticides involved. Get medical aid to deal with cases of pesticide exposure, using the procedure for “First Aid for pesticide exposure”
- Clear the area of people and animals and evacuate them upwind of the fire.
- Attempt to put out the fire if it is small with a chemical rated fire extinguisher
- Decontaminate the area. After the fire has been brought under control, and on approval of fire fighters, proceed with decontamination of equipment, protective clothing and land where pesticides have been released.

SEVERE WEATHER

The passage of tropical storms/hurricanes will be monitored by listening to radio/TV announcements from the Office of Disaster Preparedness and Emergency Management (ODPEM). The following steps will be taken in the event of a public advisory/severe weather alert.

On the issuing of a hurricane/storm watch by ODPEM the designated responsible person will monitor the progression of the storm and storm winds in order to take the necessary precautions which include:

- Reaping of mature crops and securing in the packing house.
- Clearing of hanging limbs that can cause damage.
- Checking of drainage systems to ensure they are clear from debris.
- Examining plastic mulch and ensure it is securely held by soil.
- Location of all chemicals indoors in a safe location least likely to flood. Move pesticides and chemicals (especially those in unsealed or water-permeable containers) to a higher storage location in anticipation of flooding. Don protective gear as necessary to move from one location to another.

On announcement of a storm warning:

- All debris and loose objects at the farms and at the packing house should be contained and secured in anticipation of a tropical storm or hurricane. Check on everything that can be blown away or be torn loose. Garbage cans, tools, signs. Store them all inside if possible.
- All irrigation/fertigation systems will be turned off.
- Ensure all buildings are secured, and locked.

Greenhouses

If expected winds are under 30 km/hr, no action should be taken with respect of the wind tunnels. However:

- When expected winds are >30 km/hr, vent roof plastic to Stage 1 (1 foot open) to allow winds to pass through

- When expected winds are > 40km/hr, vent to Stage 2 (2 feet open)
- When expected winds are > 50Km/hr, vent to Stage 3 (wide open)

When expected winds are expected to exceed 60Km/hr, the roof will be taken down by undoing the ropes and securing the tops. If time does not allow, the ropes will be cut with knives and the plastic roof secured to the top of the leg strut, and tying every 20 ft.

This will be done as when hurricane/storm conditions are expected within the next 12 hours. Preparations to the greenhouse are to be done prior to the storm and must never be done during storm as this is extremely dangerous.

Packing house: (On announcement of a storm warning)

- The packing house should be able to withstand hurricane force winds. The priority will be to ensure the packing house is securely battened down
- Ensure that the sheds covering the compressors are secured as much as possible (particularly the roofs).
- Remove all debris from the yard
- Consider the likelihood of power failure (based on severity of the storm) and determine whether the compressors should be shut down and power turned off at the main switch.

After the storm

After the hurricane or flood, farm land should be returned to production as soon as possible.

- Clear up debris, especially displaced plastic mulch or greenhouse plastic
- Effect emergency repairs to roofs, fertigation/irrigation systems, compost heap.
- Dispose of any dead animals immediately.
- Clear hanging limbs and destroyed crops. Where possible, mulch for disposal in compost heap
- Remove non-biodegradable debris and secure for garbage collection, once this has resumed.
- Examine plastic mulch for damage.
- Test electricity supply at the packinghouse; however, do not do so if there are loose or dangling electric wires. Report damage to the Jamaica Public Service Company Limited or the nearest police station.
- Report broken water mains to the National Water Commission.
- Do not restart rinsing operations until safe drinking water is restored from the municipal system.
- For minimal flooding or leakage from paper containers, place the water-damaged pesticide/chemicals into a secondary waste container and to dispose of original container as directed by the Pesticides Control Authority.
- If flooding of pesticide storage has occurred, don protective clothing, particularly safety boots, before investigating the immediate area. Contain the area as you would a chemical spill.

