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1.0 ABSTRACTS OF COMPLETED RESEARCH PROJECTS

(i) Performance of Corn (Zea mays) Genotypes at Coastal and Savannah Regions and Cost of Cultivation in Guyana

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NAREI

Rice and sugarcane are the two dominant crops produced in Guyana while corn is not yet cultivated on a commercial scale, resulting in import of corn (30,009 tons annually) at a cost of $11.6 million. The domestic commercial production of corn has been emphasized recently by government to meet the local demand of agro-industries involving poultry feed production. Consequently, coordinated trials of improved corn varieties were initiated at Ebini (Savannah region) during June-September, 2013 and repeated during the 2013-2014 crop season at Mon Repos in the coastal region. Twenty two improved genotypes of hybrid corn along with two local check varieties were tested for their yield performance at Ebini whereas at Mon Repos, the same set with two more composite varieties were tested during October, 2013 - January, 2014 cropping season. The new hybrids and composite were procured from CIMMYT, Colombia. Additionally, 22 and 14 new genotypes of hybrid corn were also tested in the coastal region during 2013-2014 (October 2013-January 2014) along with composite and a local variety as checks, in trials 2 and 3 respectively.

The performance of new hybrid and composite varieties of corn was outstanding with average grain yields ranging from 2,316 to 3,775 kg/ha at Ebini during 2013 crop season under rain fed conditions, whereas in the coastal region the yield was higher in the range of 5,839-8,662 kg/ha during 2013-2014 in trial 1. In trials 2 and 3, these ranges were 5,618-9,577 kg/ha and 3,102 – 9,082 kg/ha, respectively. These new genotypes except one (GC56) out-yielded local varieties significantly, at both regions

and seasons. Based on the average yield of both seasons and regions, the genotypes, GC9,GC13 and GC1 were the most high yielding types with yields of 6,170, 5,970 and 5,860 kg/ha, respectively, as compared to 2,611and 3,287 kg/ha in the case of check varieties (local yellow and local red), respectively. The cost of production was G$ 82/kg or G$37/lb at Ebini and G$ 32/kg or G$14/lb in the coastal region as compared to imported corn which costs around G$46/lb(2013-2014) and locally produced corn in the near future may easily substitute import of 30,000 tons of corn in Guyana. The results also indicated that improved high yielding corn genotypes can successfully be exploited for commercial cultivation in both Savannah and coastal regions of Guyana.

Key Words: *Corn, Zea mays, Improved varieties, Cost of production, Savannah region, coastal region, Guyana*

(ii) *Response of the Moruga Red Hot Pepper to fertilizer regimen under open field cultivation*

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The Moruga red hot pepper was introduced to Guyana because of its high yielding nature and current demand by exporters and agro-processors. There are no reports available locally on fertilizer recommendations for the Moruga red and as such a study was initiated by NAREI on a clay soil to determine the appropriate fertilizer recommendation in order to achieve maximum yields. The experiment was arranged according to the Randomized Complete Block Design using four treatments (0kg/ha, 180kg/ha, 360kg/ha and 540kg/ha) and three replications. These rates were based on the fertilizer recommendation for this variety. The fertilizer used was 12:12:17:2. Seedlings were planted 0.75m apart, and 0.75m between rows. Fertilizer was applied in split applications at two (T1: 0g, T2: 4g, T3: 9g and T4: 14g), four (T1: 0g, T2: 3g, T3: 4.5g and T4: 6.5g) and eight weeks (T1:0g, T2: 2g, T3: 4.5g and T4: 6.5g) intervals. There were significant differences in yield among the treatments. The highest yield was

obtained from treatment four (20,650kg/ha) followed by treatment three (7,938kg/ha) then treatment two (4,602kg/ha).

Key Words: *Moruga Red, fertilizer, yield, open field*

(iii) ***Response of Scotch Bonnet Yellow Hot Pepper to fertilizer regimen under open field cultivation***

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The Scotch Bonnet yellow hot pepper was a recent introduction to Guyana because of its relatively high yielding nature, high pungency and market request. It is currently in demand by exporters and agro-processors. As such a study was initiated at NAREI on a clay soil to determine the appropriate fertilizer recommendation to achieve maximum yields. The experiment was arranged in a Randomized Complete Block Design with four treatments (0kg/ha, 180kg/ha, 360kg/ha and 540kg/ha) and three replication. These rates were based on the fertilizer recommendation for this variety. The Fertilizer used was 12:12:17:2. Seedlings were planted 0.75m apart and 0.75m between rows. Fertilizer was applied in split applications at two (T1: 0g, T2: 4g, T3: 9g and T4: 14g), four (T1: 0g, T2: 3g, T3: 4.5g and T4: 6.5g) and eight weeks (T1:0g, T2: 2g, T3: 4.5g and T4: 6.5g) intervals. There were significant differences in yield among all treatment means. Treatment four gave the highest yield (13,638kg/ha) followed by treatment three (6,116kg/ha), then treatment two (3,878kg/ha).

Key Words: *Scotch Bonnet Yellow, fertilizer, yield, open field*

(iv) Response of Scotch Bonnet Yellow Hot Pepper to fertilizer regimen under shaded cultivation

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The Scotch bonnet yellow hot pepper was a recent introduction to Guyana and is currently in demand by exporters and agro-processors. This variety is very popular for its process quality, unique flavour and market request. It is apparent that climate change will have significant impact on agricultural conditions, food supply, and food security. Consequently, a study was initiated at NAREI on a clay soil to determine the appropriate fertilizer recommendation for this variety to achieve maximum yields under shaded cultivation. The experiment was arranged in a Randomized Complete Block Design with four treatments (0kg/ha, 180kg/ha, 360kg/ha and 540kg/ha) and three replications. These rates were based on the fertilizer recommendation for this variety. The fertilizer used was (12:12:17:2). Seedlings were planted 0.75m apart and 0.75m between rows. Fertilizer was applied in split applications at two (T1: 0g, T2: 4g, T3: 9g and T4: 14g), four (T1: 0g, T2: 3g, T3: 4.5g and T4: 6.5g) and eight weeks (T1:0g, T2: 2g, T3: 4.5g and T4: 6.5g) intervals. There were significant differences in yield among all treatment means. Treatment four recorded the highest yield (18,078kg/ha) followed by treatment three (7,812kg/ha) then treatment two (5,168kg/ha).

Key Words: Scotch Bonnet Yellow, fertilizer, yield, shaded cultivation

(v) *Response of Scotch Bonnet Yellow Hot Pepper under open field and shaded cultivations using fertilizer regimes*

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NAREI

The Scotch bonnet yellow hot pepper was recently introduced to Guyana and is currently in demand by exporters and agro-processors. This variety is very popular for its processing quality, unique flavour and market request. Climate change can significantly affect hot pepper grown in open field condition while shaded cultivation can mitigate the effects of climate change thereby increasing agricultural production and ensuring food security. Consequently, a study was initiated in NAREI on a clay soil to determine which cultivation (open field or shaded) will give the highest yield using different rates of fertilizer. The experiment was arranged in a Randomized Complete Block Design with two treatments [open field and shaded cultivations (50%)] and three replications. Four fertilizer rates (0kg/ha, 180kg/ha, 360kg/ha and 540kg/ha) were also applied on the two treatments. These rates were based on the fertilizer recommendation for this variety. The fertilizer used was 12:12:17:2. Seedlings were planted 0.75m apart and 0.75m between rows. Fertilizer was applied in split application at two (T1: 0g, T2: 4g, T3: 9g and T4: 14g), four (T1: 0g, T2: 3g, T3: 4.5g and T4: 6.5g) and eight weeks (T1:0g, T2: 2g, T3: 4.5g and T4: 6.5g) intervals. Shaded cultivation resulted in significant differences in yield from open field cultivation. The highest yield (18,078kg/ha) between the treatments was obtained from shaded cultivation. Shaded cultivation and rate four are recommended for this variety since it resulted in significant yield increase.

Keywords: *Yellow Scotch Bonnet, Yield, open field, shaded cultivation*

(vi) Identification of Natural Enemies of Red Palm Mite

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Natural enemies are beneficial insects used to reduce insect pest populations by providing an environmentally safe and economically viable long term solution. It is important that they natural enemies be properly identified so that they are easily distinguishable from other insects, thus allowing for easy mass rearing in controlled environments. Green Lacewing and Predator mite were found in close association with Red Palm Mite (RPM) in Guyana. These two species have the potential for use as biological control agents. Identification of the species and feeding habits were determined in laboratory studies. It was found that the green lacewing closely resembles *Ceraeochrysa caligata* and the predatory mite was from the Family: *Phytoseiidae* and the Genus: *Amblyseius* based on morphological identification. Based on feeding habits of the two predators, lacewing larvae feeds on all stages of the RPM with high preference for adult females, nymphs, eggs and males within 72 hours exposure time. The predator mite *Amblyseius sp.* had a preference for nymphs and eggs within the 48 hours period.

Key Words: *Lacewing, Predator, Amblyseius, Red Palm Mite, biological*

(vii) *Macro propagation of plantains under greenhouse and field conditions*

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Plantain is an important crop that forms part of the diet of all Guyanese. It is a key staple food that provides a source of income for farmers. It is one of the commodity with potential for increase production and productivity since it is important for the country's food and nutrition security. However, production of plantains is hindered by the shortage of good quality planting materials that are often at risk for major insect pest and diseases. Macro propagation technology is one alternative for improving the availability and quality of plantain seedlings since it requires limited training and is low cost. Studies were conducted to evaluate four detached corm techniques in the greenhouse: stem fragment (PIF) technique, whole corm (WC), split corms (SC) and meristem drilled (MD); and four infield techniques: 1) control (natural regeneration), 2) complete decapitation (CD), 3) complete decapitation with hormone (CD/BAP) and 4) false decapitation (FD). The objective was to determine the most appropriate technique for multiplication of local plantains under greenhouse and field conditions. Results from the studies indicated that the PIF technique took 28 days, SC (35 days), MD (35 days) and WC (50 days) for plantlet emergence. PIF had an average of 16 plantlets per corm, split corm (4 plantlets/corm), meristem drilled (2 plantlets/corm) and whole corm (6 plantlets/corm). Under field conditions CD recorded the highest number of plantlet emergence (5) in the first trial after 56 days. In the second trial both CD/BAP (7-8) and FD (6-7) had the highest number of plantlets emerging after 56-84 days. PIF had the highest plantlets per corm and took the shortest amount of time for plantlet emergence, while CD/BAP had the highest number of plantlet emergence in fields and proved to be the most effective techniques for use in greenhouse and field conditions.

Key Words: *Macropropagation, Detached Corm Techniques, Stem Fragment, Plantlet Emergence*

(viii) *Management of Black Sigatoka Disease of Plantain using an Integrated System Approach*

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NAREI

Black Sigatoka Disease (BSD) caused by *Mycosphaerella fijiensis* is a major constraint to plantain and banana production in Guyana. The disease first appeared in 2008 and was later confirmed by CABI in 2010. This disease affected the crop green life and yield and this effect was noted in 2012 when plantain export decreased from 158 MT in 2011 to less than 1 MT in 2012. Studies were initiated to manage BSD through improved plant nutrition, implementing cultural practices (sanitation, weed control, drainage and irrigation, monitoring of pests and other diseases) and monitoring the disease severity to guide fungicide application. Two field trials were conducted using a Randomized Complete Block Design (RCBD) with three replicates. The treatments were an improved production practice verses the one currently utilized by farmers. Results from the field trials showed that the average number of leaves per plant at Parika were 7-11 and at Timehri 6-13 with an average of four leaves at harvest. During the early stages of crop development, fungicides: Volley, Carbendazim and Stratego were effective at reducing the disease index but at flowering the disease infection was higher regardless of fungicide application. Disease infection index of ≥ 25% was adequate for recommending a spray application. This has reduced the number and frequency of fungicide application to <10 at both locations. However, more frequent monitoring (twice per month) may be needed during the flowering and fruiting period due to the increase in the disease infection index. At Parika, the bunch weight, length and girth of fingers were significantly higher for improved practice compared to the farmer's practice but there were no significant differences among the treatments at Timehri. The number of hands per bunch and number of fingers per hand were similar for both practices used in the trial. Prior to the implementation of the improved practices for controlling BSD using plant nutrition, cultural practices and fungicide applications, farmers at Parika and Timehri obtained an average bunch weight of 25-30 lb/plant. Implementation and monitoring of

an integrated management system has increased bunch weight to 39-41lb/plant at both locations.

Keywords: Black Sigatoka Disease (BSD), Improved Practices, Infection Index, Yield

(ix) *The impact of soil moisture, mulching and fertigation on the yield of vegetable crops grown under drip irrigation systems*

S. P. DeSouza, L. Persaud & O. Homenauth,

NAREI

Drip irrigation increases water use efficiency and increase crop yield and quality at the same time reducing insect pests, diseases and weeds. Field trials were conducted over a three year period at Mon Repos, Parika and Black Bush locations to determine the impact of soil moisture, mulching and fertigation on vegetable crop production. Three soil moisture levels (25%, 50% and 75% field capacity (FC)), three mulching treatments (no mulch, plastic mulch and rice straw mulch), and fertigation application (manual fertilizer + plastic mulch, fertigation + plastic mulch and fertigation + no mulch) were used in Randomized Complete Block Design with three replicates. Results from soil moisture studies showed that sweet pepper (var. Creole), boulanger (var. Long Purple) and tomato (var. F1 Mongol) grown under drip irrigation had an 5-9% increase in yield at 75% FC and bora (var. Yard Long) a 6% increase at 50% FC when compared to 25% FC. Black polyethylene plastic mulch increased Tomato (var. Heat Master) yields by 11% and F1 Mongol yields by 6%. Bora had a 10% higher yield when grown on plastic mulch compared to no mulch. Red Beans had a decrease in yield by 6-20% when grown on both plastic and rice straw mulches. Tomato (var. F1 Mongol) grown using manual fertilizer + plastic mulch had significantly higher yields compared to fertigation + no mulch. To improve vegetable crop yields production systems should utilize soil moisture at 75% FC, black plastic mulch and fertigation techniques.

Key Words: *Drip Irrigation, Fertigation, Mulching, Field Capacity, Yield*

(x) *Pre and Post-harvest evaluation of tomatoes and hot peppers grown under drip irrigated system*

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Tomatoes and peppers were evaluated at pre harvest under three field treatment conditions: no mulch + fertigation, plastic mulch and fertigation and plastic mulch + manual fertilizer; and at post-harvest under two storage conditions (cold storage and room temperature storage) for a period of five days. The parameters evaluated were fruit weight at harvest and after storage, fruit diameter, fruit firmness, ripeness and physical attributes associated with the fruits. At harvest tomatoes grown on plastic mulch + manual fertilizer (36%) and plastic mulch + fertigation (23%) were heavier than those grown without mulch. There were no significant effects of field treatments on tomato fruit ripeness, firmness and physical attributes. Tomato fruits stored under cold storage conditions were significantly firmer than those stored at room temperatures. No significant differences were observed in pepper weight at harvest and after storage among field treatments. Peppers stored under cold storage conditions had significantly better weights compared to room temperature conditions. No significant differences were observed in fruit diameter before and after storage. Pepper fruit ripeness and physical attributes were not different under storage conditions. However, fruits were significantly firmer under cold storage compared to room temperature conditions (P=0.007). With respect to field treatments, there were no differences in fruit firmness and physical attributes. However, fruits were firmer when grown on plastic mulch compared to no mulch treatments.

Keywords: Post harvest, drip irrigation, quality, storage, yield

(xi) Observational /Yield Trial for Potato (Solanum tuberosum) under shaded conditions in Guyana

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Potato is an exotic crop that is earmarked for hinterland production and subsistence scale cultivation on the coastland as part of the Guyana's Agricultural Diversification Strategy. Observation on its cultivation using imported market material was conducted on loamy sand raised beds in the shade-house at Mon Repos. Over several seasons, 225 potato seeds were produced with seed weight ranging from 5-146g in a cropping cycle of 90 days. The seeds were separated into 9 categories: 1-5g, 5 – 10g, 11 – 19 g, 20 – 29 g, 30 – 39g, 40 – 49 g, 50 -59g, 70 – 99 g and 100 – 130g and planted. Harvested weight was comparable to the upper limit of the weight range. Observations were made on methods of propagation, pests and disease management and fertilizer application. Minimal weight of planting material was determined at 57g, integrated pest management approaches were most effective, and incorporation of fertilizers in planting hole gave optimum produce.

(xii) Observational /Yield Trial for Chick Pea (cicer arietinum) on Sandy Soils under shaded conditions in Guyana

David B. Fredericks and Tracy Persaud, NAREI

Chick pea is one of several exotic crops that are earmarked for hinterland production and as part of the Guyana's Agricultural Diversification Strategy. Observation on Kabuli variety chickpea cultivation using imported market material and Lines (38) sourced from India was conducted on loamy sand raised beds in the shade-house at Mon Repos. High mortality owing to susceptibility to excess moisture and pest (root mealy bug) resulted in minimal production units. Low pod production (<20 pods/plant) and poor pod filling (<70%) resulted low production returns. The 100 seed-weight from the market variety (both accessed and produced) were superior to the accessions. Application of NPK fertilizer at planting and at pod formation enhanced production; and use of organic formulations (garlic, onion and hot pepper mixture) controlled mealy-bug infestation.

(xiii) Investigating the Effectiveness of Locally Available Liming Materials on Local Soils in Guyana

David B. Fredericks and Tracy Persaud, NAREI

The inherent acidic nature of local soils dictates that liming is necessary to achieve optimum plant growth and yield. Thus, there is need to test these various liming materials for their various interactions with different soil types and more importantly the rate and timing of applications to achieve the desired pH. Laboratory observations were conducted on three soil types Brickery Clay (Unit 36), Onverwagt Clay (Unit 41 d) and Ithaca Loamy Sand (Unit 72) using four liming materials: limestone, low grade rock phosphate, agrical (an organic calcium product) and a by-product of GWI water clarification process (GWI Effluent). Analyses indicated that Calcium Carbonate was most effective in raising the pH and reducing exchangeable acidity on Ithaca Loamy Sand; Low Grade Rock Phosphate was most effective in raising the pH and reducing exchangeable acidity on Onverwagt clay. The GWI material had a short term effective (2 weeks after application) on raising the pH of Onverwagt. Agrical has little effect on exchangeable acidity and pH but increased electrical conductivity of all soils.

(xiv) The National Strategy for Agriculture in Guyana (2013-2020): A Synopsis

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The agricultural sector of Guyana continues to be an important contributor to the Gross Domestic Product (GDP), employment generation, foreign exchange earnings and rural development of the country. Agriculture accounts for approximately 25% of Guyana's GDP providing more than 33% direct employment, both at the rural and urban levels. It has been recognised that agriculture will continue to drive sustained economic prosperity, moving Guyana to a high middle-income developing country by 2015. It is within this context that a National Strategy for Agriculture in Guyana (2013-2020), titled *'Agriculture – Our Vehicle for Sustained Economic and Social Prosperity'* was formulated. The strategy recognises that agriculture would continue to be the strategic sector in the Guyanese economy in the medium to long term basis for poverty reduction, food & nutrition security, women empowerment, income and employment generation at both rural and urban levels, diversity of production, reduced imports and enhanced exports of agricultural products. Further, it has recognised that agriculture would play a major role in the provision of inputs for other sectors of the economy such as an agribusiness and agroenergy. The impacts of climate change, disaster risk management, low carbon development and the overall change in the global economic environment in agriculture in Guyana have also been given prominence. The strategy has been designed as the F5 Agriculture Trajectory – Food/Calories (Food Security), fiber and other nutrients (nutrition security), Fuel (Agro-energy), Fashion and Medicine (Health and Beauty) and Furniture and Crafts (Comfort in Living). These are 25 priority areas identified for implementation in the Strategy. A synopsis of these priority areas would be highlighted.

Key Words: *National Strategy for Agriculture in Guyana, Strategic Sector, F-5 Agriculture Trajectory, priority areas*

(xv) Earthworm Biotechnology -an Integral approach to organic waste management

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Earthworms play a vital role in maintaining soil fertility and in bringing of efficient nutrient cycling. Vermicomposting is a simple biotechnological process of composting, in which epigeic species of earthworms are used to enhance the process of waste conversion and produce a better end product. The present research on large scale vermicomposting of cattle dung, rice straw and grass clippings was carried out during the year 2014 at NARIE. Four tanks with dimension of 2.1x2.1x1.0 m2 were set up based on structural guidelines of Vermitech and inoculated with 625 earthworms (*Eisenia fetida*) each. The vermicompost was harvest after 60 days and was subjected to physicochemical analysis. Promix which is widely used in agricultural system in Guyana was also analyzed for chemical parameters. Earthworm population was also recorded. The results indicated that the vermicompost productivity was to the tune of 1376.42 kg and numbers of earthworms were 29110 (9.6/kg/m2). Comparative analysis showed that vermicompost is better than promix in terms of total nitrogen, calcium potassium and phosphates whereas equally potent in other nutrients indicating that vermicompost can be better substitute in nursery management in terms of quality as well as cost implications. Vermicompost is a nutrient rich organic soil conditioner which can be applied to improve soil conditions for a wide range of soil types. Vermicomposting has many environmental benefits is proven to be an easy way of getting rid of garbage waste. Thus, this technique may prove to be beneficial to the soil enrichment with reduction in the use of synthetic fertilizers.

Key Words: *Vermicompost, Nutrient rich, Promix, Soil enrichment.*

(xvi) Perceptions of and Adaptation to Climate Change among Farmers in Guyana: A Preliminary Analysis

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Climate change is anticipated to have significant impacts on the agriculture sector as farming is largely a climate-driven activity. In order for farmers to adapt to the impacts of climate change, they need to first observe the changes in climate then identify and adopt feasible and effective adaptation strategies. This paper is a first step at exploring farmers' perceptions about the changes in the climate in Guyana. It also identifies what adaptation strategies farmers are already using specifically to combat climate change, the perceived effectiveness of those strategies and the barriers that exist to adaptation to climate change in general. A survey was conducted in Regions 3 and 6 as part of an economic data gathering activity with approximately 300 farmers in September and October 2014 and included questions on farmers' observations of changes in temperature, precipitation and timing of seasons over the past ten years. In addition, questions on farmers' current use of adaptation strategies including crop diversification, use of weather-resistant varieties and protected agriculture among others were recorded. The results of the survey are expected to inform policies aimed at educating farmers on climate change as well as those aimed at increasing adaptation by farmers.

