ANNUAL REPORT 2017

1.0 ABSTRACTS OF COMPLETED RESEARCH PROJECTS

(i) Evaluating the effectiveness of mulch (plastic and organic) to control weed and increase productivity in watermelon cultivation

Rebecca Narine

Watermelon (*Citrullus lanatus*) is grown in Guyana and is mainly utilized as a dessert and for export. The leading cultivar of watermelon grown in Guyana is Mickey Lee and to a lesser extent the Charleston Grey and Sugar Baby varieties. Weed control in watermelon production is a tricky task to complete after the vines of the melons have begun to branch out. Chemicals can no longer be used to control weeds resulting in manual control, which is often costly, time and labour consuming and is bemoaned by many farmers. This research was therefore aimed at creating a way of controlling weeds and at the same time increase productivity of melons. An experiment was therefore conducted using a randomized complete block design (RCBD) in the Mahaica Creek area with two treatments (mulch and no mulch/chemical) and three reps. Beds were covered with the plastic mulch and organic mulch was placed between the plastic covered rows. Weed control efficacy of the mulch was evaluated at the end of the research. Harvest weight was also recorded. Data was analyzed using the Statistix 10 software. Fruits under mulch did have a higher average weight with a 2.07kg difference from the average fruit weight of those without mulch. Total average yield per hectare for plants under mulch was 40,623kg as opposed to 27,369kg for plants that were not treated with mulch. However, the organic mulch did not play a very efficient role in controlling weeds. The plastic mulch did control weeds but overall, chemicals were more efficient in controlling weeds (herbicide Glyphosate was used to control weeds on the plots without mulch). Weed control was evaluated using visual estimation on a 0 to 10 scale with 0 equaling no observable control and 10 equaling complete weed control (Law, 2006). Data was analyzed using the Statistix 10 software which, at (P – 0.05), there was a significant difference between the mulched plot and control (herbicide Glyphosate) plot for weed control. Using Tukey HSD All-Pairwise Comparisons Test, on average, mulch controlled weeds at a 50% (5 on a scale of 0-10) rate while the herbicide Glyphosate provided 90% (9 on a scale of 0-10) control of weeds.

Key Words: *Mulch, weeds, control, efficacy, chemical, watermelon, organic*

(ii) Evaluation of five hybrid watermelon cultivars for local cultivation

Rebecca Narine

Guyana depends mainly on one cultivar of watermelon (Mickey Lee) for production and marketing. Farmers are acquainted with this cultivar, and so are the consumers. However, because of the lack of diversification, Guyana is at risk of a total collapse of this industry in the event that Mickey Lee fails to produce. This study was therefore aimed at evaluating new watermelon cultivars (Bonta, Sugar Doll, Santa Matilde, Delta and Sentinel) for sustainability under local conditions. The trial was conducted at Mahaica using a randomized complete block design with five treatments and three replicates. Data was collected throughout the trial on germination percentages, flowering, fruiting and harvesting time. Data was also collected to create plant descriptors, according to the International Union For The Protection Of New Varieties Of Plants (UPOV), for the new cultivars. Average production was recorded at 250,165.7 kg/ha, 384,998.5 kg/ha, 242,082.4 kg/ha, 279,998.9 kg/ha and 134,794.5 kg/ha for Santa Matilde, Delta, Bonta, Sentinel and Mickey Lee, respectively. All cultivars began flowering at the same time, however, Bonta and Mickey Lee were the first to produce fruits. Bonta and Mickey Lee were also harvested at the same time (73 days after germination). Delta had the seeds with more width (6.3 mm) while Santa Matilde had the longest seeds (9.4 mm). Average brix for Santa Matilde, Delta, Bonta, Sentinel and Mickey Lee were 10.8, 7.9, 8.2, 6.9 and 10.4, respectively. Mickey Lee and Bonta had ovaries with the same average circumference of 4.5 cm while Delta had the average longest ovary with 2.5 cm. Sentinel had the average thickest stem (9.8 mm), broadest (19.1 cm) and longest (22.1 cm) leaf. Bonta had the average longest petiole (11.4 cm) and Delta had the longest fruits (51.6 cm). Bonta could be a suitable replacement for Mickey Lee since it's harvested at the same time, has good production and has acceptance to the local market.

Key Words: *Watermelon, diversification, evaluation, new cultivars, Bonta*

(iii) Evaluation of the germination rate of local coconut varieties found in Guyana

Adrian Mangar and Satyanand Ramdowar

In Guyana, coconut is third most cultivated crop based on acreage. Currently, there is more emphasis being placed on coconut production taking into account the increasing demand for water coconuts as well as dry coconuts. As a result of this demand, there is a need for more coconut seedlings since there are farmers who are establishing new plantations. For this study 50 nuts of each the Surinamese Brown Dwarf and the Malaysian Dwarf varieties were evaluated for their germination rate and germination percentage. These varieties were selected because of the demand for their use as water nuts. The results show that the germination percentage for the all varieties fall within a range of 75 % - 81 %. However, the Malaysian Yellow Dwarf had the highest germination percentage of 81 %. The difference in the germination of these coconut varieties may be due to the age of nuts.

Key Words: *germination, range, production, increase*

(iv) Varietal evaluation of Jalapeno hot pepper to different fertilizer rates

Rameshwar Raghunauth

Hot pepper (Capsicum spp.) is cultivated throughout Guyana; however it is predominantly grown on the Coast. Hot pepper for commercial production is cultivated from 0.5acres to more than 3acres with cultivation at different growing stages. The Pageant hybrid variety (Jalapeno) is cultivated primarily in Mexico and the United States of America because of the increase in consumption over the last ten years. Hence, this variety was introduced because it is high yielding (18,000kg/ha), market preference and the ability to adapt to local conditions. Consequently, a trial was conducted at NAREI Demonstration farm Mon Repos, East Coast Demerara. The treatments were arranged according to the randomized complete block design (RCBD) with four treatments (Control: 0kg/ha, T1: 200kg/ha, T2: 400kg/ha and T3: 600kg/ha) with three replicates. Fertilizer (12:12:17:2) was applied in split applications at two, four and eight week intervals. The plot size for this trial was 8.64m2. Seedlings were planted 0.4m apart and 0.4m between rows. The highest yield (17,011kg/ha) was obtained from treatment three which was significantly different from all other treatment means. The second highest yield (10,288kg/ha) was attained from treatment two while the third highest yield (5,044kg/ha) was obtained from treatment one and the control obtain the lowest yield of 2,844kg/ha. It is recommended to use 600kg/ha fertlizer when cultivating Jalapeno hot pepper because higher yields will be achieved.

Key Words: *Jalapeno hot pepper, yield, fertilizer rate*

(v) Varietal evaluation of BEK bird eye chilli pepper using different fertilizer regimes

Rameshwar Raghunauth

Hot pepper is a non-traditional crop cultivated in all regions in Guyana. The bird pepper is considered native to Guyana. The current yield of bird pepper in Guyana is on average about 2,500 Kg/ha, which is very low. Therefore, the BEK variety of bird eye chilli was introduced to increase the production of bird pepper. This variety is high yielding, productive for long periods up to two years and high demand locally, regionally and international. Subsequently, an experiment was carried out at NAREI Demonstration farm Mon Repos. The treatments were arranged according to the randomized complete block design (RCBD) with four treatments (Control: 0 Kg/ha, T1: 200 Kg/ha, T2: 400 Kg/ha and T3: 600 Kg/ha) with three replicates. Fertilizer (12:12:17:2) was applied in split application at two, four and eight week intervals. The plot size for this trial was 8.64 m2. Seedlings were planted 0.4 m apart and 0.4 m between rows. The results showed that there were significant differences among treatment means for the yield of bird pepper. Treatment three obtained the highest yield (10,369 Kg/ha) which was significantly different from all other treatment means. The second highest yield (8,021 Kg/ha) was achieved from treatment two which showed significant differences from the means of treatment one and the control. Treatment one attained the third highest yield (5,274 Kg/ha) which differs significantly from the control. The control obtained the lowest yield (4,231 Kg/ha). It is recommended to cultivate bird pepper using 600 Kg/ha fertilizer to achieve maximum yields.

Key Words: *bird pepper, yield, hot pepper, BEK variety, birdeye chilli.*

(vi) Evaluation of inorganic fertilizers and organic fertilizer on the production of Scotch Bonnet hot peppers

Rameshwar Raghunauth

Hot pepper is an important crop cultivated among small and medium scale farmers in Guyana. There is a high demand for organic pepper because of the numerous health benefits for human. It is grown for both the fresh and processed markets and being exported regionally. The cultivation of hot pepper using manures as fertilizer or a combination with inorganic fertilizer is very limited because of the lack of knowledge on the utilization of manure in production. Poultry manure is considered one of the best manures to increase production. The Scotch Bonnet hot pepper has good market acceptability in Guyana. Subsequently, a study was conducted in order to determine the appropriate fertilizer rate to achieve maximum yields on a farmer's plot at Laluni, Soesdyke Linden Highway. Four treatments (Control 0 Kg/ha, T1: 50 % organic fertilizer and 50% inorganic fertilizer, T2: organic fertilizer plus bio stimulant and T3: inorganic fertilizer and) with three replicates were arranged according to the Randomized Complete Block Design (RCBD). Treatment three obtained the highest yield of (13,994 Kg/ha) which was significantly different from all other treatment means. The second highest yield (8,659 Kg/ha) was obtained from treatment one which was significantly different from treatment two and the control. The third highest yield (5,789) was achieved from treatment two which was significantly different from the control. The lowest yield (1,147 Kg/ha) was attained from the control. The organic fertilizer and bio-stimulant did not have a considerable impact on yield because of nutrient variation and also insufficient nutrient availability especially at the fruiting stage. It is therefore recommended to fertilize with 600 Kg/ha to achieve maximum yield for this variety of pepper.

Key Words: *Scotch Bonnet pepper, yield, organic fertilizer, bio-stimulant, inorganic fertilizer.*

(vii) The effect of different planting densities on the yield of sweet potato

Aretha Peters

The recommendation for planting sweet potato is 30 to 40 cm apart between plants and 90 cm between rows. It is also recommended that Beauregard, a popular cultivar in Jamaica and in the USA be planted 30 to 40 cm apart for improved yields and economic gain. It has been observed that closer spacing delays harvest in most cultivars. Responses of sweet potato cultivar AIS-0122-2 to different plant densities (75 x 15, 75 x 30, 75 x 45 and 75 x 60 cm) were studied on silt loam soil during the winter seasons for two years at TOP/AVRDC field, Kasetsart University, Kamphaeng Saen Campus. In Cameroon, two years evaluations of sweet plant densities: 10,000, 20,000 and 30,000 plants per hectare resulted in 20,000 plants per hectare produced the highest mean tuber. Sweet potato farmers in Guyana use varying plant densities with the perception that a wider spacing is needed for the vines to grow. A randomized complete block design (RCBD) was used for the trial with three treatments: 20, 30 and 40 cm plant densities replicated three times. The project sought to determine the appropriate planting density for sweet potato that will produce high yields. The results indicated that the 30 cm x 80 cm produced the highest yield (0.5250 Kg/plant). The expected outcome from the research is the availability of appropriate plant density for sweet potato in Guyana.

Key Words: *Sweet potatoes, plant density, effects, spacing*

(viii) Evaluation of new variety of tomato SV8579TE

Renee Nero, Lauren Paddy

Tomatoes are used in many different dishes normally fresh in salads and for cooking in Guyana. The Mongol F1 tomato is well adapted to Guyana's climatic conditions the said variety is used in creation of many dishes which includes "choka". The variety consists of a thin pericarp which is easily ruptured during the roasting process. Hence there is a need for the introduction of a new variety for "choka" purposes. A new variety SV8579TE has shown to have a thicker pericarp and remains turgid when roasted which produces a better "choka". As such a trial was conducted to compare yield of the new variety SV8579TE and Mongol F1. The trial was laid out in the *split plot design* with two treatments Mongol F1 and SV8579TE using four replications. Fertiliser NPK was applied to plants at transplanting, flowering and fruit set. There were significant differences among yields of Mongol F1 and SV8579TE. Mongol F1 recorded the highest yield and fruit count. Taste test of the "choka" was carried among 20 participants ranging from housewife to research scientist. Forty percent of the participants were between the ages of 20 - 30 while the other participants were equally divided between the 40 - 50 and 50 - 60 age range. Thirty one percent of the participants had never tasted tomato "choka" before and was willing to assist in the survey. Participants of the survey indicate to the researchers that although the SV8579TE was sweeter, the Mongol F1 have a more traditional taste. They also mentioned that the texture of the Mongol F1 was better and more consistent than that of the SV8579TE because it was a bit lumpy than they were accustom. The results showed that there were significant differences among treatment means for the yield of Mongol F1 and SV8579TE. Treatment one Mongol F1 obtained the highest yield of 14.15 Kg which was significantly different from the other treatment SV8579TE with a yield of 4.04 Kg.

Key Words: *Mongol F1, SV8579TE, "choka", tomato, taste test*

(ix) Evaluation of five improved varieties of cassava (Manihot esculenta Crantz) on sandy soil at Kairuni, Soyesdyke Linden Highway

P. Beecham

Evaluation of crops is crucial to select superior varieties for a targeted area. A field experiment was conducted at Kairuni Research Station on the Soesdyke Linden Highway within the sandy ecology of Guyana from April 2017- December 2017, to evaluate several morphological characteristics and yield components of five cassava (*Manihot esculenta* Crantz) varieties. The treatments (varieties) were NAREI 1, NAREI 2, Smoky prolific and M Mex (all improved varieties) and Uncle Mack (control) variety. The experiment was a Randomized Complete Block Design (RCBD) with three (3) replications. All agronomic/ field management practices were carried out when necessary. The growth parameters measured were Plant height, Stem diameter and Canopy spread. Top weight, Total crop biomass and Tuber yield were taken at harvest (270 Days After Planting). There were significant differences in, Plant height, Stem diameter and Canopy spread amongst the varieties. Root yield showed an increase of **27 %** with (**T_1** NAREI 1), **21 %** (**T_2**. NAREI 2), **11%** (**T_3** Smokey Prolific) and **2 %** (**T_4** Mmex) respectively, when compared with Uncle Mack Variety (control). Dry matter content of tubers increased significantly for the improved varieties ranging from **28** % (Uncle Mack) to **37 %** (NAREI 1). However, the harvest index was not significantly different among the varieties tested.

Key Words: *Sandy soil, harvest index, yield, dry matter*

(x) Cassava production practices and varieties cultivated in Guyana

Premdat Beecham

An assessment of cassava production practices and varieties cultivated in Guyana was carried out in order to ascertain the current production practices and varieties cultivated. In order to make appropriate recommendations for increases in yield and better management practices twenty five growers were surveyed in two farming areas (Parika and Craig) to understand their current situation of cassava cultivation practices and their constraints. The data were supplemented with semi-structured interviews. Results indicated that cassava farmers in both Parika and Craig areas are small/medium holder-based, who cultivate an average of 1 ha and 5 ha. Farmers use different cassava varieties, which are mostly sourced from within the ecological areas. Most of the farmers in Parika and Craig plant cassava stem cuttings similarly at an angle (45 degree). All farmers prepared their land for planting in a similar manner using tractor with plough, harrow and ridge. Nearly all farmers grow cassava continuously on the same field, with no intercropping. And farmers apply little or no organic and inorganic amendments to the cassava field. Cassava production varied among farmers and ranged from 14 t/ha to 27 t/ha. Farmers did not indicate any major agronomic problems/constraints to production, except access to financing. The study concluded that there the need for the access of appropriate planting materials to satisfy the farmers needs. Soil fertility management also needed to be addressed.

Key Words: *Agronomic Practices, Smallholder Production Systems, Cassava Varieties, Soil Fertility*

(xi) Evaluation of the effects of botanically derived products on leaf-cutting ants' activities in Guyana

Leelawattie Persaud, Arefia Hassan & Oceana O'Dean

Botanically derived products can be toxic to workers of leaf-cutting ants, to their fungi, or to both. Leaf-cutting ants, over the years, have challenged farmers to arrive at an effective control strategy due to their ability to develop resistance at a rapid rate towards granulated bait carriers and its active ingredients. Hence the need for constant development and testing of new bait materials for its control. Various trials were carried out to evaluate the acceptability degree of new formulated bait treatments, Control (active ingredient (a.i) Fipronil (local bait)), Citrus substrates (a.i Fipronil), Neem substrate baits, Castor bean substrate bait and Eucalyptus substrate bait. Baits with Citrus substrate incorporated had a high degree of acceptance by the ants when compared to the other bait treatments. Citrus substrate combined with Fipronil showed a 100% reduction of colony activity after seven days in all three areas of study, while the other Treatments did not. The species of ant presented in the three sample areas was the Atta cephelotes.

***Key Words**: baits, leaf-cutting ants, acceptability, Fipronil*

(xii) Control of Red palm mite in semi-open field using Natural enemies (Green lacewing and Amblyesius sp)

Therola Estwick & Anesha Stephen

Raoiella indica was first described in India in 1924 and has since then spread throughout South America and the Caribbean, Navia et al., 2010. Raoiella indica Hirst is a major pest of coconut palms in Guyana which was first observed in 2012, since then the National Agriculture Research and Extension Institute (NAREI) has used chemicals as a means of controlling this pest.

Given the thrust towards the use of more environmentally friendly/green agricultural practices in Guyana, NAREI is moving towards the use of biological control of pests and diseases in order to minimize the negative effects caused by overuse of chemical control methods.

The use of natural enemies native to Guyana such as the Green lacewing (*Chrysopidae*) and *Amblyseius sp (Phytoseiidae)* were evaluated for controlling *Raoiella indica (Acari: Tenuipalpiade)* on coconut palms. Four treatments were used: T1 (*100 Amblyseius sp*.), T2 (*100 Amblyseius sp.* and 10 green lacewings), T3 (10 green lacewings) and T4 (control, red palm mite only). The population densities of red palm mite (RPM) were estimated fortnightly for three months under semi-field conditions. The treatments showed no significant difference in the reduction of RPM over the experimental period.

However, continuous reduction in the population of RPM was observed in T2 beyond one month when compared to the other treatments. In all the treatments the RPM population fluctuated showing a reduction during the first and second month of the experiment followed by an increase in its population within the third month. The results from this study indicated that sole dependence on biological control agents was not adequate for continuous suppression of the RPM population. In addition, further studies should be done to evaluate the application of multiple releases of the natural enemies at differential periods in an adaptive IPM strategy.

Key Words: *Raoiella indica; biological control; coconut palms*

(xiii) Management of soursop wasp (*Berpthelloides sp.)*

Therola Estwick & Anesha Stephen,

The Soursop fruit for many years has been affected by the *Berpthelloides sp.* (soursop wasp). As the wasp matures it tunnels its way through the fruit leaving holes that act as a gateway for secondary infections such as, fungal growth which contributes to the deterioration of fruit and the unpleasant appearances. The bagging of soursop fruit using insect mesh to prevent the damage done by the soursop wasp was evaluated. This trial was done in Namrick (Parika), East Bank Essequibo where 32 soursop fruits were selected. Sixteen were bagged and 16 were tagged as the control. Data collection was done on a weekly basis for three months. Results revealed that the use of insect mesh significantly reduced the damage caused by the wasp. However, there was a high infestation of mealybugs and ants on those fruits covered by the mesh during the period of this experiment. Bagging of fruits using insect mesh has shown to be an effective way of reducing the damage done by the wasp. However, when the mesh is used, care should be taken to ensure it hangs completely free and is inspected and adjusted regularly to ensure the fruit does not touch the mesh.

Key Words: *soursop, bagged fruit, wasp.*

(xiv) The efficacy of botanical-pesticides (Neem extracts, garlic extracts, and chili pepper extracts) on the control of Diamond Back Moth (Plutella xylostella) in cabbage

Vishan Persaud & Oceana O'Dean

Cabbage is a popular vegetable crop consumed in Guyana and one of the most susceptible crops to pests especially the diamond back moth (Plutella xylostella). As such, farmers rely on the use of synthetic chemicals for controlling this pest thereby leaving large quantities of pesticide residue on the crop. There is therefore a need to explore the potential of botanical extracts in the control of this pest. In this experiment, the use of chilli pepper, garlic extract and neem extracts were tested to determine their efficacy against diamond back moth (DBM). The results showed that garlic extracts and neem extracts can be used to control the DBM population and deter their feeding on the leaves of the cabbage plant since they produced the best results with garlic extract being the better of the two. For the parameters evaluated such as the number of larvae, damaged leaves and number of damaged heads, no significant differences were observed between these two treatments. Chilli pepper extracts on the other hand produced results that were significantly different from the treatments but were better than that found in the untreated control.

Key Words: *Extracts of chill pepper, garlic, neem, diamond back moth, efficacy, cabbage*

(xv) The use of various plant-derived products to control the growth of Collecticum gloeosporioides and Fusarium oxysporum in vitro

Vishan Persaud, Leelawattie Persaud & Arifea Hassan

Fusarium oxysporum and Collecticum gloeosporioides (anthracnose) are two of the most common fungal diseases affecting agricultural crops and their produce. Common methods of control involve the use of fungicides; however, the use of botanical extracts is seen to be quite effective and an environmentally friendly solution. The effects of extracts of garlic (*Allium sativum*), basil and peppermint oil at concentrations of 2.5%, 7.5% and 10% on mycelial growth of *Fusarium oxysporum* and *Collecticum gloeosporioides* (anthracnose) were evaluated. The invitro results revealed that all the extracts inhibited mycelial growth at various levels. Peppermint oil had the highest inhibitory effect on mycelial growth of both fungi. For the control of *F. oxysporum*, peppermint oil at 10% concentration was more effective than the 7.5 % and 2.5% concentrations. This was followed by Basil extract with the 2.5% concentration giving the greatest inhibitory effect. Garlic extract had the least effective with the 2.5 concentration being more effective than the 7.5 and 10% concentrations. The effect of extracts on *F. oxyspor*um can, therefore, be ranked as peppermint oil >Basil >Garlic>Control. For the control of *Collecticum gloeosporioides*, at a concentration of 10%, peppermint oil showed stronger inhibitory activity than other botanical extracts, decreasing mycelial growth significantly as compared to the control. The second most effective inhibitory response was produced by the use of garlic extracts in which the 7.5 % concentration proved most effective. The use of Basil gave the least effective response to mycelial growth as compared to the other extracts. The inhibitory effect can, therefore, be ranked as peppermint oil >Garlic> basil >Control.

