NATIONAL AGRICULTURAL RESEARCH AND EXTENSION INSTITUTE

(NAREI)

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1.0 ABSTRACTS OF COMPLETED RESEARCH PROJECTS

(i) ESTABLISHING AN EFFICIENT PROTOCOL FOR MICROPROPAGATION OF BREADFRUIT (ARTOCARPUS ALTILIS) IN VITRO

Tandika Harry and Samantha Brotherson

Breadfruit *(Artocarpus altilis)* is a widely used staple crop, however, in Guyana, its use has decreased owing to scarcity of produce linked to limited planting material and cultivation. Propagation of breadfruit plants obligatory depends upon vegetative methods; however success rates are very low. Alternate techniques are therefore needed for its production. In recent years, the need for improved methods of breadfruit propagation has gained prominence to support government's crop diversification thrust. A study was initiated to support increased production of breadfruit plantlets through tissue culture techniques. This study seeks to evaluate the effects of basal Murashige and Skoog (MS) media supplemented with plant growth hormones (6-Benzylaminopurine (BAP), Indole-3-butyric acid (IBA), Indole-3-acetic acid IAA) on number of roots, number of shoots present per explant and height of explants. Ma'afala explants were cultured on 4 growth medium; T_1- MS + 0.17mg/L IAA, T_2- MS + 0.87 mg/L IAA, T_3- ½ Ms+ 0.1 mg/L IBA and T_4- Basal MS. 25 explants were used per treatment, within treatments there were 5 replicates using a factorial complete randomized design. The data was analyzed using statistix 10 software. They were no significant differences amongst treatments with the number of buds and number of shoots. However, there were significant differences amongst treatment for root development with T_3- ½ Ms+ 0.1 mg/L IBA producing the highest number of roots. Plantlets were weaned in green house with a survival rate of 100%. This protocol can be used for successful multiplication of breadfruit vareity Ma'afala *in vitro*.

Keywords: 6-Benzylaminopurine, Indole-3-butyric acid, Micropropagation, Breadfruit (Artocarpus altilis)

(ii) EFFECT OF GROWTH HORMONES 6-BENZYLAMINOPURINE (BAP) AND 3-INDOLEACETIC ACID (IAA) ON THE SHOOT PROLIFERATION AND ROOT DEVELOPMENT OF MUSA SPP. IN VITRO

Samantha Brotherson and Evan Willabus

Abstract

The current Micropropagation Protocol used for rapid multiplication of Musa species *in vitro* at NAREI's Plant Biotechnology Laboratory was providing bud proliferation for accessions Creole plantain and Cayenne banana, giving low shoot and root proliferation. Plantlet regeneration *in vitro* was hindered reducing the number of plants produced for distribution, owing to bud proliferation. In the present study, the effect of growth hormones 6-Benzylaminopurine (BAP) and 3-indoleacetic acid (IAA) on the shoot proliferation and root development of Musa spp. *in vitro* was evaluated. Explants were cultured on five growth medium: Murashige and Skoog basal media supplemented with different growth hormones; auxin (3-indoleacetic acid (IAA) ; 1 and 2.6mg/L) and cytokine (6 Benzyl- aminopurine; 2.0, 2.2, 4 and 5 mg/L). The performance of the accessions was evaluated by plant height, shoot and root number, and number of buds for a period of six months. Each treatment was replicated five (5) times, using a factorial complete randomized design; data was analysed using Statistix 10. Best shoot proliferation was observed in MS medium supplemented with 4 mg/L BAP and 1mg/L IAA; with highest shoot multiplication (average 6 shoots/explants). There was no significant difference among treatments for root development of Creole plantain and Cayenne banana *in vitro*; roots were observed for all treatments evaluated. Rooted plantlets were successfully transferred to the greenhouse, and had a survival rate of 97%.

Key words: Micropropagation, Musa species, Auxin, Cytokine, shoot proliferation

(iii) EVALUATING THE MICROPROPAGATION OF YAM (DIOSCOREA ALATA) USING GROWTH HORMONES VIA TISSUE CULTURE TECHNIQUES

Yoletta John and Samantha Brotherson

Abstract

Yams (*Dioscorea)* are known for their nutritional content, as well as their medicinal properties and traditional uses. NAREI is subjected to produce a protocol for the rapid multiplication of yams in vitro, of which the yams plantlets produced would be release to local commercial farmers. Research was conducted with the aim of increasing the multiplication rate of this crop. Experiments were conducted using *Dioscorea alata* (purple yam) through *in vitro* cultures using half strength Murashige and Skoog (MS) with two trials using four treatment compositions supplemented with two different types of growth hormones (Auxins and Cytokinin) at varying concentrations. Murashige and Skoog (MS) without no added hormones (T1) the cultures had little to no response to the treatment. Best shoot proliferation was noticed in MS that contained Auxin (NAA) and Cytokinin (BAP) with concentrations 1.25ml/L and 2ml/L respectively (T4); which also had best roots and leaf development. Ms supplemented with BAP only at 5ml/L concentration gave better nodes and internodes response. Finally, MS supplemented with (BAP) and (IAA) at 2.8ml/L and 0.98ml/L respectively was recorded with a better response in shoot height. Maximum survival rate 37.5% and 97% for trial one and trial two respectively.

Key words: Yams, Dioscoera, Dioscoera alata, in vitro, plant tissue culture, growth hormones, Auxins (IAA and NAA), Cytokinin (BAP), NAREI, MS medium

(iv) EFFECT OF INORGANIC FERTILIZER APPLICATION ON MORPHOLOGICAL CHARACTERISTICS AND YIELD OF QUINOA (CHENOPODIUM QUINOA WILLD) IN GUYANA

P. Beecham

Abstract

Quinoa (*Chenopodium quinoa* Willd.), a pseudocereal, is a new introduction in Guyana. Its production technology has yet to be explored according to local conditions. To obtain high crop yields, nutrient balance is a basic requirement. In 2019, a field trial was conducted at Mon Repos, East Cost Demerara, Guyana, South America, to evaluate different nitrogen fertilizer rates on the productivity of Quinoa. The objective was to elucidate the effects of synthetic fertilizer (Nitrogen) on the growth and yield of quinoa cultivated on Onverwagt clay soil. The experiment was laid out in Randomized Complete Block Design (RCBD), with four treatments and four replicates. Treatments used were **T1**-no fertilizer (Control), **T2** (75 Kg N/ha), **T3** (100 Kg N/ha) and **T4** (125 Kg N/ha). Results revealed that fertilising quinoa with 125 Kg N/ha resulted in maximum plant height of **25.5** cm and number of branches of **3.5/**plant at 30 days after planting (DAP). Plant height at **74.55** cm and number of branches **9.3/**plant at 60 DAP were also significantly different compared with the control. Similar results were obtained at 90 (DAP) where plant height was **91.5** cm and number of branches **11.33**/plant when Nitrogen fertilizer rate of 125 Kg N/ha was applied. Percent increase in grain yield over control treatment was also affected by nitrogen application. Comparatively genotype N1 was high yielding than N2. Furthermore, N supplementation of soil (125 kg N/ha) improved grain yield significantly **(829kg/ha)** when compared with the control treatment of **525kg/ha**. The results showed that the application of supplemented Nitrogen application can be used to improve yield and yield components of Quinoa in Guyana.

Keywords: Pseudocereal; Nitrogen application; Yield

(v) EFFECTS OF DIFFERENT LEGUMES INTERCROPPED WITH CASSAVA ON SOIL FERTILITY, WEED BIOMASS AND YIELD PERFORMANCE OF CASSAVA (MANIHOT ESCULENTA CRANTZ) IN PARIKA, GUYANA

P.Beecham

Abstract

Intercropping is a common practice among farmers in tropical regions of the world and has persisted for years, not only for traditional reasons, but also for certain advantages that helped in its ecological adaptation. Field experiment was conducted at Salem, Parika, East Bank Essequibo, during 2019 cropping season to determine the yield responses of cassava when intercropped with legume species. The experiment was carried out with the objectives to reveal the effects of legumes species on the growth and yield of cassava. The experiment was laid out in a Randomized Complete Block Design (RCBD), with four treatments and three replications. Treatments used were: **T1** sole cropped cassava (control), **T2** cassava + Cowpea, **T3** cassava + Mungbean and **T4** cassava +. Pigeon pea. Data collected were subjected to Analysis of Variance (ANOVA) using Statistix 9 software program and MS Excel for tables and graphs. Differences were declared significant at 5% & 1 % level based on Least Significant Differences (LSD). Results from the field experiment showed that cassava intercropped with cowpea, mung bean and pigeonpea yielded **20.1, 18.0** and **18.2** tons/hectare respectively a mere 3 % more than the control treatment. However, intercropping cassava with, cowpea, mung bean and pigeonpea resulted in **34, 28** and **45** % greater land use efficiency than crop grown alone. The results showed that intercropping cassava with legumes species have increased cassava production reduces weeds and provide another alternative food crop as well as improved soil quality due to its nitrogen fixing properties.

Key words: Legumes, intercropping, soil fertility, yield performance.

(vi) EVALUATION OF MORPHOLOGICAL CHARACTERISTICS AND YIELD OF FOUR IMPROVED VARIETIES OF CASSAVA AT SALEM, PARIKA, EAST BANK ESSEQUIBO

P.Beecham

Abstract

Cassava (*Manihot esculenta* Crantz) is an important storage root crop with largely unexplored and unexplained potentially valuable genetic variability in Guyana. A study was carried out at Salem, Parika, East Bank Essequibo during the 2018 and 2019 cropping seasons with the following objectives i) To evaluate five cassava varieties for their field persistency and productivity on Farmer's field (ii) To assess the cassava stem characteristics for their suitability as planting material. (iii) To improve the capability of local farmers and make available improved planting materials. The experiment was arranged in Randomized Complete Block Design (RCBD) with five treatments and three replications. The treatments were the different varieties (NAREI 1, NAREI 2, Mmex, Smokey prolific and Uncle Mack [control]). The varieties had different growth characteristics, number of branches, canopy width and tuber yield when compared with the control treatment. The highest tuber yield at nine Months after planting (MAP) was recorded by Smokey Prolific **(33.2t/ha)** followed by NAREI 1 **(32.1t/ha),** NAREI2 **(30.4 t/ha), Mmex (25.6 t/h),** while Uncle Mack (Control) was the lowest with **(19.8t/ha).** The other parameters measured showed significant differences among the varieties during the later stages at 9(MAP). Smokey Prolific recorded the highest value on plant height (**198.2cm**) and stem girth (**6.2cm**) respectively. The control (Uncle Mack) recorded the highest mean value (**106.2 cm**) on Canopy diameter.