Key Words: *Climate Change, Climate Change Adaptation, Climate Change Perceptions, Agriculture, Guyana*

(xvii) Mangrove Restoration: A comparative study of Lima and Kilmarnock restoration sites

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Mangroves are tropical and subtropical ecosystems found in intertidal zones that provide vital ecosystem services including sustenance of commercially important fishery species, improvement of coastal water quality through nutrient cycling and sediment interception, and protection of coastal communities from storm surge and erosion. Mangroves provide a variety of ecological services in Guyana including the protection of our coast land which is 1.4m below sea level and where more than 90% of the country's population reside. They also provide habitat for a diverse flora and fauna including rare species and serve as breeding and nursing grounds for marine species and are sources of food, medicine, fuel and building materials. Unfortunately, despite the importance of Mangrove forests, our knowledge concerning their rates of change remains limited. As a consequence, the need for reliable information regarding the extent and distribution of the mangroves in Guyana, as well as the need to identify the processes affecting these ecosystems and the establishment of a long term monitoring program is essential. A comparison of monitoring activities and data collected from two planted restoration sites over a nine month period was completed. The sites included 450m of coastline at Lima on the Essequibo Coast where 11,984 *Avicennia germinans* (Black Mangrove) seedlings were planted. The other is a 1003m of coastline at Kilmarnock, Corentyne where 32,448 *Avicennia germinans* (Black Mangrove) seedlings were planted. The results will show vast contrasts in growth and survival at the two sites with Lima site showing rapid growth with healthy seedlings, while Kilmarnock site has shown a very low survival rate and extensive erosion of planted seedling. The results of this program can be useful for appropriate definition of public policy and for decision making with respect to conservation, management and ecological restoration of the mangroves of Guyana.

Key Words: *Mangroves, Ecological services, Planted restoration sites, Ecological restoration*

(xviii) Coastal Engineering Approaches Applied to Protect Existing Mangroves Stands and Facilitate Natural Recruitment

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NAREI

The Guyana Mangrove Restoration Project was launched in 2010 with an overall objective of abating climate change and mitigating its effects through the protection and wise use of Guyana's mangrove ecosystem. Restoration activities commenced in 2010 and focused on restoring depleted sites along Guyana's coastline. The Project achieved varying levels of success from its planting program during the first two years. Among the sites planted, Mon Repos, BV/LBI, Section C Enterprise, Victoria and Wellingtion Park (2012), resulted in very high mortality (80%-100%) due to cyclic erosion, inadequate elevation and wave energy which engulfed the foreshore during the months of August to December. Guyana's intertidal zone is made up of long, sloping, ever-moving mud banks that originate at the mouth of the Amazon River. Huge deposits of fine silts and clays from the Amazon are carried northwest along the coast in slow moving "slings". As these mud banks, which extend out from the shore as far as three miles, progress along the coast, a pattern develops, where mud builds in one region as the crest of the bank passes, followed by a period of depletion as a corresponding trough follows. The high banks provide ideal conditions for mangrove forest growth, whereas the troughs appear to lead to erosion and depletion. This presentation includes discussion of the results of low-crest, low-cost engineering structures i.e. 100m detached Geotextile tubes running parallel to the shore at Victoria and acting as waveforce breakers, designed and constructed as an alternative to groynes; bamboo brushwood dams structures at Buxton designed to assist in accretion of mud banks to allow for colonization of mangroves; and rubble (rock) mound groynes at Mon Repos designed to protect existing mangrove fringe from further erosion and aid in the accretion of the foreshore.

Key Words: *Mangrove protection, Low cost protection measures, Mangrove restoration*

(xix) An investigation into the potential impacts on air quality during operations of the Bioethanol Plant in Berbice, Guyana

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Guyana is exploring the area of Bioethanol production with the construction of a demonstration plant at Albion, Berbice. In Guyana there are no specific limits in the EPA Air Quality Regulations with regards to acetaldehyde and formaldehyde which are emitted during the production process. This study entailed an investigation into the acetaldehyde and formaldehyde levels emitted during operations of the Bioethanol Demonstration Plant in Albion Berbice. The acetaldehyde and formaldehyde levels were measured above and six metre (6m) away from the fermentation tanks at four, twenty and twenty eight hours after the commencement of fermentation. The acetaldehyde and formaldehyde levels for the fourth hour were not detectable within the measurable range. However, acetaldehyde concentration above the tank for the twentieth and twenty eight hours were 197.22 ppm and 141.67 ppm respectively. The formaldehyde levels above the tank for the twentieth and twenty eight hour were 2.17 ppm and 1.83 ppm, respectively. The measured acetaldehyde and formaldehyde levels are above the standard recommended guidelines set out by the World Health Organisation. Attention needs to be paid to ensure that appropriate abatement mechanisms are in place to capture these gases.

Key Words: *Bioethanol production, Acetaldehyde, Formaldehyde, Fermentation, Abatement Mechanisms*

(xx) Laboratory screening and infield application of pesticides for the control of Red Palm Mite affecting coconut in Guyana

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Red palm mite (RPM) *Raoeilla indica* is an invasive pest that was discovered in late 2013 affecting coconut palms and *Musa* species on the island of Wakenaam, Guyana. Recent surveys conducted have revealed the spread of this pest in Regions 3, 4, 5 and 9. With over 10,000 MT of coconut exported in 2013, the impact of this pest on the coconut industry has devastating consequences if control measures are not implemented. Pesticide studies were conducted both in laboratory and infield to determine their effectiveness in controlling RPM populations. Results from laboratory studies using the leaf dip method have shown that chemicals Monocrotophus, Acequinocyl, Abamectin and Acetamiprid were effective at reducing female palm mite by 91, 88, 87 and 69 % respectively. Moncrotophus, Acequinocyl and Abamectin used at rates of 1000, 5000 and 10,000 ppm had >90% mortality, whereas, Acetamiprid was effective at rates of 5000 and 10,000ppm. There were significant differences in the exposure time, mites exposed to the chemicals for 48 hours had higher mortality. With respect to infield trials, chemicals applied using a mist blower showed that there were no significant differences among the chemicals Acequinocyl, Abamectin and Acetamiprid when compared to the control at 7, 21 and 28 days. However, at 14 days, Abamectin and Acequinocyl significantly reduced the population of RPM. Chemicals injected into mature palms have shown that Monocrotophus and Abamectin were significantly different from the untreated control and were very effective at reducing RPM populations at 14, 21 and 35 days after treatment applications. Chemicals Monocrotophus, Abamectin and Acequinocyl were effective at controlling RPM in both laboratory and infield studies and should therefore be part of rotation program to control RPM.

Key Words: *RPM Population, Laboratory and Infield studies, Mortality.*

(xxi) On-Farm evaluation to assess the effectiveness of the use of Pheromone to manage the Sweet potato weevil

Peters – Evans, NAREI

Cylas formicarius (sweet potato weevil) is a major pest of sweet potato weevil in Guyana. The insect feeds by tunneling within the tubers which may be honey combed by numerous legless white grub with pale brown heads. Tubers that are infected with the weevils are not suitable for consumption. Chemical control of this pest is difficult and inapplicable, while resistance to this pest by sweet potato varieties is limited. Pheromone is a non-chemical method of control that reduces the loss to sweet potato farmers. The trial commenced with investigations in the sweet potato cultivated areas that are affected by the weevil. It was discovered that the weevil was highly prevalent in Region 3, Parika back dam. Three farmers were identified and two traps were “Set-Up” on each farmer’s plot. The traps were implemented three weeks after planting on two farmers’ plot and five weeks after on one farmer’s plot. The traps were monitored one week after implementation for signs of the weevils. For each trap, counts were discontinued after 3000 adult weevils were counted. The percentage of infested tubers ranged from 4-11%.

Key Words: *sweet potato weevil, pheromone, percentage infested tubers.*

(xxii) First Report of Red Palm Mite in Guyana

S. P. De Souza, Research Scientist, NAREI

In 2013, RPM was identified as the main pest affecting coconut palm fronds on the Island of Wakenaam, in the Essequibo River. Further investigation of the pest revealed that it was found predominantly in all major coconut producing areas. In Region # 2 it was found along the Essequibo Coast but not in Lower and Upper Pomeroon. In Region # 3 it was found on the islands of Wakenaam and Leguan and along the West Bank of Demerara but it was not detected on Hog Island. In Region # 4, RPM was present along the East Bank of Demerara and >90% of the villages along the East Coast of Demerara. In Region #5, RPM was found in very few villages. No RPM was detected in Region # 6 and 10. In Region # 9 RPM was found in >70% of the villages surveyed. The major foliar pests found in all of the regions were scale insects, whiteflies and mites. Very few predatory mites (*Amblyseius sp*.) were observed in regions affected by RPM. The other major hosts of RPM found were wild *Heliconias* (ginger flower) which is considered a weed and *Musa spp.* (plantains and bananas).

2.0 STATUS REPORTS OF WORK IN PROGRESS/INITIATED

(i) Butternut squash production on trellis

Butternut squash (*Cucurbita morschata*) grows on a vine and have a yellow skin with orange fleshy pulp. When ripen, it turns increasingly deep orange. It takes a lot of space in gardens; one plant on the ground can exceed 15 feet across. Growing butternut squash on trellis can help eliminate the problem of space. Butternut squash is one of the crops identified under the National Agriculture Strategy 2013-2020 because of its nutritional and health benefits.

An experiment was initiated to evaluate the yield of butternut squash on trellis. This trial was conducted at NAREI Field Station Mon Repos. Seeds (variety: Waltham Butternut) were planted in mounds with a spacing of 2.5m between rows and 0.6m between plants. The plot size was 123.2m X 1.52m. Fertilizers (6g of12:12:17:2) were applied at 3 and 6 weeks after planting. The average number of fruits per vine obtained was 7, and the average weight of fruit was 0.7-0.9 kg. The total amount of butternut squash harvested was 170kg.

(ii) Multiplication and Production of Amjad Sweet potato

Sweet potato is considered the seventh most important food crop in the world – after wheat, Rice, maize, potato, barley and cassava, because of its versatility and adaptability. The crop is recognized as an important health food due to rich nutrient content and good source of Vitamins and minerals.

Research activities at NAREI concentrated on varietal collection, classification and evaluation. By 2005, NAREI had an infield collection of thirty eight entries and In-vitro collection of eighteen entries. Amjad sweet potato is one of the cultivar that was recommended for release into production on the Soesdyke/Linden Highway. However, farmers did not continue production of Amjad sweet potato.

The recent interest generated on production of orange flesh sweet potato in the Caribbean has motivated the collection, multiplication and production of Amjad sweet potato at NAREI, Mon Repos. Four Amjad sweet potato slips were collected from a farmer at Kuru Kururu. The slips were planted in black potting bags and multiplied from February to September, 2014. 316 Amjad sweet potato plants were planted along with one decoy variety (Cogle) in field 17. 40 cm spacing was used to separate plants on ridges. The decoy variety was planted on the two ends and center ridges. Plants were fertilized two weeks after planting using MOP, Urea and TSP. The plot was maintained by manual cleaning.

One pheromone Trap was “set-up” to control sweet potato weevil. Forty seven adult weevils were captured. During the month of November, pen manure (chicken litter) was applied around the plants. Harvesting was done during the second week January, 2015.

A total of 160 adult sweet potato weevils were captured in the pheromone trap. 438 lbs.314g of Amjad sweet potato tubers were harvested from 80 m sq. approximately 70% of the tubers were marketable.

(iii) Effects of Soil Moisture Content on the Production of Basella alba (Poi) under Staked and Shaded Conditions with supplemental Irrigation on the Coast of Guyana

Guyana’s Ministry of Agriculture Vision 20/20 directs a new focus on Farming Systems and Techniques. This project elaborates monitoring of soil moisture, cultivation on stakes, and harvesting of leaves as key areas for modernization of agronomic practices. One cropping cycle was observed during June to September 2014 on loamy sand raised beds at NAREI, Mon Repos. Leaf production showed a strong negative correlation (-0.65) between moisture percentage and yield. Harvested leaf weights were higher during periods of soil moisture content between 30 and 40% compared to periods where it was above 40%. No harvest was lost owing to cultivation damage. Leaf yield was recorded at 27442kg/acre which compares favourably to current farming

practices with leaf yields of 6600kg/ac. A cropping cycle utilising clay loam raised bed is in progress for the October 2014 to January 2015 season.

(iv) Nutrient Studies in Cherry Cultivation

Cherry producers have theorized that poor plant nutrition, and the consequent inability of plants to sustain all year round production as key limitations to cherry production and productivity. Thus, NAREI embarked on a programme to balance macronutrients in cherry fields and correlate soils' micro-nutrient status with cherry production and productivity. Work was conducted on two large scale producers at Coverden EBD and Maripa EBE. Soils' macronutrient levels were found to be high but sufficiently imbalanced to affect plant nutrition and production. Recommendations to improve soil organic matter were made and implemented with an initial positive feedback from farmers. Efforts to quantify the quality of organic matter application are ongoing through Mycorrhiza studies. However, indications are that poor productivity of cherries in an environment of optimal sun and water, and in the absence of pest and disease incidence could be corrected through the minimizing of nutrient imbalances.

Key Words: West Indian Cherry; nutrient imbalances; organic matter; and mycorrhiza.

(v) Spice Project

In 2014 four spices viz. black pepper, turmeric, ginger and nutmeg was targeted under the spices program in Guyana. A number of farmers primarily from Region # 1 received turmeric planting materials from NAREI free of cost. These Planting materials/ rhizomes were used to further expand turmeric cultivation and production in Guyana. Forty nine farmers were involved in this exercise.

(vi) Giant King Grass shows good potential for the Savannahs

The growing trend of the world's energy demand, projected depletion of fossil fuels and increasing concerns over global climate change have necessitated the exploration into renewable alternatives. Many countries have since shown increased attention to sustainable renewable energy alternatives to fossil fuels. There are many alternative feedstocks that are currently being explored with the inclusion of Pennisetum Purpureum commonly known as the giant king grass.

The giant king grass was introduced in April 2014, at Yurupukari in the Intermediate Savannahs, Guyana. A field visit was done by the National Agricultural Research & Extension Institute to the location to assess the project activities. The team consisted of Dr Oudho Homenauth, CEO of NAREI, Dr Clairmont Clementson, Head of the Department of Bioenergy and Miss Bibi Nariefa Abrahim, Research Assistant. At this point, a nursery of five acres was developed where the grasses have been growing for about four months with a height of approximately nine feet. After the first harvest, the five acres can be used to supply another one hundred acres. The growth of the grass was compared to that of other countries and the team was very impressed at its adaptability.

Moreover, this project is aimed at producing pellets from the fibers to replace coal in power plants which will aid in the reduction of carbon dioxide emissions. The extract from the grass stalks is proposed to be used for bio-ethanol production. The leaves can be used as animal feed and for propane gas production.

Giant King Grass is a form of renewable energy source with a low-carbon characteristic. The grass can be used for various purposes within the bio-energy sector and can be seen as a sustainable alternative to fossil fuels. Continuous evaluation on this project will be done so as to assess the adaptability and suitability of the giant king grass in the savannahs.

4 month old Giant King Grass in Yurupukari

Giant King Grass under observations

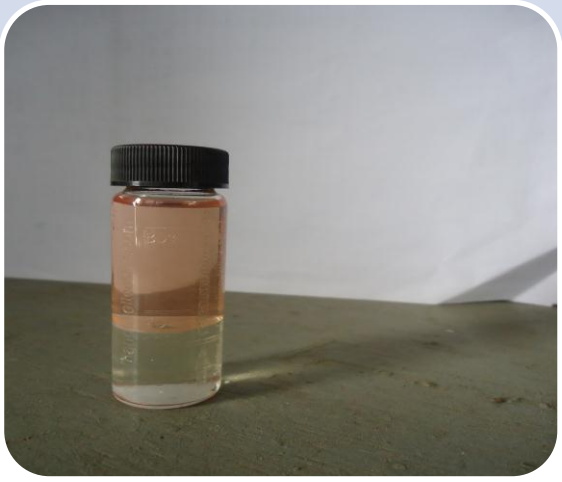
Figure 1: Showing the Giant King Grass planted in Yurupukari in the Intermediate Savannahs, 2014

(vii) Ethanol and Gasoline E-10 Blend

Due to its many distinctive properties and its miscibility characteristic with gasoline, ethanol has been introduced into the fuel sector. Ethanol may be used as a fuel itself or blended at various levels with gasoline with the most common blend being E10. Guyana has now stepped on to the stairway towards bio-ethanol production with the establishment of a Bioethanol Demonstration Plant in Albion, Berbice.

The plant was commissioned on August 28, 2013 and has been in full operations from December, 2013. This is the first bio-ethanol demonstration plant to be established in Guyana and is located in the compound of GUYSUCO Sugar Factory in Albion, East Berbice. The plant utilizes “blackstrap” molasses which is the final output from the sugar factory to produce ethanol. The plant is expected to produce approximately ten thousand litres of ethanol on a daily basis.

According to Draft Guyana Agro-energy Biofuel Policy, by 2020 Guyana is expected to produce at least sixty five percent of its national fuel consumption through agro-energy with this sector being a major contributor to the country’s gross domestic product. The bio-ethanol produced from the demonstration plant has been blended with gasoline with E10 blends and is currently being used in Ministry of Agriculture and GUYSUCO vehicles. The blend used is ninety percent (90%) gasoline with ten percent (10%) ethanol by volume. Since ethanol is highly miscible with gasoline, it allows for the fuel to be completely blended. Ethanol has a high oxygen content which allows for a more complete combustion of the engines leading to a reduction in green house gas emissions.



E10 Blend

E10 blend being pumped in MOA vehicles

Figure 2: Showing the Ethanol-Gasoline Blend, 2014

(viii) Evaluation of two varieties of corn at the Ebini Research Station

This study was planted at the Ebini Research Station in November 2014 and would evaluate two varieties of corn (Pioneer, Belize and CARDI C-001). The fertilizer recommendation to be used would be a modification of a fertilizer recommendation postulated by CYMMIT and used by Dr. Singh in a corn production study in the Savannahs. The main objective of this study is to compare the production levels of two corn varieties using a standard fertilizer recommendation in the Intermediate Savannahs.

(a) Irrigation

The Ebini Station has acquired a hand moved irrigation gun moved system that is capable of irrigating one acre. In addition to rainfall irrigation water would be supplied to the plants as required.

Table 1: Measurements to be taken

Character	**Expression**
Date of sowing	19 and 20 November 2014
Date of germination	22 November
Days required for germination	3 days
Total seed used	
Fertilizer application	24 November
Number of plants per m^2	
Number of plants per ha	
Days to 50% flowering	
Days to maturity	
Plant height (cm)	
Ear height (cm)	
Husk cover	
Ear damage score	

(0 none-5 very expressed)	
Number of cobs/plot	
Weight of cobs (kg) after peeling and drying /plot	
Grain weight (g) after drying /plot	
Kernel colour	
Number of rows per cob	
Number of seeds per row	
Grain yield per plant (g)	
Grain yield/plot (kg)	

© Rainfall during the growing period

Table 2 shows the total rainfall during the crop season from June- August 2014.

Table 2: Total rainfall and rain days during the June-August period 2014

Months	**Rainfall (mm)**	**Rainfall days**
November	156.2	20
December	140.7	16
January		
February		
Total		

(ix) Evaluation of four plant spacing on the yield parameters of two corn varieties

The objective of this study is to ascertain the optimum plant spacing for corn production in the Intermediate Savannahs.

(a) Methodology

The study is a randomized complete block design trial with three replications, four treatments and two varieties. The individual plot sizes are 1000 x 500 cm, with a 1 m wide passage way between each replication.

Corn seeds were planted 3 December 2014 and each plot had four rows, 52 seeds were planted per plot. The plant to plant distance within rows are 60 cm and between rows the distances were either 40,75,90 or 100 cm. The sowing was done by hand at a depth of 5-7 cm, one seed placed in a hole and seeds were covered with soil at sowing. Templates/stencils were made with PVC pipe to ensure that the planting distances were maintained. The template would ensure that the seeds were planted at the required distance. Plants would be resupplied at day 4 to ensure that each plot has 52 plants.

(b) Fertilizer regime

The fertilizer regime used include the following:

- 15-15-15 at planting at a rate of 50 kg/ha.
- 35 kg/ha of nitrogen in the form of urea applied in two equal amounts
- First application of urea applied at 25-30 days after planting
- Second application of urea applied at 60 days after planting

3.0 EXTENSION, TRAINING AND PROVISION OF SERVICES

3.1 Farm Visits

The total of thirty-six thousand one hundred and four (36,104) farm visits were conducted during the year in review. In July there was a change in the way farm visits were executed, leading to an increase in the number of farmers visited by extension staff. The field staff operated all in one community (saturation operation) rather than being spread throughout the Region. This led to better supervision and accountability of the staff as well as meeting more farmers. In the case with difficulty in identification of pests and diseases as well as offering recommendations, other senior staff present can offer assistance to junior personnel. The breakdown by Regions is shown in Table 3 & Figure 3.

Table 3: Farm Visits by Region Conducted in 2014

Region	Farm Visits
1	1205
2	5598
3	3532
4	8042
5	8514
6	4184
7	900
8	724
9	2439
10	966

The Coastal Regions accounted for 30,836 visits while the hinterland was 5,268. Overall farm visits were affected by cost of transportation especially in the hinterland and riverain areas on the Coast, staff limitation and climatic conditions.

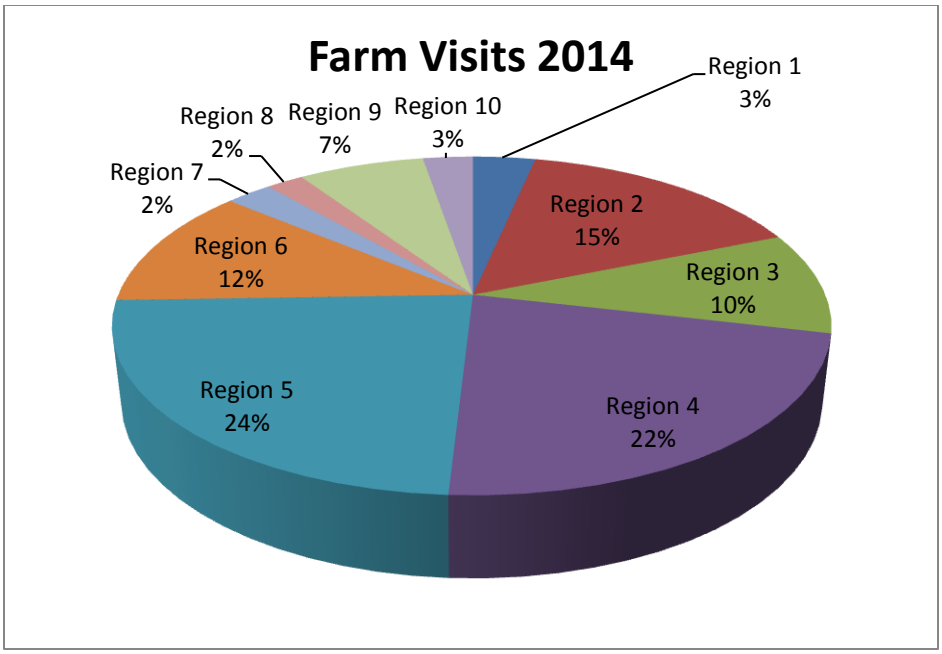


Figure 3: Farm Visits for 2014

3.2 Service Improvement

During the period under review, thirty-five (35) extension staff comprising mainly District Crop Extension Officers and Regional Coordinators were equipped with Agricultural Kits containing pH Meters, Cameras, EC meters and other equipment to assist with diagnosis and recommendations in field. All field staff were also fitted with shirts bearing the NAREI's logo to improve their recognition.