***Key Words**: Garlic, Basil, Peppermint, inhibitory effect, mycelial growth*

(xvi) The evaluation of newer fungicides and a silicon-based fertilizer for control of black Sigatoka disease in plantain

Vishan Persaud & Jewel Todd

Black Sigatoka disease (Mycosphaerella fijiensis) is one of major economic importance to the banana and plantain industry in Guyana. The use of fungicides and optimizing plant nutrition are effective measures taken to reduce severity and incidence of this disease. This study was conducted to evaluate the use of fungicides and their combination with a foliar fertilizer that provides nutrients which builds plants defense mechanisms. Experimental trials were established at little Biaboo, Mahaica and data were collected on the number of leaves, disease severity and the yield of plants. The average number of leaves ranged from 8-12. All treatments showed a degree of effectiveness against the severity of the disease. The use of Serenade in combination with potassium silicate (T3) proved to be the most effective treatment with relation to the disease infection rate. This was followed by sole Serenade application (T1-control), a combination of clearys fungicide and potassium silicate (T4) and sole application of clearys fungicide (T2). The potassium silicate applied solely (T5) to infected plants produced the least desirable results. The results for the effectiveness of the treatments against the disease infection rate can, therefore, be ranked as T3>T1>T4>T2>T5. The combination of Serenade and potassium silicate produced the highest average bunch weight. The most desirable results for a number of hands per bunch and girth of fingers were obtained by sole Serenade applications while treatment 4 and 3 produced the most favorable results for a number of fingers per hand and length of fingers respectively. A conclusion can, therefore, be drawn that the combination of fungicide and potassium silicate can be effectively used in the control of M. fijiensis.

Key Words: *number of leaves, disease severity, fungicide, potassium silicate, effectiveness*

(xvii) An Assessment of the effects of Botanical Extracts on Insect Pests incidence and on Tomato (Lycopersicon esculentum) and Sweet Pepper (Capsicum annuum L) Production

Oceana O'Dean & Anesha Stephen

Tomatoes and peppers are very nutritious and provide good quantities of vitamins A. Insect pests adversely affect and damage agricultural food production, market access, natural environment, parasitizing livestock and are a health hazard to humans. Farmers all over the world adopted the use of agrochemicals which pose a risk to the environment, ecosystems, and humans, and pests become resistant to them over time. An assessment on the effectiveness of biopesticides on the major insect-pests affecting peppers (aphids) and tomatoes (thrips). Four treatments were utilised: Treatment 1 – (50ml Orange peel –25ml Ginger – 25ml Turmeric – 900ml water), Treatment 2 – (50ml Orange peel - 900ml water), Treatment 3 – (25ml Ginger - 900ml water), Treatment 4 – (25ml Turmeric – 900ml water) coupled with a Control. Severity by Treatments for tomato showed that there was no significant difference ($p>0.05$) between treatments in the control of thrips. However, for sweet peppers, there was a significant difference ($p<0.05$) between treatments in the control of aphids. The most effective treatments for controlling the aphids were Treatment 4 and Treatment 3. Additionally, the biopesticides had no effect on the weight, taste, smell, acidity or alkalinity of the fruit produced by each crop. Hence, these extracts can be used without fear of harming the plant or its produce. Further trials using ginger and turmeric should be done to ascertain its effect on other pests. Also, acquiring the correct concentrations for maximum effectiveness is very important.

Key Words: *thrips, aphids, biopesticide, ginger, orange peel, turmeric*

(xviii) **Development of an Integrated Disease Management Programme for Black Sigatoka Disease in Guyana**

S. Pooran DeSouza

In 2017, preliminary results obtained from the Black Sigatoka Disease (BSD) management project have shown that out of the five varieties (PITA 17, PITA 21, PITA 23, PITA 27 and Grand Naine) evaluated under field conditions only PITA 17 performed well. PITA 17 took the least number of days to flower and fruit, produced large number of leaves with a very low disease infection index (6%) at bunch emergence. The tolerance of the variety to BSD allowed for adequate bunch filling resulting in average weights of 11.5 kg obtained from Mahaica and 17.3 kg from Parika. Grand Naine banana performed well at Mahaica. Plants were less than 2.5m tall, produced large number of leaves and follower suckers. It flowered within 218 days and was harvested at 288 days with average bunch weights of 21.8kg. Despite its good performance at Mahaica, it did not perform well at Parika. High disease pressure and susceptibility of the variety to BSD resulted in very poor yields. PITA 21, 23 and 27 were tolerant to BSD but their performance was not exceptional. Plants were tall with slender pseudostem, lower leaf emission, and few follower suckers with very low yields.

Key Words: *Black Sigatoka Disease, tolerant, PITA 17, PITA 21, PITA 23, PITA 27 and Grand Naine*

(xix) Environmentally sustainable management of Water Hyacinth (Eichhornia crassipes) in Guyana

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The increase of greenhouse gases and chemical fertilizer use due to the increasing energy needs and industrial revolution have contributed to climate change concerns prompting the need for alternative environmentally friendly and renewable sources. Water Hyacinth is a rapidly growing water weed whose management presents a challenge to the drainage system and a breeding area for mosquitoes thereby enabling the spread of diseases. Integrated control of water hyacinth can ensure economic and environmental benefits while keeping the population of this weed in check.

This research seeks to highlight an opportunity to derive economic and environmental benefits from water hyacinth thereby mitigating against environmental management issues. This research characterized biochar produced from water hyacinth at three pyrolysis temperatures and examined its suitability as a soil amendment along with its energy and carbon capture potential.

Increasing the pyrolysis temperature transformed the biomass matrices into a lighter and porous structure causing a decrease in density. There was an increase in ash and fixed carbon content while volatile matter decreased as pyrolysis temperature increased indicating a higher concentration of organic matter is available for carbon sequestration at higher pyrolytic temperatures.

Further, the presence of micro-nutrients and high pH makes biochar from these water hyacinth samples suitable as a liming agent and a soil amendment for vegetables, legumes and grains in open-field or shaded conditions. Also, the biochar is recommended as a fertilization and soil improvement additive to aid Guyana's agricultural production expansion into its Hilly Sand and Clay Region.

Key Words: *water hyacinth, biochar, soil amendment, carbon sequestration, drainage system*

(xx) An Assessment of the Potential use of Wind Energy for Supplying Power for a Crop Irrigation System

Vickram Persaud, Clairmont Clementson, Oudho Homenauth

The upward trends in the world's energy demands and the remarkably high and unstable fuel price could severely impact local agricultural operating costs. It is therefore imperative that, in order to make agriculture economically viable, alternative renewable forms of energy be incorporated into this very vital sector. Alternative renewable forms of energy would not only serve in the drive towards the greening of Guyana's economy, but also would significantly aid in national development. One such alternative forms of energy is the utilisation of the wind to power farm irrigation systems. This study seeks to design an effective and efficient irrigation system for NAREI's Commercial Farm; Field 30. The net irrigation requirement (NIR) of the area was determined and this was used to calculate the size of the pump and wind turbine required to satisfy this irrigation requirement. The NIR for NAREI's Commercial Farm, which is approximately 51000m2, was determined to be 14.86mm for the driest month of October. The recorded wind speed for the area was 290.4 km per day or 3.36ms-1. According to studies by the Irish Wind Energy Association, 2016 wind turbines require at least 3-5ms-1 winds to operate. It was found that a wind turbine providing 1.4kW of power would be adequate for operating the irrigation pump required for the farm. Based on the available weather conditions a wind turbine has to now be identified that would cater for the necessary parameters outlined above. It is recommended that a future study be carried out in determining the possibility of using solar power, in a hybrid system with wind power, for irrigation purposes.

Key Words: *wind energy, irrigation, net irrigation requirement*

(xxi) An investigation of bioenergy utilization in Guyana including environmental and economical impacts

Lalita Gopaul, Clairmont Clementson and Oudho Homenauth

The use of fossil fuels has been associated with climate change given the release of greenhouse gases at an environmentally damaging rate. Guyana depends mainly on imported petroleum-based products for its energy needs. This study sought to strengthen climate change mitigation efforts by investigating the use of bioenergy to supplement a portion of the fossil fuels used. Bioenergy sources were identified and quantified. With the use of a comparative approach, an analysis of the economic and environmental impacts of maximising their use and an assessment of the overall climate change effects resulting from such use, were conducted. Further, impediments and opportunities for the utilization of the bioenergy sources were identified.

Bioenergy sources identified in Guyana are rice husk from rice production, residues from the forestry industry, biodiesel from palm oil, cogeneration of bagasse, bioethanol from the molasses and biogas from cattle manure, sewage sludge, and urban and suburban waste. Without the addition of energy crops 8% of gasoline, 46% diesel and 100% LPG could be replaced by bioenergy sources. This replacement could result in foreign currency saving of US$ 111,637,110 which represents 31.43% of the current fuel expenditure. The utilisation of bioenergy can slow the process of climate change by lowering the net release of greenhouse gases into the atmosphere and reduce cost of energy consequently providing a plausible solution to the twin challenges of energy security and climate change mitigation. Bioenergy utilisation could eliminate 25% carbon dioxide, 36.14% particulates and 41.55% sulphur dioxide in Guyana. Cultivating the Giant King Grass as an energy crop can cover Guyana's energy demand with surplus for export and it can also sequester carbon with surplus for carbon credits trade.

Optimising bioenergy use can aid in transforming Guyana into a low carbon based economical model and to the forefront in the fight against climate change. However, the general challenges of investment, funding, awareness, political will among others must be addressed.

Key Words: *bioenergy, climate change, low carbon model, Guyana energy potential*

(xxii) Determination of the Rate of Reproduction of California Red Earthworms (Eisenia fetida)

Vickram Persaud, Lalita Gopaul and Oudho Homenauth

The exaggerated use of synthetic fertilizers has led to numerous environmentally degradative incidents and as such, more sustainable methods of crop production are required. An alternative is the utilisation of fresh cow's manure to produce vermicompost; for use as an alternative organic fertiliser. This study seeks to determine the rate of reproduction of Eisenia fetida, California Red Earthworms, and the rate at which these worms convert fresh cow's manure to vermicompost. Plastic buckets were set up with a thin layer of stones upon which 2" of sand was placed. In each bucket, 7 kg of fresh cow's manure was added, followed by some dried leaves. Varying numbers of California Red Earthworms were added to each bucket and each trial was replicated three times. Each bucket was then carefully monitored and watered, as the need arose, until they were completely converted to vermicompost. Upon completion of this process a population count of earthworms in each bucket was done. The buckets containing 20 worms had an average of 83 worms per bucket or a population increase of 417%. For the buckets containing 30 worms the average number of worms present in each bucket was 125 this translated to a population increase of 416%. Finally, the buckets containing 40 worms had an average population of 156 worms each or an increase of 389% in its population. The time taken for the completion of the process of vermicomposting varied based on the number of worms initially introduced into each container. On average, the buckets containing 20 worms took 90 days, those containing 30 worms took 79 days and those containing 40 worms took 71 days. Additionally, the quantity of vermicompost produced, per container was between 3.4−3.7kg. Polynomial Regression of time and population of the worms with quantity of vermicompost produced had an R2 value of 1.

Key Words*: vermicompost, Eisiena fetida, reproduction rate*

(xxiii) Determination of the Nutrient Release Rate of Vinasse on White Sand and Three Coastal Clay Soils

Clairmont Clementson, Lalita Gopaul, Vickram Persaud, Oudho Homenauth

The green revolution saw increased usage of inorganic fertilizer which boosted food production. This however, resulted in the deterioration of soil and water quality while their production also contributes to climate change. As such, researchers are now seeking to enhance the use of organic fertilizers to ensure sustainability of the agriculture sector. One such organic fertilizer is "vinasse" which is a liquid byproduct of the bioethanol demonstration plant in Guyana. Multiple studies done in Guyana found vinasse to be an excellent soil amendment. A study was conducted to investigate the rate at which nutrients are released from vinasse when applied to soils. The experiment was carried out over a period of twelve weeks using four soil types namely white sand and three coastal clay soil (Whittaker series, Onverwagt Series and Weldaad Clay). Vinasse was applied to each container of soil at a rate of 62.5ml and soil samples were analyzed at two weeks intervals for essential nutrients and weekly for electrical conductivity. The study found that vinasse contained all essential macro and micro nutrients tested for and after application they were identified in the soil except for copper which was not detected in some soil types. Over the course of the experiment, the concentration of all nutrients increased in varying non-linear patterns and while potassium, magnesium and zinc decreased between the tenth and twelfth weeks phosphorous, manganese, iron, and calcium continued an upward trend. The three clay soils showed similar trends in nutrient content throughout the experiment while nutrient content of sand was significantly lower and varied extensively over time. It was recognized that as the electrical conductivity of the soils increased between weeks five and ten, nutrient concentrations increased correspondingly. This implies that nutrients are more available for plants to uptake between this period. The use of vinasse as an organic fertilizer would result in continuous nutrient availability for at least twelve weeks.

Key Words: *vinasse, nutrients, electrical conductivity, release rate, sand, clay*

(xxiv) Development and Implementation of a Solar Powered Irrigation System

Vickram Persaud, Lalita Gopaul and Oudho Homenauth

Over the years, fossil fuels have proven to be unsustainable in that their combustion releases greenhouse gases at an environmentally damaging rate while their sources are bound to be depleted. This has led to the development of alternative sources of energy such as wind, hydro and solar energy. There is a national aim to transform Guyana into a green state, completely switching to renewable energy for power generation by 2020. Currently, farms across Guyana depend solely on fossil fuels to power their irrigation systems. As such this project seeks to design a solar powered the irrigation system for NAREI's Commercial Farm on Field 30 (51000m2). The net irrigation requirement (NIR) of the farm was determined to be approximately 14.86mm for the driest month of October. This was used to calculate the size of the pump and solar photovoltaic system required to adequately irrigate the farm. Average daily irradiance for the Mon-Repos areas is 4.73 hours. Using these parameters, the power of the pump required for irrigating Field 30the Commercial Farm was determined to be 4.4kW while 0.2kW was required for the Tunnel House. It was found that, a 1000W solar panel would provide adequate power to irrigate Field 30 while a 200W solar panel would be adequate for the Tunnel House. Further, a design for the irrigation system proposed by the Guyana Energy Agency, shows that there can be a reduction in the amount of power needed to irrigate Field 30 by taking advantage of gravity and water storage systems.

Key Words: *Solar power, irrigation, feasibility, environmentally sustainable.*

(xxv) Green Technologies and Sustainable Agricultural Practices for the Rupununi and Intermediate Savannahs

Lalita Gopaul, Nariefa Abrahim, Oudho Homenauth

Agriculture is predominantly done on large scale along the Coast of Guyana. Considering climate change and its effects, this stretch of land is extremely vulnerable especially since it houses approximately 90% of the country's population. In an effort to ensure food security in the country and to reduce food imports in the Caribbean while adapting to and mitigating the effects of climate change, the Rupununi and Intermediate Savannahs are being developed for agriculture. However, it is essential that this development does not jeopardize the integrity of the environment and the wellbeing of the population but at the same time it should be profitable. This study seeks to identify applicable green technologies and sustainable agricultural practices for the Savannahs. The adoption of green technologies such as solar photovoltaic systems, small hydro power plants and the use of biofuels for energy is necessary. Sustainable agricultural practices that can be utilized include the integrated farming systems, organic farming techniques, agroforestry, zoning for conservation farming, crop rotation, cover cropping, land rotation diversity, ecological weed and pest management, sustainable soil and water management and the use of Information and Communication Technology to facilitate these practices. There have been partnerships with neighboring Brazil in agricultural development and as such, Guyana can learn from the Brazilian agricultural model since the two countries share similar geography. There are however, several impediments to the adoption of the identified technologies and practices in the Rupununi and Intermediate Savannahs. These fall under the broad categories of financial and infrastructural constraints, complicated weather patterns, poor soil types and water availability, remoteness of the lands and insufficient education and information and communication technology.

***Key Words**: green technology, agriculture, Interior regions Guyana*

2.0 STATUS REPORTS OF WORK IN PROGRESS/ INITIATED

i. Programme for Breadfruit

Two varieties of breadfruit plants were donated to Guyana as a Hunger Initiative from Global Breadfruit, U.S.A. for the distribution to farmers. The varieties are Ma'afala and Ulu fiti.

1008 plants were acquired in June, 2016. 507 plants of the Ma'afala variety and 501of the Ulu fiti variety. Plants were transplanted to potting bags on arrival and watered when necessarily and maintained under shaded conditions. They were later transferred to larger potting bags and placed on the hardening floor where they were watered daily and fertilized twice per week with NPK 20:20:20 at a rate of 220mg/L. Weeds were removed when necessary.

Of the 1,008 plants acquired, one hundred and ninety-one plants died; 90 plants of the Ma'afala variety and 101 of the Ulu fiti variety. A total of 817 survived.

Breadfruit plants were planted at various NAREI Nurseries: six plants at Timehri Nursery, two each at Bartica and Poudreyen Nurseries and eighteen in NAREI Compound Mon Repos. Sixty-four plants were also planted and eleven replanted at field 28 Agriculture Road Mon Repos. Twenty-five plants were also donated to the Ministry of Agriculture for various locations across Guyana; five each to Indigenous People's Affairs and the Ministry of Presidency. Plants were also sold to farmers at a subsided cost. A total of three hundred and forty-five plants were sold to farmers.

Regions for distribution were selected based on the predominant areas of cultivation of this crop and farmers were selected by extension staff of NAREI. Distribution of Breadfruit was done in four regions (4, 5, 7, and 10). Farmers were given five plants each in the regions 4, 5 and 10. In region 4 eighteen farmers received plants, six farmers and a primary school for region 5, seven for region 10 and forty -seven farmers for region 7. Data collection will begin in January, 2018 and will be done every six months.

ii. Evaluation of Rhizobia Strains in Field 17 shade house

Four rhizobia bacterial strains isolated and extracted from Jack bean (Canavalia ensiformis), Sunn hemp (Crotalaria juncea), Sesbania White Stem and Sesbania Red Stem are being tested for efficacy using feijou as an indicator crop. After two cultivation cycles under shaded conditions, Jack Bean and Sesbania White Stem were comparable in nodule production, efficacy, and 100 seed weight to the established rhizobia bacterial strain 178. The third cropping cycle is at the harvesting stage of the crop. Field testing of preliminary shade-house results are in its second season at Kairuni – NAREI and will continue in 2018. Successful results will realize fresh bacterial strains being added to NAREI collection for inoculant production.

iii. The Use of Mycorrhiza in Substrate Preparation for Crop Production

This project was initiated to incorporate Mycorrhiza in local soil substrate mixes and provide an effective substitute for imported PROMIX. It aims to enhance seedling quality and effectiveness of organic matter applications to plants. Preliminary observations indicated that vermin-compost with added mycorrhiza gave best results for early germination. One hundred and five (105) substrate mixes with various combinations Tabella sand, chicken litter, vermicompost, fresh paddy hull and bio-char paddy hull were analyzed for moisture and nutrient elements. The results were evaluated against PROMIX and nine (9) substrate mixes identified for further evaluation. Diagnostic parameters for this evaluation include: percentage seed germination, lightweight - low bulk density, water holding capacity, nutrient retention, mycorrhizae efficacy and field testing of seedlings.

- **Lemon**

Before treatment applications the following data were gathered the fruits have a diameter of approximately 8.3m, an average weight 108g, Brix of 5.6% , ascorbic acid of 25.53 mg/100g, an average tree spread of 2.4M and an average tree height of 2.8M.

- **Rangpur Limes**

Before treatment applications the following data were gathered, the fruits have a diameter of 4.8cm, an average weight of 98g, Brix of 7.5%, ascorbic acid were at 17.40 mg/100g of fruits, an average tree spread of 3.5M and average tree height of 8.5M.

- **West Indian Limes**

Before treatment applications the following data were gathered, the fruits have a diameter of 6.8cm, an average weight of 65g, Brix 6.7%, ascorbic acid of 25.01 mg/100g of fruits, an average tree spread of 4.5M and an average tree height of 3.6M.

- **Mandarin**

Before treatment applications the following data were gathered the fruits have a diameter of 4.2cm, an average weight of 83g, Brix 8%, ascorbic acid of 17.61 mg/100g of fruits, an average tree spread of 3.6M and an average tree height of 2.7M.

iv. Kairuni Nursery

At Kairuni two varieties are being evaluated. The varieties are Seedless and West Indian limes.
Treatments were applied twice per year Bio20 was sprayed on a monthly basis. The treatments are as follows Treatment one control (Recommended Dosage of Fertilizer (RDF)) (500: 300: 300g NPK per plant), Treatment two Bio20 (200g per plant),Treatment three 2.2kg of chicken litter, Treatment four NPK 250:150:150g RDF + 100g Bio20 per plant and Treatment five NPK 250:150:150 RDF + 1.1kg chicken litter.

- **West Indian Limes**

Fifty-Eight West Indian trees are being evaluated. Plants are thirteen years old (not all trees because some was recently replanted). Plants are bearing but they were few fruits when this preliminary data was taken. The following data were gathered before treatment applications the fruits have a diameter 6.5cm, average weight 54.3g, Brix6.3% and ascorbic acid of 25.09 mg/100g of fruits, average tree spread 3.2M and average tree height 3.4M.

For this variety no more data was gathered because there were no fruits available after treatment applications.

- **Seedless Limes**

In this trial twenty two trees are being evaluated. Trees are three years old and were last fertilized with NPK 12:12:17:2 in January 2016. The following data were taken before treatment applications: the fruits have a diameter 6.3cm, average weight of 145.9g, Brix 6.2% and ascorbic acid 16.07mg/100g of fruits; average tree height which was 3.6M and the average tree spread was 4.7M. In **Table 1 s**ix months after treatments were applied the following data was gathered **(average).**

Table 1: Treatment after Six months

Treatment	Diameter (cm)	Weight (g)	Brix (%)	Ascorbic acid (mg/100g)	Tree spread (M)	Tree height (M)
T1	5.7	110.9	7.6	29.05	4.3	3.5
T2	6.2	136.1	7.0	31.26	5.0	3.6
T3	5.4	107.8	6.2	25.97	3.1	2.4
T4	5.4	105.4	6.6	28.17	6.7	4.8
T5	6.7	155.9	6.5	26.85	5.5	4.5

During the year the amount of fruits harvested was also noted. For Treatment 1: 0.68kg, Treatment 2: 1.04kg, Treatment 3: 0.73kg, Treatment 4: 1.05kg and Treatment 5: 0.74 kg.

v. Evaluating the performance of two new varieties of breadfruit in Guyana

In March 2017 at field 28, thirty-four Ma'afala and thirty-four Ulu fiti plants were planted. At the initial stages of planting horses and goats damaged all the plants. Boulanger, pigeon peas, sorrel and ochro were intercropped between breadfruit plants However; no fruits were harvested because of pilfering and flooding. Plants were fertilized with NPK 15:15:15(0.45kg per plant). Plot was maintained by mechanized weeding and spraying of weedicide.

In NAREI compound eight Ulu fiti and eight Ma'afala breadfruit varieties were planted in July 2017. Plants were also damaged by animals. At the nursery orchard in NAREI Compound fourteen

plants seven of each variety were planted in March 2017. At Poudreyen and Bartica Nurseries one plant of each variety were planted in September 2017. At Timehri Nursery Five Ulu fiti plants and five Ma'afala plants were planted in May 2017. Plants were fertilized with 12:12:12:2(0.45kg per plant).

vi. Evaluation of new variety of tomato Gem Pride

Harvesting was halted due to wilting of plants from excess rainfall. From the harvested tomatoes approximately 85% was of good quality and was processed. Tomatoes paste was made in two batches, due to the nature of processing and the availability of the facility at the Guyana School of Agriculture. The Mongol F1 variety produced 12kg of tomato paste 4kg of ketchup while the Gem Pride 23.2kg was processed into 9kg of tomato paste and 5.7kg of ketchup.