Key words: morphological characteristics; yield; improved varieties

(vii) EFFECT OF SYNTHETIC FERTILIZER ON THE GROWTH AND YIELD OF GINGER (ZINGIBER OFFICINALE) ON ONVERWAGT CLAY SOIL

Ramnarace Sukhna, Oudho Homenauth, Dhanpaul Oodith

ABSTRACT

A field experiment of ginger was carried out at the National Agricultural Research & Extension Institute, NAREI, Mon Repos, East Coast Demerara, Guyana, South America during 2018-2019 to study the effect of synthetic fertilizer on the growth and yield of ginger (*Zingiber officinale*) on Onverwagt clay soil. Ginger contains many volatile oils (sesquiterpenes) and aromatic ketones (gingerols). Gingerols are believed to be the more pharmacologically active constituents of ginger. This experiment was carried out with the objective to explicate the effect of synthetic fertilizers on the growth and yield of ginger growing on Onverwagt clay soils. The experimental plot was laid out in a randomized complete block design (RCBD), with four treatments and five replicates. Treatments used were **T_1** No fertilizer (Control), **T_2** 30kg N/ha, 25kg P_2O_5/ha, 60kg K_2O/ha, **T_3** 60kg N/ha, 50kg P_2O_5/ha, 120kg K_2O/ha and **T_4** 120kg N/ha, 100kg P_2O_5/ha, 240kg K_2O/ha. Fertilizer was applied in three split applications: basal, 45 and 90 days after planting (D.A.P).

Statistical analyses did not detect any significant statistical differences among the fresh rhizomes weight obtained per $3m^2$ beds. The minimum and maximum weights recorded were 19kg and 22.5kg per $3m^2$ beds, respectively. No significant pairwise differences were detected among the treatment means of length of leaves/plant, width of leaves/plant, number of leaves/plant, number of tillers/plant, plant height and weight of fresh ginger rhizomes per $3m^2$ beds. However, significant differences were observed among the day interval means of length of leaves/plant, width of leaves/plant, number of leaves/plant, number of tillers/plant and plant height. It was concluded that the different treatments utilized for this scientific experiment did not have significant effect on the growth and yield of ginger, hence this experiment will be repeated in the next cropping season to verify this result.

Key Words: Synthetic Fertilizers, Zingiber officinale, Ginger Growth and Yield

(viii) EVALUATION OF BOTANICAL EXTRACTS AND FUMIGANT ON ACOUSHI ANT ACTIVITY IN GUYANA.

Adrianna Wellington

Other Staff involved: *Oceana O'Dean, Anesha Stephen and Howard London*

Abstract

Acoushi ants are known as the tropical, fungus-growing ants, and are native to South America. They are considered one of the most destructive insect pests in Guyana's agricultural sector. Numerous initiatives have been formulated to manage this insect, namely, fumigating and baiting of nests. However, baits are the preferred method of control. This study was conducted to assess the response of Acoushi Ants (Atta spp.) to various bait formulations. This study was done at Canal #1 and Linden in 2018-2019. There were three treatments T1 (Colour+ Citrus+ Fipronil), T2 (Colour+ Fipronil) and T3 (NAREI's Bait). The results from this experiment reflected acceptance rate of the various baits by the Acoushi ants. Results from this study showed that there was a fluctuation in bait preference by the ants. From the trials conducted at Canal #1, there were no significant differences among the treatments since $p>0.05$; however, trials done in Linden indicates that there were significant differences among the various treatment since $p<0.05$. The ants exhibited a higher preference for the treatment containing the colour, citrus and the Fipronil. Incorporating citrus and colour to the current bait can enhance its appeal and increase its acceptance rate by the Acoushi ants

Keywords: Acoushi ants, citrus, colour

(ix) EVALUATION OF ENTOMOPATHOGENIC FUNGI FOR THE CONTROL OF RED PALM MITE (R. INDICA)

Amrita Churaman

Other Staff involved: *Vishan Persaud, Arifea Hassan, Anesha Stephen*

ABSTRACT

Management of Red Palm Mite has become challenging for farmers since their most used form of control is the application of agrochemicals. Agrochemicals have (imposes) serious implications on both human (health) and the environment; also, pests are becoming resistant to these chemicals. This study tested the efficacy of the entomopathogenic fungus *(Beauveria bassiana)* against Red palm mite as an alternative method to chemical control for its management. This experiment evaluated the fungus using pure culture and a commercial product in the form of a bioassay. Both aspects were done at the Bio-Lab. It was arranged in a Completely Randomized Design. The trials using the pure culture consisted of three treatments: Control - water, T_1-105 spore count, and T_2-106 spore count, replicated three times. Trials using the commercial product (BotaniGard 22WP Biological Insecticide) consisted of two treatments: Control - water and T_3 - *Beauveria bassiana*. Two of the three trials using the pure culture showed no significant differences among the treatments. For the one trial that showed a significant difference among the treatments (treatment three was statistically different from the control), a 36% mortality was observed compared to the control which had an 18% mortality. In contrast, the trials using the commercial product showed an average 84% mortality after 48 hours of application of treatment compare to the control which had an average of 19% mortality.

(x) LABORATORY BIOASSAY OF BOTANICALS FOR THE CONTROL OF RED PALM MITE (R. INDICA)

Amrita Churaman

Other Staff involved : *Analesa Skeete, Anesha Stephen*

Abstract

Management of Red Palm Mite has become challenging for farmers since their most used form of control is the application of agrochemicals. Agrochemicals have serious implications on both human and the environment; also, pests are becoming resistant to these chemicals. This study evaluates the efficacy of botanicals for the management of Red palm mite as an alternative method to chemicals. This experiment evaluated three commercially available biopesticides: Bug stomper, Asphix and Neem oil. Four trials were conducted in the Bio-Lab. The experiment was arranged in a Completely Randomized Design. It consisted of four treatments: Control (T_1) - Water, T_2 - Bug Stomper, T_3 - Asphix, and T_4 - Neem Oil. Each treatment consisted of three plates replicated three times. In each treatment, 100ml of the solution were prepared for the recommended rates. The leaf pieces were each dipped into the solutions and air-dried for 15 minutes after which ten Red Palm mites (females) were added to each piece of leaf. The leaves were then placed onto Petri dishes lined with damp cotton. Data on the amount of live RPM were taken at a 24 hr. intervals for two days. All the trials conducted showed significant differences among the treatments, meaning treatments two, three and four were statistically different from the control. Overall, after the 48 hours' interval, treatments using the Neem oil showed an 84% mortality compared to 81% and a 73% mortality for treatments using the bug stomper and Asphix respectively. The control showed the least mortality (34%).

(xi) IDENTIFICATION AND CONTROL OF SCLEROTIUM ROLFSII AFFECTING MUSA SPP. IN GUYANA.

Somwattie Pooran-DeSouza

Other Staff involved: *Kimanda Pilgrim, Ariefa Hassan*

Abstract

Sclerotium rolfsii is a soilborne fungal pathogen that affects a wide range of agricultural crops such as sweet potato, pumpkin corn, wheat, peanuts, beans, peppers and cucurbits worldwide. In Guyana, this pathogen is responsible for the decay of banana and plantain pseudostem and leaf sheaths, splitting and breaking of the pseudostem, chlorosis and necrosis of plant leaves and ultimate death of the plants. Since it was an unknown pathogen; the objectives of the study were to determine the pathogen identification, and to determine the effectiveness of using fungicides to manage the pathogen growth under laboratory conditions. Based on morphological identification the three isolates collected from Mon Repos, Mahaica and Parika were identified as belonging to Athelia rolfsii = Sclerotium rolfsii. The growth and number of sclerotia varied for the three isolates with the Parika isolate producing the largest number of sclerotia. The Parika isolate was the most aggressive of the three isolates based on the pathogenicity test. The fungicide trials conducted in the laboratory found that Antracol and Ridomil Gold were more effective than Acrobat in reducing the radial growth of S. rolfsii at 24 and 48 hrs. after incubation but at 72 hrs. none of the fungicides were able to restrict the mycelial growth of the Parika isolate. To properly manage S. rolfsii it is important that molecular work be conducted to validate the identity of these isolates and other mangement techniques be investigated.

Key Words: Sclerotium rolfsii, sclerotia, Musa, fungicides, morphological

(xii) MANAGEMENT OF BACTERIAL DISEASE OF WATERMELONS

Somwattie Pooran-DeSouza

Other Staff involved: *Kimanda Pilgrim, Vishan Persaud, Ariefa Hassan*

Abstract

Bacterial Fruit Blotch (BFB) is one of the most devastating diseases affecting watermelons in Guyana. The sporadic outbreak during the rainy season has led to over 60% crop losses by Mahaica farmers. In 2018-2019 several field trials were conducted: 1) to evaluate effects of BFB disease on two varieties of watermelon; 2) to evaluate the effects of nitrogen fertilizers on watermelon yields affected by BFB disease; and 3) to evaluate the effects of potassium fertilizers on watermelon yields affected by BFB disease; 4) to determine the effects of fungicides on the control of watermelon fruit blotch; and 5) to determine the effects of timing fungicides application for the control of BFB disease. Based on the varietal evaluation trial conducted Mickylee variety was less susceptible to BFB disease than the newly introduced variety Bonta. However, the Bonta variety had a higher yield potential (16%) and produces larger fruits (20%) compared to its counterpart Mickyelee variety. The use of nitrogen fertilizer rates by 40-60 kg/ha resulted in significant increases in watermelon yields by 15 to 27%. In field trials the best rate of nitrogen with maximum yield potential was 60 kg/ha N. The leaf severity was the lowest for treatments using 60 kg/ha N and fruit severity was lowest at 40kg/ha N. The use of potassium fertilizer rates did not have a positive impact on BFB disease. The main reason was due to the outbreak of Watermelon Mosaic Virus that occurred during the early stages of crop growth. Fungicides did not have a significant impact on watermelon yields nor did it reduce leaf and fruit severities when compared to the control. However, fungicides Rizolex and Serenade treated plants produced fruits with the highest fruit weight. The control had less leaf and fruit symptoms compared to those that were treated with fungicides. Leaf severity ratings were low for field trials but fruit severity ratings were high indicating greater disease symptom appearance on watermelon fruits. Fungicide Kocide applied at different time did not have a significant impact

on watermelon yield and leaf severity. However, there was an increase in fruit weight when fungicide applications were done weekly and bi-weekly.

Key Words: Bacterial Fruit Blotch (BFB), Varieties, Fungicides, Nitrogen, Potassium, Yield

(xiii) NAREI RESEARCH STATIONS DEVELOPMENT BY USE OF FAO CROPWAT 8.0 MODEL AND IMPACT OF CLIMATE CHANGE ON CROP WATER REQUIREMENT

Tracey Alleyne

Abstract

Currently, water scarcity severely impairs food security and economic prosperity in many countries. It is directly linked to climate change and variability, and its impact is clearly visible given the temperature and rainfall variability, and occurrences of drought that have increased and intensified over the last two decades. Crop Modelling is listed among the specific climate smart agricultural practice that the water sector can use to cope with water scarcity due to climate change.