3.3 Farmers' Field School/Demonstration Farms

The following is a summary of the farmers' field school / demonstration plots established or utilized during the period under review.

1. A total of sixteen (16) plantain management demonstration plots were used for training purposes during the year. Seventeen (17) sessions of farmers' field school were conducted with a total of 323 farmers who were trained in the management of Black Sigatoka Disease (BSD) in plantains. Five (5) plots were harvested for a second round and handed over back to

the farmer. These were replaced by five (5) new plots on other farms in an attempt to work with more farmers in other communities.

2. Two hundred and seventeen (217) demo plots were also established or maintained during the period. These are as follows:-

a) **Sweet potato pheromone lures** – Farmers were introduced to the concept of the pheromone lures (male attractant) as a form of control of the sweet potato weevil (*Cylas formicarius*) and two demonstration farms in Parika and Canal 1 were issued lures for use on their plots. A total of 172 farmers of the 200 issued used the lures on their plots in Regions 3 and 4. Pheromone lures established on sweet potato farms were used to attract males of the sweet potato weevil to a water trap. The basic concept is to trap the males, thereby reducing reproduction and fewer weevils are produced leading to reduced infestation and production of more marketable sweet potatoes.

b) **Diamondback moth (*Plutella xylostella*) pheromone lures** – 23 plots were established and monitored in Regions 3, 4 and 6. The concept was similar to the Potato weevil lures but in this case the males were attracted and trapped on a sticky pad. Whilst farmers are readily accepting the sweet potato lures they are hesitant with the diamondback lures because the results are slow and requires continuous usage even without cabbage production, in order to be successful.

c) **Rhizobium Inoculation of Bora** – Two (2) plots at Cane Grove and Little Biaboo were established to demonstrate the effectiveness of inoculum on bora production. In the case of the Cane Grove plot, the appearance and health of treated plants demonstrated more vigour but fruits were not of desired quality. The poor quality of fruits was attributed to the use of poor seed stock. Work is ongoing at Little Biaboo.

d) **Pineapple** – 2 Plots were established in Region 2 to demonstrate the use of the flowering stimulant ethephon (ethrel). These plots are the fruiting stage and harvesting is expected in June – July 2015.

e) **Scotch Bonnet Pepper Production** – A scotch bonnet hot pepper demonstration plot was established at Hope to demonstrate the production and growth of the variety. This pepper is requested by agro processors because of its taste and scent. The yield experienced is approximately 1 kg per plant.

f) **Rhizobium Inoculation of Minica IV** – Two demonstration plots on the effectiveness of inoculum on legumes were established at Dartmouth on the Essequibo Coast. Five (5) FFS were conducted at varying stages of growth and a total of 37 farmers were trained. Farmers are now utilizing the inoculum as part of the production practice. This technology has aided farmers by reducing their cost of production by at least $ 10,000.00 per crop which represents about 45% of the cost of production per acre.

g) **Soil ameliorants, pest and disease management and nutrition** – Fifteen plots were established in regions 3, 4, 5 and 6 and are used to train farmers in various techniques associated with improved management systems for tomato (4), boulanger (3), pepper (3) and plantain (2).

3.4 Field Surveys

A number of surveys were carried out during the year in review to determine what possible impact is being derived from the introduction of new technologies to farmers. These were highlighted by the following surveys:

a) **Climate Smart Agriculture – Irrigation systems –** A survey on the spread of irrigation systems utilized by farmers was completed in May. The survey revealed that rain fed irrigation remained the main irrigation system on the Coast. Farms with large acreages (in excess of ten (10) acres (4 hectare) growing pineapples, fruits, musa species, ground provision were solely dependent on rainfall for irrigation. Cash crop production use an assisted irrigation system such as pump and hose. These are common on smaller plots with high water demand for crops such as cabbage, tomato, boulanger, celery and chives. The sprinkler

system is currently expanding and is found in almost every high producing area in the country at a frequency of 1 in 17 farms. Drip irrigation was mainly limited to protected systems but these are experiencing problems with clogging of drip tapes and investment costs.

b) **Climate Smart Agriculture – Protected Agriculture – Shade House** – A survey was carried out to determine the acreage under shade culture and was completed in September. A total of 257 farmers practiced some form of protected agriculture in Guyana comprising 46 hydroponics, 2 operate full green houses and 209 are shade house practitioners. This census excludes all private nursery operators and all shade houses within the confines of NAREI compounds nationwide. The total acreage under protection is 26.24, an increase of 2.04 acres from a November 2012 estimate. The largest increase (1.2 acres) was recorded in Region 4 whilst Region 2 showed a reduction of 0.4 acres. Increases were also recorded for Regions 5 and 3.

c) **Sweet Potato and Cabbage Production** – A survey was carried out to determine the acreage under sweet potato and cabbage cultivation and was completed in July. The survey revealed that there are approximately 476 acres of cabbage and 578 acres of sweet potato routinely under cultivation. This translates to a production figure of 3,236.8 tonnes of cabbage and 3,468 tonnes of sweet potatoes per crop with a cycle of three (3) for cabbage and two (2) for potatoes per annum. It was further revealed that all production areas are significantly affected (having to use pesticides as a means of control) with diamond back moth for cabbage and sweet potato weevil in sweet potatoes.

d) **Red Palm Mite in Region 4** – A Red Palm Mite (RPM) infestation survey was conducted in Region 4 and completed in April. The investigation determined that RPM was present throughout the coastal areas from Mahaica – Timehri.

3.5 Training

Farmers

A total of 6,006 farmers / staff were trained for the year from 312 training sessions representing approximately 20 persons per session. All trainings included discussions and infield training/demonstration.

Table 4 provides a breakdown of the training.

Table 4: Breakdown of Training Programme for 2014

Training Programme	Objective	Target	Amount	No. of Training
Management of Acoushi Ant.	Staff and farmers have knowledge of methods of treating and monitoring this pest.	Extension staff and farmers	**414**	**12**
Pest and Disease detection and management.	Staff and farmers to have adequate knowledge to identify and treat pest and diseases. For staff to identify and report findings in a timely manner.	Extension staff. Farmers.	1,019	60
Strengthening of Red Palm Mite management.	To equip staff in the identification and treatment process.	Staff and Farmers.	1,926	80
BSD Management.	Transforming integrated techniques for the management of Black Sigatoka Disease.	Farmers	482	11
Training in Shade House Culture and Hydroponics.	To expose staff to techniques in Climate Smart Agriculture.	Staff and farmers.	48	3
Ground Provision. Control of sweet potato weevil using traps.	To expose farmers to making and using traps to control sweet potato weevil.	Farmers.	172	6
Orchard crops production and	To expose farmers on the correct propagation and management	Farmers	90	4

management.	techniques required for citrus crops.			
Control of coconut caterpillar.	To expose farmers in the identification and treatment of the coconut caterpillar.	Staff Farmers	64 1340	90
Good Agricultural Practices.	To educate farmers on proper agriculture system in various communities.	Farmers.	15	1
Growing of Ginger and Turmeric commercially.	To expose farmers to the management techniques involve in turmeric and ginger production.	Farmers	42	3
Methods and Techniques used in the organic production of crops.	To expose farmers to the knowledge and skills needed to produce crops organically.	Farmers.	32	1
Canada's Good Agricultural Practices.	To expose staff to established protocols in Canada as it relates to GAP.	Staff.	8	1
Diamond Back Moth Management.	To expose farmers to a regime to that would control D.B.M.	Farmers	354	40
		Total	**6006**	**312**

3.6 Community Development Plan (CDPs)

NAREI continued to provide training/technical support to the various projects being implemented under the CDP. A status report on the implementation of these activities is shown in Table 5.

Table 5: Status Report on the Community Development Plan, 2014

Regions/communities	Status
Region # 1. Manawarin	**Status** • 15 acres of cassava were planted at Manawarin; plants are about 6 months old. • Another 5 acres of land was identified for the expansion of cassava project. • A processing facility is being constructed presently. Processing equipment purchased and delivered. • Cassava will be processed mainly into cassava bread and cassreep. **Challenges faced** • It was difficult to clear forested lands for the cultivation of cassava. • Caterpillars and Acoushi ants infestation **Recommendations** • Spraying and fogging were recommended for the control of caterpillars and acoushi ants. • Training was provided on the usage of the ants baits provided by NAREI.
Region # 2. Bethany	**Status** • 2.5 acres of land was cultivated with cassava in March, 2014 and an additional 2.5 acres are presently cleared to be planted on a subsequent date.

	• A site was located for the cultivation of cash crop under irrigated conditions. **Challenges faced** • Acoushi ants and caterpillars destroying young plants. **Recommendations** • The use of a swing fog machine and baits for the control of the acoushi ants and fastac for the control of caterpillars.
Region # 7. Karrau	**Status** • About five acres of cassava was cultivated early this year at Karrau, cash crop was intercropped with cassava to provide another source of income meanwhile the cassava cultivars reach harvesting time. • A processing facility was built to process cassava into cassava bread and cassreep. **Challenges faced** • Acoushi ants is affecting the cassava cultivars • Wild animals destroying the cassava as well as the cash crop. • Procurement of processing equipment. **Recommendations** • Fogging and baiting of the acoushi ants was necessary for the control of this important economic pest. • NAREI in collaboration with Ministry of Amerindian Affairs (MoAA) will assist with the procurement of the processing equipment.
Region # 8. Itabac	**Status** • 15 acres of cassava were planted last year at Itabac and land clearing begun for another five acres.

	• The construction of a processing facility should be completed later this month. • Procurement of equipment and tools is presently ongoing. • Cassava will be processed into value added products such as Farine, tapioca, cassreep and beverages. **Challenges faced** • Caterpillars affecting young cassava plants • Difficulties accessing equipment from Georgetown hence, some equipment was sourced from a nearby Brazilian village. **Recommendations** • Cultural control (by taking out with hands and kill) and chemical control were recommended to control the caterpillars.
Region # 9. Massara	**Status** • 5 acres of cassava was cultivated in the savannah • A processing facility was erected and equipment is being procured for the production of farine, tapioca and cassreep.
Rupertee	**Status** • 5 acres of cassava planted at Rupertee early this year and a processing facility was constructed • Processing facility is partially equipped so processing will commence as soon as cassava is harvested.
Parikwaranau	**Status** 20 acres of cassava was planted at Parikwaranau in the

	savannah. A processing facility was built to process the cassava planted as well as cassava harvested from individual farmers. **Challenges faced** • Due to the severe weather conditions cassava suffered from saline toxicity and nutrition deficiency which resulted in stunted growth of cassava**.** **Recommendations** • Planting of cassava should be done during the rainy season so as to give the plant the necessary moisture that is required for normal plant growth. • It was also recommended that an irrigation system be installed at the farm to irrigate cassava when necessary. • Limestone and other fertilizer application were recommended.
Region # 10. Sand hills	**Status** • About 5 acres of red peas and black eye were cultivated at sand hills together with 0.5 acres of cash crop. • Sprinkler irrigation will be installed for cash crop production. **Challenges faced** • Wild animals affecting the farming areas. • Difficulties accessing markets • Cost for transporting inputs to and produce out of the communities.

3.7 Services

3.7.1 Laboratory Services: Entomology, Plant Pathology and Weed science.

- Plant diagnostics processed 176 person samples for pest and disease problems and provided recommendations (Table 6)

Table 6: Common Pests Identified in 2014 and Recommendations Provided

Common Pests	Crops Affected	Recommendations
Fungal Plant Diseases Fusarium wilt and fruit rot (*Fusarium sp.)**	Sorrel, Pumpkin, Pear, Corilla, Faba beans, Corn, Hot & Sweet peppers, Pak-choi, Cabbage and Banana. Regions**:** 3,4,7	• Use tolerant/resistant cultivars if available • Application of systemic or contact fungicides when necessary. • Practice field sanitation, crop rotation with non-host crops and provide good drainage.
Anthracnose * (*Colletotrichum sp.)*	Hot & Sweet peppers, Breadfruit, Citrus, Boulanger, Guava, Passion fruit, Butternut squash and Cherry. Regions: 3, 4	• Use of contact fungicides, resistant varieties and improve sanitation conditions in fields.
Black Sigatoka (*M. fijiensis)*	Plantains and bananas Regions: 3, 4	• Practice deleafing, good field sanitation, good nutrition and apply fungicides only when needed.
Foliar leaf spot (Cercospora sp, *Cercosphaerella sp.)*	Cassava, Celery, Cabbage, Tomato Regions: 3,4	• Improve field sanitation • Spray systemic fungicides (Carbendazim/Stratego) using the recommended rates. • Manage irrigation water • Provide good drainage
Sclerotina root rot* (*Sclerotina minor*)	Tomato, Hot pepper Regions: 4, 6	• Provide good drainage, apply soil fungicide (Kocide) at recommended rates, use tolerant/ resistant cultivars and practice crop rotation.
Sooty Mold, Gray Mold	Sweet Peppers, Ochro , Citrus, Thyme, Sour-sop Regions: 3, 4	• Use of contact fungicide at the recommended rates.
Rust	Bora Region:4	• Use tolerant/resistant cultivars

Bacterial Plant Diseases Bacteria leaf spot and root rot (wilt) * (*Pseudomonas sp.)*	Hot & Sweet Pepper, Sour-sop , Bread-fruit, Pumpkin, Pear, Corilla, Boulanger , Tomato, Irish potato, Thyme, Cassava, Broccoli , Calalu , Beet, Butternut squash , Pak-choi , Ochro, Sorrel, Cabbage, Chick pea, Corn, Poi, Avocado, Watermelon, Papaw	• Use clean seed material that are tolerant/resistant. • Do not plant in contaminated soil. • Apply copper base fungicide/ bactericide (2-3 applications).
Bacterial crown gall (*Agrobacterium tumefaciens*)	Sorrel Regions: 3, 4, 7	• Use of resistant cultivars • Avoid damage to the plants
Plant viruses * Citrus Tristeza Virus (*Closterovirus)*	Citrus (lemon, orange and lime)	• Use resistant rootstock • Control aphids that vector the virus (CTV).
Pepper Mild Mottle Virus (*Potyvirus)*	Peppers, tomatoes Regions: 3, 4, 6	• Use clean planting materials • Practice good field sanitation
Physiological disorders: Blossom end rot N & B deficiencies	Sweet pepper, orange fruit, calalu, sour sop Regions: 3, 4	• Practice liming when soil pH is low. • Provide plant nutrients in the right quantity at the right time.
Insects Common insects were: Aphids, coconut leaf miner, fruit fly, gall midge, citrus leaf miner, white mealy bug, scales, spider mites, red palm mite, picture winged fly, saddle worm, soursop wasp, whiteflies, thrips and stink bugs	Mainly affects vegetable (Boulanger, Bora, Pepper, Poi, Potato and Tomato) and horticultural crops (Coconut, Citrus, Guava Star apple, Pineapple, Cassava, Plantain & Banana)	• Spray or inject with recommended insecticide when necessary. • Remove weeds that's are host for insect pests • Practice good field sanitation • Bag fruits or use pheromone traps.
Parasitic nematodes reported were: Meloidgyne* Heterodera and *R. similis**	Boulanger, Hot pepper, Calalu and Plantain, Regions: 3, 4	• Use tolerant/resistant cultivars. • Practice crop rotation. • Disinfect tools and implements. • Practice soil solarization and fumigate soils if necessary.

*****Most frequently occurring plant pests

3.7.2 Soil Management and Farm Mechanization Department

(i) Micro-biology: The department collaborated with UG students on a project to test the viability of three rhizobia bacteria strains (301, SWS, SRS) from NAREI's stock. The result showed that all the strains were effective but the 301 was the most effective on Bora.

A similar collaboration is ongoing with pre-inoculated Jack bean (***Canavalia ensiformis*)** and Sunn hemp (***Crotalaria juncea***) imported for growth by GUYSUCO for use as a green manure. The observation is being conducted in Field 17 shade-house. Attempts will be pursued to recover the bacteria strain to enhance NAREI's stock.

Mycorrhiza: This project was initiated to incorporate Mycorrhiza in poor local soil substrate mixes and provide an effective substitute for imported PRO-MIX. It aims to enhance seedling quality and effectiveness of organic matter applications to plants. Five substrates mixes were analyzed for physical and chemical properties and evaluated against PRO-MIX and Vermicompost. Substrate mixes properties were manipulated by adding mycorrhiza, fertilizer and coconut fiber. The substrates were used to produce seedlings using tomato as an indicator crop. The mycorrhized and improved substrates showed vigorous growth compared to stunted growth of controls. Vermicompost was outstanding for number of leaves, plant height, and first flower after transplant to field. No yield data was obtained owing to high mortality from seed borne diseases.

(ii) Soil Chemistry Laboratory

The department conducted soil analyses and made fertilizer recommendations on 435 farmers, 8 UG students, 1 GSA, 45 MSc. students and 9 GFC soil samples.

(a) Soil Micro-Biology: The Department was involved in the production of inocula for the legume farming community. Production for 2013 was 26kg, 500% above the targeted production level of 5kg.

Establishing a Digital Soil Database for NAREI's map archives using Geographical Information Systems (GIS)

To preserve and make soils data readily accessible, NAREI has embarked on the creation of a Geographic Information System (GIS) database. One technician was trained at the Guyana Lands & Surveys Commission (GLSC), and Region 5 between the Mahaica and Mahaicony rivers (including Big Biaboo) was chosen as a pilot area to initiate this process. The project updated geo-information on the soils map to include D&I, land use and soil quality.

Establishing baseline data on Sour-sop Cultivation and production

Four soursop growing locations (Coverden, Bendorf, NAREI Kairuni and NAREI Mon Repos) were selected for observation and soil fertility monitoring. Agronomic questionnaire was developed and administered, and data on crop propagation, field establishment, orchard management and harvesting collated. Soils were analyzed and limestone and organic matter application recommended. Farmers' response is indicative of a combination of seed borer (*Bephrata maculicollis*), scale insect mealy bugs (*Maconellicoccus hirsutus*), Acoushi ants and fruit flies being detrimental to soursop production at all locations. These findings will be recorded in a brochure on soursop.

3.8 Production

NAREI's nursery programme is responsible for 9 nurseries located in the following areas: Mon Repos, Timehri, Hosororo, Charity, Pouderoyen, Fort Wellington, Benab, 1½ Miles - Potaro Road and St. Ignatius. The Regional breakdown is shown in Table 7 below.

Table 7: Regions and Nurseries

REGION	LOCATION
1	Hosororo
2	Charity
3	Pouderoyen
4	Mon Repos & Timehri
5	Fort Wellington
6	Benab
7	Bartica
9	St. Ignatius

During the period under review all the nurseries were operational and a summary of the activities for this programme are as follows:

3.8.1 Budding

A total of 25,447 citrus plants were budded as follows: orange (14,841), tangerine (1,766), West Indian lime (1,015), lemon (3,332), grapefruit (596), seedless lime (3,757), and ortanique (140).

Scions were obtained from the Kairuni Station, Timehri Orchard and selected farmers in Pomeroon and Canals Polders 1 and 2.

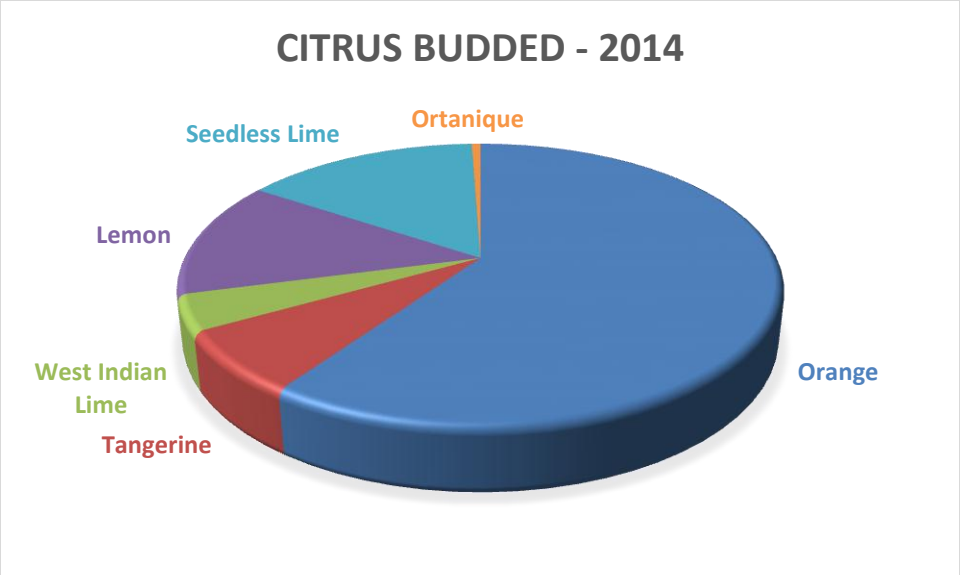


Figure 4: Chart showing citrus budded in 2014

3.8.2 Grafting

A total of 8,599 plants were grafted as follows: avocado (6289), mango (1999), Malacca apple (170), plumrose (80), and cherry (61).