Taste test was done with 85 persons from the following communities Melanie, South and North Ruimveldt, Herstelling and Haslington. In all areas persons concluded that there was no difference in taste between the two varieties of tomato paste. Minimum requirement for shelf life testing is one year. Products are to date 7 months in the shelf life stage. From production to this point all indication shows that the locally produced tomato paste stores significantly better refrigerated than at room temperature.

This experiment is in collaboration with CARDI and the seed company SEMINIS, NAREI has took the initiative to introduce a new variety that would be best suited for processing.

vii. Initiation of the production of virus free planting materials in sweet potato production on trellis

This project was implemented during the month of September 2016 at NAREI demonstration plot, Mon- Repos. Four trellises were constructed using steel posts aluminum wire, and cement, for foundation in the soil. The posts of 1.8M in length were suspended in the soil at a depth of 0.6M, while 2M spacing separates the posts within the ridges and a 1.5M separates posts between rows. Aluminum and binding wires were used to connect posts to allow for sweet potato vines to grow up on the trellises. Seven local accessions, Strong man, Amjad, Zebra, Cogle, Vanilla, Professor No.1 and Beauregard along with six accessions from the United States of America PB21, PB19, PB18, PB12, PB11 and Vaunderion were planted to grow on the trellis. These accessions were allowed to

grow upwards and vines were regularly assisted in growing on the trellis. Fertilizer (Blutrex Blossom) application was done at two weeks interval initially and once monthly after the third application at the rate of 15g per 3.7L (1gallon) of water. Weed control was done mechanically and manually. Mature seeds were harvested from all accession except Vaunderion. Ten seeds from each accession were scarified and sowed on the 28th of April, 2017. Whereby 100% germination occurred for all accessions. Six seedlings for each accession were placed in potting bags on the 16th of May, 2017, and allowed for the establishment and growth at the plant nursery. Fertilizer (Blutrex Blossom) applications were applied at the rate of 15g per 3.7L (1gallon) of water once every two weeks. Seventy six sweet potato plants were screened approximately 10 weeks after transplanting for acceptable qualities and number of tubers. Screening was done by the leading personnel, Dr. Garner from the University of Arkansas at Pine Bluff (UAPB). Twenty accessions were selected for continued assessment. These varieties were planted in the field at NAREI demonstration farm, at Mon-Repos, on the 20th September, 2017. Fertilizer Urea at the rate 160kg/ha, TSP- 150kg/ha and MOP 140 kg/ha were applied to the plants using the spot placement method 6cm away from the plants and 4cm below the soil. A second set of ten seeds were sown for each accession on the 10th of July, 2017. These accessions were planted in potting bags on the 2nd of August, 2017. Bluetrex Blossom was applied at two weeks interval after transplanting. 100 sweet potato plants screened on the 1st of November and thirty accessions were selected for continued assessment. These accessions were planted in the field on the 20th December, 2017. Sweet potato seeds were sown on the 17th of September and the 24th of November, 2017. Sweet potato seedlings are being maintained at the plant nursery for screening. 100 sweet potato plants were screened for desirable tuber quality and number. Weeds are being controlled manually and mechanically. Vy8 and Fastac were used inter-changeably for the control of leaf eating and sucking insects.

The research is based on selection of sweet potato genotypes for tolerance to environmental stresses grown under minimum cultural conditions in Guyana and participates in the National Sweet Potato Collaborators Group to evaluate regional standard entries and advanced breeding lines. Conduct cross-pollination studies on the inheritance of tolerance to environmental stress including drought, weed competition and low fertility. The purpose of this study is to collect information on yield and performance of commercially available varieties and advanced genotypes when grown in Guyana. Performance rating from 1-10 will be based on insect damage, appearance,

dry matter content and soluble solids. Entries from Land Grant Universities will be grown at UAPB. Production and grading according to the guidelines of the National Sweet Potato Collaborators. Inheritance studies will commence in greenhouse from seeds with parents highly rated on their tolerance to stresses in previous field test. Seven local and six USA sweet potato varieties or genotypes are being used and experiments conducted at the Agricultural Research Farm at NAREI and UAPB for yields and quality characteristics. Experiments will be conducted over four years namely 2015-2018 for the selection of suitable genotypes, and to identify optimum cultural practices such as in-row spacing and fertility.

This project is collaboration between the University of Arkansas at Pine Bluff (UAPB), NAREI and University of Guyana (UG) with funding from the UAPB.

viii. Evaluation of sweet potato varieties to sweet potato weevil susceptibility

This project is being conducted at Mon-Repos, field 17, which is known for high sweet potato weevil infestation. This trial re-commenced on the 15th of September, 2017 at field 17, Mon-Repos after it was destroyed by floods in July 2017. Seven local varieties Professor No.1, Amjad, Zebra, Vanilla, Strongman, Cogle and Beauregard are being evaluated in this trial. Slips were planted on ridges at a spacing of 30cm between plants and 75cm between ridges with three replications. Two Pheromone Traps were "setup" on the demonstration plot three weeks after implementation of the traps.

Over 3,000 adult weevils were captured three weeks of the traps were set-up. Traps are monitored and weevils counted weekly. Fertilizer application was done on the 3rd of October, 2017 at the rate of Urea at 160kg/ha, TSP at 150kg/ha and MOP at 140kg/ha. Weeds are removed manually. Pheromone traps are monitored and weevils counted weekly. This project will conclude on the 15th of January, 2018.

ix. Observational /Yield Trial for Onion under Shaded Conditions

In support of the Ministry of Agriculture crop diversification programme, observation trials continued to identify varieties of red and white onions adaptable to Guyana's environment. In 2017, two white varieties - Mercedes and Early Texas Grano and one red variety - Red Creole were

observed under shaded conditions. Two planting cycles were concluded for periods January to April and July to November. Days to emergence, transplanting and harvesting was 7, 30 and 149 respectively. Mercedes variety gave dried bulbs which weighed range 127 – 490.5g, 23 days of curing, and an un-refrigerated shelf life of 80 days; Texas Early Grano gave dried bulbs which weighed 86 – 327 g after 23 days of curing, and an un-refrigerated shelf life of 100 days; and Red Creole gave dried bulbs which weighed 67 – 170g after 23 days of curing, and an un-refrigerated shelf life of 100. These varieties have a production potential of greater than 17000 kg/ha and with no recorded incidence of pest and disease. The onion production chain was given a boost with the acquisition of a vacuum seeder, farmers' field school was conducted and its use demonstrated.

Based on the favorable results obtained for the cultivation of Red Creole onions under shaded conditions in 2016, open field cultivation was initiated but failed at Kairuni and Benab NAREI nurseries owing to inclement weather. In 2018, open field cultivations will be given greater emphasis.

x. Cultivation of Potato (*Solanum tuberosum*) Under Shaded and Open Field Condition

In support of the Ministry of Agriculture crop diversification programme, NAREI continued to collaborated with WUSC-PROPEL (World University Service Canada - Promotion of Regional Opportunity for Produce through Enterprise and Linkages) to identify agro-ecological areas in Guyana that are suitable for the production of potatoes. In 2017, two new varieties - Kennebec and Bristol Pride were acquired and included for observation with Spunta, Shepody and Chieftain. These varieties were planted and observed at Mon Repos shade house and in open field at Kairuni region 4; Fort-Wellington and Little Biaboo region 5, and St. Ignatius, Buru, Aishalton, Annai, Pirara, Manari, Shulinab and Takatu region 9; and Ebini region 10. Encouraging success was achieved at Little Baiboo and Mon Repos, however, at all locations, pests and diseases continued to be a major concern. These include aphids, broad mites, thrips, bacteria wilt, early blight and late blight. Unpredictable weather patterns led to crop loss and damage and in some cases early harvesting was done to secure seed material.

The potato production chain in Guyana benefited from a visit of a Jamaican team of experts working in Jamaica's potato chain. This interaction yielded seven main points for consideration. These include the need to:

a) Install a cold storage facility for planting material and produce.
b) Have easy access to phytosanitary testing and testing for toxins - solanine and chaconine, a related glycoalkaloid.
c) Establish and practice protocols for the industry, namely: cultivation, harvesting, postharvest treatment and storage.
d) Have access to varieties for testing – possibly sourced through linkages with China.
e) Implement tissue culture training as a medium term goal.
f) Organise the industry through partnerships with current importers and farmers using gentle persuasion.
g) Establishment of a Potato Unit within NAREI.

In 2018, efforts to access varieties that are heat tolerant and moderately resistant to early and late bight will continue, open field cultivation will be given greater emphasis. Areas targeted for cultivation include Little Biaboo – region 5, Kato – region 8, the Rupununi savannahs region 9, and the Intermediate Savannahs region 10. Also, the establishment of a cold storage facility will be addressed.

xi. Nutrient Studies in Cherry Cultivations

All activities in the observation plot at NAREI - Mon Repos and Bendorff EBE were focused on achieving and maintaining soil pH above 5.5, improving yield and decreasing deformation of cherries. The plot at NAREI could be described based on its performance pre and post May. During the period January to May, pH was below 4.7, fruit deformity ranged from 8-10%, yield/tree 0.5 – 1.0kg/tree and 100 fruit weight 300-305g, and soil moisture 30-35%. Compared to post May, pH was above 5.2, fruit deformity ranged from 3-0%, yield/tree 1.2 – 1.5kg/tree and 100 fruit weight 340-360g, and soil moisture 35-38%. Two of this projects' objective namely improving yield and reducing fruit deformity have been achieved, however, the parameter responsible for this response is yet to be diagnosed as both pH and soil moisture varied over the period. In 2018, pH control

plots will be established and the diagnostic parameter identified. To this end a moisture meter will be acquired to facilitate speedy soil moisture determination.

xii. Nutrient Studies in Sour-Sop Cultivations

All four observation plot were resampled in 2017 to determine and maintain soil pH above 5.5 as was achieved in 2016. Reduced pH was detected at all target areas: At Bendorff 4.8 in April, Kairuni 4.5 in May, NAREI-Mon Repos 4.4 in July and Ebini pH 4.2 in December. Observations during these periods included abortion of young fruit, deformed leaves, leaf galls (managed by serenade), seed borer, mealy-bugs (managed by abamectin 1ml/L) and sooty mold and whitefly infestation. It is instructive that incidence of pest and disease was recorded at Ebini, even-though preventative routine quarterly spraying of supertac is practiced and complete fertilizers are applied. General soil analysis to inform fertilizer application at all locations is in progress.

The average fruit weight at Bendorff is 2kg, Ebini-3.1kg, and NAREI-1Kg, however, fruit weight range is as great as 0.58 to 8.8kg and shapes range from oval to heart shaped. This raises the question of varietal differences. Thus, work on characterization of horticultural traits of soursop cultivars was initiated at all trial locations. Diagnostic parameters to be evaluated include: size, flesh consistency, pH, brix and shape aspect (height/width ratio).

(i) Production of Lettuce under Shaded Condition – 'Kitchen Garden'

The mini-shade house established on NAREI's Lawn at Mon Repos (since 2014) demonstrates the production of multiple crops in a limited space in a 'Kitchen Garden' scenario. This project promotes all year round vegetable production to sustain households in a climate smart environment such as the use of stilted raised beds, shade plastic and net.To date eleven cropping cycles of lettuce were completed at this facility. Results have shown that an average of 3 kg of lettuce can be harvested from 1m2. The average weight per plant is 0.1kg, average number of leaves amounts to 12 per plant and the average root length was 8.8cm. Crop duration ranges from 20 to 22 days. Lettuce cropping cycles are mostly affected by leaf minor, and managed by early removal of infected leaves at the earliest signs of infestation.

(ii) Comparison of Shaded Cultivation of Tomato with Roots Planted In line and 90° to the Main Stem

This project is aimed at increasing tomato production through improved root orientation. Tomato plants are grown with two rooting angles- 90^0 to the main stem, and 180^0 (in line with the main stem). Trials to assess the growth and productivity of tomato plants at these two root angles were conducted under protected conditions (shade net and plastic) in the Kitchen Garden and partially protected conditions (shade net only) in Field 17 of NAREI Mon Repos. This observational trial is in its fifth cropping cycle. Finding to date indicate that plants with 90° root angle came into fruiting 7-14 days earlier, has a longer root length (86cm to 53 cm), and give greater yield in both Field 17 shade house (1.5kg to 1.2 kg/plant) and Kitchen Garden (1.9kg and 0.8 kg/plant) for 90 and 180 degrees cultivation respectively. It may be concluded that 90° root angle facilitated greater uptake per unit root in the nutrient rich zone with its larger surface area.

(iii) The Use of Charcoal as a Soil Amendment on Degraded Soils in Guyana

This project is being executed with support from the International Institute for Cooperation in Agriculture (IICA) Flagship project - Resilience. It addresses post land-use challenges and hazard for reclaimed mine site in Guyana, and implements sustainable techniques to re-establish natural vegetation and improve soil quality. The fast growing Giant King Grass with its potential for use as an animal feed, biomass energy provider, and soil amendment as bio-char was the indicator crop. It was cultivated under shaded conditions to generate indicative results obtained as presented below.

Mine spoil/overburden has a bulk density of 1.18 g/cm3, water holding capacity of 23.9 %, pH – 5.60, electrical conductivity – 0.41, exchangeable acidity – 0.29 and organic carbon – 1.19. The charcoal used had a pH of 8.35 and water holding capacity of 65.5%. **Table 2** below showed the data taken from the First and Second Growing Cycles - 63 days after application of charcoal

Table 2: First and Second Growing Cycles - 63 days after application of charcoal

Treatment	Bulk density (g/cm^3)	Bulk density (g/cm^3)	Water holding capacity	Water holding capacity	Plant height (cm)	Plant height (cm)	Fresh Biomass yield ($kg/4m^2$)	Fresh Biomass yield ($kg/4m^2$)	Dry Biomass yield (%)	Dry Biomass yield (%)
1 – control	1.16	1.13	27.2	28.4	103.5	132.5	3.3	3.02	77.3	70.9
2 - 10t/ha	1.12	1.12	28.0	29.0	105.7	137.5	3.4.	3.24	80.0	70.4
3 - 20t/ha	1.08	1.07	34.4	33.1	116.7	152.5	4.1	4.14	79.1	69.3
4 - 30t/ha	1.06	1.04	40.9	43.0	112.8	142.5	3.2	3.80	80.5	70.4
	1st cycle	2nd cycle	1st cycle	2nd cycle	1st cycle	2nd cycle	1st cycle	2nd cycle	1st cycle	2nd cycle

The third cropping cycle will be harvested in February 2018, and data used to inform field trials.

xiii. Advanced Evaluations of the performance of cassava varietal entries in the drought-tolerant specialty-trait sub-set collection at Kairuni Research Station

Over a three-year period a total of 82 accessions were evaluated under field conditions for their response to field growing conditions, inclusive of severe drought and intense heat conditions, pest incidence, initials yields, growth habit and growth vigour at Kairuni Research Station. By mid-2017, 56 of these accessions were morphologically characterized according to the standard Bioversity International protocols. Twenty-one (20) of these accessions were assessed to be drought-tolerant and were subsequently extracted to form a drought-tolerant specialty-trait subset collection. The goal here was to further evaluate the field evaluation under a second round of drought-stress (the prevailing field conditions then permitting) and evaluate their differential yield performance under cultivation pressures of planting density, plant row design, allowed maturation period, planting method, mechanical defoliation. Altogether, four field trials were anchored between in August 2017.

xiv. Micropropagation and germplasm storage of Pineapples (Ananas comosus)

Seven varieties of Pineapples of pineapples were sourced and initiated during the year 2017. These were Montserrat, sugar loaf, black juicy, round white, Essequibo pine, pine A and pine X. Eighteen initiations were successfully carried out with these varieties. Montserrat was initiated twelves times during the year and the other six varieties once. The varieties Round white, Black juicy, Essequibo pine, Pine A and Pine X were lost due to contamination during the multiplication stage. Due to the

readily availability of the Montserrat varieties more initiations were done compared to the other varieties hence this variety was multiplied successfully. Three varieties from the previous year were weaned.

A total of 2818 pineapple plants were sent over to the green house to be weaned. Of the 2818, 731 were Montserrat, 82 pines #5, 6 pine#3 and 1999 English pine. Of the 2818 there was a survival rate of 60.9% and mortality of 39.6%.To date there are approximately 3000 pineapple plants in multiplication stage. A total of 89.5 L of media was made. 20 L were for rooting purposes and remainder for multiplication. Contamination proved to be predominantly higher in the rooting media and in Ga7 containers this is directly related to age and condition of the containers.

xv. In vitro conservation of sweet potato (Ipomoea batatas) using slow growth media

An in vitro protocol was developed for short (3 – 6 months) to long (1 year) term conservation of sweet potato accessions by modification of medium osmotic potential through incorporation of growth retardants namely mannitol and sorbitol. Nodal segments were obtained from sweet potato accessions previously multiplied in vitro on MS basal media supplemented with vitamin (inositol, 100 mg/l) and sucrose, 60g/l. Three sweet potato (Amjad, Viola and Bueguard) accessions were evaluated on three slow growth media; basal MS media supplemented 4% mannitol, basal MS media supplemented with 4% sorbitol and basal MS media supplemented with 2% sorbitol and 2% mannitol combined, and the control, which contained no growth retardants. A total of sixty cultures were used (3 genotypes x 4 treatments x 5 replicates). The aforementioned experiment is ongoing. To date the plants were assessed on height on a monthly basis up to three months. Height data will be collected up to 6 months for short term storage and one year for long term storage. The number of roots leaves and nodes, % leaf abscission and percentage survival will be scored at 2, 5 and 8 months respectively. Analysis of variance (ANOVA) will be used for indicating significant differences for genotypes, growth retardants and their interactions.

3.0 EXTENSION, TRAINING AND PROVISION OF SERVICES

The total targeted number of farm/field is shown in Table 3 and illustrated in Figures 1 and 2.

Table 3: Visits Per Region, 2017

Regions	Annual Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Reported Visits
Region 1	2,880	107	104	92	63	96	85	0	107	153	163	182	197	1,349
Region 2	4,592	-	282	207	210	241	321	377	286	288	437	312	309	3,270
Region 3	5,838	143	334	443	388	422	489	403	498	293	342	363	299	4,417
Region 4	6,672	254	343	318	318	274	301	301	304	198	230	272	266	3,417
Region 5	6,720	308	281	319	508	482	463	408	408	354	421	527	424	4,903
Region 6	4,368	44	164	211	246	249	247	153	132	172	171	279	259	2,327
Region 7	2,880	56	81	21	79	67	102	0	82	67	45	105	98	803
Region 8	2,305	79	131	176	216	237	210	230	196	0	0	0	0	1,475
Region 9	2,880	62	167	80	73	84	92	0	102	88	109	96	111	1,064
Region 10	4,410	67	134	53	59	90	0	8	12	53	92	100	86	754
Total	43,544													23,779
Achievement Rate	54.61													

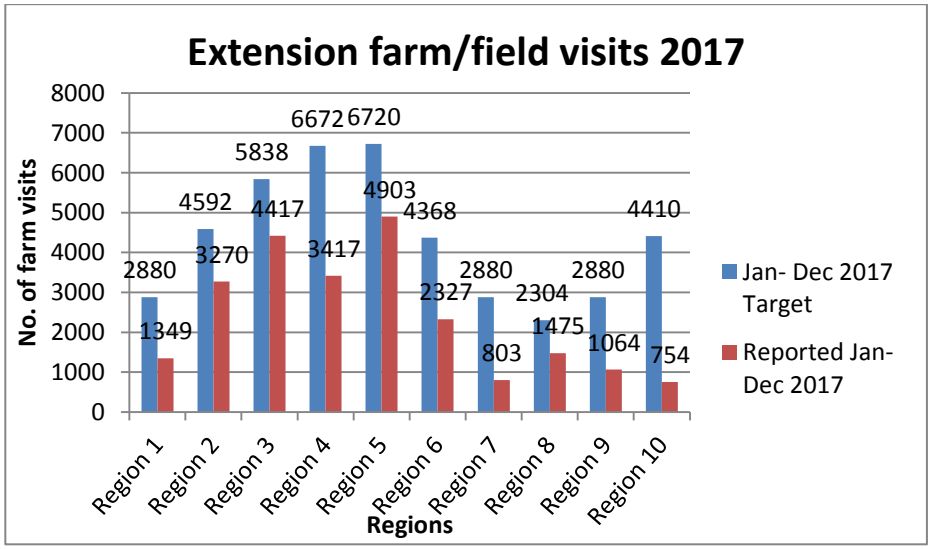


Figure 1: Number of field visits targeted vs the number reported per region in 2017

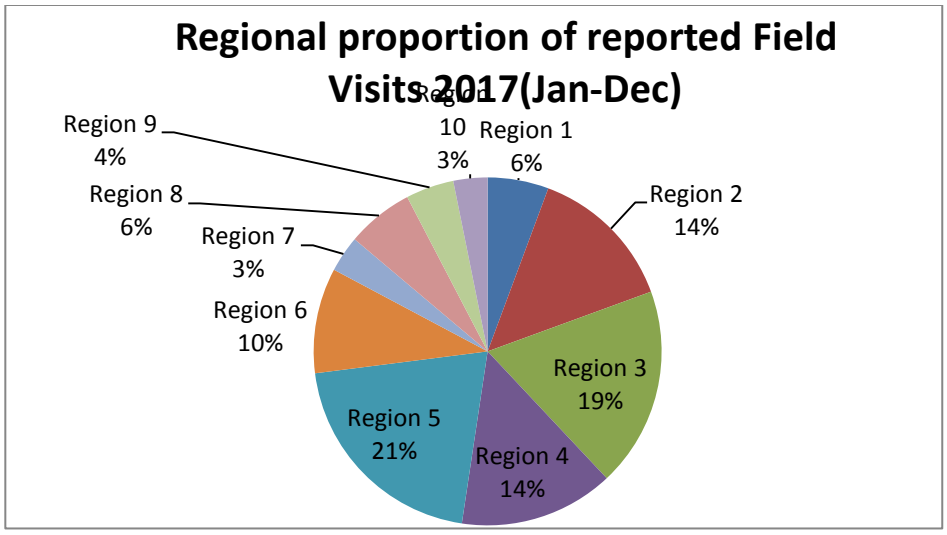


Figure 2: Region's contribution to the total reported visits in 2017

Training

The major training activities conducted in 2017 are shown in the Table 4.

Table 4: Training Conducted in 2017

Months	Programme	Number of training activities	Number of persons trained	Objective	Location	Achievement
January						
February	Benefits of composting.	**3**	**53**	Farmers know the importance of composting as it relates to plant nutrition and soil improvement.	(1) Affiance, E. Coast (2) Charity, E. Coast (3) Phillippi	Fifty three farmers can now make and use compost fertilizers on their crops.
March	Irish potato cultivation	**1**	**62**	To expose farmers to the technology and agronomical practices involved in growing Irish potatoes	Little Baiboo, Mahaica River.	Sixty two farmers acquired knowledge and skills in growing Irish Potatoes efficiently.
April						
May	Management of Black Sigatoka Disease.	**3**	**39**	To expose farmers to the integrated approach to B. S. D. Management.	(1) Jackloo, Pomeroon, (17) (2) Saint Cuthbert Mission, (11) and (3) Free And Easy, (11).	Thirty nine farmers are now better equipped with the necessary knowledge and skills to manage B. S. D.