11.0 COSTS RELATING TO MITIGATION MEASURES

This budget is a preliminary estimate of costs that will be involved in implementing the environmental management plan. It does not include:

- training costs as this will be covered by the training plan
- minor expenses that can be subsumed under normal farm or packing house operating costs (e.g. garbage removal, routine maintenance of forced air system,
- costs that can be subsumed under packing house renovation costs (e.g. installation of energy efficient lighting).

Many of the environmental management activities depend on making and incorporating sound farm management decisions and good agricultural practices, for example:

- implementing IPM,
- use of sterile medium and planting material
- consistent soil testing and monitoring,
- crop rotation,
- water and soil conservation,
- proper chemical management.

The major expenses for environmental management are associated with waste management (sewage waste, grey water and rinse water infrastructure); solid waste management and worker health and safety.

Table 6 outlines the costs associated with environmental mitigation as determined by the EIA. These costs are only an estimate based on information available at this point in time, and within the scope and level of effort assigned to the EIA. This budget will have to be revised as further operational details become known. Indications are that costs are relatively minor as a percentage of the total investment.

Table 8 - Costs associated with environmental mitigation

	J\$*	C\$	Budget note
Waste water treatment (sewage/grey and packing house rinse water) <ul style="list-style-type: none"> ▪ Design costs (professional fees) 100,000 ▪ Install system (tile field) 500,000 		1,725 8,620	Cost based on preliminary discussion with Appropriate Technologies Ltd, based on throughput of 1000 gals/day of effluent containing soil and fungicides and sewage/grey water.
Human waste disposal <ul style="list-style-type: none"> ▪ Install double ventilated pit latrine at Mountainside and Devon J\$150,000 		2590	Cost based on estimate by Construction Resource Development Centre. Does not take into account excavation through rock which is location dependent.
Solid waste disposal <ul style="list-style-type: none"> ▪ Covered garbage receptacles (Coleyville, Mountainside and Devon) 15,000 ▪ Compost heap (Coleyville, Mountainside) 10,000 		258.65 172.45	
Employee health and safety Personal protective gear <ul style="list-style-type: none"> ▪ Gloves (nitrile) 115 ▪ Gloves (black rubber) 500 ▪ Goggles (clear splash) 210 ▪ Half Mask respirators 490 ▪ Organic vapor cartridges 250 ▪ Coveralls 920 ▪ Rubber water boots 790 		2.00 8.65 3.65 8.45 4.35 15.90 13.65	These are unit costs. Once farms are in operation, management will decide how to allocate gear to workers based on job functions and farm requirements. At peak, projected employment at both farms could reach 100 persons. (Quote from National Safety Ltd.)
Shower facilities (Devon and Mountainside)	Not known	Not known	Contractor needed to provide estimate (should not exceed 75,000)
Segregated chemical storage (Devon and Mountainside) to PCA specifications (good ventilation, concrete floors)	Not known	Not Known	Contractor needed to provide estimate based on amounts of pesticides and fertilizers to be stored on farm.
Chemical spill clean-up kit (x2) <ul style="list-style-type: none"> ▪ (Sawdust/sand, long handled broom, dustpan, shovel, bucket, spray bottle) 7,500 		130.00	
Employee health and safety <ul style="list-style-type: none"> ▪ First aid kits (x3) 3,180 ▪ Misc. items not in pre-packaged first aid kit 8,700 ▪ Fire extinguishers (2 , ABC 20lb at Coleyville + 1, ABC 5 lb. per farm) 21,300 		54.85 150 367.25	Quote from National Safety Ltd Quote from National safety
Environmental monitoring** <ul style="list-style-type: none"> ▪ Soil EC tests (Electronic EC meter) 6,600 ▪ Soil analysis (range) \$300-3,500 ▪ Leaf tissue analysis (range) \$500-2,500 ▪ Other analyses (e.g. moisture, lime, organic) \$300-11,000 ▪ Waste water analysis (e.g. DO, COD, BOD) \$300-800 		115.00 5.20-60.35 8.65-43.10 5.20-189.65 5.20-13.80	Based on on-line quote. Add shipping and duties/taxes. Based on rates from Sugar Industry Research Institute
Regulatory compliance <ul style="list-style-type: none"> NEPA application fee 2,000 License fee (if necessary) 5,000 Consultant to assist in licensing (1 day) 29,000 Factories Act registration (if necessary) 3.00 		34.50 86.20 500.00 0.05	The packinghouse may require a license. It is renewable every five years. The packing house may require registration under the Factories Act. This is renewable every three years.