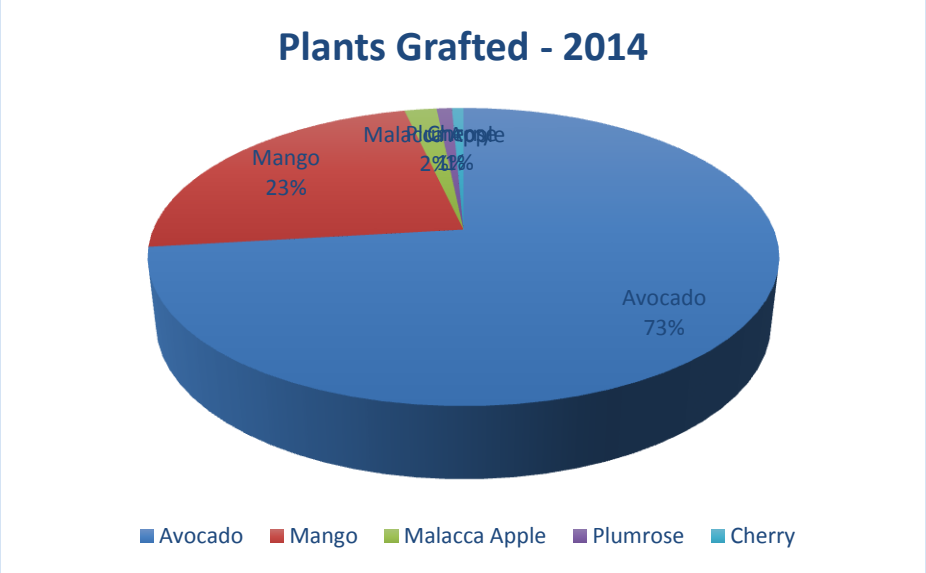


Figure 5: Chart showing grafted plant in 2014

3.8.3 Seed Supply

There was ample supply of seeds for the period, however, year round supply is limited. Most of the seeds are supplied from the Kairuni station and Hosororo. Rough lemon is also externally sourced from Regions 1 and 9.

3.8.4 Pest and Disease

Leaf spots, leaf curls and leaf miners continues to be the major pests affecting the operation. During the period under review Citrus Tristeza Virus (CTV) was found at Timehri and Benab.

3.8.5 Repairs and Maintenance

Most of the nurseries experienced some form of remedial work and under the rural Enterprise for Agricultural Development (READ) project some major work was carried out on the Coastal Nurseries ranging from shed construction to hardened floor expansion.

3.8.6 Production

A total of 150,940 plants were produced during the period (Table 8).

3.8.7 Sales

The total sale for the period was $ 11,588,477.00 for the period. This is shown in the table below.

Table 8: Plant Sales and Production 2014

Nurseries	January - December		Seedling Production
	Number of plants	Total Sale ($)	
Bartica	767	88,540	144
Benab	8519	1015020	14831
Charity	11059	1352540	19927
Fort Wellington	844	103620	1865
Hosororo	2658	630250	5872
Mon Repos	31613	4437680	45364
Pouderoyen	14639	1871430	28352
St. Ignatius	1433	245180	5299
Timehri	15525	1844217	26286
TOTAL	**87,057**	**11,588,477**	**150,940**

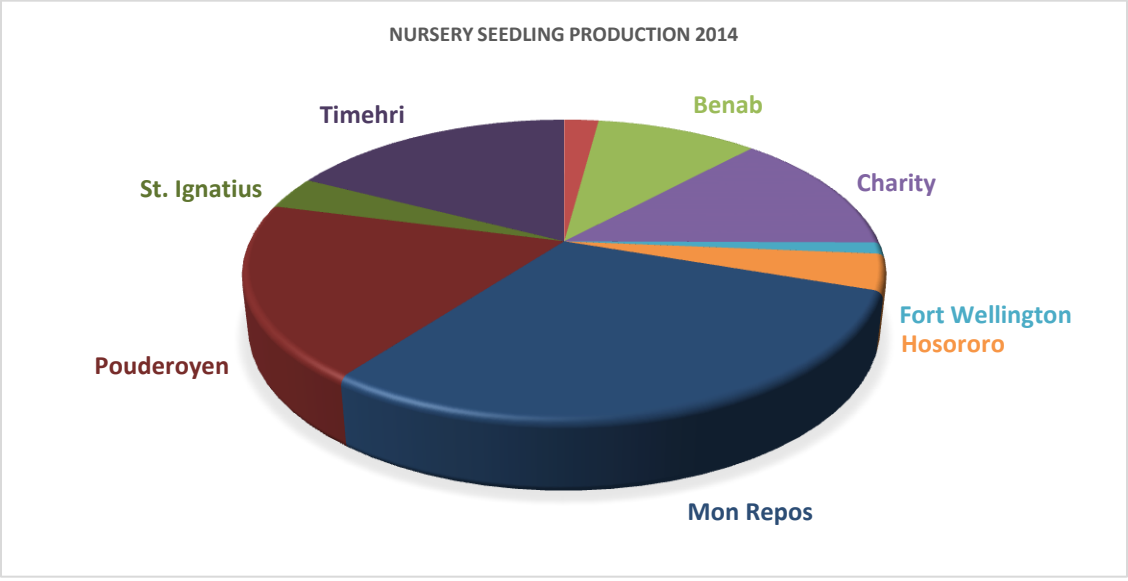


Figure 6: Nursery Seedling Production for 2014

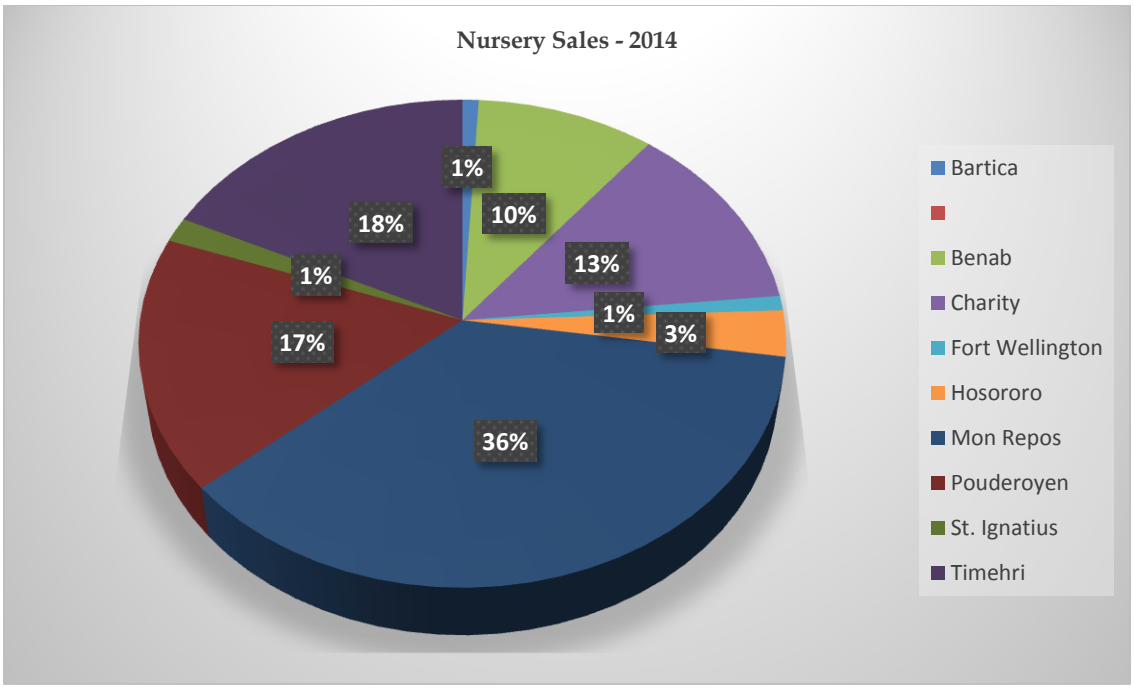


Figure 7: Nursery Seedling Sales, 2014

3.9 Seed/Seedlings

3.9.1 Commercial Seed Production

The Ebini Unit is one of the national repositories of orchard and other crop types; one of its principal tasks is to act as the primary seed production unit for NAREI. The unit planted for commercial seed production purposes cowpea Minica 4(red pea) and California 5 (black eye pea), corn (Pioneer and CARDI C-001), soybean (Tracaja and CARDI XXXXX) and sorghum. These seeds are used for increased agricultural production as well as to ensure that adequate seed material is available for the various Government of Guyana programmes. The seeds produced at the unit were transferred to the Mon Repos Unit for storage and distribution.

Additionally, NAREI was the signatory of a Service Agreement between the Ministry of Agriculture and NAREI. This service agreement which was signed by the Minister of Agriculture and the CEO of NAREI on 25 February 2014 relates to the effective management of NAREI in the provision of services.

In section 3.12 Priority Indicators. The service activity targets anticipated that the Institute contributes to the sector a total of 1000 kg of red pea seed and 500 kg of corn seed among other crops. Table 9 shows the type and amount of seed the Ebini Unit produced and supplied during the reporting year.

Table 9: Commercial crops planted at Ebini for seed regeneration, 2014

Crop Type	**Target (kg)**	**Seed produced (kg)**	**Comment**
Cowpea Minica 4	1000	1500	
Black eye pea	100	225	
Corn	500	200	80 kg distributed to farmers in Berbice river
Sorghum	100	58	
Peanut	Nil		

Additionally, the Fruits, Vegetables, Other Crops (FVOC) and Seed Technology Department produced and supply the following seeds and seedlings for 2014 (Table 10).

Table 10: Production of Seedlings and Seeds in 2014

SEEDLING PRODUCTION

Seedling Type	Variety	Quantity
Celery	Giant Pascal	5,300
Poi	Malabar Spinach	728
Lettuce	Butter Head	400
Cauliflower	Maya F1	2,100
Broccoli	Green Tropic F1	500
Tomato	Mongol	700
Hot pepper	Scotch Bonnet	2,600
Hot pepper	Moruga Red	880
Hot pepper	Yellow Star 099	400
Hot pepper	Bird Seed	400
Hot Pepper	Tiger Teeth	800
Hot pepper	West Indian Red	300
Hot Pepper	Miwiri Red	200
Sweet pepper	Goliath	1,000
Sweet pepper	King Arthur	800
Sweet pepper	Marconi	1,000
Boulanger	Long Purple	1,340
Boulanger	Black Beauty	400
Boulanger	EG 4683	400
Boulanger	Long Egg Plant	620
Onion	Walla Walla Sweet	200
Cabbage	Purple	400
Carrot	New Kuroda	100
Pak choy	Chinese Mustard	200
Beet	Bull's Blood	100
Dill	Bouquet	100
Cucumber	Chipper Select	600
Chard	Oriole Red	780
Radish	Champion	530
Mustard	Chinese	500
	Total	**24, 378**

VEGETABLE SEED PRODUCTION

SEED CROP	QUANTITY (kg)
Ochro (Clemson spineless)	12.85
Bora (Yard long)	5.78
Boulanger (Long purple)	1.01
Chilli hot pepper	0.40
Scotch Bonnet hot pepper	0.48
Tiger Teeth hot pepper	0.40
Miwiri Red hot pepper	0.34
Miwiri Yellow hot pepper	0.09
Moruga Red hot pepper	0.19
Black eye beans	2.74
TOTAL	**24.28**

SEED PACKAGED

TYPE OF SEED CROP	QUANTITY (packs)
Bora	1,446
Boulanger	959
Celery	665
Lettuce	976
Ochro	427
Hot pepper	492
Tomato	86
Black Eye Peas	308
Red Beans	295
Total	**5,654**

SEED DISTRUBUTED

SEED CROP	QUANTITY(kg/packs)
Red beans (Minica 4	325.9kg
Corn (GB)	150.5kg
Soya Beans	30.9kg
Black Eye	4.1kg
Ochro	0.3kg
Bora (Yard long)	301pks
Boulanger (Pink & White)	270pks
Ochro	347pks

	Celery	106pks
	Pepper	183pks
	Lettuce	121pks
	Tomato	80pks
	Total kg.	**511.7**
	Total Packs	**1,408**

3.10 Ant Bait Production

Table 11 showed the amount of Ant Bait production for the year 2014 which totaled 5,377 packets. Ant baits produced were sold and distributed to farmers through NAREI's interventions countrywide.

Table 11: Ant Bait Production, 2014

Months	Ant bait Production	# of packets distributed	# of packets sold to farmers
January	0	125	126
February	0	1000	57
March	1345	0	60
April	0	400	60
May	0	500	165
June	777	350	30
July	962	150	70
August	341	0	1050
September	1607	0	55
October	0	0	73
November	0	500	24
December	345	450	410
Total	**5377**	**3475**	**2180**

Amount brought forward from 2013 - 1624 packets

Amount in Stock as of 31st December 2014- 940 packets

Amount of bait expired/damaged – 406 packets

4.0 NATIONAL PLANT PROTECTION ORGANIZATION (NPPO)

During the year 2014, the NPPO implemented measures aimed at strengthening its pest surveillance and survey programmes. Detection, delimiting and monitoring activities were executed in nine (9) of the ten (10) administrative regions of Guyana to ascertain the various quarantine pests status and to ensure that measures were implemented as quickly as possible to control and eradicate any quarantine pest where discovered. The Red Palm Mite (RPM) and the Carambola Fruit Fly (CFF) continued to be pests of significant Quarantine importance to Guyana. Efforts to control and ultimately eradicate these pests continued unabated by the department. For the Red Palm Mite (RPM); quarantine activities that were implemented in the previous years continued to be enforced, especially on the Islands of Wakenaam and Leguan, to prevent the further spread and establishment of the pest in other farming areas.

Efforts to determine the spread of the Carambola Fruit Fly (CFF) in the hinterland regions, especially in areas in contiguity with Brazil, saw Guyana and Brazil collaborating in joint monitoring activities in areas of regions #8 and #9. Teams from the two (2) countries worked together to establish and service trapping lines in villages and satellite communities of Lethem and Monkey Mountain. This resulted in the discovery of the CFF pest in two (2) villages (Bamboo Creek and Paramakatoi) of region #8. All other areas visited and where traps were placed and serviced were negative for the CFF pest. Efforts to return the status of these villages to negative or zero CFF pest population will continue in the New Year 2015.

Guyana continues to be free of the Giant African Snail (GAS) and the Mango Seed Weevil which are on the watch list for the Caribbean region as pests of significant quarantine importance.

The export of regulated commodities, mainly fresh fruits, vegetables, lumber and rice has shown significant increases in 2014. The export of agricultural commodities

continued to dominate the export trade. Guyana's GDP benefitted tremendously from the increase in exports.

4.1 Inspection and Treatment Services

Agricultural commodities and regulated articles continued to be subjected to inspections prior to import and export to reduce the possible introduction of exotic pests into Guyana and/or their movement during export from Guyana.

4.1.1 Imports and Exports Inspections

The major commodities exported for the period under review were rice, sugar, lumber, fruits and vegetables for which Phytosanitary certificates were issued. For the period under review a total of one thousand one hundred and seventy (1,170) and six thousand six hundred and fourteen (6,614) inspections were conducted for imports and exports respectively.

A total of twenty nine thousand and thirty three (29,033) vehicles were subjected to inspections prior to entering or exiting Guyana at the Lethem, Georgetown, and Moleson Creek Ports. This represents an approximate ten percent increase over the number of vehicles inspected in 2013.

Four thousand five hundred and ninety seven (4,597) flights were checked for Phytosanitary compliance at the Cheddi Jagan and Ogle International Airports representing a 38 percent increase in the number of flights checked over the corresponding period last year (2013) which saw a total of three thousand three hundred and twenty eight (3,328) flights being checked.

All ocean going vessels (cargo ships, yachts, etc) were subjected to inspections in accordance with International Maritime Standards and Phytosanitary requirements for vessels entering a country. In this regards, a total of one thousand four hundred and fifty-nine (1,459) Ocean-going Vessels were inspected and clearance granted for the vessels to enter the territorial waters of

Guyana. Inspections of vessels are usually conducted in collaboration with other regulatory agencies (GRA, Immigration, etc).

4.1.1.1 Issuance of Phytosanitary Import Permits (PIPs)

For the purpose of importation, a total of one hundred and ninety-four (194) Phytosanitary Import Permits were issued for the importation of fruits, vegetables and cut flowers. This represents an increase of 125 percent over the total granted for the previous year 2013 and represent imports from countries such as the USA, Chile, India, and China.

4.1.1.2 Issuance of Wood Packaging Materials Certificates

The total number of Wood packaging Materials Certificates issued for the year 2014 was thirty five (35). A 25 percent increase over the total number of certificates issued in 2013.

Table 12: Total Number of Wood Packaging Materials Certificates Issued in 2013 & 2014

Commodity	Phytosanitary Certificates Issued	
	2013	2014
Rice	1,699	1,380
Sugar	100	79
Lumber	675	1,089
Fruits and Vegetables	553	557
Sand	30	44
Wheat Flour	36	37
Other	49	177
Commercial PC	**3,142**	**3,363**
Non Commercial PC	**252**	**273**
Total PCs Issued	**3,394**	**3,636**

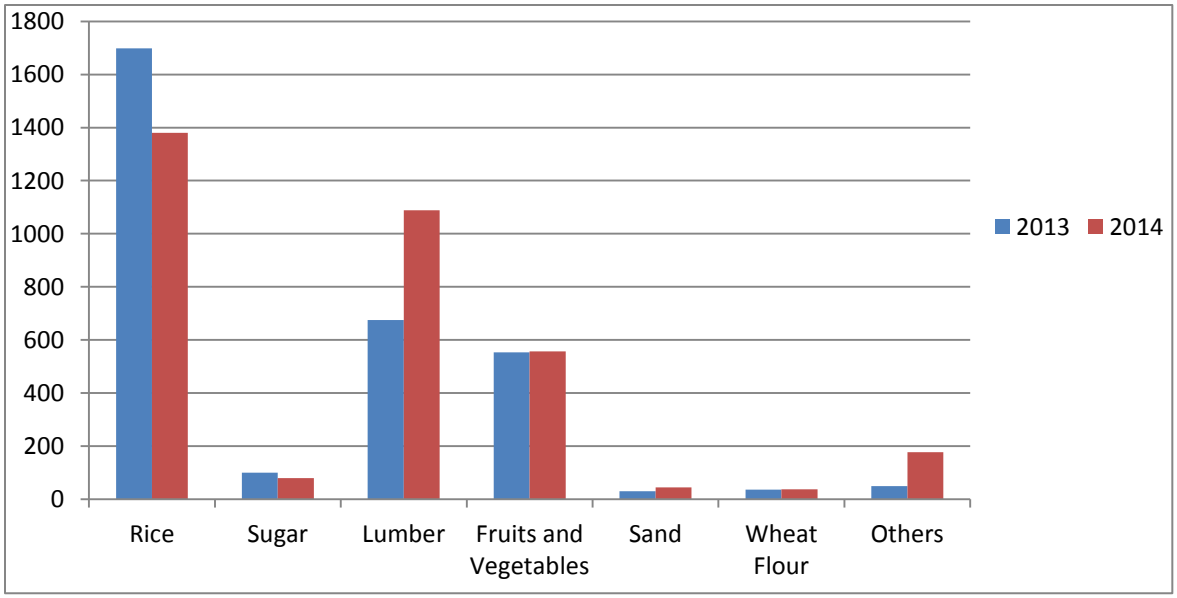


Figure 8: Commodities Exported and Phytosanitary Certificates (PC) Issued During 2013 and 2014

4.1.2 Quarantine Treatment

The treatment of commodities to prevent the movement of pests during trade continued to be enforced and supervised by the NPPO. Quarantine treatment supervision occupied a major portion of the departments work load, especially since the discovery of live pest infestation in consignments of rice that were shipped to Venezuela. The NPPO resumed responsibility for the supervision of rice fumigation as a result of the incident. This responsibility the NPPO had relinquished to the Guyana Rice Development Board (GRDB) some years ago due to staff constraints. Subsequent shipments of rice to Venezuela have all been certified free of the pest.

4.1.3 Interception/ Seizures (Illegal Imports)

The NPPO conducted inspection for illegally imported commodities at the various markets, supermarkets and stores within Georgetown, New Amsterdam, Rosignol, Moleson Creek, Springlands, and Parika. Commodities that fell within the following categories were seized and destroyed: commodities that were

1. imported without the requisite import permit;
2. found to be heavily infested with pest;
3. unfit for human consumption; and/or
4. restricted/ prohibited

One hundred and thirty three (133) such interceptions and or seizures were done for the period under review.

4.2 Plant Protection Services

Objectives: To determine the presence of exotic pests, to detect the entry of those eradicated and to monitor the spread of and control of those present.

The function of the Plant Protection Services is to conduct surveys and surveillances and provide control for key quarantine pests of economic importance to Guyana and the rest of the world. This section continued to provide safeguarding continuum and

protection against exotic pests through the implementation of activities that were geared towards early detection and control of key pests.

4.2.1 Surveys and Surveillance

4.2.1.1 Carambola Fruit Fly (CFF) & Mediterranean Fruit Fly (Med Fly)

The Carambola Fruit Fly programme was executed within nine (9) of the ten (10) administrative regions of Guyana. During the year 2014 the programme benefitted from technical and material assistance/ support from agencies and organizations such as the United States Department of Agriculture/ Animal and Plant Health Inspection Services (USDA/APHIS), IICA, UNFAO, and the Governments of Brazil and Suriname.

The assistances received were instrumental in enabling the NPPO to successfully implement strategic control and eradication activities, especially in remote regions of Guyana. The materials received included: Jackson, McPhail and Multilure Traps, Torula Yeast, Methyl eugenol, Trimedlure, Malathion, Fruit Fly bait and Fibre Blocks Board.

The NPPO conducted a workshop on the "***Control and Eradication of Carambola and other Fruit Flies of Guyana"*** for staff of the Extension Department of NAREI. This training of the Extension Personnel along with materials received from donors will be used to strengthen the Carambola Fruit Fly Control Programme of Guyana.

Regions # 2, 3, 4, 5, 8 and 9 were the main regions within which activities under the CFF work 2014 programme were executed. Monitoring of Jackson Traps that were distributed within the aforementioned Regions confirmed the presence of this quarantine pest in Regions 2, 3, 4, and 9.

Within *Region #2*; the CFF continues to be concentrated along the Pomeroon River leaving the Coast line from Supenaam to Charity CFF free.

Region # 3; Wakenaam Island and Parika back to Vergenoegen are the two areas where control actions (bait and McPhail traps distribution) were focused during this period.

Regarding Region #4; control actions conducted within targeted areas during the year has enabled the containment of the CFF within specific areas, such as Laluni, Kuru Kuru, and from Timehri to Garden of Eden.

Region #8; Joint monitoring activities revealed a positive CFF pest status for the villages of Bamboo Creek and Paramakatoi.

Regions #5 and 9 continue to be free of the Carambola Fruit Fly.

The year 2014 saw the fulfilment of the joint CFF monitoring activity between the Guyana and Brazil CFF personnel. This joint activity which was conducted during the period November 23 to December 07, 2014 focused on determining the CFF status of villages located along the Guyana – Brazil border within Regions #8 and #9. Verification of Jackson and McPhail traps that were distributed in both Regions confirmed the presence of CFF only in the villages of Bamboo Creek and Paramakatoi, of Region # 8. CFF control activities (mass trapping and blocks distribution) were conducted within the two (2) villages that were identified as positive for CFF.

The commissioning of the CFF Fruit Sampling laboratory in September has provided the much needed support to this programme; fruit samples can now be collected and observed for possible fruit fly emergence and identification.