However, there is limited application of Crop Modelling despite its potential for alleviating the impacts of climate change like Guyana which is drought prone country.

The aim of this research was to determine and compare the irrigation requirements of some selected crops during the wet and dry using CROPWAT 8.0 at Mon Repos. Climate data for a period of twenty three years was also collected from the Georgetown metrological station in Guyana. Data was analyzed using CROPWAT version 8.0 simulation model to determine the crop water requirement of some selected crops (Tomato, Pepper, Watermelon, Potato, Cabbage, Onions and Beans).

Results showed that the irrigation requirement (IR) and the frequency of irrigation for crops cultivated at Mon Repos during the wet season that coincided in the months of April/May was less than the crops cultivated during the dry season that coincided in the month of October. The irrigation requirement values for Beans, Watermelon and Potato during the wet season showed zero per crop cycle due to sufficient water that was supplied by the rain. While the irrigation requirement values for Tomato, Cabbage and Onion during the dry season showed the highest per crop cycle due to insufficient rainfall to supply the irrigation needs. Onion crop (IR) was recorded as the highest to the value of 781 mm/year, followed by Cabbage with 708 mm/year then followed by Tomato with 733 mm/year. It is recommended that in the latter case supplemental irrigation should be sourced for the crops cultivated in October since the rainfall would be insufficient to sustain the crop cycle.

Key words: CROPWAT, Irrigation requirement, Climate smart agriculture.

(xiv) INFLUENCE OF HALOPRIMING AND THERMOPRIMING SEED TREATMENTS ON GERMINATION PROPERTIES, SEEDLING PRODUCTION AND GROWTH OF TOMATO VARIETIES (GARDEN DELIGHT, MONEY MAKERS, ROMA F1, TUMBLING RED TOM).

Rebecca Narine, Dr. R. Chandranauth, Simone Thomas

Abstract

Tomato production is important in Guyana, we do not import this commodity; our local production meets our demand. It is utilized cooked or raw in a variety of ways. Seed treatments have been used in Agriculture to help protect fruits and vegetables from pathogen and pests for centuries. Today, however, these seed treatments have grown to involve technical strategies to enhance germination, improve seedling emergence, protect against pests and pathogens, increased crop uniformity, and increased vigour and yields.

Tomato seeds of six varieties were treated with hot water at 50 0C for 48 hours, hydrogen peroxide for 30 minutes and distilled water (control); after which they were sown in the seedling trays at the seedling house. Seedling emergence time was recorded and data were taken with respect to seedling vigor. The tomato seedlings were transplanted at the National Agricultural Research and Extension Institute's Demonstration Farm, Mon Repos using a Randomized Complete Block Design where they were monitored for growth and production factors and general agronomic practices were carried out. Data was collected on plant height, flowering time, harvesting time and weight of fruits. Mongol had the lowest seedling emergence rate for both control and hot water while Roma had the highest for both. . Hydrogen peroxide may not be a suitable treatment for tomato seeds since there was no germination. However, it could be useful in the treatment of other seeds. With regards to seedling vigour, there were no significant differences between the two remaining treatments for the six varieties for 2 weeks old seedlings. However, at 4 weeks of age, seedlings treated with the hot water had significantly higher quality than those that were not treated. In the field, there were no difference amongst the flowering time and fruiting time for the varieties with regards to the treatments. There were no significant differences, using the all pairwise comparison, amongst the treatments with regards to yield per hectare and plant height. However, observationally, plants treated with hot water produced more than those that were not treated. Hot water treatment should be recommended as one way of enhancing germination properties and seedling quality.

(xv) EVALUATION OF SWEET POTATO VARIETIES TO SWEET POTATO WEEVIL SUSCEPTIBILITY

Aretha Peters

Other Staff involved : *Simone Thomas*

Abstract

Sweet potato weevil *(Cylas formicarius)* is by far the most destructive pest of the sweet potato plant. Sweet potato production is often poor due to damage caused by the weevil. Varietal resistance is a built-in mechanism within the plant species to repel particular insect form feeding. Nine sweet potato cultivars were grown on St. Croix, U.S. Virgin Islands and assessed for development of weevil populations. In Africa, 134 sweet potato cultivars and landraces were evaluated for weevil resistance.

The project was conducted at Mon-Repos, field 17. A randomized complete block design was used for the trial with seven treatments (varieties)- Beauregard, Amjad, professor #1, zebra, vanilla, cogle and strong man. Treatments replicated three times. Pheromone traps were set up to confirm the presence of weevil. The parameters measured were: the number and weight of tubers, the number and percentage of damaged tubers. Expectations of the trial were varieties that are not susceptible to the weevil. Results from the trial revealed that the varieties strong man and Beauregard had the highest numbers of tuber damaged by weevil while the variety cogle had the least number of damaged tuber followed by professor.

(xvi) EVALUATION OF SPROUTS AND STEM CUTTINGS FOR SWEET POTATO PRODUCTION IN GUYANA.

Aretha Peters[1,] Rebecca Narine[2] Raghunath Chandranauth[3]

Abstract

The availability of good quality planting material is a major constraint of sweet potato production. Two types of planting materials are mainly used in sweet potato production (stem cuttings and sprouts from tuberous roots). Studies have suggested that sprouts from tuberous roots can be superior to stem cuttings as a source of planting materials. In Guyana, farmers generally use stem cuttings from established field which often accumulates insect pests and diseases thus leading to a decline in the performance of cultivars. The trial was conducted in Field 17, Mon Repos. The treatments consisted of the two main types of planting materials (sprouts and stem cuttings) which were evaluated in a randomized complete block design and replicated four times. Two sweet potato varieties (Strong man and Beauregard) were evaluated for production potentials using the two types of planting materials. The analysis of data obtained from the two cycles of the project revealed that there were significant differences in the number of tubers produced, weight of tubers, and marketable tubers; with no significant differences in nonmarketable tubers for the Beauregard variety. Analysis of data for Strong man variety indicated that there were significant differences for the number of tubers and nonmarketable tubers produced while no significant differences occurred for the weight and marketable tubers. The result from the trial indicates that the sprouts are the most appropriate planting material for sweet potato production.

Key words: Sweet Potato, Sprouts, Stem Cuttings, Beauregard, Strong Man, Tubers, Production

(xvii) INFLUENCE OF SEED TREATMENTS OF SOURSOP ANNONA MURICATA

Indira Persaud

Other Staff involved: Roberto Mendez Pelegrin

Abstract

Summary of research background, literature reviews, objectives, research methodology and expected outcomes from the research project) - maximum 300 words

This study was carried out at NAREI Compound Mon Repos. It consisted of five treatments: control untreated seeds (T1), GA3 250ppm soaked for 24hrs (T2), GA3 500ppm soaked for 24hrs (T3), Seeds soaked in water for 72hrs (T4) and Seeds soaked in water for 96hrs (T5).

The results of the experiment revealed that GA3 500 ppm for 24 hours achieved maximum germination percentage at eighty-four days after sowing with the variety Lisa. This was followed closely with the variety Blanca

Key words: Variety, seed treatments, germination, GA3.

(xviii) A MANGROVE-MUDFLAT COASTLINES IMPACTED BY SEA LEVEL RISE (SLR) & STORMS; HYDRODYNAMICS AND SEDIMENT DYNAMICS, CHATEAU MARGOT MANGROVES, GUYANA

Uwe Best

Mangrove forests are unique habitats that function as feeding grounds and nurseries for numerous fish which includes commercial and subsistence species. Over the past decades, mangrove forest cover has been greatly reduced in Guyana due to the construction of rip-raps and dams, tree harvesting, grazing of livestock and the natural processes of erosion and accretion. This complex system receives a large supplies of mud from the

Amazon which migrate in the form of mud banks influenced by complex wind patterns. When these banks are not present, the coastal plain is prone to erosion while the present of mud bank in front of the coast allow for windows of opportunities for mangrove establishment.

This project focuses on the Chateau Margot area which consists of a wide vegetated mudflat with a fringe of 200m in width and length of 800m. Along the shoreline tides normally rise about 1.5 m to 2m above the mean sea level. The management of such vulnerable and valuable environments require a comprehensive understanding of the governing processes and interactions occurring in the overall development. Thus, modeling tools is instrumental in informing on the extent of the benefits garnered from vegetated foreshores through hind cast and forecast scenarios.

As part of the study to model the extent of forest through hind cast and forecast scenarios a number of data collection were completed. Eight (8) frames were installed using stainless steel pipes among which three (3) were in the mangroves and five (5) along the mud flat at different time intervals over a period of two (2) months. Mangrove vegetation data were collected along eleven (11) transects. 10m x10m quadrants at every 20m from the edge of the seawall to the edge of the fringe were set up. This was done along the eleven transect with an average of 6-9 plots per transect. Vegetation data were obtained and includes; density of trees/ 10m2, diameter of the tree trunk at specific heights, heights of all trees in the lines per plot, salinity and temperature readings, the inundation height along the main transect. A detailed bathymetric survey of the entire domain of the model (1000mW x 6000m L) consisting of both mangrove sections and mud flat were also carried out. Key soil properties were studied through the execution of the following soil test; bulk density, hydrometer, sieve analysis, atterburg limits , slump test , total organic matter , moisture content, in-situ shear vane test and settling velocity. Samples were also taken for the calibration of the Optical Backscatter (OBS) and the determination of the viscosity. The test results were carried out upon return to the Netherland at the Delf

University of Technology. The study focuses on the role of newly planted mangroves in wave attenuation and protection of sea defence infrastructure in Guyana and the effect of mangrove density, species composition and vegetation morphology.

Study comprises of using a modelling approaches to explore the dynamics of the foreshores along the Guyana Coastline at Chateau Margot and Felicity restoration sites. Data such as wave height, current velocities, and sediment concentrations along with sediment properties will inform the design aspects and possible implementation of various interventions taken along the foreshore along the lower East Coast of Demerara.

(xix) ECOSYSTEM-BASED ADAPTION: INCREASING THE RESILIENCE OF COASTAL COMMUNITITES

Rudolph Adams

Mangrove restoration interventions completed using coastal structures during 2013 to 2018 were monitored using the recommended monitoring scheduled. These sites were assessed base on the following deliverables; salinity, pH, tree height and width, mud elevation changes and overall growth of naturally restored mangroves. The sites monitored showed increase in mud elevation and growth of both planted and natural regenerated mangroves. The Anna Regina and Devonshire Castle monitoring began the reporting year 2017 to ascertain the progress after the installation of the different structures and continued through 2019. Both sites showed increases progression at different levels. Other sites monitored and showed progression during the reporting period include Walton Hall - Time 0+3 to Time 0+12 and Lusignan Time 0.