* Does not include GTC at 16.5%

Exchange rate used C\$1=J\$58.00. C\$ rounded up to nearest \$0.05

** See Appendix 5 for SIRI laboratory rates

APPENDICES

Appendix 1 – Pesticide hazards analysis

Trade name (active ingredient) and use	Regulatory Status in Jamaica	Hazard Classification	Human Health hazard	Ecological hazard	Persistence
Xentari (Bascillus thuringiensis) Insecticide	Approved	Class III (EPA) Class IV (WHO)	Potential to irritate eyes and skin Practically non-toxic to humans	Practically non-toxic to humans and animals, including birds, most aquatic organism, bees.	No threat to groundwater – no EPA restrictions for use around water bodies
Dithane (Mancozeb) Fungicide	Approved	Class IV (EPA) Class IV (WHO)	Mild skin irritant – may result in sensitization rashes Practically non-toxic; chronic exposure may affect thyroid	Slightly toxic to birds Moderately to highly toxic to fish and aquatic organisms	Low soil persistence; unlikely to infiltrate ground water
RoundUp (Glyphosate) Herbicide	Approved	Class II (EPA) Class IV (WHO)	Practically non-toxic by ingestion and skin exposure Some potential for eye and skin irritation	Slightly toxic to birds, practically non-toxic to fish, and bees; but slightly toxic to aquatic vertebrates	Moderately persistent in soil but limited potential for run-off.
Karate (Lambda Cyhalothrin) Insecticide	Approved	Class II (EPA) Class II (WHO)	Karate more toxic formulation than other forms of the active ingredient. May cause severe skin irritation, eye irritation, tingling, burning or numbness, tremors or disruptive motor functions. Poorly absorbed through skin – toxicity more likely if ingested	Slightly to practically non-toxic to birds; highly toxic to many fish and aquatic invertebrates. Highly toxic to bees.	Little potential for groundwater contamination or surface water. Where run off occurs, would be associated with sediment.
Decis (Deltamethrin) Insecticide	Restricted	Class II (WHO)	Acute exposure may result in convulsions, paralysis, dermatitis, edema, diarrhea, dyspnea, headache, tinnitus, tremors, vomiting and death due to respiratory failure. Allergic reactions may include anaphylaxis, bronchospasm, fever, hypersensitivity pneumonia, pallor, sweating, sudden swelling of the face, eyelids, lips and mucous, burning sensation, tightness and numbness on the face, sniffs and sneeze. Dermal deltamethrin poisoning after agricultural use may occur with inadequate handling precautions, and incidents of cases of accidental or suicidal poisoning by the oral route reported. Abnormal sensations in face, dizziness, tiredness and red rashes on the skin were more common in summer than in winter. Some symptoms are exacerbated by sunlight. Effects of chronic exposure can be prevented by use of gloves and face masks.	Low toxicity to birds, but aquatic herbivorous insects affected, leading to increase in algae. Aquatic crustaceans may be affected. Toxic to bees – however during normal use concentration levels not generally considered dangerous	Absorbed by sediment in surface water; rapid uptake by plants and evaporation