June	Shade House Agronomy.	**2**	**32**	To expose farmers to Shade House Culture of growing crops.	(1)Perseverance, (17) and (2) Hybernia, (15).	Eight of these farmers have constructed shade houses and are now growing crops under same.
June	Good Agricultural Practices	**1**	**11**	To expose farmers to G.A.P. that would enable them to increase production and productivity.	St. Cuthbert Mission (11)	Eleven farmer are more efficient in managing their crops.
July	Growing Peanuts Commercially	**3**	**120**	To expose farmers to some new techniques used in growing peanuts	Orealla, Corentyne River.	Forty two persons are now more knowledgeable in growing peanuts.
	Growing peanuts	**2**	**40**	To expose farmers to practical agronomic practices involved in growing peanuts, e.g. applying limestone, fertilizing, earthing up, etc.	Orealla, Corentyne River.	Farmers were able to perform these tasks efficiently.
August	Growing Peanuts	**1**	**14**	To expose farmers to practical agronomic practices involved in growing peanuts,e.g. applying limestone, fertilizing, earthing up, etc.	Kabakabury	Farmers were able to perform these tasks.
September	Career Day. Exhibition and Fair.	**2**	**500**	To expose students to the different types of employment that exist in the field of agriculture, the basic requirements and institution where studies can be done.	Rosehall town, (300) and Canje Secondary School, (200).	Students were introduce to many different careers that can be pursued in the field of agriculture. Also, students were exposed to Budding and Grafting techniques. Students also performed the task.
September	Black Sigatoka Disease Management.	**2**	**61**	To expose farmers to the integrated approach to B. S. D. Management.	Parika Backdam and Little Baiboo.	Sixty one farmers are now equip with the necessary knowledge and skills needed to effectively manage B. S. D.
September	Capacity Building and Extension Methods.	**6**	**38**	To train staff to be more efficient and effective in their delivery of information.	N.A.R.E.I.'S Boardroom.	

September and October.	Budding and Grafting	**2**	**44**	To expose farmers to the techniques of Budding and Grafting, thus, would enable them to produce their own crops	Parika Backdam, (17) and Den Amstel, (30)	Thirty seven farmers are now equipped with the skills to produce their own orchard plants.
September	Climate Smart Agriculture; Shade House.	**1**	**14**	To expose farmers to a method of farming that would enable them to produce crops throughout the year.	Hague Backdam.	Fourteen farmers were exposed to growing crops under shade house environment. They were exposed to observing shade house construction, making of beds/boxes, mixing of potting materials, etc. Three farmers constructed shade houses and are now growing crops under these.
November	(1) Pest and Diseases Control. (2) Mixing and using Pesticides. (3) Pesticides safety precaution.	**6**	**53**	To develop in staff the ability to identify and treat simple pest and diseases.	N.A.R.E.I. (2)Onverwagt; (3) Tarlogie; (4) Den Amstel; (5) Christianburg; and (6) Charity.	Staff will be more knowledge in their content output.
November	Harvesting, selection and storing of peanuts.	**3**	**78**	Farmers should be able to harvest, grade and store peanuts according to market requirement and for replanting.	Orealla	Seventy eight farmers are now more knowledgeable in selecting and storing of peanut seeds.
November.	Types of pesticides, their uses and storage.	**1**	**30**	Farmers know that pesticides are dangerous chemicals, thus precautions must be taken when handling same.	Buxton	Thirty farmers can now identify and use pesticides effectively.
December.	Types of pesticides, their uses and storage.	**2**	**31**	Farmers know that pesticides are dangerous chemicals, thus precautions must be taken when handling same.	Free And Easy, (9) and Victoria, (23).	Thirty farmers can now identify and use pesticides effectively.
	Total	**41**	**1220**			

(1) Training of farmers and stakeholders in Black Sigatoka Disease Management

In February 2017, a two-day national workshop was held to develop a Geographic Information System (GIS) in support of Black Sigatoka Disease (BSD) Management in Guyana. A total of twenty-seven participants from various institutions of government and farmers took part in the workshop which dealt with development of recommendations for establishing interactive databases and map information systems to assist Guyana in BSD surveillance and management.

A total of one hundred farmers were trained in three separate farmers' field school activities held in July and August 2017 at Mon Repos, Mahaica and Parika. Farmers were introduced to Grand Naine, FHIA-02, FHIA-03, FHIA-21, and PITA 17, PITA 21, PITA 23, PITA 27 and our local plantain and banana varieties. Farmers were able to see the performance of the varieties under local condition against BSD and Moko disease pressure at some locations and were taught how to manage these diseases. Observations were made of the agronomic growth of the plant, the size of bunches produced and the fruit characteristics. Organoleptic tests of the varieties were also conducted with approximately 80 participants taking part in this activity.

(2) Land Use Services: Advice on optimal agricultural options

The SM&FM Department continue to play a pivotal role in determining land use options in Guyana. To this end support was given to:

i. The Ministry of the Presidency through the Office of Climate Change, through participation in its Technical Needs Assessment Steering Committee. NAREI has played a pivotal role in the process of realizing Technology Action Plans and Project Idea Notes for Mitigation and Adaptation for Guyana.
ii. The Ministry of Agriculture/ASDU in gathering soil data for the RAID project. Field work was completed in Ithaca West Berbice, and initiated in Buxton and Beterverwagting/Triumph ECD, and Mocha-Arcadia EBD

iii. Guyana Lands and Surveys Commission the focal point in the preparation and completion of the Cooperative Republic Of Guyana Land Degradation Neutrality Target Setting Programme National Report 2017- 2030.
iv. United Nations Development Programme - Japan-Caribbean Climate Change Partnership (J-CCCP). Stakeholder Consultation Report for the International Consultancy for Nationally Appropriate Mitigation Actions (NAMA) Development in Guyana (2017).
v. Production of a short film 'Seige On My Land - Guyana's Battle with Climate Change' (2017).

(3) Soil Laboratory Services

The department continues to provide soil analytical service to the agricultural community of Guyana. In 2017, 929 soil samples were received (farmers -243, researchers 227, mangrove department 188, UG Students – 26, and RAID – 177, and PROPEL – 68) representing a 31% increase over 2016. All samples were processed for analysis and fertilizers, limestone and organic matter recommended as required.

In October the highest number of samples/month – 141, was received for analysis and recommendations. Training in the use of soil analytical kits was facilitated by PROPEL in November 2016, improving the range and efficiency of services offered to farmers and researchers.

(4) Land Resources Assessment for Agricultural Production in Guyana

This project continues in its First Phase which includes facilitating the addition of both new and updated soil datasets for areas of prime agricultural interest. In 2017, the areas of interest included: Manari and Pirara – region 9, Ebini - region 10, and RAID project areas - Mocha Arcadia, Buxton and Beterverwagting/Triumph - region 4, and Ithaca - region 5. Project area boundaries were demarcated and survey lines established for soil surveys of the RAID areas; and existing soil data provided as requested. Efforts to improve technical capacity included a request for certified Geographic Information System personnel and a job description was prepared for this acquisition. Additionally, four of NAREI's technical staff benefited from introductory training in GIS. To date

29 of the 146 soils analog maps were scanned for digitizing. Maps prepared and added to database include:

a) Sketch map of NAREI Research Station Kairuni (in collaboration with Mangrove department).
b) Sketch map of NAREI Research Station (Mon Repos).
c) RAID project maps of Ithaca, Buxton, Triumph and Mocha.
d) Administrative map depicting quarantine areas for livestock in regions 1, 7, 9 and 10.

(5) Entomology, Plant Pathology and Weed Science

The Plant Pathology, Entomology and Weed Science Department of NAREI has been working in close collaboration with other sections within NAREI to routinely diagnose the varying insects, pests, diseases, parasites, virus and nutrient deficiencies that is affecting varying vegetables and fruit crops samples provided from regions, 3, 4, 5, 6, 10.

Information gathered from **Table 5**, the Lab has received approximately 115 samples for this year. 105 samples for plants and 10 samples for soils were processed. 7 soil samples were tested for nematodes.

Of the 115 samples examined, approximately 97 were fruits and vegetables, 1 filter paper was examined for contamination and more than 80% came from farmers. 32% were found with the pest and 89% with diseases and 3% with suspected nutrient deficiencies.

The identification of plant problems were done using visual methods to determine what plant parts were affected. Electron microscopy was used to identify the microbe(s) involved.

In addition special test were carried out on the samples, namely, moist chamber incubation, culturing and nematode test, to identify the Pathogen found on the samples.

With respect to the fruit and vegetable crop samples handled, we found that the most frequent fungal plant disease diagnosed are Fusarium wilt and Anthracnose and it is dominant in regions, 3, 4, 5, 6 &10. Other fungal disease identified were *Puccinia spc*, sooty mold, sclerotina rot and fruit

scab which affected mostly fruit crops. To a lesser extent, tomato, pepper and sweet pepper were affected by the fungal disease *Curvularia, sp.*

We also identified some bacterial diseases such as bacterial spots and wilt, moko disease and fruit blotch, and a few virus and nematode-affected samples. Several samples submitted were affected by poor nutrient deficiencies, insect damage and no pathogens were found, and other samples could not be processed due to poor quality of the sample.

All pests and diseases found are recorded and maintained to provide information for farmers, extension officers and researchers in the field to alert famers, exporters and quarantine officers of the pest and disease potential in the areas.

Table 5: Total Samples for the Year 2017

Common Pests	**Crops Affected**	**Recommendations**
Fungal Plant Diseases Fusarium wilt. (*Fusarium sp*.)	Poi, Banana, Pepper, Pumpkin, Tomato, Sorrie, Breadfruit, Boulanger, Cucumber, Celery, Eggplant & Pak-choi Regions: 4, 6 & 10	• Application of systemic or contact fungicide when necessary. (Carbendazin) • Practice field sanitation, crop rotation with non-host crops and provide good drainage.
Anthracnose (*Colletotrichum sp.)*	Passion fruit, Mango, Boulanger, Breadnut, Potato, Cherry, Guava, Lime, Pepper, Avocado, Breadfruit, Soursop, Pomegranate, Cucumber, Sweet pepper, Celery & Sorrie Regions: 3, 4, 5 & 6	• Practice crop rotation. • Use of contact fungicides, resistant varieties and improve sanitation conditions in fields.
Curvularia sp.	Tomato, Pepper & Sweet pepper Regions: 4 & 6	• Improve field sanitation • provide good drainage • Spray systemic fungicides • (Carbendazim) using recommended rate.
Puccinia sp. (rust)	Lime & Mango Region: 4	• Application of systemic or contact fungicide when necessary. (Carbendazim) • Practice field sanitation
Sooty mold (combination of multiple fungi)	Soursop & Tangerine Region: 4	• Use of contact fungicide at the recommended rate.

Sclerotinia rot	Pumpkin & Guava Region: 4	• Provide good drainage, apply soil fungicide (Carbendazim) at recommended rates, use tolerant/ resistant cultivars and practice crop rotation.
Fruit scab (*Venturia sp*.)	Shaddock, Citrus & Avocado Region: 4, 3 & 10	• Sterilize equipment, use of Carbendazim
Bacterial Plant Diseases Bacterial spots and wilt *(Pseudomonas sp.)*	Passion fruit, Tomato & Pepper Region: 4	• Use clean seed material that are tolerant/ resistant. • Do not plant in contaminated soil. • Apply copper based fungicide/ bactericide (2-3 applications)
Moko disease (*Ralstonia solanacearum*)	Plantain Region: 3	• Remove all bananas and plantains in the area and replace with other crops • Refrain from planting bananas and/or plantains within the affected area for 5 years
Bacterial fruit blotch	Watermelon Region: 5	• Application of copper based fungicide/ bactericide (Seranade) • Practice field sanitation, crop rotation with non-host crops and provide good drainage.
Virus CTV	Lime, Orange, Seedless Lime & Citrus Regions: 3,4,6 &10	• Remove all affected crops and sanitize affected area
Insects Common insects were: Stink bug, Lace bug, Fruit flies, Leaf miner Aphids, Whiteflies, Red palm mite, Weevil, Mites and Melon moth	Crops mainly affected: *Fruit* Guava, Lime, Coconut & Tangerine Region: 4 *Vegetables* Tomato, Pak-Choi, Breadnut, Sweet Potato, Tomato, Red beans & Cassava Region: 3 & 4	• Spray or inject with recommended insecticide when necessary (Caprid, Alverde, Abamectin, Pronto, Admire, Karate and Triazophus) • Remove weeds that are host for insect pest. • Practice good field sanitation • Use of Yellow sticky traps • Use of nets to cover fruits (protection from Wasp)
Physiological Disorders Nutrient Deficiency	Coconut – Fruit falling at premature stage Lime - Yellow leaves Region: 4	• Fertilize using micro-nutrients. • Use of potash and nitrogen

Parasitic Nematodes	Plantain, Tomato, Butternut squash, Celery, Lime & Potato Regions: 4	• Use of Vydate L, practice crop rotation, use of integrated crop management. • Use of tolerant/ resistant cultivars. • Fumigate soil if necessary.

4.0 HORTICULTURE

(a) Rehabilitation and expansion of a "medium density mixed orchard"

The main activity for 2017 was to rehabilitate the Mon Repos Orchard from its initial disorganized state of plants dominated with bearing root-stock, plots with missing trees, and the absence of common stands of plants. Tangerine and orange budded trees were pruned of dominant rough lemon rootstock, unfortunately only the tangerines survived. New plots of Tangerine (60), Valencia orange (60), Sapodilla (14), Guava (30), and Gooseberry (13) were established to create plots with appropriate spacing and layout. Single units of Malacca Apple (Cashew) (17), Sour-sop (20), Carambola (Five finger) (24) and Genip (7) were maintained and new plots planted with seedlings except for Mango, Psidium, and Star-apple. Plots of W.I Lime (30), Grapefruit (Red and White) (23 each), Breadfruit (16) and Breadnut (11), Suriname Cherry (30), Pomegranate (30), Sweet Tamarind (8) and Custard apple (14) were added increasing the genetic pool of the orchard.

(b) Implementation of a new grafting technique on mango: Stone grafting (epicotyl grafting)

The present procedure of mango seedlings production at NAREI limits rapid movement of plants to the orchard; seedlings are allowed to grow during a period of 4-6 months and then grafted which require minimum of two extra moths before take them to the fields. With the epicotyl grafting technique it was possible to produce grafted mango seedlings ready for planting on the field within 3-4 months period. Besides four (4) persons were trained on the execution on the technique: two from Mon Repos Nursery, one UG graduate and one GSA graduate.

(c) Nurseries

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

(d) Sales

In Table 6, the total sale for the period was $ 24,418,585.00 which surpass the Projected Nursery's target of $17,025,000. A total of 106,110 plants were sold during the period.

Table 6: Plant Sales and Production 2017

Nurseries	**January - December**	
	Number of Plants Sold	**Total Sale ($)**
Bartica	6,648	310,725
Benab	8,112	1,588,975
Charity	9,560	2,198,450
Fort Wellington	2,188	424,875
Hosororo	3,431	928,100
Mon Repos	34,396	8,083,080
Pouderoyen	19,364	4,632,030
St. Ignatius	3,806	825,750
Timehri	18,605	5,426,600
Total	**106,110**	**24,418,585**

5.0 THE INTERMEDIATE SAVANNAHS – EBINI

For the first six (6) months of 2017, the Ebini Unit achieved approximately 98% of its objectives as was detailed in its work programme for the first half of 2017. The establishment of the Drip Irrigation System was the only activity that was not completed due to the delayed arrival of the Orchard Plants from Mon Repos.

Our major constraint was the high level of precipitation which prevented us from successfully harvesting our Minica 4 crops which were planted during December 2016 and January 2017 and the harvesting of our Blackeye crops that were planted during January/February 2017. The recorded rainfall for the period January to June 2017 was 1358.7 mm as compared to 1157.2 mm for the corresponding period of 2016 – an increase of 14.85 (**Table 7**).

Table 7: Rainfall (mm) Recorded for January to June 2009-2017

Months of				**YEARS**					
of the Year									
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
January	178	158.2	148.7	153.3	39.8	123.6	263.3	6.6	94.4
February	102	64.4	112.2	213.8	332.4	181.2	102.3	113.4	224.9
March	79.1	154	491	64.4	63.9	4.1	99	24.6	110.2
April	140	290.7	57.7	324.9	187.8	92.7	123	329.5	20.1
May	64.3	623.2	120.5	240.7	441.5	130.6	273.9	358.1	372.2
June	213	243.8	132.4	220.8	411.5	309.1	225.7	325	536.7
TOTAL	776.4	1534.3	1062.5	1217.9	1476.9	841.3	1087.2	1157.2	1358.5

From 2009 to 2013 the recorded rainfall fluctuated with the average rainfall per month ranging from 129.4 mm in 2009 to 246.2 mm in 2013. From 2014 to 2017, the recorded rainfall per month steadily increased yearly from 140.2 mm during 2014 to 226.4 mm during 2017. If this trend of increasing recorded rainfall continues, we may have to review our planting dates for most of our crops.

In addition, the month of June 2017 recorded the highest amount of rainfall (536.7 mm) for all June months from 2009 to 2017 – moisture levels unsuitable for crop production.

CROPS

(a) MINICA 4

A total of 1.55 hectares of Minica 4 was planted between 8th December 2016 and 20th December 2016. An additional acre of Minica 4 was planted 26th January 2017.

A total of 1341kg of Minica 4 was shelled and 313kg was sold to Supermarkets, Staff and shops for a total price of $147,500. A total of 114kg was unfit for human consumption (discolouration of seed) and approximately 91kg (still in pods) was kept as seed material for the next crop. We also had 159kg that was spoilt (rain affected). A total of 364kg was sent to Mon Repos for Storage purposes.

(b) BLACKEYE PEAS

On 26/1/2017 0.5 ha Blackeye Peas was planted and the pre-emergent herbicide (Roundup) was applied on 27/1/2017.On 9/2/2017 this 0.5 ha was fertilized with a mixture of TSP, Urea and M.O.P. at the rate of 50kg/ac.

A total of 40.8kg was harvested 31/3/2017 from the 0.5 ha that was planted. Once again rainfall affected the yield of this crop. From the 40.8kg harvested, 15.8kg was in poor condition and it was decided to replant this crop during August 2017.

(c) PEANUTS

A total of 0.9 ha of Peanuts (Variety - AK62) was planted 14/6/2017. The pre-emergent herbicide Roundup was applied 1 day after at the rate of 200ml/20 L of water and on 29/6/2017 this crop received its first fertilizer application (12:12:17:2) at 45kg/acre. On 30/6/2017 the weedicide Fusil (12.5 EC) was applied at the rate of 200ml/ 20 L of water.

(d) CORN

One (1) acre of Corn was planted 21/5/2017 at 30 cm within rows and 90 cm between rows manually. Germination, estimated at 85%, was observed on 26/5/2017 (5 days after planting. The

amount of seed used was 11.5 lbs./acre and the first fertilizer application was on 30/5/2017. The second fertilizer application was on 15/6/2017.

(e) Mixed Orchard

The trees in this Orchard were as follows as at June 30th 2017: Pears 28, Mangoes 40, Oranges 35, Sour Sap 24, Pomegranate 6, Guava 16, Rough Lemon 35 and 7 Golden Apple trees.

All trees in this Orchard were fertilized twice during this reporting period and pruned once – to control height and shape. Circle weeding was done twice during this period and a general cleaning using the Bruch Cutter was done during January and April 2017. Fruiting was observed on the Orange, Sour Sap, Golden Apple, Pear during the second half of 2017.

Even though more rainfall (111.4 mm more) was recorded during 2016 as compared to 2017, the timing of the rainfall was significant in terms of its influence on our crop production during 2017 (**Table 8**). Crops that are planted during the November/December are usually harvested during February/March in the following year and, during 2017, the rainfall recorded February/March was 68.2 mm more than the average rainfall during the corresponding periods from 2009 to 2017. In addition, only the month of April 2017 (20.1 mm of rainfall) could have been considered as the only dry month for 2017 while, on the other hand, for the entire 2016 the months of January, March and October were pretty dry.

Further, the rainfall record during June 2017 (536.9 mm) was 271.9 mm more than the 8-year average of 265 mm for the corresponding period from 2009 to 2016 – conditions devastating for crop production.

Table 8: Rainfall Data (mm) from 2009 to 2017 and Average monthly rainfall data from 2009 to 2017

				MONTHS OF THE YEAR									
Years	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**SEPT**	**Oct**	**Nov**	**Dec**	**TOTAL**
2009	178	103	79.1	140	64.3	251	213	183	59.9	160	45	126	1602.3
2010	158	64.2	154	290.7	623.2	243.8	353.8	143.6	151.7	41.4	242.6	108.4	2575.6
2011	149	112	491.4	57.7	120.5	132.4	209.4	77.3	184.1	212.6	139.6	77.4	1963.3
2012	153	232	61.4	324.9	240.7	220.8	379.4	144	62.8	80.1	110.4	84.6	2094.2

2013	39.8	332	63.9	187.8	441.5	411.5	315.7	252.1	17.8	108.3	95.7	256.1	2522.6
2014	124	181	4.1	92.7	130.6	309.1	131.3	41	22.2	0	156.2	140.7	1332.7
2015	263	102	99	123	273.9	225.7	371.3	200	72.5	1.8	112	129.3	1974.1
2016	6.6	113	24.6	329.6	359.1	325	252.7	173.6	218	41.1	84.2	304.2	2232.1
2017	94.4	225	110.2	20.1	372.2	536.9	297.3	102.5	98.4	81.5	64.9	117.4	2120.7
Av. MTh	134	155	112	193	282	265	278	152	98.54	80.63	121.2	153	2024.38
Rainfall													
2009/17													

(f) Irish Potato

A total of 455 seeds – comprising of 5 varieties - was planted 18th February 2017. Those seeds were obtained from the Soils Department, in conjunction with PROPEL as part of their countrywide observation trials. The 5 varieties and their corresponding seed count were as follows: Bristol Pride 89, Chieftain 123, Kennebec 65, Shepody 78 and Spunta 100. The early on-set of the rains negatively affected the yield of this crop type. The data obtained from this observation Trial was sent to the Soils Department for analysis.

6.0 NATIONAL PLANT PROTECTION ORGANISATION (NPPO)

Introduction

The year 2017 was a successful one for the NPPO in terms of achieving the set goals and objectives that were set for the year. The Unit continued unabated with its plant protection activities that were all geared towards ensuring the smooth flow and acceptance of Guyana‟s exported agricultural products by trading partners, as well as the facilitation and quick processing of commodities during imports.

The major areas of success continued to be within the plant protection section of the NPPO, where our surveys and surveillances activities/ programmes very much impacted on the pest population densities of the major quarantine pests that are of concern to us and our trading partners. The NPPO strengthened its safeguarding continuum on the coast or major cash crop cultivation areas of Guyana and extended protection strategies for critical pests such as the Carambola fruit fly, red palm weevil, red palm mites and the med fly within the same areas.