On the other hand, at restoration sites in Regions No.4 and 6 it was observed; extensive erosion continued at Hope E.C.D., Green Field E.C.D and Wellington Park Corentyne Berbice throughout the year 2019. At Wellington Park remains the ongoing problem of inflow of sawdust coming from the Sawmills up the

Corentyne River that is impacting the soil and contributing to erosion and loss of the entire mangrove forest while at Green field and Hope experiencing impacts of coastal processes in the form retreating mud shore.

The analysis of the data concluded that it is feasible to restore Guyana's coast with black mangroves provided that the necessary site assessments are completed to ensure suitability of site and appropriate elevations of 2.3–2.7m above chart datum. Anthropogenic activity, either directly at the intervention site or as a result of pollution, significantly impacts the sustainability of restoration interventions

2.0 STATUS REPORTS- COMPLETED PROJECTS

(i). THE USE OF TRELLISES TO ENHANCE CROSS POLLINATION FOR THE PRODUCTION OF VIRUS FREE PLANTING MATERIALS IN SWEET POTATO PRODUCTION.

Aretha Peters

Other Staff involved : *Simone Thomas*

PROJECT SUMMARY

The sweet potato plant is an indeterminate perennial, but it is grown as an annual. It is produced by vegetative propagation using vine cuttings from production fields. This method may accumulate pathogens, particularly viruses, in the planting stock resulting in decline in yield and sometimes quality. This project is a collaboration between the University of Arkansas, NAREI and University of Guyana with funding from the University of Arkansas.

The decline of farmers producing sweet potato is largely due to rising production cost including pesticides, fertilizers and cultural practices. Secondly, commercial and small acreage producers in Guyana lack adequate information to determine which varieties have tolerance pests, drought and yield well under minimum cultural conditions. 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 University of Arkansas at Pine Bluff 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.

(ii). CHARACTERIZATION AND EVALUATION OF SWEET POTATO

Aretha Peters

Other Staff involved : *Simone Thomas*

PROJECT SUMMARY

Summary of research background, objectives, research methodology, results conclusion

Characterization and evaluation add value to the collected and introduced germplasm, also increase its utilization in crop improvement. Germplasms are the most valuable and essential raw materials in meeting the current and future needs of crop improvement programs. Sweet potato has a very high genetic variability and thousands of accessions of sweet potato exist in germplasm collections at the International Center for Sweet potato. More than 8,000 accessions, cultivars and breeding lines of sweet potato ($2n = 6 \times = 90$), and nearly 26,000 accessions of other Ipomoea species are maintained in 83 gene banks world-wide (Kuo, 1991, Rao et al., 1994). In Guyana, extensive work has been done on characterization of sweet potato during the 1990s, however, the major sweet potato germplasm has been lost at the main agriculture research institute. Information available in the sweet potato base does not make identification of local accessions simple with the lack of photographs for most of the accessions. Sweet potato is very frequently associated with small farmers who are responsible for

maintenance of many genetic diversity of the crop in on farm conservation. The modernizations of agriculture and rural exodus have caused loss of genetic diversity in crops, including the sweet potato. Therefore, it is essential to collect and to conserve germplasm and keep it in organized collections for later characterization, evaluation and documentation (Cabral et al., 2010).

Activities completed and Accomplishment:

During 2019, twenty one accessions were obtained. Seven accessions were obtained from Mon Repos, three from Parika, One from Region1, eight from Villages on the East Coast Demerara and two from Ebini. Seven accessions were characterized and evaluated. These are strong man, zebra, vanilla, cogle; Amjad, professor and Beauregard. The information obtained is being entered into a sweet potato computerized data base.

(iii). EVALUATING TWO VARIETIES OF SWEET PEPPER USING DIFFERENT NUTRIENT SOURCE TO INCREASE PRODUCTIVITY.

Rameshwar Raghunauth

Other Staff involved: *Michelle Washington*

The results show that the application of vermicompost and NPK fertilizer was effective in increasing sweet pepper yield. This can be seen in the improvement in vegetative parameters (plant height, plant spread, no of branches) and yield parameters (average fruit weight, no. of fruits/plant, plant weight, plot weight and total yield). This regime can be adapted to ensure sustainable sweet pepper cultivation in Guyana. Sunsation sweet pepper variety was effective as it obtained the highest yield of 30 t/ha as a result of an increase in vegetative (plant height, plant spread no. of branches) and yield parameters (mean fruit weight, no. of fruits, plant weight, plot weight and total yield). This variety can be grown in Guyana to increase production and reduce imports of this commodity as it can be cultivated to meet the demands by consumers.

(iv). IN VITRO PROPAGATION OF COCOS NUCIFERA L.

Analesa Skeete and Evan Willabus

The coconut palm (*Cocos nucifera* L.) is a versatile important crop cultivated in more than 90 countries in the world, with Guyana ranking as number 24 in worldwide production. In Guyana, coconut is ranked as the third most important crop whereby small farmers are being considered as the primary coconut producers, highlighting Regions two and four as the largest producing areas. The growing demand for coconuts and its by-products was triggered by worldwide market trend in the food, health, beverage and cosmetic sector. To fulfil the mandate for the supply of coconuts, it is imperative to produce healthy-characterized planting material to supply both local and regional market. This can be done through large scale production of *in vitro* coconut plantlets, which will complement the conventional way of plant regeneration through seed nuts.

To date the department was able to develop a protocol for coconut plantlet regeneration through zygotic embryogenesis. Nonetheless, to further enhance coconut production, the exploration of the plantlet regeneration model using somatic embryogenesis is vital. Clonal propagation of coconut is of prime importance for rapid multiplication since it possess the potential to massive production (Fernando *et al* 2004; Oropeza *et al* 2004). Somatic embryogenesis is a means by which plants can regenerate bipolar structures from somatic cell under controlled conditions in an artificial media (Méndez-Hernández *et al* 2019). This model has the capability to generate more than one plantlet per explant compared to that of zygotic embryogenesis.

(v). MICROPROPAGATION OF YAM (DIOSCOREA ALATA)

Joann Griffith and Evan Willabus

In 2019, a protocol for the multiplication of different yam accessions was developed. To date there are six local yam accessions *in vitro* storage. Three new accessions namely purple, orange and white were acquired and added to the tissue culture gene bank. Full MS media supplemented with 20g/L sucrose, 1.6mg/L BAP with

0.5mg/L, 1.0mg/L NAA respectively proved to be best suited in providing high multiplication rates, internodes, leaf size, shoot and root proliferation. Bell and nut yam showed favorable results on media type T2.White, purple and orange yam had the best responses on media type T1. Hard yam showed responses on both media types there were no significant differences observed.

Fifty yam plantlets were successfully acclimatized and the remainder multiplied and stored *in vitro.*

(vi). ACQUISITION, CONSERVATION AND CYCLIC IN VITRO PROPAGATION OF CASSAVA (MAIHOT ESCULENTA) AND SWEET POTATO (IPOMOEA BATATAS)

Samantha Brotherson

Maintenance of parent plants (stock) in greenhouse (*ex vitro*) was done through routine fungicidal application, followed by weekly applications of plant nutrient solutions (PNS) for the parent stock. Explants from each accession were initiated following the established protocol for cassava and sweet potato multiplication *in vitro*. Subsequent, to successful multiplication explants were placed on a conservation medium for short to long term storage. Monitoring of viability of cultures was done every month and data collection was done every three months for plant height, viability of cultures and contamination of cultures. Forty-three (43) accessions of sweet potato and thirty seven (37) cassava accessions are in the germplasm collection.

(vii). IN VITRO PROPAGATION OF COCOS NUCIFERA L.

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NAREI's protocol for coconut plantlet regeneration

A total of 247 coconut explants are currently *in vitro*. One hundred and one (107) are currently in growing media (MS + 60g/L sucrose + 2g/L+ 1.0 g/L NAA + 1.0 g/L BAP), meanwhile at total of 140 remains in germination media (MS + 60g/L sucrose+ 2.5 g/L charcoal). Accessions currently in vitro are:

Table1. Coconut accessions currently *in vitro*

Accession	Amount *in vitro* (Growing media)	Amount *in vitro* (germination media)
Green	39	70
Orange	2	
Yellow	7	
Jamaican Gold or Brown boy gold	21	70
Panama Tall	16	
Cocorit	7	
Bastard	14	

Indian Variety	1	

(viii) SPICES

Turmeric (*Curcuma longa*)

A total of 79.54kg of turmeric planting materials were distributed to five farmers of regions 3, 4 & 5, these planting materials were used to expand turmeric cultivation in Guyana. A total of 6,521.19kg of fresh turmeric rhizomes purchased from farmers were processed at the factory located at Region #1.

Scientific experiments of turmeric were established at NAREI, Mon Repos and Kumaka, Region #1 with the Title: "Effect of Inorganic Fertilizers on the Growth and Yield of turmeric (*Curcuma longa* L.) on Onverwagt clay and Pegasse soil". Parameters such as number of leaves per plant (Total # of leaves of first 2-3 main tillers), width of leaves, length of leaves, plant height and number of tillers were evaluated. Preliminary results indicated that the different fertilizers treatment have an effect on the growth and yield of turmeric. The complete statistically analyzed data will be presented at NAREI's Annual Research Conference.

Ginger (*Zingiber officinale*)

Scientific experiments of ginger were established at NAREI, Mon Repos, and Kumaka, region #1 with the Title: "Effect of Inorganic Fertilizers on the Growth and Yield of ginger (*Zingiber officinale*) on Onverwagt clay and Pegasse soil". Parameters such as number of leaves per plant (Total # of leaves of first 2-3 main tillers), width of leaves, length of leaves, plant height and number of tillers were evaluated. Preliminary results for the ginger experiment carried out at Kumaka, Region #1 indicated that the different fertilizers treatment have an effect on

the growth and yield of ginger. The complete statistically analyzed data will be presented at NAREI's Annual Research Conference. The ginger experiment at NAREI Mon Repos is still ongoing.

Data collected from ginger experiment established in 2018 and completed in 2019 at NAREI, Mon Repos were statistically analyzed. The results were presented at NAREI's Research Conference held at the Plant Science Building, G.S.A Compound (October 29-30, 2019) with the theme: Paving the way for Sustainable Development through Innovative and Adaptive Research. Statistical analysis indicated that:

- ✓ Statistical analyses did not detect any significant statistical differences among the fresh rhizomes weight obtained per $3m^2$ beds. The minimum and maximum weights recorded were 19kg and 22.5kg per $3m^2$ beds, respectively.