The four (4) months of operations saw the intake of 146 fruit samples from Regions 3, 4, 5, 8 and 9. Fruit samples included; Carambola, cashew, cherry, golden apple, guava, jamoon, lime, mango, monkey apple, orange, pepper, plum,

psydium, sapodilla, soursop and tamarind. To date, the laboratory has seen the emergence of 649 pupa and the evolution of 425 fruit flies; more specifically 160 *Anastrepha spp*, 226 *Bactrocera spp* and 39 unclassified.

Analysis of emergence data, thus far, proved the presence of both *Anastrepha* and *Bactrocera spp* within Regions # 3 and 4. It revealed a greater percentage of *Anastrepha spp* in fruit samples from Region #3 compared to that of Region #4 whilst, the percentage of *Bactrocera spp* in Region #4 was greater than that from samples taken from Region #3. *Bactrocera spp* was noted as being the most prevalent fruit fly overall. Fruit samples from Regions 5 and 9 had zero pupa presence throughout laboratory observations and the two pupa found in samples from Region #8 never completed metamorphosis.

It must be noted that Regions # 3 and 4 were the areas where majority of sampling was done and still require much investigation. Hence, the need for continuous collection and analysis of fruit samples from all Administrative Regions of Guyana. The data accumulated thus far is preliminary and will be used as a guide for continuous research within this field.

The 2014 CFF surveillance work programme was accomplished with the monitoring of 894 Jackson Traps, 207 McPhail Traps, the distribution of 1,152 fibre board blocks and collection of 144 fruit samples.

Surveillance activities for the Mediterranean Fruit-Fly (Med-Fly) commenced with a distribution of twenty (20) multi-lure traps within Region # 4. Preference was given to locations in close proximity to International Airports, Supermarkets and Markets, Hotels and Guest Houses. The observation and verification of the Med-fly's status in these primary locations will commence in January of 2015.

4.2.2 Pink Hibiscus Mealybug (PHMB)

The presence of the Pink Mealy Bug is currently restricted to regions # 2 and # 3 and in very low population densities. These areas for Quarantine and trade purposes have been designated Areas of Low Pest Prevalence (ALPP) for the pink hibiscus mealy bug. This classification allows Guyana to export agricultural commodities that are hosts to the pink hibiscus mealy bug.

Biological control continued to be the sole management strategy for the control of the Pink Mealybug. The parasitic wasp, *Anagyrus kamali* and the ladybird beetle, *Cryptolaemus montrouzieri* were the two (2) natural enemies that were released during the period 2005 – 2007 and continues to effectively manage the pest population.

Sites that were monitored in both regions (2 and 3) ranged from signs of crinkling but with no Mealybug colonies (score 2) to small inconspicuous colonies of mealybugs at terminal buds (score 3). Majority of sites inspected were at a score 2 position, indicating positive natural enemies activities.

4.2.3 Papaya Mealybug (PMB)

The NPPO continued with its passive surveillance programme for the Papaya Mealybug in key locations within regions # 3, 4, 5 and 6. These regions are presently free of the papaya Mealybug. Monitoring of these regions will continue in the New Year to commence the process for the establishment of these regions as official Pest Free Areas (PFAs) for this pest in accordance with WTO/SPS and IPPC Guidelines, ISPMs #4 “Requirements for the Establishment of Pest Free Areas (PFAs)”.

4.2.4 Giant African Snails (GAS)

Passive surveys were conducted for the Giant African Snail (*Achatina achatina*) which continues to be a pest of economic and quarantine importance to Guyana

and the Caribbean region. This pest is known to cause significant economic damage to crops and is present in some Caribbean countries such as Barbados.

Surveys were conducted at the various wharves within Georgetown and at the ports-of-entry. Guyana continues to be free of this pest.

4.2.5 Mango Seed Weevil

Passive surveys were conducted for the Mango Seed Weevil *Sternochetus mangiferae* (Fabricius) which continues to be a pest of economic and quarantine importance to Guyana and the Caribbean region. Guyana continues to be free of this pest. Sites visited during inspections included wharves, container terminals and bonds.

4.2.6 Red Palm Mite (RPM)

The Red Palm Mite (RPM), *Raoiella indica,* is a tiny brightly coloured species of mite that causes damage to Palms, Heliconia, Ginger spp and *Musa spp* in the Caribbean. It was discovered in the latter part of 2013 on the island of Wakenaam, Guyana. The Red Palm Mite is considered a quarantine pest and thus the responsibility of the National Plant Protection Organization (NPPO) within the National Agricultural Research and Extension Institute, NAREI. Extensive Detection surveys were initiated in 2013 to determine the spread of the pest, internal quarantine measures were implemented on Wakenaam and Leguan islands and Chemical Treatment of Coconut Palms commenced on the Island of Wakenaam and other areas after laboratory bioassay studies and field trials concluded that Monocrotophos and Abamectin produce the highest RPM mortality.

The NPPO in 2014 carried out Detection surveys in regions # 2,3,4,5, and 9. Samples were collected randomly in different location, leaflet were bagged, labeled and placed in a cooler for transport to the laboratory.

- In Region # 2; 23 Grants were surveyed along with 63 Villages. 101 and 198 samples were collected respectively and submitted to the laboratory for analysis. Samples taken from villages stretching from Supenaam to Onderneeming were positive for RPM, while all other villages and Grants were negative.

- In Region # 3; 13 Villages were surveyed on the West Coast of Demerara, all 63 samples that were collected proved positive for RPM.
- Survey was carried out in 53 Villages in region # 4; where 210 samples were collected and all indicated the presence of RPM.

- Four of the 62 villages surveyed in region # 5 were positive for RPM from a total of 249 samples collected.

- All of the 68 samples collected were positive for RPM from the 17 villages surveyed in Region # 9.

Internal Quarantine measures were implemented on the islands of Wakenaam and Leguan and also at the Parika wharf, Region # 3 to prevent the spread of the pest.

These activities were executed jointly by staff of the NPPO and CDSS Departments of NAREI in an effort to contain the pest on the islands until the official eradication programme was implemented.

The NPPO outlined internal quarantine guidelines for movement of plants, plant products & regulated articles from Wakenaam and Leguan Islands. All palms and

it's by- products were fumigated with Phostoxin tables for 72 hours before leaving the islands. Farmers were issued with an internal certification slip to verify that their produce was treated accordingly.

A total of 2,108,732 dried coconuts; 55,239 Brooms; and 11,683 water coconuts were fumigated on the island of Wakenaam while 33,200 Dry Coconuts, 190 Brooms and 0 water coconuts were fumigated on Leguan.

Internal quarantine checks were carried out at the Parika wharf, Region #3 to verify the validity of the internal certification slips of farmers coming from Wakenaam and Leguan.

Chemical Treatment of the Red Palm Mite was conducted using spray and injection application of pesticides. Abamectin were applied to coconut and *Musa spp* using a mist blower, while Monocrotophos was injected into the coconut trunk using a power drill at a 45 degree angle.

Treatment was carried out in Wakenaam, Mahaica, Hog Island and on the Essequibo coast during the 2014.

- Total of 16,932, 3,000, 3000 and 400 trees were treated with Monocrotophos on Wakenaam Island, Mahaica, Essequibo coast and Hogg Island respectively.
- 31.3 acres of plantain tress were sprayed with Abamectin
- 400 coconut palms were sprayed with Abamectin

As part of the public awareness initiative, residents were visited and advised on their role in the containment of this pest, by adhering to the guidelines issued by the NPPO. Residents were also educated on the importance of having their

affected produce appropriately treated before transporting same off the island and to present their internal quarantine slips to the authorities in Parika.

Public awareness was also conducted in the form of poster, quarantine signage, distribution of brochure, meeting and infield discussions with local residence and school children in areas visited.

4.3 Certification Services

The certification activities executed under this programme was satisfactory as it relates to awareness/training, audit inspections, verification and certification. As shown in table 13, major accomplishments were made in terms of the execution of the annual work programme activity, which accounts for certification activities done in region number 2, 3, 4, 5 and 6.

Table 13: Certification Services by Regions for 2014

Region	Awareness/training	Audit inspection	Verification
2	Executed	Executed	Executed
3	Executed	Executed	Not applicable
4	Executed	Executed	Not applicable
5	Executed	Executed	Not applicable
6	Executed	Executed	Not applicable

Certified farms/ nurseries were revisited following the information provided on the NPPO's Certification list of 2006. A total of 536 farms were visited in the regions identified, of the farms/ nursery visited , 50 accounts for revisits made to certified farms while 486 were visits made to new farms/ nursery. One farm (Pomeroon Oil Mill/ Tennis farm, located in Pomeroon region # 2 was GAP certified. Twenty one farms (21) were identified for re-certification in Regions # 3, 5 and 6 allotted as 2, 9 and 10 respectively.

4.4 Pest Risk Analysis (PRA)

Objective: To assess the risk of introduction and establishment of exotic pests, diseases or weeds on/in imported commodities that may cause economic damage to Guyana's flora and fauna

The Pest Risk Analysis (PRA) Programme of the NPPO is developed on the basis of a process of investigation, evaluation of information and decision making with respect to a certain pest. The PRA process is initiated once it is known or determined that this pest is a quarantine pest.

Subsequently, an evaluation of the potential of introduction of the pest into the country is done. With identification, determination and evaluation done, the process culminates with decision making to avoid or reduce the probability of entrance or establishment of the pest into the country. Table 14 showed the PRA activities conducted for 2014.

Table 14: PRA Activities Conducted for 2014

PRA Type	Commodity source	Import location /Destination	Commodity to be imported/exported	Status
Conduct PRA	India	Guyana	*Zea mays (L.)* Seed	PRA Initiated, PRA information provided by the exporting country.
Provide information to facilitate PRA process	Guyana	Trinidad & Tobago	Lumber sp. (hard wood)	Requested information provided
Provide information to facilitate PRA process	Guyana	Suriname	Lumber sp. (hard wood)	Requested Information compiled by NPPO Guyana. Conclusion of process is pending additional information by the importer to confirm

				lumber sp. types.
Conduct PRA	Dominica	Guyana	Banana	Information provided to initiate the PRA process was not accurate. The process is incomplete.
Provide information to facilitate PRA process	Trinidad & Tobago	Guyana	Citrus (limes)	Process initiated, pending the provision of information regarding the exact source/location

4.5 Public Awareness

Objective: To ensure that the public and other stakeholders are aware of the role and operations of the NPPO as it relates to plant protection and international trade. To ensure that farmers are provided with information to enable them to better protect their crops and produce market quality products.

The NPPO Public awareness program activities were done with the objective of sensitizing/familiarizing stakeholders about the operation of plant protection and quarantine services offered by NAREI, it was also aimed at instituting feedback /encourage responsiveness of all beneficiaries.

These activities were executed following a standard approach of needs assessment, planning and implementation.

Public awareness activities were executed in the form of formal in-house and outdoor training sessions offered to staffers of (MoA and its related agencies) students, producers and importer/ exporter. There were also sessions of single interaction with importers /exporters and NPPO staff. The distribution of brochure and pamphlets served as the ultimate means of the sensitization process.

Table 15 showed the NPPO public awareness activities conducted in 2014.

Table 15: Public Awareness Activities, 2014

Awareness type	Execution Date	Recipients
Formal in-house training on General plant protection and Quarantine procedure/services.	1st quarter of 2014	NPPO staff , stakeholders
Formal in- house training Inspection Procedures	1st quarter of 2014	NPPO staff , stakeholders
Formal in-house training NPPO certification program , (guidelines for certification)	1st quarter of 2014 2nd quarter of 2014 3rd Quarter of 2014 4th quarter of 2014	NPPO staff , stakeholders (farmers group in region # 3, 5 and 6), Agencies of MOA
Informal sessions on trade (Import/export) requirements	1st quarter of 2014	NPPO staff , stakeholders
Informal training sessions on the management of the incinerator (use and maintenance)	1st quarter of 2014 2nd quarter of 2014 4th quarter of 2014	NPPO personnel , MOH personnel
Informal training on Pest Risk Analysis process	2nd quarter of 2014	NPPO personnel
Formal in – house training on management of information systems (EMIS)	4th quarter of 2014	NPPO staff
Informal session on kiln certification	3st quarter of 2014	Stakeholder group

Brochure and pamphlets produced:

- Control and spread of Carambola fruit fly in Guyana
- Red Palm Mite Alert
- Giant African Snail Alert
- Plant Protection Measures against Red Palm Mite
- Restriction on the importation of agricultural commodities
- Guidelines for certification
- NPPO – Plant Protection and Quarantine

4.6 Pest Diagnosis, Advisory and Laboratory Services

Objectives: To assist farmers in identifying their pests' problems and to carry out effective control measures without pesticide contamination.

To ensure safe food for consumers from the farm to the table.

The Fruit Fly (FF) laboratory was commissioned under NAREI in September, 2014. The principal objective of the lab is to lend support to the monitoring and detection aspects of NPPO's FF programme; which extends\across the various geographic regions of the Republic of Guyana with emphasis on hinterland areas. The Carambola Fruit fly and Mediterranean Fly scientifically known as the *Bactrocera carambolae* and *Ceratitis capitata* respectively are exotic pest of economic importance (Quarantine pests) in Guyana. Their presence holds significance to the NPPO since they can hinder trade with Regional and International partners thereby crippling Guyana's fruit export.

The FF lab currently has one permanent staff Mr. Wrights, but attains regular operational inputs from Plant Protection Officers, whose focus is the rearing of fruit flies attained from samples collected and prepared within the lab for the purpose of identification and geographic representation. This in turn will assist in the control and possible eradication of within Guyana. However, the lab has also found the evolution of fruit fly belonging to the genus *Anastrepha*, from multifarious fruit samples investigated

during the aforementioned period. The *Anastrepha spp* is known to be indigenous to Guyana and their presence in various fruit samples revealed their extreme distribution..

During the period under review, fruit samples were submitted from five administrative regions; 3,4,5,8 and 9 for the purpose of assessing the fruit fly status within these geographic locations. Fruits that were investigated included; carambola, cashew, cherry, golden apple, guava, jamoon, lime, mango, monkey apple, orange, pepper, plum, psydium, sapodilla, soursop and tamarind. The laboratory has seen a total of 13 entries recorded resulting in the examination of 146 individual fruit samples.

An analysis of the acquired data from the examination of fruit sample revealed the emergence of 649 pupa and the evolution of 425 fruit flies; more specifically 226 *Bactrocera spp,* 160 *Anastrepha spp*, 0 *Ceratitis spp* and 39 of unclassified.

It is essential to note that the commissioning of this laboratory has also contributed significantly to enhancing the phytosanitary measures being applied in relation to rice export. This is being done through the collection, preparation and investigation of rice samples being exported in bulk from the various mills around Guyana; Saj Rice Group, Fairfield Rice Mill and Technomills. These samples are collected by quarantine Officers/Inspectors and submitted to the lab where they are prepared and stored, with continuous examination for the presence of insect pests that would degrade its quality in any form.

The lab has received 41 rice sample entries which consisted of a total of 440 individual rice samples.

The continuous monitoring of rice sample from previous months led to the discovery of an unidentified larva which later developed into a moth (unverified), along with three insect pests preliminary noted as weevil (unverified). Two of the weevils acquired from a rice bran sample along with the moth acquired from a rice sample were attained from Saj Rice Group mill from shipments destined for Panama. The remaining single weevil

was obtained from a rice sample acquired from Fairfield Rice mill also destined for Panama. Presently, the lab is monitoring rice samples recently submitted. Table 16 below indicated the total fruit fly emergence per region from September to December 2014.

Table 16: Total fruit fly emergence per region from September to December, 2014

Administrative Region #	**Number of samples**	**Number of Pupa evolved**	**Number of adult Flies emerged**	**Number of *Anastrepha spp***	**Number of *Bactrocera spp***	**Number of *Ceratitis spp***	**Others**
3	71	203	197	120	38	0	39
4	59	446	228	40	188	0	0
5	6	0	0	0	0	0	0
8	2	2	0	0	0	0	0
9	8	0	0	0	0	0	0
Total	146	649	425	160	226	0	39

5.0 THE INTERMEDIATE SAVANNAHS – EBINI 2014

1.	Floyd Benjamin	-	Senior Research Technician
2.	Kevin Gonsalves	-	Technician
3.	Aaron Leitch	-	District Extension Officer/Research Assistant
4.	N. Cumberbatch	-	Coordinator

5.1 Programme: Special Project under the direct supervision of the Chief Executive Officer

The Ebini Research Station programme activities for 2014 were moderately successful. One of the positives was the protocol developed and used in the establishment of fruit plants in the Intermediate Savannahs, and while this is a long term programme, the initial results are impressive. The overall survival percentage of the new plant introductions to the nursery was 92%, additionally, the increase in height of the plants during the reporting year was impressive, and the overall increase was 318%.

The grain legume programme was given a major boost with the signing of a Memorandum of Understanding between NAREI and the New Frontier Agricultural Company, an entity that has Brazilian roots. The MOU was for the company to conduct research activities for soybean production at Ebini, as a precursor for the development of a large scale agricultural complex in the Savannahs. The New Frontier Agricultural Company planted 10 ha of soybean at the Ebini during the reporting period. Additionally, the New Frontier Agricultural Company has installed a dish network system which enables the residents of the station to access internet services, thereby improving the access to communication on the station.

The research unit was also successful in fulfilling the mandate for grain legume production which was established between the Ministry of Agriculture and NAREI, by producing in excess of 1,500 kg of Minica 4 (red pea) seed, additionally, the cost of production of the seed was estimated to be between $172 and $200 per kg.

Corn production was badly affected during the reporting year, mainly because 2014 was perhaps one of the drier years in recent history in the Intermediate Savannahs. In order

therefore to reduce the dependency on rainfall for our crop research and production activities, the station has installed an irrigation system.

The rehabilitation programme which was started in 2013, with financing made possible by the ***Agricultural Export Diversification Progranmme Loan No. 1929/BL-GY***, and funds provided by the Inter-American Development Bank (IDB) was finally completed during the reporting year. These development activities caused considerable disruption to the station's activities, however it was expected that these activities should auger well for the future of the station, particularly as it relates to the planned research and development programmes of NAREI, the food security programmes of Guyana, seed production of selected crops, germplasm evaluation and observation studies of introduced crops and managing plant genetic resources of coconut, mango and other important orchard crops.

The rehabilitation programme was not restricted to the repairs of buildings, the station was the recipient of a Massey Ferguson 280 tractor with front bucket, a 7 ton dump trailer, a brush cutter, a post hole digger and a disc harrow.

The station in 2014 in collaboration with the Ministry of Foreign Affairs hosted the Heads of Guyana's overseas diplomatic missions, the visit was undertaken to highlight to our diplomatic representatives the potential of the savannahs for large scale agriculture production, and to showcase some of the research and production activities being undertaken at the station.

The weather situation experienced in 2014, particularly the amount of rainfall recorded at the Ebini Station in 2014 affected most of our crop production activities, only 1332.7 mm was recorded and there were only 171 rainfall days as compared to 2522.6 mm in 2013 and 2094.mm in 2102.

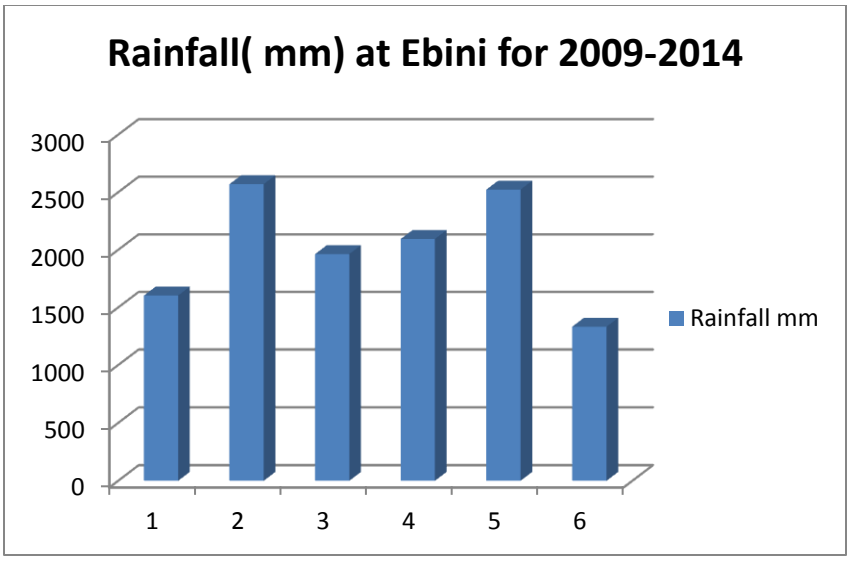


Figure 9: Total annual rainfall at Ebini for the years 2009-2014

The year 2014 was perhaps one of the drier years in recent history it cannot however be so declared because the rainfall figures for October were not available; however it has been well established that March and October are two of the drier months in the savannahs (Table 17) and judging from the amount of rain that fell in the previous months October was equally as dry. In March only 4.1 mm of rain was recorded and the highest amount recorded was 309.1 in July.

Table 17: Monthly rainfall amounts for the Ebini Station, 2009-2014

Months	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall (mm) 2009	178	103	79.1	140	64.3	251	213	184	59.5	160	45	126	1602.9
Rainfall (mm) 2010	158.2	64.4	154.0	290.7	623.2	243.8	353.8	143.6	151.7	41.4	242.6	108.4 1-16 Dec	2570.4
Rainfall (mm)	148.7	112.2	491.4	57.7	120.5	132.4	209.4	77.3	184.1	212.6	139.6	77.4	1963.3

2011													
Rainfall (mm) **2012**	153.3	231.8	61.4	324.9	240.7	220.8	379.4	144.0	62.8	80.1	110.4	84.6	2094.0
Rainfall (mm) **2013**	39.8	332.4	63.9	187.8	441.5	411.5	315.7	252.1	17.8	108.3	95.7	256.1	2522.6
Rainfall (mm) **2014**	123.6	181.2	4.1	92.7	130.6	309.1	131.3	41.0	22.2		156.2	140.7	1332.7

Table 17 shows the monthly rainfall amounts recorded for the past five years (2009-2014) at Ebini. Traditionally the month with the most predictable rainfall was during the period May to July; however over the past five years only June and to some extent July seem to fit that pattern with the exception of May 2010, when the highest amount of rain was recorded. The table also shows that with the rainfall pattern between the months of September –March the growing of crops that require 120 days for maturity and indeed the orchard crops would be extremely difficult without irrigation. The only dependable period for crop production appears to be the period of May-August. There were 232 rainfall days for the year 2013 as compared with 200 for 2012.