Our quarantine services were enhanced through the continued exposure of staff to training and hands on demonstrations that were conducted by local as well as international experts. The closer collaboration that now exit between the NPPO and the Guyana Revenue Authority (GRA) served to ensure the capture and processing of all agricultural commodities that were exported and imported thereby reducing the chances of new pest introductions. Inspections and processing of exports and imports increased significantly and with also significant participations and cooperation from exporters, mills and other clients.

Farm certification remained an area of great challenge for the NPPO. Work will continue with in the New Year to ensure greater participation and buy in by farmers. However, notwithstanding the challenges, the NPPO was able to increase its farm visits and certified a total of one hundred and forty one farms.

Plant Protection Services

1) Carambola Fruit Flies

Of the ten (10) administrative regions, monitoring and control activities were conducted in seven, namely; Regions # 2, 3, 4, 5, 6, 8, and 10. Based on results obtain through the monitoring component of the program, the Unit recognized the need to implement Control measures in areas highly infested with CFF with the aim of reducing the population. The Unit was hampered greatly in this aspect due to the unavailability of adequate materials and Staff, only executing control activities in region 2, 8 and 10 during 2017. The unit carried out training of staff on all aspects on the Carambola Fruit Fly programs and well as other aspects of the surveillance unit.

According to Table 9, the Fruit Sampling component of the Carambola Fruit Fly (CFF) Program saw activities being done in similar regions previously survey in 2016 i.e. #3, 4 and 5 in order to conduct comparative studies, with this in mind the lab saw a total of 22 entries that were submitted resulting in the processing of 493 fruit samples.

Table 9: Total Fruit Fly Emergence per Region for 2017

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*	Other
3	406	803	744	252	472	0	20
4	36	182	182	66	116	0	0
5	51	0	0	0	0	0	0
Total	**493**	**985**	**926**	**318**	**588**	**0**	**20**

In assessing the Carambola Fruit Fly program, specifically the control component, with regard to its population and distribution in 2017, there is much need for more control activities and also the inclusion of other control techniques into the said component. The inclusion of techniques such as fruit collection and bait spays are more cost effective, environmentally friendly and easy to work with. The results of incorporation these techniques have shown to be the direction in which this unit will be moving toward in the future. More public awareness is also needed to educated farmers and imports on the use and sale of protein baits, making them readily available farmers will also be appreciative of the easy of application. This collective approach by the Ministry of Agriculture and other Stakeholders is what is needed to harness true control of the Fruit Fly situation in Guyana.

The Formulation of a Tri country (Guyana, Brazil and Suriname) Carambola Fruit Fly Control Project to be Funded by IDB currently in process also gives hope that the Fruit Flies situation in Guyana will improved once initiated.

Active surveillance for the Mediterranean fruit fly, Ceratitis capitata, continued throughout 2017. Multi-lure traps distributed in "high priority areas" were serviced and the results indicate that Guyana is still free from this pest. .

2) Red Palm weevil

The areas under surveillance presently are Pomeroon and lower Essequibo coast (Region 2), Landcaster and North Bygeval (Region 4), Farm, Fellowship and Letter T (Region 5). The RPW pheromone traps are presently disseminated within the aforementioned communities and are required to be serviced monthly and the pheromone lures changed quarterly. There are presently forty-eight (48) traps within region two (2), Fifteen (15) traps in region four (4) and twenty-seven (27) traps in region five (5) resulting in a total distribution of 90 RPW traps.

During this work year surveillance activities were limited to regions four (4) and five (5), where seventeen (17) new traps were established in region five (5). During surveillance activities,

officers dedicated time towards public awareness on the importance of the exercise and the basic identification of RPW, along with the adverse effects it has on coconut plants and production.

All traps serviced within regions four (4) and five (5) during this period were found to be negative for RPW. Hence, provides preliminary indication for the areas being free of RPW.

The officers of the unit were also exposed to RPW identification Training.

3) Red Palm Mite (RPM)

A total of 48 Surveys, surveillance and control activities for the Red Palm Mite (RPM) were carried out in Regions 2, 3, 4, 8, and 10. Within Region 2 surveys were carried out in Lower Pomeroon River area while in Region 3 the West Bank Demerara area was targeted. For Region 4 the areas targeted were the East Bank Demerara, Linden Soesdyke Highway. For Region 8 the areas surveyed were Madhia, Micobie, Tumatumari and for Region 10- Linden, Kwakwani and Ituni. Farmers, Residents and other concerned parties were educated on the threat of RPM and how to deal with same.

19,876 Coconut palms on Wakenaam Island, Leguan island, Hogg island, Trully island, Liberty island, Pomeroon river and along the Essequibo were treated with Inisan and Abamectin by injecting the trees at a 45-degree angle and applying 10 mls of the chemical for the treatment of the RPM. Chemical were also distributed to farmers in all of the above mentioned areas. Approximately 27,857 Water coconuts were washed in a bleach solution before leaving the Wakenaam Island. 50,425 Brooms were fumigated before leaving the Wakenaam Island with Phostoxin tablets in garbage bag for a period of 72 hours. 2,497,517 Dry coconuts were fumigated before leaving Wakenaam Island with Phostoxin tablets for a duration of 72 hours.

The Natural enermies population reared in the laboratory did not reach the required quantity to be release.

4) Pest Diagnosis, Advisory and Laboratory Services

For the period 2017; the surveillance team embarked on the strategic regional surveillance of Carambola Fruit Fly via fruit sampling within regions 3,4 and 5.. This methodology was employed to establish an organized way of assessing the status and geographic distribution of fruit flies across Guyana. A total of 22 batches being submitted resulting in the examination of 480 individual fruit samples. Fruits that were investigated included; Avacado, Achee, bilimbi, carambola, cashew (red), cashew(white), cherry (local), cherry (suriname), dunks, fat poke, golden apple, guava, Jamoon, lime, lemon, mammi, mango, nooni, orange, papaw, passion fruit, pepper, plum, pomegranate, psydium, sapodilla, soursop, sowry, star apple, tamarind, tangerine and whitey.

As shown in Table 10, An analysis of the acquired data from the examination of fruit sample revealed the emergence of 985 pupa and the evolution of 926 fruit flies; more specifically 588 Bactrocera spp, 318 Anastrepha spp, 0 Ceratitis spp, 20 Unverified .

Table 10: The number of pupa evolved in the surveyed regions

Types of Fruit fly	Number of fruit fly	Percentage
Anastrepha spp	318	34.34%
Bactrocera spp	588	63.50
Ceratitis spp	0	0
Unverified	20	2.16%
Total	926	100%

It is essential to recognize that this laboratory also aids in providing measurable service that contribute 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.

5) **Plant Quarantine Services**

The function of regulation, facilitation and administration of quarantine treatments were executed at the various official ports- of entry of Guyana such as the Cheddi Jagan International Airport, Ogle International Airport, Stabroek Market Wharf, Moleson Creek ferry crossing, Springlands, Charity, Parika, and at the various container terminals within Georgetown. Inspections of imported agricultural commodities and all regulated articles continued at wharves, terminals and at bonds and warehouses to facilitate the imports. A total of three thousand four hundred and eighty nine (3,489) inspections were recorded so far for the year. This number represents one hundred and seventy four (174) percent of the targeted frequency. The major imported commodities were: potatoes, onion, garlic, wheat, and spices.

The Quarantine department continued its surveillance activities for agricultural commodities that were illegally imported. Commodities that were rejected are those that were imported without an Import Permit, were pest infested and /or unfit for human consumption. For the period under review a total of three hundred and forty seven (347) interceptions/ rejections were recorded.

A total of four hundred and fourteen (414) Import Permits were issued for the importation of various agricultural commodities for the reporting period. This figure represents one hundred and thirty-eight (138) percent of the targeted frequency for the year.

A total of one thousand four hundred and eighty three (1483) ocean going Vessels were subjected to inspection to ensure compliance with phytosanitary requirements for all vessels entering the territorial water of a country. All of the vessels inspected were permitted to enter Guyana since they all met the requirements for entry. This figure surpassed the targeted frequency in the number of inspections conducted on arriving and departing ships.

A combined total of three thousand five hundred and forty-seven (3,547) flights were inspected at the two (2) International Airports (Cheddi Jagan and Ogle International Airports) for the reporting period. Quarantine officials inspected flights upon arrival and also passengers, passengers' baggage, cargo and ensured that international garbage were appropriately disposed

of Vehicles entering and or leaving Guyana that were subjected to inspection and phytosanitary treatment to eliminate the possibility of pests entering or leaving Guyana were thirty-two thousand and seven hundred and seventy-one (32,771) and represented one hundred and two percent of our target for the year.

A total of four thousand eight hundred and sixty-nine (4869) rice fumigations were supervised for the export of rice and rice products.

Seven thousand five hundred and ninety-six (7,596) inspections of exported agricultural commodities and regulated articles to ensure compliance with importing countries' phytosanitary requirements were conducted. The major commodities inspected for export included: Rice, Sugar, Lumber, Fruits, Vegetables, Sand and Charcoal (**Table 11**).

A total of three thousand nine hundred and twenty-two (3,922) phytosanitary certificates were recorded as issued for the reporting period. This figure represents approximately one hundred and twelve percent (112) percent of the targeted frequency. This is evidence of exporters' compliance in meeting the entry requirements of trading partners and the export requirements of Guyana.

Table 11: Commodities Exported and Phytosanitary Certificates (PC) Issued during 2016 and 2017

Commodity	**Phytosanitary Certificates Issued**	
	2016	**2017**
Rice	1,241	1,318
Sugar	132	83
Lumber	1,196	1,489
Fruits and Vegetables	423	479
Sand	33	56
Wheat Flour	28	70
Other	120	93
Commercial PC	**3,265**	**3,656**
Non Commercial PC	**260**	**266**
Total PCs Issued	**3,677**	**3,922**

6) **Farm Certification**

For the reporting period a total of three hundred and sixty-six (366) farm visits were made and one hundred and forty-one farms were certified for 2017. These farms were inspected and certified for the export of fresh fruits and vegetables.

7) WTO/ IPPC Enquiry and Notification Points

Two (2) enquires were made during the reporting period of 2017. A total of nineteen (19) draft documents (standards, guidelines, etc.) were received by Guyana for review and comments and also several questionnaires that were all submitted to IPPC and WTO regarding Quarantine Principles and Procedures for the period under review.

8) Pest Risk Assessment

PRA conducted base on request for new commodity importations. These were only one (1) such requests for the year 2017.

7.0 MANGROVE MANAGEMENT PROJECT

(a) Monitoring and Enforcement

The general objective of monitoring restoration sites is to collect and store data as part of an integrated monitoring system utilizing GIS technology and human resources and to share this information among the different agencies and stakeholders to improve the management of Guyana‟s Coastal Zone as part of an integrated Climate Change mitigation and adaptation strategy

(b) Monitoring Schedule

Table 12, the monitoring schedule consists of the following timelines for each planted restoration site.

Table 12: Monitoring Schedule

Time Zero	Measurements taken and observations made at start of process. Baseline measurements
0 - 3 months	Measurements taken and observations made after three months
0 - 6 months	Measurements taken and observations made after six months
0 - 9 months	Measurements taken and observations made after 9 months
0 - 12 months	Measurements taken and observations made after twelve months (Year 1)
0 - 18 months	Measurements taken and observations made after eighteen months
0 - 24 months	Measurements taken and observations made after twenty four months (Year 2)
0 - 36 months	Measurements taken and observations made after thirty six months (Year 3)

0 - 48 months	Measurements taken and observations made after forty eight months (Year 4)
0 - 60 months	Measurements taken and observations made after sixty months (Year 5)

The monitoring of sites where coastal infrastructure was implemented as the restoration intervention follows a similar schedule with the only difference being that the next measurement after Time Zero is taken after six months i.e. 0-6 months.

The **Table 13** below provides an overview of the sites monitored during 2017. Monitoring parameters collected at each site informed detailed reports on the impact of the restoration interventions.

Table 13: Individual site monitoring schedule 2017

Location	Restoration intervention	Date restored	Monitoring data	Series	Date completed	Comments
Region 2						
Lima	Plantation (AG)	2013	Elevation/Fore structure	Time 0+48	27-29 Oct 17	Extensive natural regeneration and growth of planted seedlings
Anna Regina	Structure (BW)	2013	Forest Structure	Time 0 Time 0+6	18-21 Apr 17 27-29 Oct 17	Natural regeneration; increase in elevation
					17	
Devonshire Castle	Structure (GT)	2014	Forest structure	Time 0 Time 0+6	22-25 Apr17 30 Oct-2 Nov 17	Natural regeneration
Region 4						
Victoria	Structure (GT) Natural	2011	Forest structure/Elevation	Site 1- Time 0+48 Site 2 Time 0 & Time 0+6	27-28 Mar 17 16-17 Sept 17	Rapid Assessment
Hope	Plantation (AG)	2011	Elevation/Forest structure	Time 0+48	10-13 Oct 17	Erosion occurring
Green Field	Plantation (AG)	2012	Elevation/Forest Structure	Time 0+48	28 Jun-1Jul 17	Erosion occurring

Better Hope	Plantation (AG)	2016	Elevation/Forest structure	Time 0+6 Time 0+9 Time 0+12	3-9 Aug 17 5-14 Jul 17 18-26 Sep 17	Extensive natural regeneration
Region 5						
Village No. 6-8 W.C.B.	Site 1 Plantation (AG)	2011	Elevation/Forest structure	Time 0+48	6-11 Sept 17	Extensive natural regeneration
Village No. 6-8 W.C.B.	Site 2 Plantation (AG)	2012	Elevation/Forest structure	Time 0+48	15-23 Mar 17	Extensive Natural regeneration
Region 6						
Wellington Park	Site 1 Plantation (AG)	2011	Elevation/Forest structure	Time 0+48	15-18 Jun 17	
Wellington Park	Site 2 Plantation (AG)	2012	Elevation/Forest structure	Time 0+48	15-18 Jun 17	
Wellington Park	Site 3 Natural	2012	Elevation/Forest Structure	Time 0+48	15-18 Jun 17	

AG- Avicennia germinans; RM – Rhizophora Mangle; LR – Laguncularia racemosa

BW- Brushwood; GT – Geotextile tube;

(c) Mangrove GIS Monitoring System

GIS is used as an integral tool in the mangrove monitoring system to capture and analyze spatial data for better planning and decision making. During 2017 the Department utilized GIS to assess and plan restoration interventions, monitor the impact and change overtime of restored sites based on the interventions implemented and captures monitoring data reported by rangers in the field.

Map products to guide restoration interventions, topographic and geotechnical surveys were developed. These included location maps of sediments traps i.e. brushwood dams and geotextile tube groynes in Region 2 and topographic surveys in Region 2 and 4. Data was collected on the completed coastal structures at Reliance, Mainstay and Land of Plenty on the Essequibo Coast in order to verify and track of the total length of the structures and establish baseline for long term monitoring of impacts.

Spatial data of erosion occurring along the coastline was update to the GIS database. Erosion was reported and observed in Regions 2, 3, 4 and 6. Notable erosion sites which were mapped include Greenfield, Hope Beach and Wellington Park.

The Department continued to provide support for the mapping and characterization of coconut plantations and the establishment of a coconut plantations geo-database. Spatial and attribute data on plantations located in Region #5 and #6 was updated.

(d) Enforcement

During 2017, the Department continued to collaborate with partner agencies, Guyana Forestry Commission and Environmental Protection Agency, to investigate reports of destruction to mangroves. A site visit was conducted in March 2017 with representatives from NAREI, GFC and EPA to investigate two issues: mangrove cutting for T-Shore in New Amsterdam and dumping of waste by saw millers in Canje Creek.

- **Mangrove cutting:**

Following a report by Mangrove Volunteer Ranger in New Amsterdam, an investigation was conducted regarding a contractor cutting mangroves for housing construction. The investigation revealed that the trunks of black mangrove trees were being as T-Shore to support the columns on a concrete house. Following this investigation the Guyana Forestry Commission issued a fine to the identified contractor.

- **Dumping of sawmilling waste**

The Wellington Park, Corentyne restoration site has experienced extensive erosion and loss of mangroves due to changes in soil conditions from extensive buildup of saw dust. The EPA and GFC were invited to investigate the source the pollution. The team visited four sawmilling operations in Canje Creek. The visit revealed that all of the saw milling operations were dumping their waste into the Canje Creek. This waste (sawdust) is then carried along the coast by the waves and deposited on sites with lower elevations such as Wellington Park. The result of this pollution has been the destruction of 490m of mangroves at the Wellington Park restoration site over a period of time.

NAREI discussed with the EPA and GFC the enforcement of environmental regulations which govern sawmilling operations and disposal of waste. At the end of 2017, no definitive action was taken by the regulatory agencies to regularize this situation. NAREI will continue to engage the EPA and GFC on this issue.

Discussion on status of mangroves along Guyana's coast

Monitoring of coastal mangroves carried out by the Department during 2017, reinforced the dynamic nature of Guyana‟s coastline and the need for research to inform understanding about the coastal dynamics, mud shoal movements and its impact of mangrove regeneration.

While there are a number of sites along the Essequibo Coast showing evidence of natural regeneration of mangroves as a result of previous restoration interventions (seedling planting, coastal structures) and accreting sediments, the opposite has been recorded along West Coast Demerara and selected sites on the East Coast of Demerara where erosion has resulted in significant loss of natural and restored forest.

(e) Restoration – Gains (+)

Significant growth and extension of mangrove forest at monitored restoration sites, both in forest length and width has be recorded at the following sites (**Table 14**).

Table 14: Restoration Sites showing significant growth and extension of forest

Site Name	Restoration intervention Type/Date (YYYY)	Extent as at 31/12/17 (Length/Width	Remarks
Essequibo Coast, Region #2			
Lima to Hampton Court	Seedling and Spartina Planting/2013	3,650m/60-150m	As a result of successful seedling planting at Lima the forest has extended to the neighbouring villages as the area accreted and the Lima forest provided a source of seeds.
Devonshire Castle	Geotextile tube Groyne/2014 Spartina Grass	1,155m/100m	Extensive Natural regeneration as a result of sediment buildup following construction of Geotextile tube groyne (**Figure 3**)
Anna Regina	Brushwood Dam/2013	300m/50m	Regeneration of forest within brushwood dam and further inland
East Coast Demerara, Region #4			
Chateau Margot/Success	Seedling planting/2011	750m/135-200m	Extensive natural regeneration north towards
Le Ressouvenir/Felicity	Seedling planting/2012	850m/220-280m	Extensive natural regeneration north towards Atlantic
Montrose/Vryheid's Lust	Natural regeneration	806m/80-150m	Extensive natural regeneration as a result of seed source from neighbouring
Better Hope to Sparendaam	Seedling planting/2016 natural regeneration	620m/30-70m	High survival of planted 2016 planted seedlings, and significant natural regeneration of neighbouring sites (**Figure 4**)
West Coast, Berbice, Region #5			
Village #2 (Zee Zight) to Village #9 (Expectation)	Seedling planting/2011/2012 natural regeneration	5,053m/200-600m	Seedling planting completed at Village #6 and 7 has resulted significant regeneration east and west of the planted site and north towards the Atlantic 9 (**Figure 5**).

Figure 3: Devonshire Castle, Essequibo Coast, Region #2, Geotextile tube groyne

Figure 4: Better Hope, East Coast Demerara, Region 4 (planted and natural regeneration)

Figure 5: Village No. 7 (Williamstoo), West Coast Berbice, Region #5

(f) Erosion – Mangrove Loss (-)

Monitoring has recorded mangrove losses due to erosion at several sites along the coastline, notable along West Coast Demerara, Region #3, Wellington Park, Region 6 and Hope Beach and Greenfield, Region #4. Losses at these sites have been attributed to the natural erosion cycle, with the exception of Wellington Park where saw dust pollution coming from the Canje Creek has resulted it loss of the mangroves.

Approximately 3Kilometers of mangroves was lost along West coast Demerara (Ruimzeight, Windsor Forest, Crane, Rotterdam) due to erosion which the Department started to monitor in 2014 (**Figure 6**). At the end of 2017, more than 98% of the forest was lost. Ministry of Public Infrastructure, Sea & River Defence Division has on ongoing project to construct hard sea defences (rip rap) to protect the community from overtopping due to the loss of the mangroves.

In Region #4, Hope Beach and Greenfield continue to recorded mangrove losses due to erosion. Approximately 30- 60m width of mangroves has been lost been to the front of the restoration site facing the Atlantic (**Figure 7**). While the Greenfield restoration site is currently experiencing losses, this is not as rapid when compared to Hope Beach. The soil conditions at the site changed from muddy clay to sandy sediments (sand and shells) which has resulted in loss of trees to the front of the forest (facing the Atlantic).

As reported in under "Enforcement" approximately 490m of mangroves along the Wellington Park foreshore was lost due to pollution (**Figure 8**)

Figure 6: Remaining mangroves along Rotterdam-Ruimzeight, West Coast Demerara Region #3

Figure 7: Map showing area of mangrove lost at Hope Beach, Region #4

Figure 8: Map showing the area of mangrove lost at Wellington Park, Region #6

Research and Development of Guyana's Mangrove Forest

The Department collaborated with two MSc students to fund their mangrove related thesis research.

Researcher:	Colis Primo
Supporting University:	School of Environment, Natural Resources and Geography
Research Title:	Understanding the Litterfall Dynamics of Restored and Natural Mangrove Forests (*Avicennia Germinans*) along Guyana's Coastline
Status at End of 2017:	Completed

Abstract:

The genesis of this research was to understand litter fall dynamics of natural, degraded and restored mangrove forests along Guyana coastlands. Having an in-depth understanding of the litter fall situation will allow both government and researchers to appreciate the differences in production rates between restored, degraded and natural forests. This research presents an opportunity for investigators to see if stand age and other environmental variables affect litter production, and provided an understanding of the effects of seasonality on the production and whether canopy structure and salinity has an effect on production.

This study was conducted at three independent areas, Village #7, Wellington Park and Hope/Victoria located along Guyana‟s coastal belt. All sample plots were developed prior to this research by the Guyana Mangrove Restoration Project. This research was conducted between the period of February – July 2017 spanning Guyana‟s wet and dry weather seasons. All litter traps were emptied on a monthly basis and oven dried for 72hrs at 70 0C.

In general, this paper argues that litter production of mangroves along Guyana's coast is influenced by seasonality with varying production levels emanating from the various sites studied. This study has shown that all three sites dropped leaves in both the dry and wet seasons. However, various peaks and drops in the production of litter were noted by the study.

Additionally, this paper could not definitively conclude that forest structure and age had an impact on the overall production of litter fall for all sites, since measurements were taken at the onset of the project. It also propose continuous monitoring in terms of structural development of the forest stands is needed for more definitive understanding of the various influences on litter production.

This research concludes that there are significant disparities in the production levels emanating from each site and varying factors located at the site can be responsible for the variation. It was recognized that a longer time period would be needed to develop a more in-depth understanding of the litter fall dynamics.