- ✓ No significant pairwise differences were detected among the treatment means of length of leaves/plant, width of leaves/plant, number of leaves/plant, number of tillers/ plant and plant height.

- ✓ Significant differences were observed among the day interval means of length of leaves/plant, width of leaves/plant, number of leaves/plant, number of tillers/plant and plant height.

- ✓ It was concluded that the different treatments utilized for this scientific experiment did not have significant effect on the growth and yield of ginger, hence this experiment will be repeated in the next cropping season to verify this result.

(ix). Mangrove

Monitoring and evaluation: Focused on the construction, design and use of a results-based monitoring and evaluation system for projects and how the objectives that were initially developed are achieved; identification of the weaknesses of interventions and establish ways in which interventions can be improved.

Mangrove Workshop April 2019, Coronie, Suriname: WWF Guianas, Stitching SORTS Suriname and the Mangrove Action Project, hosted a training workshop titled "Regional Training Workshop in Mangrove Ecosystems in Guianas". This training was held at Burger Informatie Centrum, Coronie Suriname on May 6 to May 10, 2019 with the objective of:

The workshop integrated presentations from country representatives and site visits in Suriname to view practical demonstration of mangrove restoration initiatives being implemented in the country.

Mangrove Exchange Workshop, Georgetown, Guyana: Following the successfully Guianas mangrove workshop completed in April 2019, WWF Guianas collaborated with NAREI to host a follow-up workshop in Guyana in November 2019.This session focused on the exchange of knowledge, experiences and lessons learned among various stakeholders to improve mangrove management, restoration, conservation and legal frameworks for the protection of mangroves in the Guianas.

Four (4) restoration sites subjected to implementation of coastal structures were monitored during the period 2018-2019. For the most part, these sites showed increase in elevation and natural colonization of mangroves. In Region 2, the Anna Regina and Devonshire Castle coastal infrastructures supported sedimentation and the creation of a habitat suitable for mangroves showed noteworthy growth the naturally regenerated mangroves.

On the other hand, extensive erosion continued to affect the Hope Beach, Greenfield and Wellington Park sites during the year. At Wellington Park Region No.6 site continues to be impacted by the ongoing inflow of sawdust from sawmills up the Corentyne River which has contributed to erosion and loss of the entire mangrove forest.

The capacity of the monitoring programme was increased with the acquisition of an Unmanned Aerial Vehicle (UAV/Drone) in 2018. The acquisition of aDJIPhantom 4 Advance drone significantly improved mangrove monitoring and facilitated monitoring of inaccessible areas.

A methodology was developed for mapping of mangrove forest using imagery captured by the drone. A pilot project was designed to map the mangrove extent along the coast from Montrose to Ogle. Two drone missions were completed to capture high resolution imagery of the site. A total of 678 images were captured along 2000m meters of coastline.

Analysis of the imagery will be completed utilizing Pix4D photogrammetry software which was procured during the last quarter of 2019.

Additional flights were completed along Pomeroon River and section of Supenaam as part of the field verification process to assess areas of uncertainty as part of the mangrove cover analysis.

The community based mangrove management subcomponent seeks to address anthropogenic impacts on mangroves in Guyana by engaging with local communities living adjacent to mangrove areas and facilitating their participation in management activities, livelihood activities, public awareness and education programme.

The focus of the department's community based mangrove management program is centered on the formation of Village Mangrove Action Committees (VMACs). VMACs are community groups comprised of volunteers who have an interest in community development and are willing and able to support the restoration of their coastal mangrove ecosystem.

Part of the Department's goal is to develop sensitivity and awareness of the vital roles that mangroves play; the extraordinary environment to which they have adapted and their vulnerability to external pressures. The rationale for the public awareness campaign is that as public understanding of mangroves increase and a sense of shared national responsibility is fostered, restoration and protection will become sustainable.

NAREI in year 2019 supported the research on mangroves in Guyana completed through the Conservation International "NBS Mangrove Project. This project was a one year primer project which started in 2018 and facilitated the completion of critical baseline research on Guyana's mangroves. Research completed;

- Blue Carbon Inventories and potential revenue streams (Guyana and Suriname)
- Scoping review of Nature based options and solutions for Coastal Defenses (Green-Gray infrastructure for Guyana and Suriname)
- Regional Biophysical Review of the NBS-LME Mangrove Ecosystem.
- Assessment of the effectiveness of existing coastal restoration efforts and efficiencies achievable at scale
- Systematization and descriptive analysis of policies and regulations that affect the conservation and sustainable use of mangrove ecosystems in Guyana and Suriname.
- Local Community Mangrove Ecosystem Goods and Services (EGS) valuation study (Guyana and Suriname**)**
- Produce a synthesis study of ongoing and past studies and projects that assessed or generated data on mangroves in Guyana
- Mangrove Cover Analysis

3.0 ONGOING PROJECTS

(i) THE MANAGEMENT OF ANTHRACNOSE IN LABORATORY, INFIELD TRIALS AND DURING POST-HARVEST.

Vishan Persaud

Anthracnose is caused by fungi in the genus Colletotrichum, which is a very common group of plant pathogens, causing diseases on numerous plant species worldwide. Identification of Colletotrichum to species is usually based on more than one characteristic, such as morphological (physical appearance) and pathogenicity on host(s), and more recently using molecular analysis. Many species of Colletotrichum infect more than one host and, in addition, more than one species of Colletotrichum may be present on a single host. Anthracnose affects crop production both infields and at postharvest. It has a wide host range and over the years control of this disease has proven difficult for farmers. Anthracnose, like any other pathogen, stands a risk of becoming resistant over time and new genetic variations exist. These new variants are often more aggressive isolates; they can spread faster and infect a wider range of hosts. The improvement in genetic tools has made identification much more accessible. New diagnostic tools, such as real time polymerase chain reaction (PCR), allows for rapid detection and identification of these plant pathogens. The objective to be achieved in this project is to identify suitable control measures for managing anthracnose both infield and during post- harvest storage. To date, amended media was prepared and anthracnose cultures applied, monitoring and data collection continues. Indicative results show that fungicides Bellis and Antracol is effective in controlling anthracnose through the production of lower mycelium growth. Cholorothanil was found to be the least effective. In 2020, laboratory and field trials will continue.

(ii). EFFECTS OF BOTANICAL EXTRACTS ON BLACK SIGATOKA DISEASE.

Vishan Persaud

Mycosphaerella fijiensis causes black Sigatoka disease (BSD) which is a major leaf spot disease affecting the Musa species. It affects the overall yield and quality of the fruit. Since there are few fungicides available for use in Guyana, there is a high possibility of fungicide resistance. The main challenge in disease management is to ensure that the plant survives and produce a viable economic return. An integrated approach by using plant extracts (Garlic and Pepper) were applied at specific concentration using foliar spray along with control showed no differences in controlling the disease efficiently. The experiment was carried out using three treatments (Garlic Extract, Pepper Extract, Neem oil, Control) and a Randomized Completely Block Design to analyse data such as the Youngest Leave Spot, Number of Leaves, Disease Severity (Infection Index) and also the Weight and Number of Bunches. The objective to be achieved in this project is to determine the efficiency of botanical extract in the control of Black Sigatoka Disease in vitro experimentation. To date, botanical extracts were prepared, fields sanitised and fertiliser applied, pending adequate growth for bio-pesticide application. In 2020, bio-pesticides will be applied and diseased fields monitoring.

(iii). AN ASSESSMENT OF THE EFFECTS OF BOTANICAL EXTRACTS ON INSECT PESTS INCIDENCE AND A TOMATO (LYCOPERSICON ESCULENTUM) PRODUCTION

Vishan Persaud

Tomatoes are very nutritious and provide vitamin A, and other important components of our daily diets. It is cultivated in more than 170 countries. A major threat to tomato production is insect pests that adversely affect its production, market access and natural environment. These pests are usually treated by synthetic chemicals. However, the extensive use of chemicals in agricultural enterprises poses a significant threat to workers' and consumer's health and the environment. Hence, an alternative treatment is necessary. The aim of this

experiment was to determine whether ginger and turmeric can be used to manage whiteflies on tomato plants at the NAREI's Demonstration Farm, Agriculture Road, Mon Repos. To date, two trials were completed whose indicative results showed turmeric and garlic gave some measure of control. In 2020, the effectiveness of botanicals against whiteflies under laboratory and open field conditions will be evaluated.

(iv). CONSERVATIONAL BIOLOGICAL CONTROL: ENHANCING FLORAL RESOURCES AS FOOD SOURCE FOR LACEWINGS IN GUYANA AGROECOSYSTEMS

Vishan Persaud

Pest management in Guyana is dominated by agrochemicals which are not good for the environment and human health. However, with the rich biodiversity that Guyana has, conservational biological control can be explored and exploited to reduce crop losses caused by pests. Conservational biological control is aimed at using components of the environment to enhance pest management. Strategies such as 'Companion Planting' where plants that attract natural enemies are planted within or around cropping systems to increase the natural enemy's presence to reduce insect pest affecting crops. This approach can be implemented in Guyana, using plants and natural enemies found in our agro ecosystems. The study is intended to explore the use of flowering plants to enhance the propensity of lacewing species to reduce pest population in the natural regions of Guyana. To achieve this, lacewings species found in Guyana will be first identified. A survey will be conducted for crop and non-crop plant species that have characteristics to support lacewing species, followed by studies to determine longevity and fecundity of lacewing adults feeding on floral resources and the agronomy and ecology of these plant species. Finally, the requirement of floral resources distribution in or around cropping systems for green lacewing and arthropod diversity in these agro ecosystems will be evaluated. These results are anticipated to make significant inroads into the adaptation of eco-friendly pest management in Guyana, contributing to the green state development strategy. To date, eight flower producing plants have been identified with characteristics suitable for maintaining the survival and reproduction for the adult green lace wing. Laboratory

research continues with four flowering plants known for their ability to enhance lacewing propensities in agro-eco systems. Additionally, works has commenced on the identification of lacewing species found in the coconut agroecosystems. In 2020, this project will continue in collaboration with and support from two final year students from the University of Guyana and volunteers facilitated by Partners of America to provide specialist guidance in mass rearing of green lacewing.