5.2 Grain Legume Research

5.2.1 The development of technological packages for legume production in the Intermediate Savannahs

The grain legume programme of the Ebini Unit explored the development and refinement of technology for the production of Minica 4 (red pea) black eye pea as well as soybean production in the Intermediate savannahs. The objective of the grain

legume programme is to refine and test the available technology for the enhanced production of grain legumes in the Intermediate Savannahs.

5.2.2 Red pea production

The cow pea variety Minica 4 was planted in the field referred to as the sugar cane field, in the crop research area, Ebini on 25 July 2015. Two areas were selected, one area was previously cropped with cowpea and measured 1.20 ha, (PLOT A) and the second area that was planted was never previously used for open row crops, and this area measured 3,200 m sq, (PLOT B).

5.2.3 Land Preparation

The soil was considered as a sandy to sandy loam soil, and the traditional land preparation on these soils include an initial ploughing with a three disc plough and crossing cutting with a disc harrow. In order therefore to attain an acceptable seed bed two passes of the harrow were required.

5.2.4 Planting

Planting of cowpea in the savannahs is best suited towards the end of the rainy season, ideally allowing harvesting in the dry periods of September/October or March. This crop was planted on the 25 July 2014, germination was observed in both plots on 28 July 2014.

The seed rate used was 25-30 kg/ha, and both plots were planted by hand. The planting was done in rows 45 cm wide and 10-15 cm within rows, seed depth was approximately 2.5 cm. Prior to planting the seeds were treated with an inoculant, GlycinMax. The rhizobium strains *(Bradyrhizobium japonicum*) which was used in this planting exercise, was one introduced by the Brazilian company NF Agriculture, a company that at the present time is conduction a soybean study at Ebini.

At planting, the plots were also sprayed with the herbicide Round-up, a pre-emergent herbicide at a rate of 2 L per ha.

5.2.5 Fertilizing and fertilizer use

The only fertilizer application was done on 30.07.2014, five days after planting and two days after germination. The fertilizer used was 12-12-17-2.

On the plot referred to as PLOT A, the rate of fertilizer used was 100 kg/ha and the method of application was broadcast, this method of application is the one currently used by the farming community in the Berbice River, although the rate of application used in this exercise may be more than the farmers normally apply.

The second field PLOT B was planted on the same day and received similar cultural operations as PLOT A; however PLOT B fertilizer regime was different. The fertilizer was applied in a band at the side of the plants and the rate of application was 200 kg/ha. The actual amount of fertilizer applied were as follows, 115 kg for PLOT A and 65 kg for PLOT B.

5.2.6 Harvesting

Harvesting of the crop began on 29.09.2014, a total of 66 days after planting, however harvesting could only be effected in PLOT A, as the plants in PLOT B were not mature enough for harvesting. The harvesting procedure was manual and the processing was also done manually.

Table 18 below showed the Production Parameters of Minica 4 acquired during the Study, 2014

Table 18: The Production Parameters of Minica 4 Studies for 2014

Character	Expression	
Date of sowing	25-07-2014	
Date of germination	28-07-2014	
Days required for germination	3 days	
Plot size	Plot 1	Plot 2
	1.2 ha	0.32 ha
Total seed used	30 kg	8 kg
Fertilizer amount	Recommended	Recommended
	100 kg/ha	200 kg/ha
Fertilizer application	Broadcast	Band/side dressing
Actual amount of fertilizer used	115 kg/ha	65 kg/ha
Days to 50% flowering	40-50 days	40-50 days
Days to maturity	66-75	70-80
Plant height (cm)	44.12	40.2
Number of pods /plant	13	10.5
Pod weight (g)/ m sq (dry weight)	263.4	212.8
Seed weight (g)/ m sq (dry weight)	192	158.6
Percent seed weight /pod weight	72.89	74.5
Number of seeds/pod	18	19
Grain weight (kg/ha)	1,920	1,586

Table 19 showed the cost of production studies for Minica 4 in the Intermediate Savannahs, 2014

Table 19: Cost of Production for Minica 4 Studies, 2014

Parameters	**Unit costs**	**Actual Costs**	
		Plot (1.2 ha)	**Plot 2 (.32 ha)**
Land preparation 1 plough and 2 harrow	$29,650/ha	$35,580.00	$9,488.00
Planting costs (2 hours)	$4,000.00	$4,000.00	$2,000.00
Seed cost	$1000/kg	$30,000.00	$8,000.00
Fertilizing application (hand) 1 person ½ day	$1,000.00	$1,000.00	$1,000.00
Cost of fertilizer per bag			
12-12-17-2	$7,000.00	$17,888.00	$10,111.00
Pesticides			
Pesticide application (hand) 1 person ½ day (3)	$1,000.00	$3,000.00	$3,000.00
Round-up, 2 L/ha (one application)	$1,650/L	$3,960.00	$1,056.00
Select- 12 @ 2L/ha (2 applications)	$9,750/L	$46,800.00	$12,480.00
Harvesting hand (pod weight)	$44-55/kg	$158,040.00	$34,080.00
Processing (pod weight)	$30/kg	$94,824.00	$20,428.00
Cost of empty bags (1 bag to 50kg)	$40/bag	$1,850.00	$407.00
Total cost		$396,942.00	$102,050.00
Cost /ha		$330,785.00	$318,906.00
Cost /kg of red pea		$172.00	$201.00
Wholesale price/kg, delivered in Georgetown (10/10/2014)	$528.00		
Wholesale price at Berbice river (10-10-2014)	$660.00		
Transportation from Berbice river to New Amsterdam	$200/bag		

5.2.7 Rainfall during the growing period

The total rainfall during the crop was 68.4 mm. There were 17 rainfall days as shown in Table 20

Table 20: Rainfall During the Growing Period of Minica 4 in the Intermediate Savannahs, 2014

Months	Rainfall (mm)	Rainfall days
July	5.2	1
August	41	10
September	22.2	6

5.3 Black eye pea production at the Ebini Research Station

The black eye pea variety California No 5, the seed of which was received from the Caribbean Agricultural Research and Development Institute (CARDI), Belize was planted at the field referred to as the sugar cane field, in the crop research area, Ebini on 29 July 2015. The area planted was 3,738 m sq.

5.3.1 Land Preparation

The soil was considered as a sandy to sandy loam soil, and the traditional land preparation on these soils include an initial ploughing with a three disc plough and crossing cutting with a disc harrow. In order therefore to attain an acceptable seed bed two passes of the harrow is required.

5.3.2 Planting

Planting of cowpea in the savannahs is best suited towards the end of the rainy season, ideally allowing harvesting in the dry periods of September/October or March. This crop was planted on the 29 July 2014, germination was observed in both plots on 2 August 2014.

The seed rate used was 25-30 kg/ha, and both plots were planted by hand. The planting was done in rows 45 cm wide and 10-15 cm within rows, seed depth was approximately 2.5 cm. Prior to planting the seeds were treated with an inoculant, GlycinMax. The rhizobium strains *(Bradyrhizobium japonicum*) which was used in this planting exercise, was one introduced by the Brazilian company NF Agriculture, a company that at the present time is conduction a soybean study at Ebini.

At planting, the plots were sprayed with Round-up, a pre-emergent herbicide at a rate of 2 L per ha.

5.3.3 Fertilizing and fertilizer use

The only fertilizer application was done, five days after planting and two days after germination. The fertilizer used was 12-12-17-2. The rate used was 200 kg/ha and the application method used was to band the fertilizer at the side of the plant within the rows.

5.3.4 Harvesting

Harvesting of the crop began 59 days after planting, the harvesting procedure was manual and the processing was also done by hand. Table 21 below showed the Production Parameters for Black Eye Pea for the study conducted in 2014.

Table 21: The Production Parameters for Black Eye Pea Acquired During the Study, 2014

Character	Expression
Date of sowing	29-07-2014
Date of germination	02-08-2014
Days required for germination	3 days
Plot size	0.3738 ha
Total seed used	30 kg
Fertilizer application	Band/side dressing
Fertilizer amounts	200 kg/ha
----------Days to	24

50% flowering	
Days to maturity	59
Plant height (cm)	40.8
Number of pods /plant	11.36
Pod weight (g)/ m sq (dry weight)	161.2
Seed weight (g)/ m sq (dry weight)	120
Number of seeds/pod	9
Grain weight (kg/ha)	1,200

Table 22 showed the Cost of Production for black eye peas conducted in the Intermediate Savannahs for 2014.

Table 22: Cost of production studies for black eye peas in the Intermediate Savannahs, 2014

Parameters	Unit costs	Actual Costs
Land preparation 1 plough and 2 harrow	$29,650/ha	$23,518.00
Planting costs (2 hours)	$4,000.00	$,2000.00
Seed cost	$1000/kg	$11,400.00
Fertilizing application (hand) 1 person ½ day	$1,000.00	$1,000.00
Cost of fertilizer per bag		
12-12-17-2	$7,000.00	$11,822.00
Pesticides		
Pesticide application (hand) 1 person ½ day	$1,000.00	$1,000.00
Round-up, 2 L/ha (one application)	$1,650/L	$1,254.00
Select- 12 @ 2L/ha $9,750/L (2 applications)	$9,750.00	$14,820.00
Harvesting hand (pod weight)	$44-55/kg	$30,628.00
Processing (pod weight)	$30/kg	$18,377.00
Cost of empty bags (1 bag to 50kg)	$40/bag	$360.00
Total cost		$111,179.00
Cost /ha		$292,576.00
Cost/kg		$244.00
Transportation from Berbice river to New Amsterdam	$200/bag	
Wholesale price in GT $960/gal (1 gl. of peas = 3.6 kg (8 lbs)	$266.00/kg	

5.3.5 **Rainfall during the growing period**

The total rainfall during the crop was 63.2 mm. Table 23 indicated that there were 16 rainfall days.

Table 23: Rainfall During the Growing Period of Black Eye Peas in the Intermediate Savannahs, 2014

Months	Rainfall (mm)	Rainfall days
August	41.0	10
September	22.2	6

5.4 Soybean research

The objective of the study is to determine the production and productivity of two soybean varieties in the Intermediate Savannahs.

The study was designed was a RCBD study, the study had four fertilizer treatments and two soybean varieties Var Tracaja which was developed by EMBRAPA Brazil and CARDI S-15, the project area was 1 ha, and there were 16 plots each measuring 600 metres with a passage way between the plots. The seeds were planted with a four row planter and the plots were fertilized by hand. Seeds were inoculated with, GlycinMax; the rhizobium strains *(Bradyrhizobium japonicum*) which were introduced by the Brazilian company NF Agriculture. The fertilizer regime used was modifications of a fertilizer recommendation developed by CARDI and CIAT for the Intermediate Savannahs.

The study was planted on 15-06-2014 and germination was observed on 21-06-2014. The fertilizer recommendations for soybean are shown in Table 24.

Table 24: Fertilizer Recommendations for Soybean Studies in the Intermediate Savannahs, 2014

Fertilizer 1	Fertilizer 2	Fertilizer 3	Fertilizer 4
12-12-17-2 at 250 kg/ha at planting. Kerisite 100 kg/ha at planting 35 DAP MOP at 170 kg/ha Kerisite 100 kg/ha TSP 70 kg/ha	12-12-17-2 at 250 per ha Kerisite 100 per ha 35 DAP 15-15-15 at 250 per ha Kerisite at 100 per ha MOP at 100 per ha	15-15-15 at 250 per ha Kerisite at 100 per ha 35 DAP 15-15-15 at 250 per ha Kerisite at 100 per ha	15-15-15 at 250 per ha Kerisite at 100 per ha 35 DAP 15-15-15 at 250 per ha Kerisite at 100 per ha

Unfortunately, this study was badly affected by the lack of moisture during the planting season. The studies were planted on the 15 June 2014, during the period when there was adequate rainfall. Soybean generally require approximately 120-130 days for maturity and also requires adequate water particularly at flowering, pod set and pod fill, table 1 shows that there was not enough rainfall to ensure adequate yield, and while the plants had in excess of 15 pods per plant, more than 60 percent of the pods did not have any seed. The average plant height was 40 cm and the pod length was 8 cm.

6.0 MANGROVE MANAGEMENT PROJECT

This report covers the period of 12 months from **January 1, 2014 through to December 31, 2014** and provides a review of the activities which were implemented by the NAREI Mangrove Restoration and Management Department during the period.

The beginning of 2014 marked the incorporation of the Mangrove Restoration and Management Department under the National Agricultural Research & Extension Institute following the completion of the project phase under the Guyana Mangrove Restoration Project. All technical and field staff previously engaged under GMRP, were contracted under NAREI to form the new department. At the beginning of the year the Department's staffing consisted of four technical staff, three administrative staff and nine field staff (rangers).

The Department's 2014 Programme of Work was developed based on recommendations and lessons learned during the implementation of GMRP. The recommendations and results contained in the final report and other technical reports submitted by Landell Mills Limited, the company engaged to provide technical assistance for the implementation of GMRP, provided the main input for the development of the 2014 Programme of Work.

During the implementation of GMRP, it was noted that the reality of work on the highly modified shoreline in Guyana, is that few perfect sites exist along the shoreline which will lead to development of a mangrove forest within a short timeframe. The Mangrove specialist attached to the project, noted that in reality, to restore the mangrove belt in the scale and timeframe required in Guyana, mangrove planting needs to be carried out in conjunction with other methods of mangrove restoration. This recommendation, combined with ongoing community involvement, public awareness and education formulated the basis for the activities executed under the 2014 Programme of Work.

6.1 Mangrove restoration activities during the period focused on several combined interventions based on specific site conditions. Restoration interventions included,

planting *Avicennia germinans (*Black mangrove*)* seedlings, planting *Spartina brasiliensis (*Spartina grass*)*, construction of coastal engineering structures, restriction of community use and restoration of natural hydrology.

a) *Planting Avicennia germinans*: The Department in collaboration with a local NGO, Guyanese Women in Development, completed planting of 1057meters of coastline with 34,478 *Avicennia germinans (*Black mangrove) seedlings. Twelve community nurseries were established and thirty residents from the villages of Mon Repos, LBI, Pigeon Island, Buxton, Friendship and Strasthphey were trained in mangrove seedling propagation. Planted restoration sites completed during the year were Buxton (5,758 seedlings, 338 meters), Lusignan (19,395 seedlings, 669 meters) and Nooten Zuil (9,325 seedlings, 50 meters).

b) *Transplanting of Spartina brasiliensis:* Given the limited number of suitable sites for mangrove restoration through planting, sites identified as having unsuitable soil characteristics (sling mud as opposed to consolidated mud), were selected based on other criteria for planting Spartina grass as a means to consolidate the mud and support natural recruitment of mangrove seedlings. One thousand and eight plugs of Spartina grass were transplanted to four sites in Region #2 and Region #5 (La Belle Alliance 240 plugs; Lima 284 plugs; Coffee Grove 240 plugs; Kilmarnock 244 plugs) to support the restoration of a total of 163.7 of coastline.

c) *Construction of coastal engineering structures*: During the period one coastal engineering construction project was completed in Region #2. Phase (1) of the Devonshire Castle groyne field was completed with the construction of two geotextile tube groynes measuring a total of 150m (Groyne 1-150m; Groyne 2-50m). The project was designed to support accretion of sediments along 500m of the Devonshire Castle foreshore resulting in an increase in the elevation of the foreshore to a height that can support mangrove restoration. The project was successfully completed by Samaroo Investments at a cost of GYD$27,984,000.

d) *Restoration of natural hydrology:* The Department commenced the first project to restore the hydrology of a mangrove site that has been altered over the years. The Wellington Park Hydrological Restoration Project was awarded and mobilization works commenced in December 2014. The project consists of the excavation of two 200m channels in an effort to re-introduce tidal flow into the salt pan at the site to restore the natural hydrology of the area. The Wellington Park project aims to restore 7.5ha of shoreline to mangroves and is expected to be completed by January 2015.

e) *Restriction of community use:* Anthropogenic activities in mangrove forests continue to be one of the main contributing factors to mangrove destruction. Site assessments conducted by the Department resulted in the identification of stresses on several areas due to livestock grazing. Following several unsuccessful community consultations, the Department constructed several gates and fences at threatened sites (threats to planting and natural recruitment) to restrict livestock grazing in the mangroves. Interventions included the construction of three cattle guards with gates and fences (two steel guards and one virtual guard) in Region #5 and Region #6 (No. 7 Village, Kilmarnock and Wellington Park). Two gates and fences were constructed in Region #4 at Lusignan and Mon Repos to protect the planted seedlings at Lusignan from grazing. Combined, these restrictive measures will protect and restore 5.6 kilometers for coastal mangrove forest.

6.2 Mangrove protection and monitoring activities during the period focused on several areas: monitoring standing forest; monitoring planted restoration sites (*Avicennia and Spartina),* assessments to select suitable restoration sites and monitoring the effectiveness of coastal engineering structures against design parameters.

(a) Monitoring standing forests: During the period the Department maintained nine mangrove rangers to monitor 30.3 kilometers standing forests in Region #4, #5 and #6, plus the entire Essequibo coastline from Walton Hall to Anna Regina and Leguan Island. The area in Region #3 from Rotterdam to La Jalousie was

continuously monitored by the Department's Monitoring Officer. The capacity of rangers was further increased through completion of training programs in Mangrove Ecology, Restoration and Management and the identification of avifaunal biodiversity in the mangrove forest and conducting bird guiding tours on the coastline. Notable issues observed during the period included loss of mangroves along West Coast Demerara (Rotterdam to La Jalousie) attributed to natural erosion, mangrove losses due to livestock grazing in Region #5 and extensive natural regeneration of mangroves following the implementation of restrictions at Village #7, WCB.

(b) Monitoring restored sites (Avicennia and Spartina): During the period the monitoring team completed ongoing monitoring of all planted restoration sites based on a quarterly scheduled from the restoration date. Monitoring parameters measured included site elevation, seedling growth (height, base diameter, bole height, DBH), salinity, temperature, fertility and Ph. Analysis of the monitoring data collected supported site selection and provided critical information for future restoration activities.

An integral part of the monitoring as been the use of technology, i.e. GIS, to support data analysis and storage. Updated imagery of the coastline obtained from Google Earth has been processed to capture and document the extension of mangroves resulting from restoration activities.

Monitoring results indicate that the use of Spartina grass to support mud consolidation and accretion thereby resulting in natural regeneration of mangroves, has been successful at Lima on the Essequibo Coast and Village #7, West Coast Berbice. Spartina grass planted in 2013 has extended an additional 20m in length and width and has significant numbers of naturally regenerated mangrove seedlings.

Results of monitoring of planted *Avicennia* indicate extensive regeneration in Region #5, Village #7 beyond the plantation in length and seaward. The established forests

has also supported increase elevation to the east (Village #6) thereby support extensive natural regeneration.

© *Monitoring coastal structures*: Coastal engineering structures constructed under GMRP were continuously monitored for structural integrity and effectiveness based on design. Topographical surveys conducted recorded increase in foreshore elevation of 0.2m to 0.5m in lee of Mon Repos rubble mound groyne. Geotextile tube breakwater constructed at Victoria has resulted in increase elevation of the foreshore protected from the heavy wave action thereby resulting in rapid increase in the coverage of planted Spartina grass and natural recruitment of mangroves.

6.3 Mangrove Research and development activities during the year involved Departmental research on restoration sites and facilitation of research projects by two University of West Indies students. Research projects conducted included an assessment of the "Role of Coastal Mangroves in Guyana" completed by MSc student Ranata Robertson. This project, expected to be completed January 2015, will provide scientific data on wave attenuation in a planted *Avicennia germinans* site. Research was also completed by MSc student Ms. Tameka King on avifaunal biodiversity in a natural and planted mangrove site. Both of these projects when completed will provide critical data to support ongoing restoration activities.

6.4 Community involvement is the cornerstone of all mangrove restoration, monitoring and protection activities undertaken. At the end of 2014, seven VMAC groups with an active membership of thirty community volunteers participated in mangrove awareness activities in Region #2, #4, #5 and #6. During the period, the Department continued to strengthen the Village Mangrove Action Committees (VMACs) established under GMRP. The capacity of VMAC members to better support mangrove restoration and protection activities was further enhanced through participation in mangrove ecology and management workshop, participation in training in the identification of avifaunal biodiversity in mangroves and conducting tours. VMAC community awareness during the

period included conducting community cleanup activities as part of “World Cleanup Day” and “World Environment Day”, enhancement of community and school bus sheds and play grounds, house to house awareness and conducting awareness programs in churches.

During the period, the Department continued with the implementation of the **public awareness and education campaign on the importance of mangroves**, building on initiatives started during the previous years. The Mangrove Visitor Center and complimenting Mangrove Heritage Trail Tour facilitated over seven hundred visitors inclusive of students and tourists.

7.0 PUBLICATIONS

1. D. P. Singh, O. Homenauth N. Cumberbatch, V. Persaud F. Benjamin (2014) ***'Performance of Corn (Zea mays) Genotypes at Coastal and Savannah Regions and Cost of Cultivation in Guyana'***: Greener Journal of Agricultural Sciences' ISSN: 2276 – 7770 ICV (2012):6.15.