(g) Mangrove Protection and Rehabilitation

Following the steps of the Ecological Mangrove Restoration and the identified elevation of 2.3m -2.7m above C.D for successful mangrove restoration in Guyana, NAREI‟s 2017 restoration program focused on the following interventions:

1. Spartina grass planting
2. Seed dispersal trails
3. Coastal infrastructure

Spartina Grass Planting

Project Location: Walton Hall, Essequibo Coast

Date completed: November 2017

Description:

Walton Hall is located on the Essequibo Coast, Region #2 and is boarded by the villages of Devonshire Castle to the south and Paradise to the north. Mangrove restoration intervention at this site included construction of 340 meters of bamboo brushwood dam in 2015 and 2016. Spartina grass was previously planted at the site in 2015, however this was not successful due to the Sargussum seaweed which washed ashore and killed the grass.

In November 2017, 0.4 hectare of Spartina grass planted at Walton Hall within the boundaries of the brushwood dam. The objective of the planting is to support consolidation of the soil and promote natural regeneration of mangroves similar to the success of neighbouring Devonshire Castle.

Seed Dispersal trials

Project Location: Richmond, Essequibo Coast

Date completed: November 2017

The limited availability of seeds from a striving nearby forest has been identified as one of the reasons for lack of natural regeneration at several sites along the Essequibo coast where other critical criteria such as elevation is sufficient. In such cases, the intervention has been traditionally been focused on preparing nursery grown seedlings and transplanting these along the foreshore to support restoration. However, literature suggests that disbursement of mangrove seeds may potential be as effective as planting nursery grown seedlings which would be more in keeping with the natural process.

A small trial of seed dispersal was completed in Richmond, Essequibo Coast, Region #2. Avicennia germinans seeds were harvested from healthy forest (Hope Beach, Greenfield and Victoria). The seeds were then soaked for 7 days to fully germinate to a minimum of two leaf shoots. The seed were then disbursed within three 10mx10m plots and places 1m, 1.5m and 2m apart in each plot.

Monitoring conducted in December 2017 indicated that the seeds trail was unsuccessful. The methodology will be reviewed and a new trial designed for implementation in 2018.

(h) Coastal Engineering Interventions - Brushwood dams/Sediment Traps Concept

Guyana‟s intertidal zone is made up of long, sloping, 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 four kilometers, 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 is the situation under which the mangrove forest of the north coast of South America has evolved, and with which it can be presumed to have been in some sort of dynamic equilibrium. However, in recent decades, as the mangrove belt has been progressively depleted, the dynamics of the system seem to be overriding the forest‟s ability to recover from an erosion cycle. The sea defence structures also probably play a role in the destabilization of the mangrove forest. They interrupt the normal wave energy flow onto the land, and restrict the ability of mangrove stands to shift their boundaries as sea levels rise.

Further, complications are possibly created when fresh water running off the land is interrupted by sea defence structures and channeled into drainage canals, thus altering the natural dispersion of fresh water into the mangrove forest.

The National Mangrove Management Action Plan (NMMAP, 2010) identified the need for coastal engineering structures which can reduce wave energy and permit the deposition of sediments and encourage accretion and stabilization of coastal mud banks. These structures could be groynes (structures that extend perpendicularly into the intertidal zone from the sea wall) including low-cost, permeable, low-crest structures and breakwaters (parallel to the sea wall).

An alternative to groynes, are brushwood dam/ sediment traps, in the form of low crest, low cost structures running parallel to the shore and acting as wave force breakers. These can be constructed at relatively short notice, and could be the essential element in efforts to protect established and developing stands from erosion.

As part of its 2017 Capital Programme, NAREI designed and implemented two projects along the Essequibo Coast:- Geotextile Tube groyne and bamboo brushwood dam field.

(i) Design Concept of Brushwood Structures

The objective of the brushwood dam project is to stabilize the shoreline and promote reforestation of mangroves by gradually allowing sediments to deposit and consolidate. It

is also desirable for the project to have no adverse impacts to adjacent shorelines (i.e. cause increased erosion of adjacent shorelines).

The project must remain functional during the typically daily water levels and wave conditions in order to be effective in accumulating sediments. In addition, the structure should remain stable when subjected to the 10 year return period water level and wave height.

The brushwood dam was chosen for several reasons:

- Biodegradable – estimated lifespan of 3- 7 years
- Low cost, easy to construct compared to a rubble mound breakwater or groyne

Brushwood structures can be classified as groynes/breakwaters created by placing timber or bamboo piles in the form of rows parallel or perpendicular to the seashore. The piles of each row are placed 30cm apart while the width of the structure is approximately 60cm. Brushwood Dams are usually constructed approximately 1m above ground surface with embedment depth ranging between 5.5m to 6m below ground surface in most cases. In other instances the embedment depths will be deeper or shallower based on data produced after completing sub-surface geotechnical soil investigation. After the installation of two bamboo fences parallel to each other at adequate embedment depth, infill of bamboos or other materials, are placed within the two rows of piles and strapped taught with polypropylene ropes to complete brushwood dams. Bamboos are strapped horizontally across the rows of piles to enable an equal distribution of forces (from wave impacts, mooring of boats and other human actions) throughout the structures thus ensuring the structure has a longer life span. Finally, the structure is sealed by strapping short pieces of bamboos as braces across the width throughout the structure to prevent bamboos from escaping from within the structure while providing further structural strength. Short pieces of bamboos are also strapped below the bamboo infill to prevent sinking of materials in the sling mud condition.

(j) Design Concept of Geotextile tube

The groynes are designed to absorb energy from the ocean to the shore, trap sediment from long shore drift, and significantly reduce coastal erosion. Over time, the elevation of the foreshore is expected increase to an elevation suitable for mangrove forestation. It is anticipated groynes will accelerate restoration by creating a larger footprint of suitable foreshore elevations over a much shorter timeframe than what would naturally occur in the absence of groynes.

The geotextile tubes structure are completed using geo grids, scour aprons, anchor tubes, geotubes and user friendly fill ports. The construction of this groyne employs the following methodology:

- Placement of geo grids to act as part of the structure required foundation
- Positioning of scour aprons combined with anchor tubes directly unto the geogrids to provide further foundational support and stability to the structure
- Fill anchor tubes to maintain steadiness of the underlying materials during the installation of the larger tubes
- Align and place geotubes unto scour apron and geo grids followed by sand filling using a slurry system

Theoretically, in order to ensure the successful completion of Geotextile tube groyne in the soft muddy foreshore conditions found along the coastline of Guyana, other engineering solutions should be incorporated along with geo grids and scour aprons to provide a safer working platform, optimal structural support and a significant reduction in ground settlement after construction of the tube. Engineering solutions to be included in the construction methodology includes but not limited to:

- Application of sand to create a beach-like foreshore to provide foundational support to the infrastructure as sand is highest in compressive strength when saturated.
- Construction of a rafter-like structure using iron bamboos placed unto the foreshore followed by the assembling of the geotube structure.

Both solutions are expected to significantly reduce shearing of top mud surface and ground settlement as these solutions will dampened the point loads to the underlying ground due to the structure.

(k) Implementation of NAREI 2017 Mangrove Restoration Programme

NAREI‟s 2017 Capital program included the construction of a 600m bamboo brushwood dam and 100m geotextile tube groyne on the Essequibo Coast.

The primary objective of the 2017 Capital Program is to extend the implementation of bamboo brushwood dams and the use of geotextile tubes to increase sedimentation and subsequently increase soil elevation at locations along the Essequibo Coast in Region No. 2. This was be supported by the completion of topographic and geotechnical surveys to inform the design of these structures and support analysis of data on the effectiveness of completed structures.

The foreshore along the villages of Land of Plenty to Bushlot was identified for the implementation of brushwood dams and geotextile tubes. These sites were selected based on assessment completed by the NAREI mangrove department.

- **Land of Plenty to Bushlot, Essequibo Coast, Region 2**

  The Land of Plenty to Bushlot restoration site is located along the Essequibo Coast within the Anna Regina Township and spans the villages of Land of Plenty, Mainstay, Reliance and Bushlot.

The foreshore of Land of Plenty to Bush Lot is approximately 2,567m linear length. This foreshore is protected by rip rap and earthen dam. The increased roughness and porosity of the revetment should theoretically reduce scouring of the foreshore area and promote mud accumulation due to the dissipation of wave energy. While this holds true near the north-western end of the site (Reliance to Bushlot), most of the foreshore to the southern end still remains stable with increasing mud accumulation and colonization of coastal grasses and mangroves.

A brushwood dam groyne field along with a geotextile groyne is proposed to attenuate wave energy and trap suspended sediments (sling mud) in the lee of the groynes. The addition of the groynes will accelerate mangrove restoration by increasing the area of suitable foreshore elevations over a much shorter timeframe.

The livelihood of the residents of the four villages is heavily dependent on agriculture. Essequibo coast can be described as the rice producing capital of Guyana. The population of the four villages is 1,852 (Census, 2012) comprising 545 households (**Table 15**). The majority of the housing is situated along the main access road approximately 200- 800 meters from the existing sea defence structures.

Table 15: Household Data, 2017

Village	No. of Households	Male	Female	Total population
Land of Plenty	66	78	73	151
Mainstay	27	46	44	90
Reliance	255	461	425	886
Bushlot	197	355	370	725
Total population of Project site	545	940	912	1852

Population of restoration site (Census 2012)

- **Geotextile Tube Groyne**

Project Name: Installation of Geotextile Tube along the foreshore of Reliance, Essequibo Coast, Region No. 2

Contractor: Samaroo‟s Investment

Contract Sum: GYD13, 864,000

Commencement Date: September 20, 2017

Completion Date November 15, 2017

Supervisor NAREI Engineer, Luandra Jack

Design objective

Two 50m geotextile tubes established perpendicular to the shoreline to reduce longshore drift and shoreline erosion. The expected result is reduction in longshore drift and re-establishment of conditions conducive to mangrove establishment.

Status as at 31st December 2017 Completed

Length of shoreline (parallel to shoreline) to be restored 880 meters

Site Description

The geotextile tube groyne was implemented on the Reliance foreshore. The Reliance foreshore is composed of soft to medium dense mud with significantly low elevation. The foreshore is also comprised of a sea defense structure (riprap). Vegetation along the foreshore consists of extensive growth of *Cyperus articulatus* extending approximately over 100 meters from the base of the rip rap structure (**Figure 9**). Mud particles are transported along this site in a north- westerly direction but are not allowed to consolidate. Hence, the geotextile tube groyne was recommended to aid in the slowing down of the water forces to promote sedimentation and allow to mud particles to consolidate.

NAREI introduced two geotextile tubes to form a 100m groyne to trap sediments transported along the foreshore of Reliance (**Figure 10**). Geotechnical investigation (sub surface

investigation) was completed in June 2107 to assess the soil shear strength/bearing capacity and stratification to provide generalized knowledge of the sub-surface of the foreshore to inform the design and construction methodology of the structures.

Engineering Design

The project entailed the installation of a 100m Geotextile Tubes along the Foreshore of Reliance, Essequibo Coast, Region # 2.

Two bamboo rafters measuring 6.4 meters wind and 51.8 meters long were fabricated and installed on the forshore. The bamboo rafters were used as part of the foundation of the tubes. The foundation for the geotubes was further reinforced by pumping sand on the rafters 1m from ground surface at location designated for the proposed structure.

Two 50m Geotextile Tubes and two 52m Geotextile Scour Aprons were then placed at the foreshore of Reliance to form a 100m groyne. The orientation of the groyne is 90 degrees to the Reliance Seawall.

The final step entailed the pumping of sand into tubes using a gravel pump and elevated pipe system.

- **Status of implementation as at 31 December 2017**

The construction of the 100m geotextile tube groyne along the foreshore of Reliance, Essequibo Coast was successfully completed on 15 November 2017. The nature of this project required the use of machinery and was not heavily labour intensive, employment for eight persons from the Essequibo coast during construction.

Figure 9: 100m geotextile tube groyne with Cyperus articulatus in foreground, Reliance, Essequibo Coast, Region No. 2. Date 13 Dec 2017

Figure 10: Completed 100m geotextile tube groyne, Reliance, Essequibo Coast, Region No. 2 during high tide. Date: 12 Dec 2017

Expected outcome

The structure is expected to support the restoration of 880 meters of mangroves parallel to the shoreline by reducing wave action along 530 meters with the lee of the structure and tapping sediments along 350 meters.

Overtime, the elevation of the foreshore is expected to increase to an elevation suitable for mangroves to colonise. It is anticipated that the groyne will speed up the restoration of this area by creating a larger footprint of suitable foreshore elevations over a much shorter time-frame than what would naturally occur in the absence of the groynes. The phase in the restoration process will entail the planting of Spartina brasiliensis to promote soil consolidation.

Challenges

During construction a number of defects to the tubes were discovered which resulted in minor delay in project implementation. It was concluded that the defects were due to manufacturing fault and possibly poor storage. The defects were repaired to satisfaction and it is not expected that to have any impact on the structure. Monitoring the structural integrity will form part of NAREI‟s monitoring programme.

- ***Bamboo Brushwood Dam***

Project Name: ***Installation of a 600m Brushwood Dam along the Foreshores of Land of Plenty to Bushlot, Essequibo Coast, Region No.2***

Contractor: ***S&K Construction & Consultancy Service & General Supplies***

Contract Sum: ***GYD19,224,000***

Commencement Date: ***October 25, 2017***

Completion Date ***February 22, 2018***

Supervisor ***NAREI Engineer, Luandra Jack***

Design objective ***600m bamboo brushwood dams established perpendicular to the shoreline to act as sediment traps.***

Status as at 31st December 2017 ***90% Completed***
Length of shoreline (parallel to shoreline) to be restored
450 meters

- **Status of implementation as at 31 December 2017**

At the end of the reporting period four of the structures are 100% completed. These are:

- 100m of Brushwood dam placed perpendicular to the Mainstay foreshore
- 100m brushwood dam positioned at 45 degree angle to the Mainstay foreshore
- 100m brushwood dam constructed perpendicular along the Reliance/Mainstay border
- 100m brushwood dam constructed perpendicular along the Land of Plenty foreshore

 Construction of two 100m brushwood dams to be positioned at 45 degree angle to the Land of Plenty foreshore is currently on-going and expected to be completed by 3rd week of January 2018.

The nature of this project is labour intensive and required a significant labour force to achieve the desired results. Over forty six persons from Essequibo coast were recruited to harvest and transport bamboos and provide labour during construction.

(l) Public Awareness and Education on the Benefits of Mangrove Forests

Public awareness and education executed during the period targeted schools along the coastline through the facilitation of school tours, in-school presentations and summer camps during school vacation period (**Table 16**).

Public outreaches to achieve community buy-in of mangrove restoration included on-site one on one discussions, health outreaches, house to house awareness, church awareness, community meeting, tourism and exhibitions.

The mangrove Heritage Trail Tour continues its integral part of public awareness campaign and targets Guyanese and foreign tourists.

Table 16: M&E Public Awareness and Education 2017

Results Level	Ref #	Indicator	Unit	Baseline	Target	Achievement 31/12/17	Comments
Outcome	6.1	Increase national awareness about the importance of mangroves through the dissemination of information on mangrove restoration, protection and management	0	0	0		
Output	6.1.1	Number of students sensitized about the importance of mangrove (grade 5-6 students)	Number	700	650	283	
	6.1.2	Number of visitors participating in Mangrove Heritage Trail Tour	Number	449	1000	845	84% of target achieved. 88% increase from 2016

	6.1.3	Number of students participating in mangrove camps	Number	100	100	102	
	6.1.4	Number of persons reached through social media platform	Number	110	200	202	1275 page at end of 2017. 200new likes during year

(m) Mangrove Heritage Trail

The Mangrove Heritage Trail Tour provides a unique heritage and environmental tourism product to local and foreign visitors. Visitors to the tour for the year 2016 totalled 845 persons from government agencies and organizations, foreign tourists, students and local NGO"s. This represents 35 individual tours and an 88% increase from 2016.

The Table 17 below provides and summary of tours completed during 2017:

Table 17: List of Tours Completed 2017

#	Date	Agency/School/Tour Operator	Number of participant
	Agencies/Organisations (5/131)		
1	February 02	EPA mangrove tour	36
2	January 22	Conservation International	3
3	July 27	PAC zoo camp	29
4	July 20	GIS mangrove camp	8
5	July 06	National Science camp	55
	Schools/Universities (9/596)		
6	February 22	Tutorial Academy	51
7	February 28	Latchman Singh Primary	72
8	February 28	Patentia Secondary	171
9	March 10	Dominion School	52
10	March 16	ISA Islamic School	52
11	October 04	Berbice High School	50
12	October 20	Charlestown Secondary School	6
13	October 24	Marian Academy	69
14	March 15	Richard Ishmael Secondary	73
	Private Tour/Tour Operators (22/118)		
15	January 10	Private tour	4
16	January	Wilderness Explorers	3
17	January 29	Private tour	2
8	March 01	Wilderness Explorers	2

19	March 18	Wilderness Explorers	9
20	March 02	Roraima Duke Lodge	12
21	April 29	Private tour	1
22	May	Private tour	6
23	May	Private tour	6
24	July	Private tour	32
25	July	Private tour	6
26	July	Private Tour	2
27	August 15	Wilderness Explorer	3
28	August	Wilderness Explorer	2
29	August	Private tour	5
30	September 14	Wilderness Explorer	3
31	September	Private tour	2
32	September	Private tour	3
33	October 03	Wilderness Explorer	4
34	October 21	Wilderness Explorer	4
35	October 24	Wilderness Explorer	5
36	November 01	Wilderness Explorers	2

8.0 HUMAN RESOURCES DEPARTMENT, 2017

1. **RECRUITMENT - Forty-One (41) persons were recruited in 2017 as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

	Name	Designation	Date of Employment
1.	Jumain Hubbard	Crop Extension Assistant	2017-06-01
2.	Judason Bess	District Crop Extension Officer	2017-07-04
3.	Shivraj Singh	Crop Extension Assistant	2017-07-04
4.	Alvin Prabudial	Crop Extension Assistant	2017-07-04
5.	Leroy Bobb	District Crop Ext. Officer	2017-09-18
6.	Nicholas Chetram	Crop Extension Assistant	2017-09-07
7.	Aubrey Austin	Crop Extension Assistant	2017-09-11
8.	Althea Scott	Crop Extension Assistant	2017-09-11
9.	Emelio La Rose	Crop Extension Assistant	2017-09-18
10.	Allison James	Crop Extension Assistant	2017-09-18
11.	Robin Joseph	Crop Extension Assistant	2017-09-18
12.	Darwin Grenville	Crop Extension Assistant	2017-09-18
13.	Garfield John	Crop Extension Assistant	2017-10-16
14.	Jurena Robinson	Crop Extension Assistant	2017-10-16

B. **GENERAL ADMINISTRATION AND FINANCE**

	Name	Designation	Date of Employment
1.	Ishwar Mukhram	General Worker	2017-01-26
2.	Bobby Sikander	Security Guard	2017-01-29
3.	Premchand Parasram	Security Guard	2017-01-29
4.	Nandkumar Gopal	General Worker	2017-01-30
5.	James Rodney	General Worker	2017-01-30
6.	Surrendra Beharrylall	General Worker	2017-01-30
7.	Dwyte Henry	General Worker	2017-02-07
8.	Sunita Chitram	Confidential Secretary	2017-02-13
9.	Irvin Benjamin	Gen. Wkr. (Temporary)	2017-02-27

10.	Derol Gill	General Worker	2016-03-15
11.	Tishana Arthur-Persaud	Monitoring & Evaluation Asst.	2017-04-24
12.	Shellman Jones	General Worker	2017-04-03
13.	Elizabeth Campion	General Worker	2017-05-01
14.	Terance Ram	Human Resources Officer	2017-07-04
15.	Anandram Jankey	Driver	2017-07-24
16.	Kishan Daniels	General Worker	2017-08-07
17.	Badrie Harnarine	Security Guard	2017-08-09
18.	Romila Boodram	Communications Officer (Temp.)	2017-09-01
19.	Sundaram John	General Worker	2017-09-21
20.	Jankienauth Mohabir	IT Technician	2017-10-09

C. **MANGROVE**

Name		**Designation**	**Date of Employment**
1.	Kevin Paltoo	Admin. Asst. (Mangrove)	2017-02-06

D. **NATIONAL PLANT PROTECTION ORGANIZATION**

Name		**Designation**	**Date of Employment**
1.	Stacey Paul	Quarantine Officer	2017-12-11

E. **RESEARCH AND DEVELOPMENT**

Name		**Designation**	**Date of Employment**
2.	Jewel Todd	Research Assistant	2017-01-03
3.	Komal Wahab	Research Technician	2017-06-01
4.	Adrianna Wellington	Research Assistant	2017-12-11
5.	Tandika Harry	Research Assistant	2017-12-11
6.	Kimanda Pilgrim	Research Assistant	2017-12-11

2. **RESIGNATION – Five (5) persons tendered their resignations as follows:**

A. **GENERAL ADMINISTRATION AND FINANCE**

Name	**Designation**	**Date of Resignation**
1. Natalia Hutson	IT Technician	2017-09-30
2. Godfrey Bess	Internal Auditor	2017-10-09

B. **NATIONAL PLANT PROTECTION ORGANIZATION**

Name	**Designation**	**Date of Resignation**
1. Ansel Todd	Plant Protection Officer	2017-12-16

C. **RESEARCH AND DEVELOPMENT**

Name	**Designation**	**Date of Resignation**
1. Clarimont Clementson	Research Scientist	2017-03-21
2. Jewel Todd	Research Technician	2017-08-04

3. **TERMINATION – Two (2) persons services were terminated as follows:**

A. **GENERAL ADMINISTRATION AND FINANCE**

Name	**Designation**	**Date of Termination**
1. Bisnauth Raghoo	General Worker	2017-01-25
2. Pooran Persaud	General Worker	2017-07-26

4. **DISMISSAL –Five (5) persons were dismissed as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	**Designation**	**Date of Dismissal**
1. Kaimraj Kandhai	Regional Crop Ext. Officer	2017-01-23
2. Garfield John	Crop Extension Assistant	2017-06-08
3. Surrendra Winjajellum	District Crop Ext. Officer	2017-11-28

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Dismissal
1. Ms. Shivanie Rampersaud	Confidential Secretary	2017-01-16

C. **NATIONAL PLANT PROTECTION ORGANIZATION**

Name	Designation	Date of Dismissal
1. Simone Taylor	Quarantine Inspector	2017-05-04

5. **NON RENEWAL OF CONTRACTS – Nine (9) persons' contracts have not been renewed as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date not renewed
1. Desmond Hendrax	DCEO	2017-08-01
2. Alesia Bristol	Crop Extension Assistant	2017-09-01
3. Vibert Torres	Crop Extension Assistant	2017-03-31
4. Irvin Benjamin	General Worker	2017-06-26

B**. GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date not renewed
1. Kevin Balgobin	General Worker	2017-03-01
2. Mareica Gonsalves	General Worker	2017-05-01
3. Annie Grannum	General Worker	2017-05-01
4. Vernon Jones	Heavy Duty Operator	2017-05-01

C. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date not renewed
1. Colin Nero	Research Technician	2017-09-07

6. **PROMOTION – Seven (7) persons were promoted as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Promotion
1. Esther Lewis	Senior Crop Extension Asst.	2017-09-01

2. Eon Sampson	Regional Crop Extension Offr.	2017-09-12
3. Shamie McAlmont	Senior Crop Extension Asst.	2017-10-09
4. Joylene Hamilton	District Crop Ext Offr.	2017-12-11

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	**Designation**	**Date of Promotion**
1. Donette Harry	Senior Security Guard	2017-07-01

C. **RESEARCH AND DEVELOPMENT**

Name	**Designation**	**Date of Promotion**
1. Samantha Brotherson	Research Scientist	2017-03-01
2. Bibi Abrahim	Research Scientist	2017-10-09

7. **RE-DESIGNATION –Two (2) person was re-designated as follows:**

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	**Designation**	**Date Re-designated**
1. Kawal Mangal	District CEO	2017-05-01

B. **RESEARCH AND DEVELOPMENT**

Name	**Designation**	**Date Re-designated**
1. Alleya Shahabudeen	Research Technician	2017-04-18

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

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	**Designation**	**Date Transferred**
1. Quincy Scotland	Regional Crop Ext. Officer	2017-10-01

B. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date Transferred
1. Julian Nedd	Research Assistant	2017-01-17

9. **VOLUNTARY WITHDRAWAL OF SERVICE:**

Two (2) persons have withdrawn their services as follows:

A. **CROP DEVELOPMENT AND SUPPORT SERVICES**

Name	Designation	Date of Withdrawal
1. Parmesh Rambharose	Extension Agent	2017-01-01

B. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Withdrawal
1. Brian Desmond	General Worker	2017-01-19

10. **DEATH: Two (2) persons died as follows:**

A. **GENERAL ADMINISTRATION AND FINANCE**

Name	Designation	Date of Death
1. Moses Jackson	Senior Security Guard	2017-06-16

B. **RESEARCH AND DEVELOPMENT**

Name	Designation	Date of Death
1. Elton Wray	Research Assistant	2017-07-04

10. **TRAINING**

A. **OVERSEAS**

1. Ms. Kene Moseley, Project Coordinator, National Agricultural Research & Extension Institute participated in the CLME+ Project Ecosystem Based Management Workshop from March 10-11, 2017 in French Guiana.