(v). DIAMOND BACK MOTH (DBM) MANAGEMENT

Vishan Persaud

The use of entomopathogenic agents and plant extract for the management of pests and diseases in Guyana is in line with the Guyana Green State Development Strategy that targets sustainable agriculture practices. This research intends to provide farmers with effective means of managing Diamond Back Moth management, thereby reducing the economic damage they suffer. It is intended to develop product(s) that are effective and has less impact on the environment than the pesticides currently available on the local market. The use of natural pest management strategies can also be cost effective in the long term, thereby reducing the cost incurred to the country for the importation of synthetic chemicals. Field trials were conducted and will be continued on a farm in Parika back-dam West Coast Demerara. Between the periods April-June 2019, September-November 2019 and February-May 2020 the efficacy of Neem oil 2%, Pest Out 2%, *Beauveria bassiana* 30ml, *Bacillus thuringienesis (bt)* and Match on Diamond Back Moth will be tested. To date, two trials were completed. In the first trial, the five treatments had similar efficacy on DBM incidence and cabbage head diameter, however, cabbage treated with neem had significantly higher masses than those treated with *B. bassiana* and B.t but was not significantly different to those treated with Pest Out or Match. In 2020, this project will continue to completion.

(vi). MANAGEMENT OF LEAF CUTTING ANTS USING A HOMEOPATHIC METHOD.

Vishan Persaud

Leafcutter ants or Acoushi ants occur naturally and are native to the Americas. They offer ecological benefits such as soil restructuring, dormancy interruption and the secondary dispersion of seeds from native species. However, changes in the natural landscape due to agricultural activities and deforestation have led to an uncontrolled increase in the leafcutter ant populations, which have become potential problems in several agroforestry cultures. The use of toxic baits with long residual effects are the primary management approach to controlling leafcutter ant populations. This method appears to have quick and temporary results, although it increases the risk of environmental contamination. Hence, technologies with low environmental impact are needed. Homeopathic preparations have shown great potential in the control of pests to cabbage and corn plants. This project is aimed to determine the efficacy of two homeopathic treatments in the management of acoushi ants' bait. To date, one trial was completed using 4 treatments - Macerated Method, Triturated Method, Water and No treatment – with no observable differences seen between treatments. In 2020, the evaluation of the effectiveness of these homeopathic methods on the management of leaf cutting ants will continue.

(vii). INTEGRATED PEST MANAGEMENT (IPM) OF COCONUT.

Vishan Persaud

The coconut palm (Cocos nucifera L.) is one of the most important and useful plant in the world. Coconut is the third most cultivated crop in Guyana. It contributed approximately five billion USD in 2015 in foreign exchange. However, this crop is faced with the challenge of managing pest and diseases. IPM strategies are deemed as the way forward in controlling these dilemmas whilst maximizing production. The IPM strategy minimizes the effects of the growing concern of pesticides usage today. Also, in coconut cultivations, healthy trees benefiting from Good Agronomic Practices are less likely to suffer from attacks by pests and diseases. Four location, Clonbrook (1.8ha), Hague (0.5ha), Wakenaam (0.9ha), and Upper Pomeroon (0.9ha) and Lower

Pomeroon (0.5ha), were chosen for this research. Two treatments - Farmer's Practice and NAREI's Practice - replicated four times are being evaluated. Preliminary results show that red palm mite prevalence was low for this reporting period.

(viii). AN EVALUATION ON THE USE OF ENTOMOPATHOGENIC FUNGUS (BEAUVERIA BASSIAN) FOR THE MANAGEMENT OF THE MEALYBUG ANT COMPLEX IN PINEAPPLES

Vishan Persaud

Ananas spp (Pineapple) is one of the most important fruit crops in Guyana. Cultivating pineapples in Guyana has its ups and downs. One issue affecting pine apple production in Guyana is the scarlet tip disease which is caused by a virus. This disease is of economic importance since it causes 100% loss in production one out break occurs. All these fungi are common in the soil micro-habitat insect colony and are therefore considered biologically relevant. This study aims to provide an alternative management strategy for the mealy bug ant complex, and will evaluate the use of *B. bassiana* in the management of mealy bug-ant complex in pineapple. To date, pineapple farms were identified, *B. bassiana* cultured, and efforts at mass production of wettable powder initiated. In 2020, collaboration with NAREI extension officers in regions 2 and 3 will continue with data collection, monitoring and plot maintenance.

(ix). THE PRESERVATION AND LONG-TERM STORAGE OF TRICHODERMA AND BEAUVARIA.

Vishan Persaud

Beauvaria and Trichoderma are classified as two of the most widely used entomopathogenic fungi in modern day agriculture with the latter also functioning as a plant symbiont. However, in order for them to be utilized in sustainable agriculture practices for the control of pest and diseases, samples of these fungi must be preserved and stored so that they can be readily available for research and mass production. As such an experiment was setup to test the viability of both fungi for a period of one year. Data is being collected on the viability of the fungi on a monthly basis. Trichoderma was successfully preserved from April to November, 2019, under all of

the preservation methods tested (distilled water stasis, glycerol, silica gel, mineral oil and wheat middling). Beauvaria was viable from May to November, 2019, when preserved under distilled water stasis and silica gel method; however, it was not viable for glycerol and mineral oil preservation. Glycerol and mineral oil preservation were viable until the month of October 2019 (6 months). Data collection will continue until April, 2020.

(x). USE OF EXCLUSION BAGS FOR THE MANAGEMENT OF SOURSOP PEST.

Vishan Persaud

Soursop *(Annona muricata L.)* belongs to the family Annonaceae; per Soheil et al., (2015). Annona muricata L was said to be originated in the humid tropics of northern South America and the Caribbean. The fruit may weigh up to 15 pounds and is often a lopsided heart-shaped. Soursop fruit is known for its many benefits such as having anti-cancerous properties, rich in vitamin B, C, and minerals, the pulp is used to make juice and ice cream; the leaves are used to fight hypertension, fever and insomnia (Gonzalez, 2002). Womeni et al., (2016) revealed that the flowers are rich in antioxidants.

In developing a technological package for soursop, it is important to establish management techniques for the pests and diseases associated with this crop. Management approach for these are well established and is presently been formulated in a manual. However, *Brephatelloides spp* poses a threat to the industry.

Brephatelloides spp is a major pest of soursop in Guyana. It is commonly known as the soursop wasp or seed borer. Fruits are usually infected when the adult wasp oviposit in the soft seeds of young fruits. The larva then develops in the seed of the young fruit and as it matures, tunnel its way out the fruit leaving holes which leads to secondary infection. Research has shown that the use of chemicals helped in the reduction of the pest for a short period but has led to phytotoxic damage of the fruit (Mc Comie, 1987). Further research was done using paper bags, however, although there was a decrease in fruit damage the fruit was heavily infested with pink

mealybug, rot and some fruit failed to develop (Munroe et al., 2003). Taking this into consideration a research was design to use insect exclusions bags made of different materials dipped in organic derived pesticides to cease the pest from infecting the young fruits. To date, an evaluation was conducted and found that soursop seed borer *(Bephroides macullicolis)* and soursop moth *(Cerconata annonella)* are affecting soursop fruits in Guyana. Collaboration with The Tropical Agricultural Research and Higher Education Center in Costa Rica was very instrumental in NAREI obtaining the exclusion bags. Collaboration with final year student of the University of Guyana will assist with data collection.

(xi). EFFICACY OF TRICHODERMA FOR THE CONTROL OF BSD.

Vishan Persaud

Trichoderma can be used as a biological agent for the control of many plant pathogens (Cavero, Hanada, Gasparotto, Coelho Neto, & Souza, 2015). Black Sigatoka Disease (BSD) caused by the fungus *Mycosphaerella fijiensis* is of major economic importance in the plantain industry, damaging the foliar parts of plants, significantly reducing yield. As such an experiment is set up to test the effects of *T. harzianum* on the control of BSD. The experiment consists of two spraying intervals (7 days and 10 days) for a period of 90 days and one level of *Trichoderma harzianum* spore concentration (1.0×10^8). Data will be collected on the disease severity for a period of three months at 30, 60 and 90 day intervals. This project is being conduction as an on farm trial in Little Biaboo Village, Mahaica. Plant growth of the plantain suckers were affected by the dry season, thus, the application of treatments will be rescheduled to January, 2020.

(xii). IDENTIFICATION AND CONTROL OF WHITE MOLD ON BANANA.

Vishan Persaud

Sclerotium rolfsii is a soil borne fungal pathogen that is found in warm tropical and subtropical regions of the world. It affects wide range agricultural crops such as sweet potato, pumpkin corn, wheat, peanuts, beans, peppers and cucurbits. The pathogen usually infects plant parts that are in contact with the soil. Early symptoms include water-soaked lesions on crown or lower stem, yellowing, wilting of foliage, and collapse of the plant (Ridge & Shew, 2014; Dwivedi & Prasad, 2016).

Having infected the crop, the pathogen grows and produces white mass of mycelium that envelopes the lower portion of the plant and eventually spread upwards and inwards. It produces large number of sclerotia that are white or tan when immature and dark brown when matures (Remesal, et al., 2010; Dwivedi & Prasad, 2016).

S. rolfsii is known to survive in soils for long periods of time without a host. Some environmental conditions that favours the pathogen and disease development are soil moisture levels of 70% field capacity, high temperatures (25 to 35oC), humid conditions and acidic soils. The pathogen can be spread by wind, water, animal and soil (Ridge & Shew, 2014; Dwivedi & Prasad, 2016).

Management of *S. rolfsii* includes an integrated approach with control measures focusing on a combination of cultural biological and chemical methods. Control measures may include crop rotation using less resistant crops; deep ploughing, soil solarization, and the use of black plastic mulch to eliminate inoculum levels; addition of soil amendments such as compost and straw to reduce disease incidence; biological control such as the use of antagonistic fungi: Trichoderma and Gliocladium; and chemical control (Ferreira & Boley, 1992).

This project aims to identify the causal agent of white mold affecting bananas, and evaluate fungicides for the management of white mold in laboratory studies. To date, fungicides Antracol and Ridomil Gold) showed some efficacy in controlling anthracnose as they produced a lower mycelium growth. Acrobat was the least effective formulation.

(xiii) THE CONVERSION OF COCONUT (COCOS NUCIFERA) WASTE TO BIOCHAR AND BIOFUEL.

Tracy Persaud and David Fredericks.

Organic wastes from the processing of green and dry coconuts are widely generated in Guyana. About 80 to 85% of the weight of coconut is considered waste, which are inappropriately dumped in waterways e.g. Pomeroon River, legal landfills e.g. Haags Bosch Sanitary Landfill Site facility at Eccles, EBD, and subjected to open burning (illegal dump sites country wide). These methods of disposal contribute significantly to carbon dioxide and methane emission (Yerima & Grema, 2018). The recent and further planned expansion of the coconut industry coupled with present poor waste disposal practices poses environmental concerns unless this waste is harnessed and alternative use is found for this material. One potential solution is the use of coconut shells and husk for the production of biochar as a soil amendment for marginal and degraded soils and as a biomass fuel (biofuel) for the pyrolysis process. Through the pyrolysis process it is possible to convert agricultural waste into biochar that can be used as a soil amendment for marginal soils (700 and 800 Soil Series) in areas such as the Soesdyke Linden Highway or the Intermediate Savannahs. The National Agricultural Research and Extension Institute recently acquired a kiln for the pyrolysis of these organic wastes into soil amendments.