2. MOU between National Agricultural Research & Extension Institute (NAREI) and the Centro De Invesigacion Cientifica De Yucatan, A.C. (Mexico) for Academic Exchange and Collaboration, 2014

8.0 HUMAN RESOURCES DEPARTMENT REPORT, 2014

1. **RECRUITMENT – Fifty-eight (58) persons were recruited in 2014 as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Employment
1. Garfield John	Crop Ext. Assistant (Mon Repos)	2014-04-14
2. *Samantha Chung-Howard	Crop Extension Assistant (Reg. 10)	2014-09-01
3. *Alesia Bristol	Crop Extension Assistant (Reg. 3)	2014-09-01
4. *Telica Moore	District Crop Ext. offr. (Reg. 6)	2014-09-01
5. *Thanesia Joseph	District Crop Ext. Offr. (Reg. 5)	2014-09-01

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Employment
1. Lennon Bess	Security Guard (Reg. 2)	2014-04-03
2. Ramesh Persaud	Security Guard (Mon Repos)	2014-05-11
3. Robert Sahadeo	Security Guard (Mon Repos)	2014-09-15
4. Rohan Persaud	Security Guard (Mon Repos)	2014-11-05

C. **GENERAL SERVICES**

Name	Designation	Date of Employment
1. Louanna Rodney	General Worker (Ebini)	2014-01-30
2. Brian Desmond	General Worker (Mon Repos)	2014-04-07
3. Pooran Persaud	General Worker (Mon Repos)	2014-04-07
4. Allon Sarju	Driver/Off. Asst. (Mon Repos)	2014-04-14
5. Brian Harold	General Worker (Mon Repos)	2014-06-23
6. Christopher Bourne	General Worker (Timehri)	2014-07-01
7. Phulmattie Budhram	General Worker (Mon Repos)	2014-07-01
8. Sheamma Hoppie	General Worker (Pouderoyen)	2014-07-01
9. Danesh Narine	Driver (Mon Repos)	2014-07-15
10. Trivenie Badrudin	Driver (Mon Repos)	2014-07-15
11. Paul Persaud	General Worker (Mon Repos)	2014-07-16

12. Rajendra Surujpaul	General Worker (B/M) (Mon Repos)	2014-09-01
13. Rickey Deeno	General Worker (B/M) (Mon Repos)	2014-09-01
14. Aquela Ally	Gen. Wkr. (Cleaner) (Reg. 3)	2014-09-01
15. Richard Alleyne	General Worker (Mon Repos)	2014-09-18
16. Linda Williams	General Worker (Reg. 9)	2014-09-22
17. Jitendra Persaud	General Worker (Mon Repos)	2014-09-22
18. Jermain Johnson	Driver (Mon Repos)	2014-11-03
19. Rajendra Persaud	General Worker (Mon Repos)	2014-11-18
20. Ahmar Singh	Heavy Duty Operator (Mon Repos)	2014-11-18

D. **MANGROVE**

Name	**Designation**	**Date of Employment**
1. Rudolph Adams	Monitoring Officer (Mon Repos)	2014-01-01
2. Luandra Jack	Engineer (Mon Repos)	2014-01-01
3. Zola Narine	Monitoring Officer (Mon Repos)	2014-01-01
4. Alex Pestano	Ranger (Reg. # 6)	2014-01-01
5. Luan Gooding	Ranger (Reg. # 4)	2014-01-01
6. Mahase Persaud Itwaru	Ranger (Reg. # 4)	2014-01-01
7. Pooran Ragnauth	Ranger (Reg. # 4)	2014-01-01
8. Richard Thom	Ranger (Reg. # 5)	2014-01-01
9. Raymond Hinds	Ranger (Reg. # 4)	2014-01-01
10.Donald Ramlakhan	Ranger (Reg. # 3)	2014-07-01
11. Padmini Dudnath	Comm. Dev. Offr. (Mon Repos)	2014-07-14
12. Shiva Balroop	Ranger (Reg. # 2)	2014-09-01
13. Collis Andrews	Ranger (Reg. # 4)	2014-09-08

E. **NATIONAL PLANT PROTECTION OFFICE**

Name	**Designation**	**Date of Employment**
1. Alvin Ramdin	Quarantine Inspector (Reg. 9)	2014-09-15
2. *Johnathan Wrights	Plant Protection Offr. (Mon Repos)	2014-09-17

F. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Employment
1. Richard Nigel Cumberbatch	Snr. Res. Scientist (Mon Repos)	2014-01-01
2. Paul Bhikram	Research Technician (Reg. # 5)	2014-03-24
3. *Ramish Baichoo	Research Assistant (Mon Repos)	2014-09-01
4. *Lauren Paddy	Research Assistant (Mon Repos)	2014-09-01
5. *Theroka Estwick	Research Assistant (Mon Repos)	2014-09-01
6. *Alleya Shahabudeen	Research Technician (Reg. # 10))	2014-09-01
7. Bibi Abrahim	Research Assistant (Mon Repos)	2014-09-02
8.* Jonathan Melville	Research Assistant (Mon Repos)	2014-09-02
9. Rajiv Singh	Research Assistant (Mon Repos)	2014-09-10
10. Aaron Hanif	Research Assistant (Mon Repos)	2014-09-15
11. Joann Nedd-Griffith	Research Assistant (Mon Repos)	2014-09-17
12. *Denisia Whyte	Research Assistant (Mon Repos)	2014-09-17.
13. Nalinie Oodith	Research Technician (Mon Repos)	2014-10-16
14. Dhanpaul Oodith	Research technician (Mon Repos)	2014-11-03

* represent Cuban and GSA graduates

2. **RESIGNATION – Twelve (12) persons tendered their resignations as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Resignation
1. Natalie Dela Cruz	Crop Ext. Asst. (Reg. # 2)	2014-02-28
2. Teisal Kamaludeen	Crop Ext. Assistant (Reg. # 3)	2014-09-28

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Resignation
1. Karen Phillips	Security Guard (Mon Repos)	2014-05-01
2. Holda Poonai	Finance Manager (Mon Repos)	2014-05-01
3. Rajaindra Singh	Deputy CEO (A & F) (Mon Repos)	2014-10-04

C. **GENERAL SERVICES**

Name	Designation	Date of Resignation
1. Petrenia Sinclair	General Worker (Ebini)	2014-01-30
2. Ralph Pollard	General Worker (Mon Repos)	2014-08-07
3. Mohamed Fazil	General Worker (Mon Repos)	2014-10-07
4. Ronald Jaundoo	General Worker (Mon Repos)	2014-12-13

D. **MANGROVE**

Name	Designation	Date of Resignation
1. Rabindra Persaud	Ranger	2014-05-16
2. Ryan Toolsiram	Comm. Dev. Offr. (Mon Repos)	2014-06-01

E. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Resignation
1. Ronn Sullivan	Research Assistant (Mon Repos)	2014-09-07

3. **DISMISSAL – Three (3) persons were dismissed as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Dismissal
1. Jason Jeune	Crop Ext. Asst. (Reg. # 7)	2014-01-17

B**. GENERAL SERVICES**

Name	Designation	Date of Dismissal
1. Charles Finlayson	Off. Asst./Driver (Mon Repos)	2014-04-09
2. Ramsammy Drugen	General Worker (Mon Repos)	2014-10-24

4. **TERMINATION - Three (3) persons were terminated as follows**:

A. **GENERAL SERVICES**

Name	Designation	Date of Dismissal
1. Chandradat Arjoon	Driver/Off. Asst. (Mon Repos)	2014-03-10
2. Udysteir Ram	General Worker (Mon Repos)	2014-08-18
3. Denesh Narine	Driver (Mon Repos)	2014-10-21

5. **VOLUNTARY WITHDRAWAL OF SERVICE – Six (6) persons have withdrawn their service as follows:**

A**. CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Withdrawal
Jason Jeune	Crop Ext. Asst. (Reg. # 7)	2014-01-17

B. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Withdrawal
1. Jessica Robertson	General Worker (Reg. # 9)	2014-07-04

C. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Withdrawal
1. Bhagouti Mahabir	Security Guard (Mon Repos)	2014-10-29

D. **GENERAL SERVICES**

Name	Designation	Date of Withdrawal
1. Paul Persaud	General Worker (Mon Repos)	2014-07-17
2**.** Brian Harold	General Worker (Mon Repos)	2014-08-25
3. Richard Alleyne	General Worker (Mon Repos)	2014-09-19

6. **NON RENEWAL OF CONTRACTS – Seven (7) persons contracts were not renewed**

A**. RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Non-Renewal
1. Basantie Bissoon	General Worker (Mon Repos)	2014-01-31

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Non-Renewal
1. Lloyd Doorga	Security Guard (Reg. # 2)	2014-04-30
2. Claudette D'Avilar	Library Assistant (Mon Repos)	2014-04-30

C. **GENERAL SERVICES**

Name	Designation	Date of Non-Renewal
1. John Henry	General Worker (Reg. # 1)	2014-04-30
2. Sybil King	General Worker (Mon Repos)	2014-04-30
3. Winston Naughton	Driver (Mon Repos)	2014-04-30
4. Chandi P. Bipat	General Worker (Mon Repos)	2014-10-03.

7. **PROMOTION – Three (3) persons were promoted as follows:**

A **NATIONAL PLANT PROTECTION OFFICE**

Name	Designation	Date of Promotion
1. Seraita Moseley	Pl. Quarantine Offr. (Ogle)	2014-01-01

B**. RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Promotion
1. Ramnarace Sukhna	Research Scientist (Mon Repos)	2014-08-04

C. **GENERAL ADMINISTRATION AND FINANCE**

	Name	Designation	Date of Promotion
1.	Anthonette Benjamin-Bourne	Snr. Secretarial Asst. (M/R)	2014-12-01

8**.** **TRANSFER – Two (2) persons were transferred as follows**:

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Transfer
1. Quincy Bentinck	District Crop Ext. Offr.	2014-01-30

B. **RESEARCH AND DEVELOPMENT**

	Name	Designation	Date of Transfer
1.	Cliffton Joseph	Research Assistant	2014-12-15

9. **RE-ASSIGNMENT – One (1) person was re-assigned as follows:**

A. **GENERAL SERVICES**

Name	Designation	Date Re-assigned
1. Rhonda Abrams	Gen. Wkr. (Stores Asst.)	2014-10-01

Table 25: Staffing at NAREI, 2014

Categories	No. of Positions	Positions Filled	Position Vacant
Crop Extension Services	99	80	21
General Admin. & Finance	82	49	33
General Services	157	111	46
National Plant Protection Office	52	*31	27
Research and Development	91	59	32
Mangrove	15	15	0
Total	**496**	**345**	**159**

*** Represents overlapping of six (6) Plant Quarantine Officers which is reflected under staffing at NPPO**

NON CONTRACTED EMPLOYEES

Extension Agents 21

Table 26: Staffing in the Crop Development and Support Serviced Department, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Deputy Chief Executive Officer	1	1	0
National Crop Extension & Training Coordinator	1	0	1
Training Manager	1	1	0
Regional Crop Extension Officer	12	6	6
District Crop Extension Officer	30	32	-
Training Officer	1	0	1
Senior Crop Extension Assistant	13	4	9
Crop Extension Assistant	40	36	4
Total	**99**	**80**	**21**

The Hinterland and the Coastal Coordinators are reflected as Regional Crop Extension Officers, hence their current positions are not stated.

NOTE: The increased number of District Crop Extension Officers represent Cuban Scholars from the Ministry of Agriculture.

Table 27: Staffing in the General Administration and Finance Department, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Deputy CEO (Admin. & Finance)	1	0	1
Senior Finance Manager	1	1	0
Human Resources & Admin. Manage	1	1	0
Finance Manager	1	0	1
Corporate Secretary	1	0	1
Internal Auditor	1	1	0
Projects/PRO	1	1	0
Senior Human Resources Officer	1	0	1
Librarian	1	0	1
Accountant	2	1	1
Human Resources Officer	2	2	0
Farm Manager	3	2	1
Administrative Assistant	2	2	0
Security Supervisor	1	1	0
Assistant Librarian	2	1	1
Storekeeper	4	2	2
Senior Human Resources Clerk	2	2	0
Confidential Secretary	2	2	0
Information Technology Technician	2	1	1
Senior Secretarial Assistant	1	1	0
Cashier	3	0	3
Accounts Clerk	6	6	0
Secretarial Assistant	6	3	3
Human Resources Clerk	2	0	2
Data Entry Clerk	1	1	0
Library Assistant	2	0	2
Security Guard	30	18	12
Total	**82**	**49**	**33**

Table 28: Staffing in the General Services Department, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Heavy Duty Operator	10	6	4
Drivers/Office Assistants	20	6	14
Well Operator	1	1	0
Welder	1	0	1
General Workers	125	98	27
Total	**157**	**111**	**46**

Table 29: Staffing in the National Plant Protection Office, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Assistant Chief Executive Officer/Chief Plant protection Officer	1	1	0
Senior Plant Protection Officer	1	0	1
Senior Quarantine and Pest Risk Officer	1	0	1
Plant Protection Officer	5	4	1
Plant Quarantine Officer	5	*11	0
Senior Plant Quarantine inspector	5	0	5
Senior Plant Protection Assistant	4	0	4
Plant Protection Assistant	10	0	10
Plant Quarantine Inspector	20	16	4
Total	**52**	**31**	**27**

*Six (6) additional Plant Quarantine Officers were employed in 2013

Table 30: Staffing in the Research and Development, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Chief Executive Officer	1	1	0
Assistant Chief Executive Officer/Chief Research Scientist	1	0	1
Head, Fruits, Vegetables and Other Crops (Senior Research Scientist)	1	0	1
Head, Entomology, Pathology and Weed Science (Senior Research Scientist	1	0	1
Head, Biotechnology and Seed Technology (Senior Research Scientist)	1	0	1
Head, Soils and Farm Mechanization (Senior Research Scientist)	1	0	1
Head, Bio Energy (Senior Research Scientist)	1	0	1
Horticulturist	1	0	1
Research Scientist	15	8	7
Nurseries Manager	1	1	0
Research Assistant	30	28	2
Nursery Supervisor	5	1	4
Senior Research Technician	6	1	5
Research Technician	16	12	4
Laboratory Attendant	10	7	3
Total	**91**	**59**	**32**

Table 31: Staffing in the Guyana Mangrove Management Department, 2014

Category	Authorized Positions	Positions Filled	Vacant Post
Project Coordinator	1	1	0
Admin. Finance Officer	1	1	0
Monitoring Officer	1	1	0
Community Dev. Officer	1	1	0
Monitoring Officer/GIS Technician	1	1	0
Engineer	1	1	0
Ranger	9	9	0
Total	**15**	**15**	**0**

TRAINING

OVERSEAS

Workshops/Forums/Training Courses/Seminars/Meetings

1. Mr. Brian Sears, Assistant Chief Executive Officer attended the 'Eight Session of the Commission on Phytosanitary Measures' from 31 March to 4 April, 2014 in Rome, Italy.

2. Ms Adele Pierre, Plant Protection Officer attended the '3rd Meeting of the Caribbean Plant Health Directors Emergency Response Preparedness Plans and Mechanisms for Response from May 8-9, 2014 in Antigua.

3. Dr. Oudho Homenauth, Chief Executive Officer, attended the Planning Workshop on 'Organic, Hydroponic, and Hybrid-System Growing for Caribbean Schools and Model for Local Caribbean Entrepreneurship' during the period May 7th, 2014 to May 10, 2014 in St. Kitts.

4. Mr Aaron Ramroop, Regional Extension Coordinator attended the Training on 'Family Farming' from July 14-25, 2015 in Mexico.

5. Mr Rohit Singh, Coastal Coordinator attended the Training in Protected Agriculture from July 14, 2014 to August 1st, 2014 in Mexico.

6. Mr Premdat Beecham, Research Assistant participated in a course titled 'Modern Production Technologies, Processing and Utilization of Cassava', from July 28th, 2014 – August 1st, 2014 in Colombia.

7. Ms Leelawattie Persaud, Research Assistant attended the Training in Soil & Water Conservation' from August 3 – 16, 2014 in Mexico.

8. Ms. Seema Singh, Plant Quarantine Officer, participated in the Regional Training Course on Plant Quarantine Principles and Procedures from August 10th – 22nd, 2014 Trinidad and Tobago.

9. Ms Sri Devi Nanku & Ms Analesa Skeete, Research Assistant attended the Training on 'Plant Pathology Techniques' from August 11th - 29th, 2014 in Mexico

10. Mr. David B. Fredericks, Research Scientist participated in the Workshop on Small Holder Rural Producers and Climate Smart Agriculture Production and Marketing in Saint Lucia from September 02-03, 2014 at the Bay Garden Hotel.

11. Mr Brian Sears, Chief Plant Protection Officer and Mr Royden Glen, Senior Plant Quarantine Officer (ag) attended the forum that introduced Canada's New Regulatory Framework for Federal Food Inspection in May, 2014 and its subsequent consultations in August and September, 2014.

12. Mr Ansel Todd, Senior Plant Protection Officer attended the Regional International Plant Protection Commission (IPPC) Workshop for 2014 in the Caribbean Region, from September 22 -25th, 2014 in Kingston, Jamaica.

13. Mr Brian Sears, Chief Plant Protection Officer and Mr Paul McWatt, Plant Protection Officer participated in a meeting to finalize logistics between Guyana/Brazil governments to conduct a joint venture on the monitoring of CFF in Regions 8 & 9 in Guyana during the period March 12th -14th, 2014 in Brazil.

LOCAL

Workshop/Meeting/Training

1. Mr. Ansel Todd, Senior Plant Protection Officer (ag) and Ms. Zareefa Bacchus, Plant Quarantine Officer participated in a Food Safety Training/seminar that was facilitated by CARICOM in May 2014.

2. Ms. Adele Pierre, Plant Protection Officer participated in GNBS consultations on Comformity Assessment and ISO17026 in August, 2014.

3. Shamein Moseley, Senior Plant Quarantine Officer (ag), Adele Pierre, Plant Protection Officer, Kendra Belgrave, Plant Quarantine Officer, Evette Barker, Plant Quarantine Inspector, Dorrett Jones, Plant Quarantine Inspector attended

two (2) sessions of the Ministry of Agriculture's Export Management Information System (EMIS) meeting and training sessions held at Brain Street and MOA's boardroom in September, 2014.

4. Shamein Moseley, Senior Plant Quarantine Officer (ag), Zareefa Bacchus, Plant Quarantine Officer, Seema Singh, Plant Quarantine Officer, Leon Folkard, Plant Quarantine Officer, Lionel Ramdin, Plant Quarantine Officer, Shamane Richmond, Plant Quarantine Officer, Taijbally Ramsingh, Plant Quarantine Officer, Anawatttie Gobind, Plant Quarantine Officer, all attended the Service Providers Training on Safe Use, Handling, Storage and Disposal of Pesticides and Integrated Pest Management at Regency Hotel, Georgetown on October 28-30, 2014.

5. Shamein Moseley, Senior Plant Quarantine Officer (ag), Leon Folkard, Plant Quarantine Officer, Adele Pierre, Plant Protection Officer, Lionel Ramdin, Plant Quarantine Officer, attended a training session on Capacity building and compliance with national and international food safety standards on November 3-15, 2014.

6. In house trainings were conducted in the following areas, GAP/Farm Certification, Carambola Fruit Fly, Red Palm Mite, Pink and Papaya Mealy Bug, Quarantine Procedures and Protocols Agreements, ISPMs, Fumigation procedures and Disaster Management Plan.

9.0 FINANCIAL REPORT

STATEMENT OF FINANCIAL POSITION
AS AT 31st DECEMBER, 2014

	Note	As At 31.12.2014	As At 31.12.2013
		$	$
Assets			
Non Current Assets			
Property, Plant & Equipment	2	333,964,400	235,940,622
Total Non Current Assets		**333,964,400**	**235,940,622**
Current Assets			
Inventory	3	159,552,148	125,586,903
Debtors	4	93,627,331	41,809,483
Short Term Investment	5	5,438,929	5,412,758
Cash and Bank	6	198,495,330	257,431,070
Total Current Assets		**457,113,738**	**430,240,213**
Total Assets		**791,078,138**	**666,180,835**

STATEMENT OF FINANCIAL POSITION
AS AT 31st DECEMBER, 2014

	Note	As At 31.12.2014	As At 31.12.2013
		$	$
Equity & Liabilities			
Equity			
Grant from Foreign Sources	7	51,897,479	51,897,479
Government of Guyana Contribution	8	912,384,722	775,739,804
Revaluation of Stock		341,781	341,781
Accumulative Surplus/(Deficit)		(192,407,517)	(174,079,028)
Total Equity		**772,216,464**	**653,900,035**
Liabilities			
Non Current Liabilities			
Ministry of Public Works	9	5,606,815	5,606,815
Total Non-Current Liability		**5,606,815**	**5,606,815**
Current Liabilities			
Creditors	10	13,254,858	6,673,985
Total Current Liabilities		**13,254,858**	**6,673,985**
Total Equity & Liabilities		**791,078,138**	**666,180,835**

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The accompanying notes form an integral part of these financials statements. These financial statements were signed on the_____ by:

Senior Finance Manager Chief Executive Officer

STATEMENT OF COMPREHENSIVE INCOME
FOR THE PERIOD ENDED 31st DECEMBER, 2014

	Note	Period Ended 31/12/2014	Period Ended 31/12/2013
		$	
Revenue			
Government of Guyana Subvention	11	672,002,000	619,386,480
Income from Operation	12	16,490,730	23,374,042
Other Income	13	231,274,629	227,856,877
Interest Earned	14	179,531	145,731
Total Revenue for the year		**919,946,890**	**870,763,130**
Expenditure			
Wages & Salaries		463,504,848	403,782,812
Overhead Expenditure		76,169,168	57,622,028
Material, Equipment & Supplies		21,377,477	32,864,902
Fuel & Lubricant		21,927,370	19,220,761
Rental & Maintenance of Buildings		9,579,518	7,413,351
Maintenance of Infrastructure		1,207,898	1,791,821
Transport, Travel & Postage		43,102,825	42,946,659
Utility Charges		36,590,452	32,661,330
Other Goods & Services		25,234,539	23,066,240
Other Operating Expenses		188,620,801	93,160,493
Education Subvention & Training		3,545,570	1,763,723
Old Age Pension		1,005,243	1,035,156
Disposal	15	200,000	60,000
Depreciation	2	46,209,670	43,971,327
Total Expenditure for the year		**938,275,379**	**761,360,603**

STATEMENT OF CHANGES IN EQUITY

FOR THE PERIOD ENDED 31 DECEMBER, 2014

	Grants from Foreign Sources	Government of Guyana Contribution	Revaluation of Stock	Accumulated Surplus/Deficit
Balance as at 01.01.2014	**51,897,479**	**775,739,804**	**341,781**	(174,079,028)
Adjustment to Surplus/Deficit as at 01.01.2014				
Surplus/Deficit as at 31.12.2014				(18,328,489)
Capital Contribution		335,851,792		-
Capital Contribution adjustment		(199,206,874)		
Balance as at 31.12.2014	**51,897,479**	**912,384,722**	**341,781**	**(192,407,517)**

APPENDICES

Appendix 1

SERVICE ACTIVITY TARGETS FOR 2014

RESEARCH & DEVELOPMENT

ACTIVITIES	INDICATORS
1. Develop new cash crops such as carrots, garlic , chickpeas and different varieties of sweet potato	1. Experimental plots for carrots established at March 2014.
2. Establishment of cassava demonstration plots in Region No.9 to demonstrate improved production techniques.	2. Trial plots established by April 2014.
3. Develop and Sustain a Crop & Livestock Genetic Compendium for Guyana.	3. Draft 1st Compendium presented by June 2015.
4. Develop a Rubber Plant Nursery at Kairuni.	4. Rubber Plant Nursery report by June31st, and December 31st, 2014.
5. Acquire and field test improved/higher yielding varieties of corn, soyabean and cassava, and other relevant crops	5. At least 2 varieties of relevant crops are field tested in 2013/2014 and varieties are released to farmers 2014/2015 and subsequent years
6. Evaluation of current protected agricultural systems in order to identify constraints affecting production and making the necessary recommendations.	6. (a) Report prepared by March 2014. (b) Manual on Protected Agriculture in Guyana completed by July 2014.
7. Establish more modern semi- protected agricultural systems.	7. Introduction of high tunnel structures by June 2014.
8. Develop macro propogation techniques for plantains.	8. At least one such technique established by June 2014.
9. Demonstrate the use of micro- irrigation systems coupled with fertigation.	9. At least ten (10) such systems established on Farmers'Field by April 2014.
10. Seed regulations developed	10. Seed Regulations adopted by June 2014.
11. Introduction of commercial size soya cultivation	11. Crop production statistics presented 1 crop of soya by Dec 2014
	12. Quinoa plot data presented by JUNE 2015