2. Dr. Oudho Homenauth, Chief Executive Officer, participated in the Fourth Strategic Advisory Committee (SAC) Meeting held in Jamaica from March 22 to 23, 2017.

3. Mr. Brian Sears, Assistant Chief Executive Officer/Chief Plan Protection Officer, participated in the Twelfth ($12^{th)}$ Session of the Commission on Phytosanitary Measures, held in the Republic of Korea during the period April 5 to 11, 2017.

4. Messrs. Brian Sears, Assistant Chief Executive Officer/Chief Plant Protection Officer and Ansel Todd, Senior. Plant Protection Officer (ag), participated in the Carambola Fruit Fly Control and Eradicating Supporting Project, held in Belem, Brazil from May 8 to 12, 2017.

5. Ms. Aretha Peters, Research Assistant, participated in a training course on Sweet Potato Virus-Indexing at the University of Arkansas, USA during the period June 02 to 25, 2018.

6. Messrs. Brian Sears, Assistant Chief Executive Officer/Chief Plant Protection Officer and Ansel Todd, Senior. Plant Protection Officer (ag), participated in the Guyana/Brazil Frontier Meeting from June 5-6, 2017 held in Brazil.

7. Ms. Kene Moseley, Project Coordinator, participated in the Regional Mangrove Meeting, held in Suriname from June 13 to 14, 2017.

8. Ms. Adele Pierre, Plant Protection Officer participated in a 'Trade Symposium' on June 19, 2017 in Suriname.

9. Mr. Brian Sears, Assistant Chief Executive Officer/Chief Plant Protection Officer, participated in the Tenth (10^{th}) Meeting of the Caribbean Health Directors and the fifth (5^{th}) Meeting of the CARICOM Plant Health Directors held in the Dominica Republic from July 11 to 14, 2017.

10. Mr. Kesta Smartt, Plant Quarantine Officer, participated in a training course on Plant Quarantine Principles and Procedures, held in Trinidad during the period July 31 to August 11, 2017.

11. Ms. Kene Moseley, Project Coordinator, NAREI Mangrove Department participated in a conference titled: "*Protection of Coastal Ecosystems along the Guiana Shield",* held at the U.S. Embassy in Paramaribo, Suriname on August 1 to August 4, 2017

12. Ms. Zareefa Bacchus, Plant Quarantine Officer, participated in the Regional International Plant Protection Convention (IPPC) Workshop, 2017 for the Caribbean Region during the period September 13-15, 2017 in Barbados.

13. Mr Paul McWatt, Plant Protection Officer participated in the Old World Bollworm Identification Training from September 12-14, 2017 in Trinidad and Tobago.

14. Seraita Moseley, Plant Protection Officer participated in the "CDB workshop in Aichi Target 9' from September 18-22, 2017 in Jamaica.

15. Mr. Brian Sears, Assistant Chief Executive Officer/Chief Plant Protection Officer, participated in the Carambola Fruit Fly Control and Eradicating Supporting Project, held in Belem, Brazil during the period October 7 to 14, 2017.

16. Ms. Amrita Churaman, Research Assistant participated in the UNU-BIOLAC Training Programme: Molecular Diagnosis of Emerging Plant Diseases and Integrated Management of Plant Health, at the University of the West Indies - St Augustine, Trinidad and Tobago from October 23-27, 2017.

17. Mr. Premdat Beecham, Research Assistant, participated in a workshop on Agroecology and legumes, held in Lima, Peru during the period November 8 to 9, 2017.

18. Ms. Adele Pierre, Plant Protection Officer participated in the '2017 Advance SPS Training Course' held from October 23 – November 10, 2017 in Geneva, Switzerland.

19. Ms. Leelawattie Persaud, Research Assistant and Mr. Ramsingh Taijbally, Plant Quarantine Officer, participated in a training course on the Inspection of Agri-food Products in Pots, Airports and Borders, as well as on Information Geospatial for the Prevention of Disasters and Productive Uses. Use of Drones, Formulation of Statics, as well as platform of Cellular Technology (Application), held in Mexico during the period November 13-17, 2017.

20. Mr Brian Sears Assistant Chief Executive Officer/Chief Plant Protection Officer, participated in the 8th Meeting of the Guyana-Suriname Cooperation Council Meeting held from December 7-8, 2017 in Suriname.

2. LOCAL

1) Vishan Persaud, Amrita Churaman, Ariefa Hassan and Leelawattie Persaud participated in an In-House training on '***Potato Production'*** sponsored by PROPEL from February 21-22, 2017 in the NAREI Boardroom.

2) Ocean O'Dean & Leelawattie Persaud, Plant Pathology Department '***Training on Statistical Data Analysis for Evidence Based Policy Making*** 'sponsored by the Ministry of Agriculture from 7-11th March 2016 Georgetown ,Guyana

3) Ms Selena Lepps, participated in the " Occupational Safety and health Symposium" from April 18-19, 2017, Guyana

4) Ms. Tracy Persaud, Research Scientist, Ms. Denisia Whyte and Mr. Vickram Persaud, Research Assistants, participated in a Technical Forum on Good Agricultural Resilient Agriculture held at IICA on 2017-06-28.

5) Messrs. Ramnarace Sukhna, Research Scientist and Royden Glen, Senior Plant Quarantine Officer (ag), participated in a training course on Principles of Supervisory Management, Module 1 held at the Ministry of the Presidency during the period August 7 to 11, 2017.

6) The under-mentioned persons participated in a training course of the Union of Agricultural and Allied Workers on the Dynamics of Health and Safety in the 21th Century, held at the GSA on August 11, 2017:

NAME	**DESIGNATION**
a. Abiola Anderson	General Worker
b. Brenda McGarrell	General Worker
c. Diane Younge	-do-
d. Rohanee Leonard	-do-

e.	Semona Laundry	-do-
f.	Selwyn Spencer	General Worker (Porter)
g.	Ustacia McGarrell	General Worker
h.	Lavern Benjamin	Laboratory Attendant
i.	Seetadai Pickette	-do-
j.	Lorraine Gordon	-do-

7) Ms. Mahawattie Goopcharran, Senior Human Resources Clerk, participated in a training course on Principles of Human Resources Development, Module 1, held at the Ministry of the Presidency during the period August 21 to 25, 2017.

8) Messrs. Ramnarace Sukhna, Research Scientist and Royden Glen, Senior Plant Quarantine Officer (ag), participated in a training course on Principles of Supervisory Management, Module 11 held at the Ministry of the Presidency during the period September 11 to 15, 2017.

9) Ms. Selina Lepps, Administrative Assistant and Ms. Shanecia Bellamy, Plant Quarantine Officer, participated in a training course on The Services of the Customer Care Professional, held at the Ministry of the Presidency during the period September 5 to 7, 2017.

10) Ms. Meneca Fitzpatrick, Crop Extension Assistant and Mr. Quincy Bentinck, District Crop Extension Officer, participated in a training course on Aquacultue Technology for Guyana, held at the Regency Hotel, Georgetown during the period September 15 to 28, 2017.

11) Ms. Schedelia Hodge, Accounts Clerks and Ms. Anesha Stephen, Research Technician, participated in a training course on Occupational Safety and Health, held at the Ministry of the Presidency during the period October 31 ro November 02, 2017.

12) Ms. Mahawattie Goopcharran, Senior Human Resources Clerk, participated in a training course on Principles of Human Resources Development, Module 11, held at the Ministry of the Presidency during the period October 9 to 12, 2017, 2017.

13) Ms. Nathalie Woolford, Library Assistant, participated in a training course on Records and Registry Management, held at the Ministry of the Presidency during the period November 13 to 17, 2017.

14) Ms. Renee Nero, Research Assistant and Ms. Grace Watson, Research Technician, participated in a workshop on Conflict Resolution, held at the Ministry of Agriculture on November 22, 2017.

Table 18: List of Training, Meetings and Seminar Attended by NPPO Staff, 2017

No.	DATE	TRAINING/MEETING/WORKSHOP	TYPE	ATTENDEES/ PARTICIPANTS	HOSTING COUNTRY
1	1/25/2017	Public Consultation on the GNBS Metrology Bill and the Amended GNBS Act	Meeting	Sh. Moseley	Guyana
2	1/27/2017	General Staff Meeting	Meeting	NPPO Staff	Guyana
3	3/8/2017	GNBS Meeting	Meeting	B. Sears, Z. Bacchus	Guyana
4	4/20/2017	National Codex Committee Stakeholders Forum	Meeting	(1) S. Moseley	Guyana
5	5/12/2017	EU-FLEGT Meeting with GFC	Meeting	(2) R. Glen, Z.Bacchus	Guyana
6	4/28/2017	Port Establishment at Charity	Meeting	(1) B. Sears	Guyana
7	5/4/2017	CARICOM development Fund (CDF) Consultancy: regional cohesion policy invitation to stakeholder consultations	Meeting	(1) B. Sears	Guyana
8	5/18/2017	7th Meeting of the Guyana/Suriname Cooperation Council	Meeting	(1) B. Sears	Guyana
9	5/24/2017	General Staff Meeting	Meeting	(17) NPPO staff	Guyana
10	5/25/2017	Meeting on Field testing of Guyana's legality definition under the Guyana-EU Forest Law	Meeting	1) Sh. Moseley	Guyana
11	6/6/2017	Meeting on Field testing of Guyana's legality definition under the Guyana-EU Forest Law	Meeting	2) Sh. Moseley, Glen	Guyana
12	June 19-21	Meeting for the discussion of issues relating to Bilateral trade between Guyana and Suriname	Meeting	(1) B.Sears	Guyana
13	6/27/2017	Preparatory Meeting under Guyana/Brazil/St. Kitts & Nevis Partial Scope Agreement (PSA)	Meeting	(1) B.Sears	Guyana
14	7/28/2017	General Staff Meeting	Meeting	(17) NPPO staff	Guyana
15	Aug 7-9, 2017	Consultations and Technical Validation of CARICOM"S Draft Environment and Natural Resources Policy and Draft Environment Action Plan 2017-2022	Meeting	(1) Leon Folkard	Guyana
16	9/7/2017	Meeting at MoA	Meeting	(1) B.Sears	Guyana
17	9/11/2017	Meeting on CODEX	Meeting	(1) B.Sears	Guyana
18	9/13/2017	Interagency preparatory meeting for Guyana-Suriname Corporation Council Meeting	Meeting	(1) B.Sears	Guyana

19	9/14/2017	WTO Technical Trade Facilitation Committee Meeting	Meeting	(1) B.Sears	Guyana
20	9/21/2017	Preparatory Meeting for Guyana-Suriname 8th Cooperation Council	Meeting	(1) B.Sears	Guyana
21	Oct 2-6, 2017	COTED Meeting	Meeting	(1) B.Sears	Guyana
22	10/20/2017	First working group meeting (video conference) under Guyana/Brazil/St. Kitts & Nevis Partial Scope Agreement (PSA)	Meeting	(1) B.Sears	Guyana
23	10/27/2017	General Staff meeting	Meeting	NPPO Staff	Guyana
24	12/11/2017	NPPO Meeting	Meeting	NPPO Staff	Guyana
25	1/25/2017	Fruit Fly Collection and Laboratory preparation of samples	Training	B. Nandlall	Guyana
26	2/15/2017	Phosphine Fumigation Training	Training	Bradford, Dey, Bellamy	Guyana
27	2/28/2017	General Staff Meeting and Training	Training	NPPO Staff	Guyana
28	March 14-17	Monitoring and Evaluation Training Course	Training	Z. Bacchus	Guyana
29	3/31/2017	General Staff Meeting and Training	Training	16 NPPO Staff	Guyana
30	4/24/2017	Enhanced personal development Training	Training	(1) Kesta Smartt	Guyana
31	5/18/2017	Gender Training	Training	(1) Seraita Moseley	Guyana
32	5/24/2017	Carambola Fruit Fly control Training	Training	(17) NPPO staff	Guyana
33	July 10-29, 2017	GIS Training	Training	1) Paul McWatt	Guyana
34	7/28/2017	RPM Training	Training	(17) NPPO staff	Guyana
35	Aug 7-11, 2017	Principles of Supervisory Management - Module 1	Training	1) R. Glen	Guyana
36	Sep 11-15, 2017	Principles of Supervisory Management - Module 1	Training	1) R. Glen	Guyana
37	10/24/2017	Red Palm Weevil Training	Training	(2) McWatt, Wrights	Guyana
38	10/27/2017	Training on PMB, Farm Certification, Documents preparation and verification	Training	NPPO Staff	Guyana
39	Nov 20-21	Pest Prioritization Training/Workshop	Training	(11) NPPO Staff	Guyana
40	Nov 22-24	PRA Training/Workshop	Training	(11) NPPO Staff	Guyana
41	12/11/2017	Training reports on SPS & Quarantine Procedures	Training	NPPO Staff	Guyana
42	Feb 27-28, 2017 2017	National Workshop to develop a Geographic Information (GIS) System in support of Black Sigatoka Disease Management	Workshop	L. Ramdin	Guyana

Table 19: Staffing at NAREI

Categories	No. of Positions	Positions Filled	Position Vacant
Crop Extension Services	98	*95	16
General Admin. & Finance	243	*182	63
National Plant Protection Office	52	*36	30
Research and Development	93	62	31
Mangrove	17	14	3
Total	**503**	**389**	**143**

**** Represents overlapping of four (4) District Crop Extension Officers, nine (9) Crop Extension Assistants, one (1) Confidential Secretary, One (1) Communications Officer and fourteen (14) Plant Quarantine Officers which is reflected under staffing at CDSS, GA&F and NPPO.***

NON CONTRACTED EMPLOYEES

Extension Agents 20

Table 20: Staffing in the Crop Development and Support Services Department

Category	Authorized Positions	Positions Filled	Vacant Post
Deputy Chief Executive Officer	1	0	1
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	*34	0
Senior Crop Extension Assistant	13	5	8
Crop Extension Assistant	40	*49	0
Total	**98**	**95**	**16**

*represents overlapping of four (4) District Crop Extension Officers and nine (9) Crop Extension Assistants

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

Table 21: Staffing in the General Administration and Finance Department

Category	Authorized Positions	Positions Filled	Vacant Post
Human Resources Manager	1	0	1
Administrative Manager	1	1	0
Finance Manager	1	1	0
Corporate Secretary	1	0	1
Internal Auditor	1	0	1
Projects/PRO	1	1	0
Senior Human Resources Officer	1	1	0
Librarian	1	0	1
Accountant	2	1	1
Human Resources Officer	2	2	0
Administrative Officer	1	1	0
Communications Officer	1	*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	*3	0

Information Technology Technician	2	1	1
Senior Secretarial Assistant	1	0	1
Cashier	3	0	3
Accounts Clerk	6	6	0
Secretarial Assistant	6	3	3
Human Resources Clerk	2	0	2
Data Entry Clerk	2	1	1
Library Assistant	2	0	2
Heavy Duty Operator	10	4	6
Drivers/Office Assistants	20	9	11
Well Operator	1	1	0
Welder	1	0	1
General Workers	125	114	11
Senior Security Guard	2	2	0
Security Guard	30	18	12
Total	**243**	**182**	**63**

** Represent overlapping of one (1) confidential Secretary and one Communications Officer.

Table 22: Staffing in the National Plant Protection Organization

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	2	3
Plant Quarantine Officer	5	*19	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	14	6
Total	**52**	**36**	**30**

* represents overlapping of fourteen (14) Plant Quarantine Officers

Table 23: Staffing in the Guyana Mangrove Management Department

Category	Authorized Positions	Positions Filled	Vacant Post
Project Coordinator	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	12	9	3
Total	**17**	**14**	**3**

Table 24: Staffing in the Research and Development

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	1	0	1

Scientist)			
Horticulturist	1	0	1
Research Scientist	15	9	6
Monitoring & Evaluation Officer	1	1	0
Monitoring & Evaluation Assistant	1	1	0
Nurseries Manager	1	0	1
Research Assistant	30	29	1
Nursery Supervisor	5	1	4
Senior Research Technician	6	1	5
Research Technician	16	14	2
Laboratory Attendant	10	5	5
Total	**93**	**62**	**31**

9.0 PUBLICATIONS

1. Moseley, K, Adams, R, Homenauth, O. “Climate Change Adaption Strategies for Urban Coastal Communities: Lessons from Guyana's Mangrove Restoration Programme.” *Sustainable Urban Development: The Gap Between Rhetoric and Reality. A Critical Review of Presentations from the Caribbean Urban Forum 2016, Suriname*, Caribbean Network of Urban and Land Management, 2017, pp.

10.0 FINANCIAL REPORTS 2017- UNAUDITED STATEMENT

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE
STATEMENT OF FINANCIAL POSITION
AS AT 31 DECEMBER, 2017

	Note	31.12.2017	31.12.2016
		$	$
Assets			
Non Current Assets			
Property, Plant & Equipment	2	450,103,908	426,212,937
Total Non Current Assets		450,103,908	426,212,937
Current Assets			
Inventory	3	190,788,245	163,685,323
Receivables	4	10,815,099	13,459,118
Cash and Cash Equivalents	5	198,961,922	227,624,965
Total Current Assets		400,565,266	404,769,406
Total Assets		850,669,174	830,982,343

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE
STATEMENT OF FINANCIAL POSITION
AS AT 31 DECEMBER, 2017

	Note	31.12.2017	31.12.2016
		$	$
Equity & Liabilities			
Equity			
Grant from Foreign Sources	6	51,897,479	51,897,479
Government fo Guyana Contribution	7	985,768,334	959,245,722
Revaluation of Stock		341,781	341,781
Accumulative Surplus/(Deficit)		(261,167,459)	(219,806,973)
Total Equity		776,840,135	791,678,009
Liabilities			
Non Current Liabilities			
Ministry of Public Works	8	5,606,815	5,606,815
Total Non Current Liabilities		5,606,815	5,606,815
Current Liabilities			
Payables	9	68,222,224	33,697,519
Total Current Liabilities		68,222,224	33,697,519
Total Equity & Liabilities		850,669,174	830,982,343

The accompanying notes form an integral part of these financial statements. These

financial statements were signed on the ……by:

Chairman

Chief Executive Officer

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE
STATEMENT OF COMPREHENSIVE INCOME
FOR THE YEAR ENDED 31 DECEMBER, 2017

	Note	31.12.2017	31.12.2016
		$	$
REVENUE			
Government of Guyana Subvention	10	885,928,417	818,077,756
Income from Operations	11	33,300,978	80,061,561
Other Income	12	13,119,229	93,060,672
Interest Earned	13	210,804	83,424
Gain on disposal of Motor Vehicles		3,722,064	3,520,000
Income Adjustment under IAS 20	14	-	-
Capital Expenditure/Income		-	651,000
Total Revenue for the Year		936,281,492	995,454,413
Expenditure			
Wages & Salaries		612,877,986	578,371,981
Overhead Expenditure		90,820,001	89,328,163
Material, Equipment & Supplies		27,188,882	23,495,625
Fuel & Lubricant		14,521,367	18,609,728
Rental & Maintenance of Buildings		10,306,379	12,976,090
Maintenance of Infrastructure		1,760,124	7,141,275
Transport, Travel & Postages		33,022,409	39,313,773
Utility Charges		40,401,780	32,450,321
Other Goods & Services		35,932,171	30,261,598
Other Operating Expenses		16,477,426	21,402,897
Education Subvention & Training		1,420,599	982,224
Old Age Pension		1,008,505	1,036,273
Severance Payment		835,515	80,957,964
Red Palm Mite		3,769,220	48,250,100
Project expenses		1,312,614	5,033,694
Write off of bad debts		-	-
Write off of inventory		-	-
Loss on disposal of property, plant & equipment		-	-
Depreciation	2	85,987,000	37,392,630
Total Expenditure for the year		977,641,978	1,027,004,336
(Deficit)/Surplus		(41,360,486)	(31,549,923)

NOTE 14 This was left with zero because prior years figures consisted of depreciation which is already accounted for under expenditure. In effect it appears that if it is included under the IAS 20 line item it is actually zeroing the depreciation charge for the year.

Also the other figures comprise of the Capital expenses code 7000 which will be shown as a line item in the expenses section of the comprehensive income statement.