Trade name (active ingredient) and use	Regulatory Status in Jamaica	Hazard Classification	Human Health hazard	Ecological hazard	Persistence
Marathon (Imidacloprid) Insecticide Admire (Imidacloprid)	Minor use	Class II and III (EPA) Class IV (WHO) Class II/III (EPA)	Moderately toxic, though reported incidents of poisoning rare. Symptoms would likely include fatigue, twitching, cramps, and muscle weakness including the muscles necessary for breathing	Toxic to game birds, but with observed behavior by birds to avoid treated sees. Toxicity to fish low, but may be very toxic to aquatic vertebrates. Highly toxic to bees, especially if used during flowering.	Limited risk of groundwater contamination if used as directed, but moves rapidly through soil. Presence of organic material and ground cover decreases half life in soil.
Bravo (Chlorothalonil) Fungicide	Restricted	Class II (EPA) Class IV (WHO)	Slightly toxic, particularly via dermal contact, leading to eye and skin irritation (dermatitis and inflammation of eyelid). Very high doses may result in ataxia, rapid breathing, bleeding and death.	Practically non-toxic to birds, but highly toxic to fish, aquatic invertebrates and marine organisms. Non-toxic to bees.	Moderately persistent, though high temperature and moisture increases degradation. Persistent fungicide on plants; residues may be found on harvested crops.
Fusilade (Fluazifop-p-butyl) Herbicide	Approved	Class IV (EPA) Class III (WHO)	Slightly to practically non-toxic, though single large dose may cause severe stomach and intestinal distress, drowsiness, dizziness, ataxia and fatigue. Inhalation may cause vomiting, lung congestion and in large	Practically non toxic to birds, but may be moderately to highly toxic to fish, but slightly toxic to aquatic invertebrates. Low toxicity to bees.	Low persistence in soil and groundwater.
Ridomil (Metalaxyl) Fungicide	Minor use	Class III (EPA) Class IV (WHO)	Based on animal tests, slight toxicity by ingestion or dermal contact. No specific information on effect on humans.	Practically non-toxic to birds and freshwater fish. Slightly more toxic to freshwater crustaceans. Non toxic to bees.	High persistence and high water solubility pose threat of groundwater contamination. Degradation increased by sunlight. Residues found in potatoes and grapes.
Vermitec (Abamectin) Insecticide	Restricted Use	Class IV (EPA) Class II (WHO)	May be highly toxic to mammals at very high doses and EC formulations may cause slight to moderate eye and skin irritation. Poison symptoms include dilated pupils, muscle twitching and unsteadiness.	Practically non-toxic to birds; highly toxic to fish and extremely toxic to aquatic organisms. Highly toxic to bees.	Low persistence - rapidly degrades in soil especially in sunlight. Insoluble in water and unlikely to contaminate ground or surface water
Malathion Insecticide	Approved (local manufacture)	Class III (EPA) Class III (WHO)	Slightly toxic though numerous malathion poisoning incidents reported among pesticide workers and small children through accidental exposure. Animal testing and use experience show effects on central nervous system, immune	Moderately toxic to birds, large range of toxicity in fish. Various aquatic invertebrates extremely sensitive as well as aquatic stages of amphibians. Highly	Low persistence in soil. Soluble in water so may pose a risk of groundwater and surface water contamination.