The use of biochar in farming systems will play a vital role in increasing options for sustainable management of sandy type soils. It will improve on existing best management practices to improve the productivity of marginal

and degraded soils, and decrease the environmental impact on water and soil resources. The way forward is to analyze the physical and chemical properties of the biochar produced from the coconut waste and evaluate its effectiveness as a soil amendment on marginal and degraded soils in Guyana. Emphasis will also be placed on scaling up of operations on coconut farms for on farm production, the use of coco peat in seedling substrate production and as a carrier for Rhizobia inoculant production.

(xiv). EVALUATION OF ONIONS AND IRISH POTATOES IN OPEN FIELD CONDITIONS.

Tracy Persaud, David Fredericks and Judason Bess

The evaluation and commercial production of white and red onions continued in 2019 with emphasis on open field and shaded cultivation. Cultivations were done on farmers' plot in regions 3, 4, 5, 6 and 10. Farmers in Phillipi and Timehri harvested approximately 23,702 kg/ha and 20,800 kg/ha of white and red onions respectively. Inclement weather destroyed several seeds beds and replanting had to be done, harvesting from these plants will be done first quarter 2020. The main focus for 2020 is increasing commercial production of both red and white varieties of onions by providing technical advice and support to current farmers and bringing new farmers on board. Research will be done on evaluating the use of pelleted seeds as an efficient and easy way for direct planting.

A perquisite for the storing of Irish potato planting materials is having a cold storage facility with temperatures range from $3 – 5^0$C in order to prevent sprouting of seeds. A cold storage facility with these specifications was purchased and installed for this purpose. The operationalizing of the cold storage facility will allow for the purchasing and correct storage of large quantities of tropical varieties of Irish potatoes that will be used for research and production purposes. In 2020 emphasis will be placed on acquiring planting materials and conduct observational trials with farmers in coastal and hinterland areas.

(xv). SOIL CHEMISTRY LABORATORY

The department continues to provide critical soil analytical service to the agricultural community of Guyana. In 2019, 776 soil samples were received from various stakeholders (farmers, researchers, mangrove department, RAID project areas, UG students). All samples were processed for analyses and fertilizers, limestone and organic matter recommended as required. Purchasing of reagents and laboratory glassware were done in an effort in increasing the number of analyses being done and the efficiency of services offered to farmers, researchers and other stakeholders.

(xvi). RURAL AGRICULTURAL INFRASTRUCTURE DEVELOPMENT (RAID)

David Fredericks, Judason Bess, Allison James, Shivraj Singh and Nicholas Chetram.

RAID is geared towards the development of Small Scale Farming Communities in Regions 4 and 5 (Ithaca, Buxton/Friendship, BV/Triumph and Mocha Arcadia). It focuses on the rehabilitation of drainage and irrigation systems, clearing access dams and farm lands in these areas. During 2019 a total of 159 farm visits were in the four project areas. Farmers in Buxton received 70 tissue culture plantain and 30 banana suckers, while farmers in Mocha received 48 tissue culture plantains. Farmers within the RAID project areas were given the necessary technical support and advice in good agricultural practices, climate smart agriculture, diversification and intensification. Farmers were advised on proper field sanitation, judicious use of chemicals, home remedies for control of pest, proper record keeping, use of raised beds to reduce risk of flooding, mulching, crop rotation, compost production and management etc. A total of 147 soil samples, 24 tissue samples and 4 water samples were analyzed for the four areas.

(xvii). THE USE OF MYCORRHIZA AS A BIO-STIMULANT FOR CROP PRODUCTION IN MARGINAL SOILS

Foyleann Van Klavern, David Fredericks

Further evaluations were done on the three substrate mixes that contained Tabela Sand, chicken litter, vermicompost, fresh paddy hull and rice husk biochar used in various proportions to create a local potting mixture as an alternate to imported PROMIX. Three cycles of seedlings were sown in the substrate mixes for comparative analyses. Destructive sampling of roots, staining and microscopic examination for observation of mycorrhiza colonization was done; results indicated that all seedlings planted in the local substrate mixes were mycorrhized. Plant growth parameters and chemicals analyses of biomass were all comparable to those obtained from the PROMIX. These encouraging results have led to the production of our local potting substrate S-SOWMIX. 400 liters of S-SOWMIX was produced and available for sale to farmers. Positive feedbacks were received from farmers that purchased the S-SOWMIX for seedling production. A 60 liters pack is sold for $10,000. Further research will be done in 2020 to evaluate seedlings grown in S-SOWMIX to open field conditions and production.

(xviii). THE USE OF RHIZOBIUM INOCULANT IN LEGUME PRODUCTION

Foyleann Van Klavern, David Fredericks

Four new local strains of rhizobia inoculant Jack bean, Sunn hemp, Sesbania White Stem, and Sesbania Red Stem were produced and maintained. 20 kg of rhizobia inoculant was produced, and 3 kg were distributed to farmers in the various regions through extension services.

Research continued in 2019 evaluating the efficacy of rhizobia inoculant on the growth and yield of feijou at Kairuni. Research for 2020 will focus on the isolation and identification of rhizobia bacteria from strains that

are under evaluation and evaluating the combination of rhozibia inoculant and mycorrhiza on the growth and yield of bora and red peas.

(xix). PRODUCTION OF LEAFY VEGETABLES USING HYDROPONICS AND SHADE-HOUSE FACILITIES

Denisia Whyte and David Fredericks

Hydroponics is an agricultural practice which can be implemented to adapt to climate change. Agriculture is highly sensitive to climate change since it depends largely on environmental conditions. Properly implemented, hydroponics gives more produce in less time than open field production. This theory was supported during observational trials with pak choy at NAREI's facility in 2019 when crops matured for harvest in five weeks as opposed to seven weeks in traditional cultivation. Three cropping cycles of pak choy were completed in the hydroponics facility. Results show that the system was able to produce of 350 heads of pac choy with an average weight, number of leaves and root length of 108g, 12 and 39cm respectively. These cropping cycles were successful due to upgrades to the system such as the installation of nets cups which replaced the use of sponges to allow roots to access nutrient solution. In addition, reservoirs were painted black and a cover was installed to prevent the growth of algae.

(xx). PRODUCTION OF FRUIT TYPE VEGETABLES USING HYDROPONICS AND SHADE-HOUSE FACILITIES

Denisia Whyte and David Fredericks

Improving cropping techniques to increase food production and security is one of NAREI's main focus. This project is aimed at increasing tomato production through improved rooting structure. Like all plants, healthy root and vegetative growth is necessary for optimum flowering and fruiting. To achieve this tomato plants were grown using two rooting angles - 90^0 and 180^0 to the main stem, this was done to evaluate which planting angle would significantly improve plants' growth and productivity. One cropping cycle was completed in the kitchen

garden which resulted in the 90^0 roots producing 1.02 kg while the 180^0 roots produced 0.8 kg per plant; root length recorded was 65.3cm and 46cm respectively. One cropping cycle is ongoing in the kitchen garden facility which was initiated simultaneously with the current cropping cycle in the hydroponics facility.

(xxi). LAND RESOURCE ASSESSMENT FOR AGRICULTURAL PRODUCTION IN GUYANA

Jonathan Melville, David Fredericks and Vernon Duncan

Twenty-seven soil maps that cover different locations in regions 4, 5, 6 and 10 have been fully digitized. These areas include Canje, Atkison-McKenzie, MMA, Blairmont-Bath Sugar Estate, Andabo-Taurakuli-Abary, Mon Repos Station, Yarrowkabra, Belfield, BBP, Canal No. 2, Cove and John, Craig-Soesdyke, Hope Cum Annex, Ebini-Ituni Kwakwani. Most of these areas are extensive and mapped on a small scale basis. A substantial number of areas required multiple map sheets to produce total coverage of these areas, e.g. MMA has Sheets 1, 2, 3 and 4. As such, sub-maps comprise a significant portion of this list of 27. The final stage of this programme is to input crop recommendations from the FAO and Ministry soil survey reports into the attribute data fields of soil units. This activity will create a map set that can fully inform agricultural stakeholders in the farm development process. Additionally, coordinates were collected to map the boundaries and layout for NAREI commercial farm at Mon Repos and Kairuni Horticultural Center on the Linden-Soesdyke Highway.

(xxii). TO EVALUATE THE USE OF AM FUNGUS IN THE ALLEVIATION OF SALT STRESS IN BELL PEPPER (CAPCIUM ANNUM).

Judason Bess and David Fredericks

Soil salinity in many parts of the world has become a serious land degradation issue and this issue is exacerbated in the arid and semi-arid regions like Guyana where most of our agriculture is concentrated on the coastland. As salt water getting further inland, the crop sector is adversely being affected due to loss of

productivity and arable lands. In efforts to utilize these lands that are unproductive as a result of high levels of salinity, soil samples were taken at six different locations from Mahaica Berbice to West Coast Berbice. Results from these samples show that five out of the six areas have salinity above 1 ds/m, which can affect the productivity of certain crops. After the September springtides, breaches in the sea defense in the Danzig-Fairfield area caused farmlands to become flooded with saltwater. Visits were made to areas and soil and water samples were taken for analyses, based on the results a farm within the area was identified to commence the project. This project will commence when the flood water has receded.

(xxiii). NUTRIENT STUDIES OF SOURSOP (ANNONA MURICATA)

Jonathan Melville and David Fredericks

Baseline pH has been established by the analysis of soil samples from the experiment locations: Bendorff, Kairuni and Ebini, and the newly established orchards in Moblissa, Mocha and Kairuni. pH levels are outside the optimum range (5.5 to 6.5). Thus, liming studies have been the basis of 2019's work programme, where the primary objective is the correction of soil pH of systematically selected trees (based on experimental design) and comparison with control. Baseline pH (mean) experiment locations are as follows:

Location	**Variety**	**Treatment**
Bendorff	Unknown	**T1**: 4.3; **T2**: 4.5
Ebini	Unknown	**T1**: 5.3 ; **T2**: 5.1
Kairuni (Old plot)	Blanca	**T1**: 4.7; **T2**: 5.0
	Lizza	**T1**: 5.1; **T2**: 5.0
	Morada	**T1**: 4.7 ; **T2**: 4.8
Kairuni (New plot)	Blanca	pH: 5.8
	Lizza	
	Morada	
Moblissa	Blanca	pH: 4.2
	Lizza	

	Morada	
Mocha	Blanca	pH: 4.4
	Lizza	
	Morada	

Based on limestone recommendations, lime has been applied at all locations and a 2nd iteration of soil sampling of all locations will be done to compare the soil pH response of limed trees and control. Mature orchards (Bendorff, Ebini and Kairuni-Old) will have fruits sampled for measurement of quality parameters in 2020.