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE

STATEMENT OF CHANGES IN EQUITY

FOR THE YEAR ENDED 31 DECEMBER, 2017

	Grants from Foreign Sources	Government of Guyana Contribution	Revaluation of Stock	Accumulated Surplus/ (Deficit)	Total
	$	$	$	$	$
Balance as at 01.01.2016	51,897,479	848,594,722	341,781	(188,257,050)	712,576,932
Unrestricted net assets				-	-
Deficit as at 31.12.2016				(31,549,923)	(31,549,923)
Capital Contribution		110,000,000			110,000,000
Capital Contribution adjustment		651,000			651,000
Balance as at 31.12.2016	51,897,479	959,245,722	341,781	(219,806,973)	791,678,009
Balance as at 01.01.2017	51,897,479	959,245,722	341,781	(219,806,973)	791,678,009
Unrestricted net assets				-	-
Deficit as at 31.12.2017				(41,360,486)	(41,360,486)
Capital Contribution		63,540,695			63,540,695
Capital Contribution adjustment		(37,018,083)			(37,018,083)
Balance as at 31.12.2017	51,897,479	985,768,334	341,781	(261,167,459)	776,840,135

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE

STATEMENT OF CASH FLOW

FOR THE YEAR ENDED 31 DECEMBER, 2017

	Note		31.12.2017		31.12.2016
OPERATING ACTIVITIES					
Net Surplus/(Deficit) for the year			(41,360,486)		(31,549,923)
Adjusted for:					
Depreciation		85,987,000		37,392,630	
Loss/(gain) on disposal of property, plant and equipment		(3,722,064)		(3,520,000)	
Government of Guyana subvention		67,850,661		16,647,397	
			150,115,597		50,520,027
Operating Surplus/(Deficit) before changes in working Capital			**108,755,111**		**18,970,104**
(Increase)/Decrease in Inventories		(27,102,922)		3,049,677	
(Increase)/Decrease in Accounts Receivable		2,644,019		16,507,882	
Increase/(Decrease) in Accounts Payable		(34,524,705)		(20,601,394)	
			(58,983,608)		**(1,043,835)**
Net Cash Inflow/(Outflow) from Operating Activities			49,771,503		17,926,269
Cashflows from Investing Activities					
Purchase of property, plant and equipment	2	(106,427,000)		(64,919,568)	
Net Cash Inflow/(Outflow) from Investing Activities			**(106,427,000)**		**(64,919,568)**
Financing Activities					
Government Contribution	8	76,875,377		110,000,000	
Net Cash Inflow/(Outflow) from Financing Activities			76,875,377		110,000,000
Net decrease in cash and cash equivalents			20,219,880		63,006,701
Cash & Cash Equivalent as at 1 January			178,742,043		115,735,342
Cash & Cash Equivalent as at 31 December			198,961,923		178,742,043

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE
NOTES ON THE FINANCIAL STATEMENTS
FOR THE YEAR ENDED 31 DECEMBER, 2017

	31.12.2017 $	31.12.2016 $
Note 8		
Non Current Liabilities - Ministry of Public Works	5,606,815	5,606,815
Note 9		
Current Liabilities - Payables		
Other Creditors	(9,870,880)	-
Accounts Payable	19,284,724	7,079,617
Accrued Expenses	58,808,380	26,617,902
	68,222,224	33,697,519
Note 10		
Subvention	885,928,417	818,077,756
Note 11		
Income from Operation		
Sale of Plant	23,390,300	21,476,650
Acoushi Ants Bait	137,400	85,400
Other Agri Produce	143,140	7,940
Rental of Houses	5,271,000	786,800
Sale of Seeds	50,500	149,900
Technical Services	4,125,438	57,314,871
Tender Documents	115,700	150,000
Sanitation & Maintenance Fee	67,500	90,000
Total Income from Operation	33,300,978	80,061,561

Note 12		
Other Income		
Miscellaneous	13,119,229	93,711,672
Gain on Sale of Fixed Assets	3,722,064	3,520,000
Note 13		
Interest Earned		
Interest	210,804	83,424
Fixed Deposit	-	-
	210,804	83,424
TOTAL INCOME	936,281,492	995,454,413

	31.12.2017 $	31.12.2016 $
Note 14		
Adjustment under IAS 20		
Purchase from Capital funds expensed out	982,688	-
Stock issued from Capital Purchases	5,803,500	(651,000)
Current year depreciation	85,987,000	37,392,629
Statement of Comprehensive Income	92,773,188	36,741,629

Note 15

Disposal/Accumulated Depreciation

Two vehicles were disposed during the year. Total costs and accumulated depreciation were removed from the Fixed Asset Register.

NATIONAL AGRICULTURAL RESEARCH & EXTENSION INSTITUTE BOARD

NOTES TO THE FINANCIAL STATEMENTS

DEPRECIATION SCHEDULE

AS AT DECEMBER 2017.

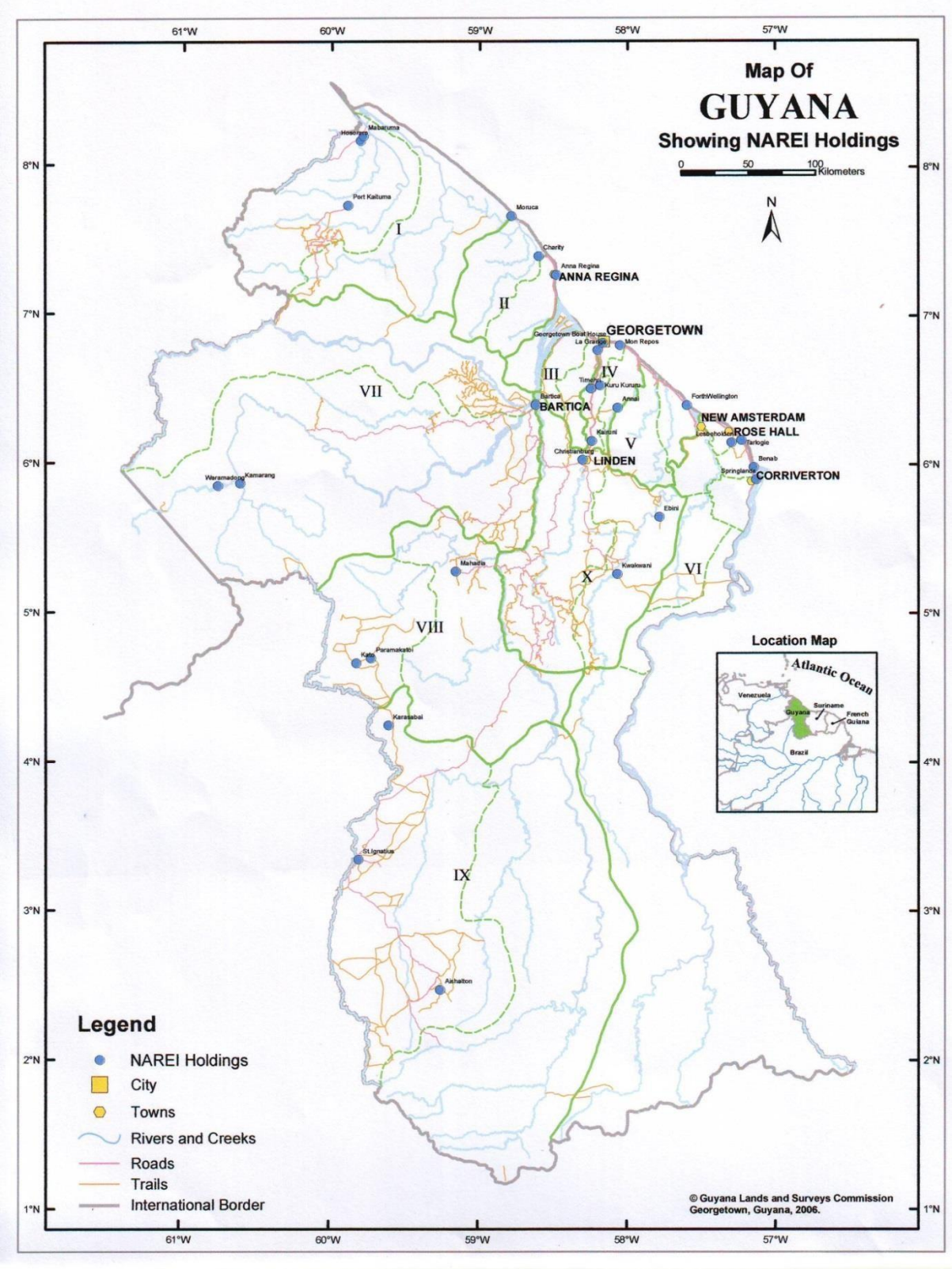
NOTE 2	**Buildings**	**Machinery, Equipment & Motor Vehicle**	**Furniture, Fittings & Office Equipment**	**Laboratory Equipment**	**Library Books**	**Total**
	G$'000	**G$'000**	**G$'000**	**G$'000**	**G$'000**	**G$'000**
Percentage	5%	20%	20%	20%	15%	
Cost						
At December 31, 2016	524,625,000	358,979,354	93,603,554	80,159,000	2,262,000	1,059,628,908
Additions	67,606,000	33,825,000	2,564,000	2,432,000	-	106,427,000
Disposal	-	(3,722,000)				(3,722,000)
At December 31, 2017	592,231,000	389,082,354	96,167,554	82,591,000	2,262,000	1,162,333,908
Accumulated depreciation						
At December 31, 2016	248,885,000	220,959,000	78,260,000	79,599,000	2,262,000	629,965,000
Charge for the year	17,467,000	64,625,000	3,615,000	280,000	-	85,987,000
Written back on disposal	-	(3,722,000)				(3,722,000)
At December 31, 2017	266,352,000	281,862,000	81,875,000	79,879,000	2,262,000	712,230,000
Net Book Values						
At December 31, 2017	325,879,000	107,220,354	14,292,554	2,712,000	-	450,103,908
At January 1, 2017	275,740,000	135,948,000	15,342,000	560,000	-	427,590,000

Appendices

Appendix 1

	Q1			Q2			Q3			Q4					
Crops	**Total Acreage Surveyed**	**Expected Yield/ ac**	**Estimated Production**	**Total Acreage Surveyed**	**Expected Yield/ ac**	**Estimated Production**	**Total Acreage Surveyed**	**Expected Yield/ ac**	**Estimated Production**	**Total Acreage Surveyed**	**Expected Yield/ ac**	**Estimated Production**	**Total Estimated Production 2017**	**Total Estimated Production 2016**	**Change in production from 2016 to 2017**
Banana	1,097.0	10.5	3,201.0	1,382.0	10.5	4,353.1	1605.89	10.51	4,219.4	1378.89	10.5	3,823.0	15,596.5	27292.73	-43%
Beans	119.8	0.8	95.8	113.8	0.8	91.0	176.12	0.78	137.3	176.12	0.8	147.9	472.1	253.54	86%
Bitter cassava	1,393.1	12.9	458.2	1,393.1	12.9	4,492.0	1394.05	12.88	4,488.8	1429.05	12.9	9,203.1	18,642.1	30506.99	-39%
Bora	847.8	7.8	6,612.9	877.8	7.8	6,846.9	877.81	7.75	6,803.0	877.81	8.8	7,680.9	27,943.8	21834.80	28%
Boulanger	807.6	16.3	13,163.9	731.6	16.3	11,925.1	731.60	16.36	11,968.9	664.78	16.4	10,875.7	47,933.5	44612.29	7%
Bread Fruit	23.0	9.1	209.2	22.0	9.1	200.1	21.98	9.01	198.1	21.98	9.0	198.3	805.6	242.52	232%
Breadnut	13.5	5.3	71.5	13.5	5.3	71.5	13.49	5.27	71.1	13.49	5.3	17.8	231.9	172.78	34%
Broccoli	2.0	9.9	19.8	2.0	9.9	19.8	2.40	9.9	23.8	2.40	4.0	9.5	72.9	6.60	1004%
Butternut Squash	2.0	10.0	20.0	2.0	10.0	20.0	4.00	2	8.0	5.00	2.0	10.0	58.0	123.48	-53%
Cabbages	188.7	13.3	2,509.1	189.7	13.3	2,522.4	189.65	7.97	1,511.5	122.94	15.2	1,871.1	8,414.1	7045.01	19%
Callaloo	85.5	27.1	2,317.9	93.0	27.1	2,520.3	93.00	21.84	2,031.1	93.00	22.9	2,129.7	8,999.0	7246.54	24%
Carambola	114.8	16.7	1,917.4	119.8	16.7	2,000.9	129.21	16.38	2,116.4	129.21	17.4	2,245.7	8,280.3	6442.86	29%
Carilla	205.3	8.7	1,786.3	245.3	8.7	2,134.3	245.32	8.54	2,095.1	323.00	9.5	3,081.4	9,097.1	7502.88	21%
Carrot	1.8	3.5	6.4	1.1	3.5	3.9	3.33	1.62	5.4	3.33	1.6	5.4	21.0	6.31	233%
Cashew (Malaka)	51.6	15.3	787.3	51.6	15.3	787.3	51.62	15.33	791.4	51.62	15.3	791.4	3,157.3	786.90	301%
Cassava	1,821.0	12.7	5,510.0	1,821.0	12.7	5,781.0	1821.00	12.27	5,585.9	2302.00	12.3	14,122.8	30,999.7	42840.10	-28%
Cauliflower	1.8	4.1	7.3	1.8	4.1	7.3	1.80	2.32	4.1	4.80	2.4	11.6	30.4	19.18	59%
Celery	94.9	26.8	2,543.8	110.2	26.8	2,953.4	110.20	26.1	2,876.2	110.20	26.1	2,876.2	11,249.6	5580.02	102%
Cherry	140.2	4.4	617.0	140.2	4.4	617.0	140.23	4.1	574.0	165.32	5.4	892.7	2,700.7	2209.90	22%
Cocoa							24.10	4.17	100.4	225.40	8.2	1,841.5	1,941.9	2141.16	-9%
Coconut	13,115.1	4.8	44,159.0	13,115.1	4.8	15,521.0	13115.12	4.75	15,574.2	13547.12	4.8	64,348.8	139,603.0	130683.44	7%
Coconut water (#nuts)	28,000.0		4,982,324.0	28,000.0		3,587,126.0	28000.00	0	3,641,141.0	28000.00	-	-	12,210,591.0	15841479.20	-23%
Coffee							2.70	1.22	3.2	72.70	2.9	210.1	213.3	141.15	51%
Corn	257.2	3.7	944.1	200.2	3.7	734.9	200.24	3.7	740.9	200.24	3.7	740.9	3,160.8	2406.69	31%
Cucumber	100.3	7.1	713.2	98.3	7.1	699.0	98.31	7.18	705.9	98.31	8.2	804.2	2,922.2	2479.29	18%
Dasheen	99.1	6.2	614.1	81.1	6.2	502.5	81.05	6.3	510.0	81.05	6.2	502.5	2,129.1	1228.84	73%
Eddoes	345.8	6.2	2,144.2	345.9	6.2	2,144.8	345.94	6.3	2,179.3	345.94	6.2	2,144.8	8,613.1	5876.45	47%
Eshallot	56.7	9.7	549.3	61.7	9.7	597.7	61.74	9.1	561.8	61.74	9.1	561.9	2,270.6	1613.64	41%
Ginger	209.1	29.4	6,148.4	209.1	29.4	6,148.4	209.13	20.56	4,299.7	443.13	21.6	9,553.9	26,150.4	24013.92	9%
Golden Apple	22.8	1.3	30.1	22.8	1.3	30.1	22.83	1.3	29.6	22.83	1.3	29.7	119.6	44.96	166%
Goose Berry							1.40	4.1	5.7	5.10	4.1	20.9	26.7	19.22	39%
Granadilla	5.6	1.5	8.5	5.6	1.3	7.3	5.58	1.3	7.2	5.58	1.3	7.3	30.2	19.58	54%
Grape Fruit	235.6	0.9	212.1	230.6	0.9	207.6	230.61	0.8	184.4	230.61	0.9	207.6	811.6	544.68	49%
Guava	38.8	4.3	165.3	38.8	4.3	165.3	38.80	4.3	166.8	38.80	4.3	166.8	664.3	519.18	28%
Lemon	97.0	1.8	174.7	97.0	1.9	184.4	97.04	2.8	271.7	97.04	4.8	465.8	1,096.5	522.76	110%
Lettuce	86.6	9.7	840.4	80.6	9.7	782.2	80.64	9.7	782.1	80.64	9.7	782.2	3,186.8	2196.13	45%
Limes	272.7	2.9	790.9	272.7	3.1	845.4	356.10	3.1	1,103.0	356.10	3.1	1,103.9	3,843.2	2435.78	58%
Mamee Apple	9.9	1.7	16.9	9.9	1.7	10.0	9.91	4.82	47.7	9.91	4.8	47.8	122.3	50.66	141%
Mangoes	493.8	4.3	2,123.5	493.8	4.3	2,123.5	493.83	4.29	2,118.5	466.83	4.3	2,002.7	8,368.1	4660.93	80%

Married man	11.6	11.8	136.7	12.6	11.8	148.5	12.59	11	138.5	12.59	11.0	138.5	562.2	266.45	111%
Musk Melon	18.9	7.5	141.5	18.9	7.5	141.5	18.86	7.4	139.5	18.86	2.3	42.6	465.0	876.00	-47%
Mustard	0.9	6.4	5.8	0.9	6.4	5.8	0.90	6.6	5.9	0.90	1.3	1.2	18.7	18.13	3%
Ochro	499.0	9.6	4,790.3	444.0	9.6	4,262.3	336.00	11	3,696.0	336.33	9.6	3,215.3	15,963.9	10731.00	49%
Onion	5.6	3.4	19.1	3.6	3.4	12.3	3.61	4	14.4	15.50	1.4	21.2	67.0	1.75	3731%
Oranges	867.4	5.3	4,597.1	867.4	5.3	4,597.1	867.37	5.4	4,683.8	867.37	5.4	4,666.5	18,544.4	2039.04	809%
Pakchoi	101.4	13.1	1,324.8	98.4	13.1	1,285.7	98.44	13.17	1,296.4	98.44	13.2	1,296.5	5,203.4	2889.53	80%
Papaw	556.7	30.9	17,201.2	561.7	30.9	17,355.7	561.67	30.68	17,232.2	562.67	30.7	17,262.8	69,051.9	41881.09	65%
Parsley	4.7	22.9	107.4	4.6	22.9	105.1	4.59	6.87	31.5	5.59	8.7	48.6	292.7	201.52	45%
Passionfruit	108.1	15.0	1,621.3	109.5	15.0	1,642.6	117.51	15	1,762.6	117.51	15.0	1,762.6	6,789.2	2280.75	198%
Peach	1.1	1.8	2.0	1.1	1.8	2.0	1.11	1.62	1.8	1.11	1.6	1.8	7.6	3.96	92%
Peanuts	81.0	1.4	113.3	82.0	1.4	114.7	81.96	0.9	73.7	81.96	1.2	95.9	397.7	193.20	106%
Pears	449.3	6.4	2,875.6	449.3	6.4	3.0	449.32	6.4	2,875.0	449.32	6.4	2,875.6	8,629.3	1382.87	524%
Hot Peppers	513.8	6.4	3,288.5	513.8	6.4	3,288.5	513.83	6.43	3,303.0	513.83	13.4	6,900.7	16,780.8	10744.76	56%
Pigeon Peas	16.2	1.2	19.5	16.2	1.2	19.5	16.21	1.24	20.1	16.21	1.2	20.1	79.1	44.66	77%
Pineapples	2,348.4	7.2	16,908.7	2,348.4	7.2	3,043.0	2348.43	7.26	4,262.0	2348.43	7.3	8,524.5	32,738.2	27534.42	19%
Plantain	8,151.2	15.3		7,151.2	15.3	24,070.0	7151.21	15.3	27,353.0	7151.21	15.3	41,996.8	93,419.8	78694.83	19%
Pomegranate	4.0	7.0	28.1	4.0	7.0	28.1	4.01	7	28.0	4.01	7.0	28.1	112.2	23.80	371%
Potato	9.0	19.1	171.7	5.0	19.1	95.3	4.99	9.54	47.6	4.99	9.5	47.6	362.2	0.00	
Psydium	1.6	7.8	12.6	1.6	7.8	12.6	1.62	7.8	6.0	1.62	7.8	12.6	43.9	1048.32	-96%
Pumpkin	999.2	8.5	8,493.3	1,152.0	8.5	9,792.0	1152.00	8.48	9,768.0	1152.00	11.5	13,225.0	41,278.2	33519.33	23%
Raddish							0.00	0	-	0.50	0.5	0.3	0.3	0.00	
Ramboutan	14.0	6.4	89.6	14.0	6.4	89.6	14.00	0.64	4.5	9.90	6.4	63.4	247.1	270.21	-9%
Saeme	93.9	28.0	2,629.6	91.1	28.0	2,550.8	91.10	27.9	2,541.0	91.10	27.9	2,541.7	10,263.1	3874.50	165%
Sapadilla	49.9	2.1	104.7	49.9	2.1	104.7	49.86	2.1	95.0	49.86	3.1	154.6	459.0	405.35	13%
Sorrel	96.2	2.8	269.4	79.0	2.8	221.2	79.00	2.8	221.2	79.00	2.8	221.2	933.0	394.03	137%
Sour sop	167.7	2.1	352.2	167.7	3.1	415.0	167.69	3.1	519.0	131.69	3.1	408.2	1,694.4	488.62	247%
Spinach	17.2	4.6	79.0	10.0	4.6	46.0	10.00	1.38	13.8	4.00	1.4	5.5	144.4	52.44	175%
Squash	290.0	5.8	1,682.0	237.5	5.8	1,377.5	237.50	5.8	1,377.5	237.50	5.8	1,377.5	5,814.5	5755.94	1%
Star apples	8.3	3.4	28.1	8.3	3.4	28.1	8.25	9	74.2	8.25	3.4	28.1	158.4	85.00	86%
Sugar apple	7.4	1.7	12.6	7.4	1.7	4.0	7.39	9	66.4	7.39	1.7	12.6	95.5	431.80	-78%
Sweet Peppers	265.7	19.4	5,153.7	266.7	19.4	2,172.0	266.65	19.39	2,585.0	346.00	20.4	7,054.9	16,965.6	22795.00	-26%
Sweet Potatoes	575.5	9.7	5,582.1	590.0	9.7	5,723.0	590.00	9.7	573.0	289.00	9.7	2,803.3	14,681.4	18631.80	-21%
Tangarine	397.9	4.3	1,711.0	380.0	4.3	1,634.0	380.00	4.4	1,672.0	462.27	12.5	5,778.4	10,795.3	140.33	7593%
Tannia							24.40	1.88	45.8	24.40	1.9	46.6	92.4	2248.18	-96%
THYME	120.4	7.4	890.8	121.0	7.4	895.4	121.00	7.4	895.4	91.00	7.4	673.4	3,355.0	1864.80	80%
Tomatoes	489.5	16.9	8,271.9	390.0	16.9	6,591.0	390.00	17.08	6,661.2	618.00	17.1	10,555.4	32,079.5	19092.00	68%
Turmeric	24.0	17.0	408.2	27.0	17.0	459.3	33.00	11.9	392.0	33.00	11.9	392.7	1,652.2	910.72	81%
Water Melon	589.6	8.9	5,230.1	811.0	7.9	6,382.6	811.00	14.96	12,132.0	622.00	15.0	9,305.1	33,049.8	22156.78	49%
Yam	80.2	7.7	617.5	75.0	7.7	577.5	75.00	7.4	555.0	29.82	7.7	229.6	1,979.7	1465.79	35%
Total													**845,247.43**	**701,762.56**	**20%**


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
Mabaruma
Port Kaituma
Moruca
Charity
Anna Regina
ANNA REGINA
GEORGETOWN
Mon Repos
Kuru Kuru
Annai
BARTICA
NEW AMSTERDAM
ROSE HALL
Tarlogie
Benab
CORRIVERTON
Ebini
LINDEN
Kwakwani
Mahaitia
Weramadong
Kamarang
Paramakatoi
Karasabai
St Ignatius
Aishalton
I
II
III
IV
V
VI
VII
VIII
IX
X
Location Map
Atlantic Ocean
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Legend
NAREI Holdings
City
Towns
Rivers and Creeks
Roads
Trails
International Border
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