Trade name (active ingredient) and use	Regulatory Status in Jamaica	Hazard Classification	Human Health hazard	Ecological hazard	Persistence
			system, adrenal glands, liver, and blood. Symptoms of acute exposure include numbness, tingling sensations, uncoordination, headache, dizziness, tremor, nausea, abdominal cramps, sweating, blurred vision, difficulty breathing or respiratory depression, and slow heartbeat. Very high doses may be fatal. Protein in the diet and gender may affect toxicity with females being much more susceptible than males.	toxic to honeybees.	
Dimethoate	Restricted (local manufacture)	Class II (EPA) Class II (WHO)	Moderately toxic by ingestion, inhalation and dermal absorption Effects of acute exposure include numbness, tingling sensations, uncoordination, headache, dizziness, tremor, nausea, abdominal cramps, sweating, blurred vision, difficulty breathing and slow heartbeat. Very high doses may result in death. Persons with respiratory ailments and liver malfunction may be at increased. High environmental temperatures or exposure to visible or UV light may enhance toxicity. Chronic exposure may result in influenza-like condition, impaired memory and concentration; disorientation, severe depression, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking; drowsiness or insomnia.	Moderately to highly toxic to birds; moderately toxic to fish. Highly toxic to bees.	Low persistence in soil. Highly soluble in water but degrades quickly due to hydrolysis.
Actara (Thiametoxam) Insecticide	Approved	Class III (WHO)	No specific poisoning symptoms	No information available	No information available
Pegasus (Diafenthiron) Insecticide	Approved	Class III (WHO)	No specific poisoning symptoms	No information available	No information available
Selecron (Profenofus) Insecticide	Restricted	Class II (WHO)	No detailed information on toxicity. Poison symptoms include abdominal cramps, abnormal flow of saliva, convulsive seizures, diarrhoea, dizziness, headache, muscle twitching, nausea, pinpoint eye pupils, sweating, temporary	No information available	No information available

Trade name (active ingredient) and use	Regulatory Status in Jamaica	Hazard Classification	Human Health hazard	Ecological hazard	Persistence
			paralysis, tightness in chest, unconsciousness, vomiting, weakness		
Kocide (Copper hydroxide) Fungicide	Restricted	Class II (WHO)	No detailed information on toxicity. Poison symptoms include abdominal cramps, nausea, vomiting.	No information available	No information available
Aliette (Fosetyl AL) Fungicide	Restricted and managed use	Class IV (WHO)	No detailed information on toxicity. No specific poison symptoms.	No information available	No information available
Magnate sulphate 75 (Imazalil) (fungicide, post-harvest treatment)	Restricted use	Class III (WHO) Class II (EPA)	Eye and skin irritation; eye damage	Practically non-toxic to birds; moderately toxic to fish	Highly persistent in soil; soluble in water, strongly bound to soils thus unlikely to pose a risk to groundwater. Leaching practically nonexistent and accumulation did not appear to be a problem.
Benlate (Benomyl) (fungicide, post-harvest treatment)	Restricted use (bananas, plantains)	Class III and IV Class IV (EPA)	Eye, skin and mouth irritation	Low acute toxicity to mammals. Relatively non toxic to bees. Toxic to highly toxic to fish. Toxic to earth-worms at low concentrations over long periods of time.	Strongly bound to soil and does not dissolve in water but breaks down within hours. Highly persistent - when applied to bare soil the half-life is 6 to 12 months.
Amistar (Azoxystrobin) Fungicide	Approved	Class IV (WHO)	No detailed information on toxicity. No specific poison symptoms.	No information available	No information available
Neem-X Azadirachtin (Insecticide)	Approved	Class IV - WHO	Skin, eye and respiratory irritation. Relatively non-toxic.	No significant effect on birds or wildlife including fish	Breaks down rapidly in water or light. Does not persist in water, soil. Low mobility in soil.

Sources: <http://extoxnet.orst.edu/pips/ghindex.html> and <http://www.caribpesticides.net>

APPENDIX 2

Ministry of Agriculture Packing House Requirements for Agricultural Exports

1. Building must be separate from a dwelling house.
2. Building must be of sound construction.
3. Floor must be of concrete to facilitate washing after packing.
4. Floor space should be a minimum of 600 sq. ft. (550 sq. metres).
5. Suitable fixtures and equipment for grading and handling of the produce must be in place, such as:
 - tables for sorting and grading
 - tanks for washing and chemical treatment
 - drying racks or pallets
6. Building should have:
 - adequate lighting
 - adequate drainage
 - proper sanitary facilities
 - adequate storage space (for boxes and chemicals)
7. Packing house must be separate from any activity that could be considered incompatible with the handling of fresh produce.
8. Access to telephone recommended.
9. There must be adequate space for loading and unloading of produce.
10. Building must be protected against the entry of insects, birds, rodents and other vermin or anything likely to contaminate the produce.
11. There should be adequate provisions in the packing house to ensure proper inspection of produce by Plant Quarantine/Produce Inspectors.