12. Development of Experimental plot for quinoa 13. Consolidate the pilot projects for corn, soya, chickpeas and promote as commercial crops for farmers	• Corn, Soya, chickpeas pilot reports analyzed in 2014 and production by at least 2 farmers with 50 acres in 2014 and • 200 acres in 2015. • 3,000 acres by 2020
14. Develop a new variety of sweet potato to target export market	Farmers are organized to cultivate 50 acre of new variety sweet potato to test market in 2014
15. Develop carrots and garlic in commercial size farms	• Pilot farms are producing carrots and garlic for local markets by end of 2014 • at least 10tons by 2016
16. Consolidate the production of spices – ginger, black pepper and turmeric to meet local market demands	• Production of ginger, black pepper and turmeric increased by 50% in 2014. • at least 10tons by 2016 • 200% by 2020, reducing imports by at least 25% by 2020.
17. Establishment of Biotechnology Laboratory to support tissue-cultured germplasm	Biotechnology Laboratory at NAREI functional by June 2014
18. Production of tissue-cultured plantlets (pineapple and plantains) and maintenance of in vitro storage of cassava and sweet potato germplasm	• Tissue-cultured germplasm of pineapples, plantains, cassava and sweet potato being maintained by June 2015 • 30, 000 plantlets being available for farmers by June 2015
19. Use of DNA fingerprinting (molecular markers) characterization and ensuring seed purity	• At least one fingerprinting completed by December 2014 • two completed in 2015
20. Develop suitable nutrient medium for use in hydroponic farms	using a local hydroponic medium in a hydroponic farm by 2015
21. Update Farmers Manual	2nd Edition of Farmers Manual by January 2015
22. Conduct post-harvest studies in crops of economic importance	Reports of 4 post-harvest studies presented to HOD by June 2015
23. Demonstrate production of culinary spices and herbs for the hospitality industry and promote these systems to farmers to diversify their production	• Pilot farms of herbs and spices such as cilantro, beet and parsley are developed and seedlings provided for farmers by 2015 • with at least 5 farmers engaged in commercial production by 2018
24. Develop a pilot White Potato plot in order to reduce imports of White Potato	• In 2015 at least two farmers start plots

25. Introduce certain specialty fruits as new commercial crops e.g rambutan	• Production of 2000 seedlings (8 acres) annually from 2014 • at least 50 acres of rambutan by 2020
26. Establish a new Tissue Culture Laboratory at NAREI	The new Tissue Culture Laboratory at NAREI is commissioned by June 2014
27. Establish a new Bio-Control Laboratory at NAREI	The new Bio-Control Laboratory at NAREI is commissioned by June 2014
28. Build new shade houses at NAREI facilities across the country	New shade houses functional at NAREI, GSA, Kairuni, Ebini, Hosororo, Temehri, #63 and Lethem
29. Establish a National Soil Health Testing Laboratory	The National Soil Health testing Laboratory is launched by September 2014
30. Develop on-farm fertilizer production system, e.g. vericomposting	NAREI has at least two in its demonstration farms by 2015 and at least 5 are functioning in farmers plots by end of 2015
31. Encourage the use of innocula, green manure and mychorrize in farms	Innocula used for beans by end of 2014. Green manure demonstrated for sugar cane by December 2014
32. Investigate the impact of micro-nutrients on crop production	• Studies started by April 2014. Crops studied are sugar cane, rice and horticultural crops • first report available by April 2015
33. Establish weed control measures for field crops such as corn, soya and beans	SOP for weed control established and in use for new crop season in 2014
34. Develop program for GIS mapping of agriculture soil and match soil profile with crop profile	• Acquire the GIS hardware and software and complete Region 5 by December 2014 • two regions in 2015
35. Establish Farmers Demonstration Farms for the control of Black Sigatoka	• At least one Demonstration Farm functional in each Region by 2016 with less than 5% losses to Black Sigatoka
36. Strengthen the Management of Black Sigatoka Disease in Plantains	• Plantain production increased from 20 lbs/bunch to 40 lbs per bunch by 2016 by use of IPM
37. Increase cultivation and export of sweet pepper	• Sweet pepper cultivation and export is increased by 100% by 2016
38. Increase production of plantains and bananas to meet demands of the agro-processing industry and for exports with sigatoka-resistant plantain and banana cultivars	• Sigatoka-resistant plantain and banana acreage increased by 25% by 2016 • Production of plantains and bananas increased by 50% by 2018 • Export increasing by 100% by 2020 and agro-processing demand increased by 1oo% by 2020
39. NAREI establishes List of Potential Pests and Diseases Risk for Farmers in	• The List of Common Plant Pests and Diseases in Guyana will include a chapter on

Guyana	Potential Pests and Diseases
40. Develop commercial plots for Butternut Squash	• Increase butternut squash production to 25 tons by 2018 and export of 20 tons per year by 2018
41. Develop laboratory methods for common plant pests and diseases	• Plant Health Laboratory certified and proficient in testing for at least 50% of common pests and diseases
PRODUCTION AND DIVERSITY OF TRADITIONAL CROPS	
1. Appoint a Coconut Focal Point to provide leadership for the industry	A Coconut Focal Point is appointed and provided with training in Mexico under an IICA-funded program
2. Reinvigorate and expand the coconut industry by promoting new plants for old coconut plantations and promote new coconut plantations	(a) A Coconut Industry Strategy is approved in 2014 (b) At least 4,000 new plants in existing fields by 2015 (c) At least three new coconut plantations by 2016 (d) 30% increase in coconut production by 2020
3. Acquire high yielding coconut varieties from other countries, particularly for coconut water, virgin coconut oil and other value-added product	• MOUs with Centers of Excellence in Mexico and South Pacific with the aim of acquiring improved coconut cultivars commencing in 2014 • protocols are developed for importation by 2015
4. Develop a strategy for a new cassava industry in Guyana that meets Food Security needs of our people and is commercialize for value-added product	(a) A Cassava Industry Focal Point is appointed (b) The Strategy for a New Cassava industry is approved (c) Cassava yield per acre is increased by 100% by 2020 (d) Cassava production is increased by 150% by 2020
5. Establish a coconut oversight committee to ensure the coconut industry is expanded through public/private partnerships	• Minutes or our meetings in 2014 available • Hosts Coconut Forum in 2014
6. Promote commercial production and export of soursop	• Soursop production is increased by 25% in 2015 • 100% in 2020 and export is at least 5 tons by 2020
7. Promote the use of and cultivation of avocado (pears)	• Avocado production is increased by 10% in 2014. • Avocado production is increased by 30% in 2016 • Avocado production is increased by 100% in 2020
8. Complete an assessment of the existing horticulture industry in Guyana	A Report of the Horticulture Industry and its potential is available by 2015

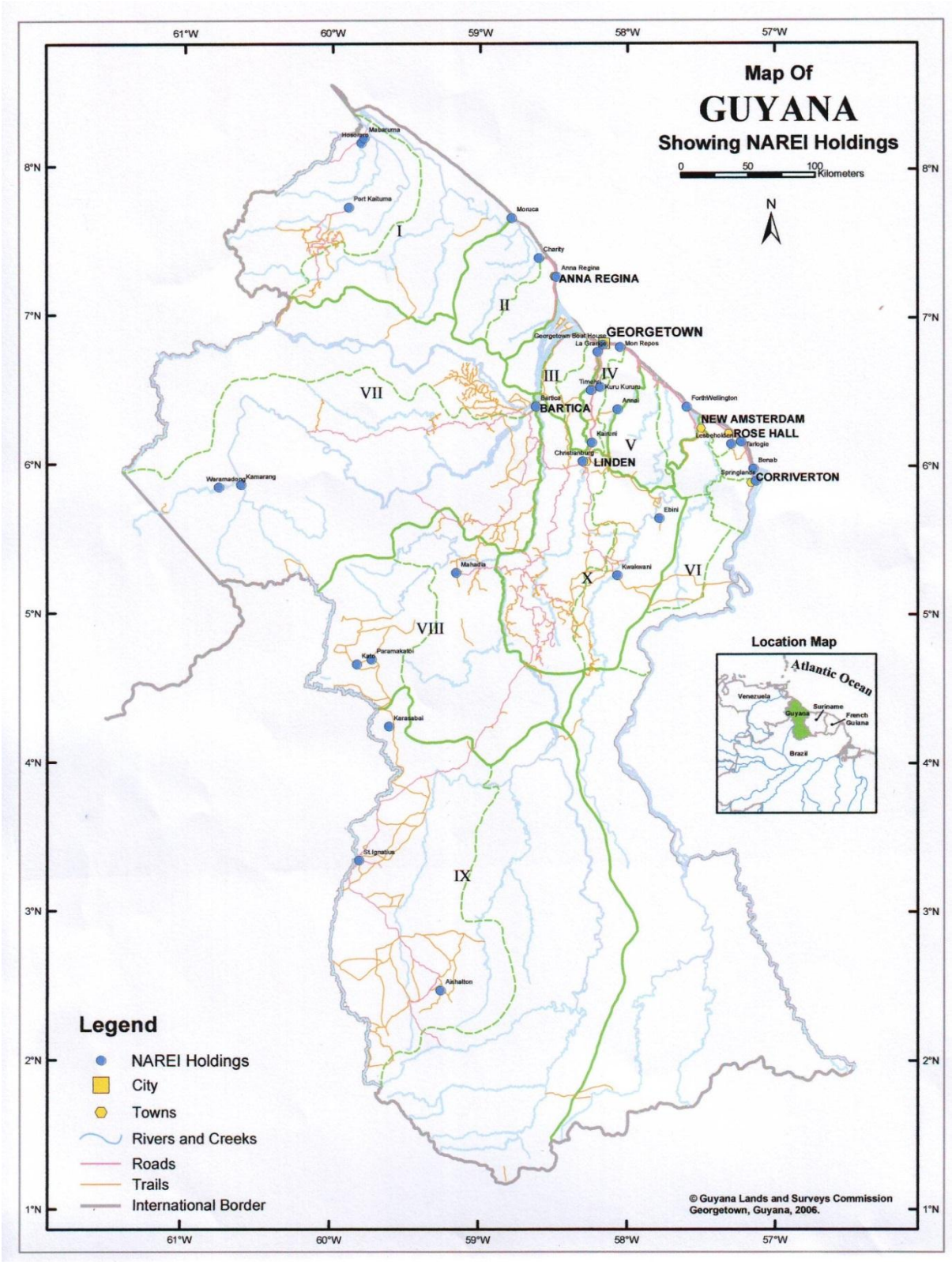
9. Prepare Draft Policy on Agro-Energy (Bioenergy)	Cabinet adopts Agro-Energy Policy by April 2014.
10. Introductory use of bio-ethanol blended fuel for vehicle use by March 2014 and full-use by August 2014.	Initial indicator data on fuel use recorded and accumulated by August-September for 20-25 MOA vehicles.
11. Diversify the use of GUYSUCO molasses and explore the capability of other sources as substrate (cassava, sweet potato, rice) for bio-ethanol production.	Feasibility study for use of other substrates like cassava completed by December 2014. Expansion of acreage under cultivation of crops capable of use in bio-fuel production from 2015.
12. Bio-gas production and utilization on large farms to reduce dependency on fossil fuel source generators	At least 2 Homesteads/farms successfully producing bio-gas energy by end of 2014
13. Promote mega-farms for production of Bio-Fuel in Guyana, using sugar cane, palm oil and other crops	At least one mega-farm feasibility studies initiated in 2014 and MOUs signed with two private investors for mega-farms in Canje Basin and Intermediate Savannahs
14. Expand production of citrus products – oranges and lime for export	• A Focal Point for Citrus Production is appointed • Export of orange and lime products increase by 100% by 2020
15. Promote the use, production and export of saigan as a health product	• Saigan production is increased, local use is popularized and at least 2 tons exported by 2020
16. Develop a plan to increase horticulture production in Guyana	• Horticulture production is increased by 50% by 2020 in Guyana
17. Promote an export industry for horticulture products from Guyana	• At least five persons are exporting horticulture products from Guyana and exports amount to $US1M by 2020
18. Bio-gas production and utilization on large farms to reduce dependency on fossil fuel source generators	• At least 2 Homesteads/farms successfully producing bio-gas energy by end of 2014 • adding an average of 2 per year to 2020, with measured reduction of fossil fuel used
19. Commercial quantities of bio-ethanol and biodiesel produced	• At least 50,000 liters of bio-ethanol /biodiesel produced per year by 2020
PLANT HEALTH	
1. Implement Plant Health Act and prepare Plant Health Act Annual Report	Plant Health Act Regulations are enforced by end of 2014 and Minister of Agriculture approves Plant Health Act Annual Report within 60 days after end of year.
2. Establish a Crop Farmers Register by Geographic Location and by Crops Cultivated (Farmers Information System)	• Crop Farmers Register is completed for Region 2, 5, 9 by end of 2014, • Region 6, 7, 10 by end of 2015

	• Farmers Information System fully developed by 2018
3. Develop a Farm Certification and Traceability System for Guyana	Farm Certification System functional in 2014 and Traceability legislation and system functional in 2015
4. Develop an Organic Certification System	The Organic Certification System fully functional by 2015
5. Further improve Extension Services to farmers with greater accountability and more engagement with farmers	Farmers benefit from more frequent and focused extension services and weekly reports which are analyzed and interventions made
QUARANTINE, INSPECTION AND CERTIFICATION	
1. Strengthen the PPQ Unit of NAREI	A Director of PPQ is appointed by end of 2014
2. Review the Quarantine Laws and Regulations periodically	The Quarantine Laws and Regulations revised by end of 2015 and mandatory review every three years
3. Strengthen the functioning of quarantine, inspection and certification services at all ports of entry	All quarantine, inspection and certification units at ports of entry with trained staff and SOPs are in use
4. Conduct annual PPQ awareness programs	At least one TV, radio and newspaper awareness program, and at least two stakeholders and community awareness programs per year
5. Maintain a list of pests and diseases which require plant quarantine interventions	List of pests and diseases which require quarantine measures is published in a publicly available format each January and all staff are familiar with list
6. NAREI establishes List of Common Plant Pests and Diseases and their enemies and Reviews this List Annually	The 1st Edition of List of Common Plant Pests and Diseases and their enemies in Guyana is published in 2014 and published annually after
7. Develop a Plant Pest and Disease Surveillance and Epidemiology Manua	The Plant Pest and Disease Surveillance and Epidemiology Manual published in 2015 and revised every 3 years
8. Develop an Early Warning System for Plant Pests and Diseases	Regular surveillance of farms are conducted with at least 100 farms visited per month
9. Pest Data Management System (PDMS) developed and computerized	• PDMS at NAREI is computerize by 2015 • Each regional office is computerized by 2017
10. A Pest Risk Assessment (PRA) Program is developed	The PRA is conducted at least once per year in each Region and Farmers Pest Risk Advisories are provided
11. Seek certification of laboratories with Guyana Bureau of Standards	The various plant laboratories are certified by the Bureau of Standards by 2015
12. Maintain suitable Plant Quarantine Rooms for each Port of Entry	Each Port of Entry has access to a functional Plant Quarantine Facility certified by appropriate standards
DISEASE CONTROL AND ERADICATION	
1. Develop a more robust Integrated Pest Management (IPM) System and develop an IPM Manual	1. An IPM System is functional and an IPM Manual is provided to all extension workers and some farmers by June 2015.
2. Increase routine control and eradication	2. (a) Monthly survey reports for key pests

surveys for key pests and diseases	and diseases (b) PFAs routinely established and maintained ©Quarantine and phytosanitary interventions in place
3. Strengthen the Red Palm Mite Control and Management Program in the coconut industr	Pest is contained in defined areas, eradication measures imposed and monthly and quarterly reports to demonstrate effectiveness
4. Develop new approaches to manage Acoushi Ants in hinterland farms	A new Acoushi Ants Control Program rolled out by end of 2014 Acoushi Ant damage is measured from 2015
5. The Fruit Fly Control Program is resuscitated	New Fruit Fly Program implemented in 2014 Fruit Fly Laboratory functional by 2015
6. Identify cultural/biological control measures for important pests such as Diamond Back Moth, Sweet Potato Weevil and Red Palm Mite	Natural enemies list chemical and biological control measures prepared and available for widespread distribution and use by December 2014
7. Implement prevention measures for spreading of pests and diseases from in-country supply or imported planting material, e,g, white potato	(a) Conditional NO Objection stamp on PQ import permits implemented from February 2014 (b) Pest-Free Import Protocols strengthened and enforced by February 2014
8. Conduct study to identify viral diseases affecting solanacious crops and ensure that extension service personnel are capable of identifying these viral pests	Study completed by December 2014
9. Implement program of introducing natural enemies for various pests in quarantined area	Quarantined Area Report reviewed monthly, natural enemies identified and sourced by December 2014 routinely used in 2015, especially for RPM.
10. Control pests through the use of internationally recommended fumigants	A list of fumigants and SPs for their use is maintained by NAREI/PTCB and personnel are trained in their use
11. Review import and other policies for fresh fruits and vegetables and ensure enabling policies are in place to support import substitution and export expansion	Review import and other policies for fresh fruits and vegetables and ensure enabling policies are in place to support import substitution and export expansion Import and other policy changes recommendations

	for fresh fruits and vegetables are proposed to Cabinet
12. Develop and implement a NEW CROPS Policy and identify New Crops Priority	NEW CROPS Policy approved by HOD in 2014 and at least one new commercial crop in 2014 and annually after
13. Germplasm (Gene Bank) – In-House and Field - Facility in Guyana to FAO Germplasm Standards	The Germplasm Facility (Gene Bank) is formalized by end of 2015
14. Establishment of Crop Development and Diversification Unit	Reports of 4 meetings of CDU-NAREI with at least one improved and new plant per year Unit is launched with TOR in March 2014. (Previously established in 2011)
15. Establishment of an Agriculture Mapping Program for Guyana using GIS/GPS technology and techniques	Mapping for at least two Regions completed by December 31st 2014
16. Develop comprehensive liming requirements for agricultural soils. 17. Conduct studies to dtermine the nutrient status of agricultural soils in order to promote integrated nutrient management.	Liming requirements developed for six (6) soils by June 2014. Results available for ten (10) soils by June 2014 INM Manual for Soils distributed to farmers by June 2015

Appendix 2


Map Of
GUYANA
Showing NAREI Holdings
0 50 100 Kilometers
N
61°W
60°W
59°W
58°W
57°W
8°N
7°N
6°N
5°N
4°N
3°N
2°N
1°N
ANNA REGINA
GEORGETOWN
BARTICA
NEW AMSTERDAM
ROSE HALL
LINDEN
CORRIVERTON
I
II
III
IV
V
VI
VII
VIII
IX
X
Location Map
Atlantic Ocean
Venezuela
Guyana
Suriname
French Guiana
Brazil
Legend
NAREI Holdings
City
Towns
Rivers and Creeks
Roads
Trails
International Border
© Guyana Lands and Surveys Commission
Georgetown, Guyana, 2006.

2013 Non Traditional Crop Production

Commodity	TOTAL
Legumes	**MT**
Corn	250
Minica # 4	1,178
Black eye	-
Other Legumes	184
Oil Seeds	-
Coconuts (dry) - each	23,216
Coconut (water)-000s nuts	5,978
Provisions	
Cassava (sweet)	7,650
Sweet Potato	2,144
Eddo	3,385
Plantain	15,246
Other provision (Yam)	826
Vegetables	-
Tomato	11,657
Cabbage	2,255
Pumpkin	9,622
Bora	8,270
Ochro	3,394
Boulanger	5,741
Squash	3,172
Cucumber	3,144
Other Vegetables	3,681
Spices & Seasoning	-
Eschallot	4,428
Hot Pepper	7,969
Ginger	1,915
Other Spices	453
Citrus	-
Lime	986
Grapefruit	297
Orange	2,581
Other Citrus	434
Fruits	-
Avocado (Pear)	211

Mango	1,125
Banana	5,168
Pineapple	6,113
Watermelon	2,191
Cherry	1,249
Passion Fruit	889
Papaw	4,980
Other Fruits	1,998
	-
Coffee	5
Cocoa	2

2014 Non Traditional Crop Production

Commodity	Total
Banana	11,845.76
Beans	1,138.12
Bitter cassava	13,214.45
Bora	10,013.52
Boulanger	20,900.11
Bread fruit	196.22
Breadnut	128.44
broccoli	5.77
Butternut squash	66.30
Cabbages	7,428.53
Calaloo	7,599.17
Carilla	3,979.21
Cashew (Malaka)	328.17
Cassava	30,228.38
Cauliflower	34.37
Celery	9,978.48
Cherry	2,008.81
Chives	283.01
Citrus	8,812.36
Coconut	35,347.96
Water coconuts	9,355,682.00
Coffee	306.26
Corn	1,134.38
Cocoa	-
Cucumber	9,249.82
custard apple	-
Dasheen	1,115.04
Dunks	-
Eddoes	17,331.89
Eshallot	1,169.69
Five Finger	522.88
Genip	139.94
Ginger	5,917.10
Golden Apple	171.29
Goose berry	14.56
Granadilla	16.29
Grape Fruit	7,400.55
Guava	217.63

Lemon	1,845.22
Lettuce	235.88
Limes	6,293.63
Mamee Apple	173.58
Mangoes	2,577.08
Musk melon	1,114.22
Married man	143.36
Ochro	37,615.11
Oranges	4,300.02
Pakchoi	1,492.09
Papaw	5,860.31
Parsley	122.50
Passion Fruit	1,469.73
Peach	13.15
Peanuts	329.93
Pears	5,773.24
Peas	140.62
Peppers	9,667.90
Pigeon peas	60.42
Pineapples	47,419.00
Plantain	46,545.90
Plum	0.90
Pomegranate	56.28
Psydium	473.83
Pumpkin	12,587.04
Rambutan	118.24
Saeme	3,554.05
Sapodilla	492.29
Sorrell	-
Soursop	2,013.75
Spinach	-
Squash	3,855.01
Star apples	175.50
Straw berry	-
Sugar Apple	14.52
Sweet Peppers	3,503.00
Sweet Potatoes	12,631.95
Tangarine	7,461.06
Tannia	4,247.45
Tumeric	64.89
Thyme	4,483.68

Tomatoes	14,984.95
Water melon	18,897.69
Yam	1,219.15
Onions	-
Carrot	-