All operations must take place under cover of the approved packing house.

Agricultural Exports

General Information

1. Produce must be packed in **properly labeled, clean, unused** boxes or bags.
2. Each package (box or bag) must be clearly labeled with the following information:
 - **Name and address of exporter**
 - **Name of produce**
 - **Weight**
3. Boxes must be standard for the produce packed therein. There are standard boxes for produce such as peppers, thyme, yam, dasheen, calaloo, papaya, and oranges.
4. For oranges, the packing house must have equipment for sizing and grading.

5. All produce for export must be inspected and certified by inspectors of the Plant Quarantine/ Produce Inspection Unit of the Ministry of Agriculture.
6. Appointments for inspection must be made at least **24 hours** prior to the time of inspection.
7. All air shipments must be inspected at the Export Complexes located at the Norman Manley International Airport in Kingston (**telephone #: 924-8906**) or at the Sangster International Airport in Montego Bay (**telephone #: 940-4146**).
8. All produce should be packed at a registered Packing House.

APPENDIX 3
Pesticides Control Authority Training Manual and Chemical handling handbook

APPENDIX 4
National Environment and Planning Agency (NEPA) License To Discharge Application

**APPENDIX 5
SIRI LABORATORY RATES**

**CENTRAL LABORATORY
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LABORATORY RATES EFFECTIVE FEBRUARY 1, 2005

SOIL ANALYSES

pH	\$300.00
<i>Nitrogen</i>	\$500.00
Phosphate, Potash, Calcium, Magnesium, Sodium	\$350.00 each
pH, N, P, K	\$1300.00
pH, N, P, K, Mg, Ca, Na,	\$2100.00
pH, N, P, K, Mn, Fe, Cu, Zn, OM, % moisture	\$3500.00
Olsen's phosphate	\$1000.00
Micronutrients (Mn, Fe, Cu, Zn, B)	\$500.00 each
Salinity survey (pH, EC, Ca, Mg, Na, K, CO ₃ , HCO ₃ ⁻ , Cl ⁻ , SAR)	\$2 900.00
Salinity survey without chloride	\$2 200.00
SAR	\$1300.00

LEAF TISSUE ANALYSES

Nitrogen, Phosphate, Potash, Calcium, Magnesium	\$420.00 each
NPK	\$1000.00
NPK, Ca, Mg	\$1800.00

Micronutrients (Mn, Fe, Cu, Zn, B) \$500.00 each

Water analyses (pH, EC, Ca, Mg, Na, K, CO₃, HCO₃⁻, Cl⁻, SAR) \$2500.00
Without chloride analysis \$1800.00

OTHER ANALYSES

- Moisture, (soil, leaf) \$500.00
- Free Calcium Carbonate \$350.00
- Mechanical Analysis \$400.00
- Lime Requirement \$500.00
- Organic Matter \$500.00
- Cation Exchange Capacity \$500.00
- Electrical Conductivity \$300.00
- Saturation Percentage \$1100.00
- Ash \$1000.00
- Acidity \$500.00
- Brix \$700.00

WASTEWATER ANALYSES (HACH)

- Chemical Oxygen Demand (COD) \$700.00
- Biochemical Oxygen Demand (BOD) \$800.00
- Dissolved Oxygen (DO) \$300.00
- Alkalinity \$500.00
- Nitrate, Phosphate and Sulphate \$400.00 each
- Total Suspended Solids \$500.00
- Oil and Grease \$700.00
- pH \$300.00
- Electrical Conductivity \$300.00
- Chlorides \$700.00

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