(xxiv). THE COMPARISON OF BARE-ROOT AND BAGGED SOURSOP (BENDORFF)

Jonathan Melville and David Fredericks

Standard maintenance practices have formed the bulk of 2019's work programme. The most recently established pH baseline is 4.7 (composite of bare-root and bagged). Liming has been completed and re-sampling will be done to show any changes in soil pH.

(xxv). NUTRIENT STUDIES OF WEST INDIAN CHERRY (MALPIGHIA EMARGINATA)

Jonathan Melville and David Fredericks

A draft methodology for a nutrient management programme that can be implemented in nutrient study experiments for different fruit tree crops was developed in collaboration with the Fruits Vegetables and Other Crop Department. However, no on-farm trials have been established for cherries because of the unpreparedness of identified farmers to facilitate this experiment. Other farmers will have to be identified as soon as possible so that this project can commence.

(xxvi). GREEN-HOUSE GAS INVENTORY OF THE AGRICULTURAL SECTOR (FOR THE THIRD NATIONAL COMMUNICATION TO THE UNFCCC)

Jonathan Melville, Judason Bess and David Fredericks

Training on data compilation and computation of emission source data was done with Coalition for Rainforest Nations (CfRN). A fair understanding on appropriate data selection and the theoretical background on Agriculture Forestry and Other Land Use (AFOLU) emissions and associated formulae were gained.

This training was followed up by an intensive data collection exercise that sought to collate all relevant emission source data from the agricultural agencies of NAREI, GLDA, GRDB and GuySuCo. Some supplementary information was also garnered from the Bureau of Statistics and FAO as they have coverage of specific inputs such as fertilizer importation and usage.

Systematic computation of raw data allowed the input of emission source data for crops, livestock and fertilizer use. However, data gaps meant that not all emission sources could be accounted for such as manure management (other than application to fields), enteric fermentation, cultivation of organic soils and limestone use. Nevertheless, the module sets were completed as far as possible and submitted to the OCC as NAREI's official contribution to the compilation of the GHG inventory for the agricultural sector. It is expected that this document is being integrated within the technical framework of Guyana's TNC to the UNFCCC, which is slated to be done by 2020.

(xxvii) INVESTIGATING THE EFFECT OF MICRONUTRIENTS APPLICATION ON THE YIELD AND FRUIT QUALITY OF EXISTING LIME PLANTS.

Rebecca Narine

Lime is a popular, prominent fruit crop of tropical and sub-tropical climatic regions. It is valued for segments in the fruit; it can be used for its fresh fruit juice, in beverages and also in culinary for the sour taste. The fruits are well known for their dietary, nutritional, medicinal and cosmetic properties and are also a good source of citric acid, flavonoids, phenolics, pectin, limonoids, ascorbic acid etc. in addition to potassium, foliate, calcium, thiamin, niacin, vitamin B6, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals. In Guyana, it is the third most popular citrus with the seeded West Indian Lime being the most popular variety cultivated. Most of Guyana's produce is sold in the fresh market, although a small portion is exported to Barbados. Recently, it has been brought to the attention of the National Agricultural Research and Extension Institute that a problem exists with the quality of limes being produced; this is assumed to be attributed to a lack of micronutrients supply. When macronutrients are supplied in relatively high proportions to stimulate the growth of newly planted citrus trees, extreme depletion of micronutrients can develop because of marked top growth, and micronutrient deficiencies can appear. Therefore, a balance between macronutrients and micronutrients is needed. This research aims to highlight the importance of micronutrients and its effects on the yield and quality of limes. It is being done at a Kairuni and NAREI's Demo farm with existing lime trees. The experimental layout being used is the randomized complete block design with three treatments (no nutrient application, foliar micronutrients application and foliar + soil nutrients application) and three replications. General agronomic practices are being practiced. Yield data to be collected will include fruit set percentage, number of fruits per tree, yield (kg/tree), fruit weight, fruit length and fruit breadth. Fruit quality data will include rind thickness, pulp weight, juice content, acidity and micronutrient concentration.

4.0 EXTENSION AND TRAINING

(i) Hinterland Regions

A total of twenty-nine thousand and twenty (29,020) routine farm visits were executed for the year 2019. This accounted for a ninety-four (94%) percentage achievement. A decline in visits was experienced within the hinterland regions and was due in part to the heavy and prolonged rainfall that was experienced during the first half of the year making some areas in accessible. The Hinterland Regions recorded a total of seven thousand six hundred and twenty (7,620) farm visits or sixty-four (64%) percent of set target, while the Coastal Regions recorded a total of a twenty-one thousand four hundred (21,400) such visits or one hundred and thirteen (113%) percent of set target during the reporting period. Coming out of these visits, farmers registered their concerns in relation of wild animal damaging farms, the accessibility to seeds and planting materials etc. Extension Farm visits were ramped up to increase exchange of information on demo plots. A total of five hundred and fourteen (514) farmers group meeting were held where NAREI collaborated with GLDA, FAO and other agencies to organize meetings to assist farmers and stakeholders and to resolve farming issues. This activity recorded a percentage achievement of one hundred and twenty-four (124%).

At these farmer's clinic, pest and disease identification were done, recommendations were given to farmers accordingly. A total of one thousand four hundred and ninety-two (1,492) clinics were held and attended by farmers and other stakeholders, representing a seventy-one (71%) percent achievement.

Farmers field school got off to a late start in 2019 due to the late start of the demonstration projects in some Regions. Field schools were used to demonstrate the various activities (agronomic, pest control, fertilizer usage, cropping densities, etc.) for crop improvement and for increase yields. Farmers participation was

high, and it is expected that farmers will buy in and adopt the new methodologies, and technological information provided.

A total of two thousand and eighty-seven (2,087) packs of Acoushi ants' bait were distributed to farmers to aid in the control of the Acoushi Ants. This programme experienced some setbacks since the baits were now being offered for sale. The control of the Acoushi ants programme continues to engage the attention of NAREI, especially in view of the green state development initiatives undertaken by the Government and the fact that the use of agro-chemicals, the traditional methods of control, would have to be reconsidered. NAREI has begun to re-introduce alternatives methods of control which involves the use of botanicals and natural barriers as means of control.

A total of sixty-three (63) individual soil samples were collected and submitted to the Soils Department for analysis. Soil samples are usually collected and submitted to the Soils Department of NAREI for analysis. Results are communicated to farmers to form the basis for soil amelioration and correction in most cases.

A total of seven (7) individual water samples were collected and submitted for analysis while twenty-nine (29) pest samples were collected and submitted for analysis.

A total of two hundred and eighty-four (284) meetings / outreaches were conducted for the period under review. All Regions saw collaborative outreaches /meetings with several governmental and non-governmental agencies.

The year 2019 saw several training programmes being executed to aid in increasing the knowledge base of farmers and other stakeholders for increase production and productivity in the agriculture sector. For the

period under review, a total of one thousand three hundred and seventy-three (1,373) farmers, staff and stakeholders were trained in different aspects of agriculture. Staff, stakeholders and farmers were trained in the identification, surveillance and baiting of the Carambola Fruit Fly. This fly is of economic importance, in that it affects foreign trade.

Youths from Jacklow, Pomeroom, were exposed to citrus cultivation, (budding and grafting) This training was done to expose farmers to the technique of citrus growing and method of propagation. Farmers from Orealla and Siparuta were trained in: (1) Budding and Grafting; (2) Acoushi Ant control; and (3) Black Sigatoka management practices. Farmers were from Orealla and twenty-five (25) from Siparuta were trained. Farmers were involved in farmer's field day exercises where they were exposed to: (1) Shade House management; (2) Pruning techniques; and (3) Growing of celery.

(ii) Coastal Regions

The year 2019 has been a good year for the Extension Services especially in relation to the implementation and achievement of plans and targets that were set in accordance with the programme of work. The coastal work programme was geared toward the achievement of the Institution's strategic goal in support of the Green State Development Strategy, growing community awareness of sustainable agriculture, enabling the adaption and transfer of green technologies and crop diversification.

To aid in the transfer of technologies various demonstration plot/projects were established. These included demo plots to demonstrate black sigatoka disease management, citrus cultivation on sandy soil, the cultivation of exotic crops such as scotch bonnet, cauliflower, carrot and onions under shade house conditions. The cultivation of beans and bora using inoculums, limestone and fertilizers for increase yields. The production of red cabbage, peanut, ginger, carrot, onion and broccoli to aid in the import substitution drive.

Encapsulated in the 2019 work program were farm visits, a crucial task of extension service which was be executed by every extension officer with the objective of providing technical advice, support and to disseminate agricultural information to farmers and the general public while concurrently collecting production data. Farmer clinics and farmer field schools are methods that were applied to aid in the transfer of technologies and new and improved cultivars. Extension Officers participation in farmer's group meetings to rekindle the formation of cooperative society and aid in the establishment of linkages between farmers and relevant resource groups.

(iii) Achievement 2019 Visit to isolated Communities/ Rivers

A total of thirty-seven (37) visits to isolated communities/river were executed throughout the coastal regions during the year 2019. All the regions were able to achieve set targets, except for Region Ten (10) where the vehicle assigned to access the communities was stolen. Sixty percent (60%) of the total visits were executed in Region Two (2), especially in the Upper and Lower Pomeroon areas where several coconut DEMO plots were established. Visits in these areas served to address several issues including flooding, dry-spell, damages to crop caused by heavy wind, crop damage assessment, RPM, coconut caterpillar and cockle infestation, and BSD.

In Region Three (3), these visits were conducted mainly in Santa Mission, Berribisshiballi, Lanaballi, Aliki, Truily Island and Hogg Island. The common issues that were identified throughout these communities were Acoushi ant management, Coconut Cockle infestation and BSD infection. Also, the need for training on Cashew nut production was identified and addressed.

For Regions four (4) and five (5); St Cuthbert Mission and Moraikobai respectively, had their share of visits where DEMO plots were established and farmers training needs were met, especially in the area of peanut, beans and citrus production. Also, in the area of Acoushi Ant management.

In Region six (6), the isolated communities that were visited included Orealla, Canjie Creek and areas within the Berbice River. Issues related to flooding, BSD management and training were addressed during the visits.

(iv) Farm Visit

A total of twenty-one thousand four hundred (21,400) farm visits were conducted throughout the coastal regions during the year 2019.This figure represents 113% achievement relative to the set target. The target for 2019 was strategically set to improve the quality of extension service provided to the farming community by dedicating more time for each client to ensure effective dissemination of the appropriate information and the adaptation of the relevant technology. Region five continues to record the most farms visit as a result of its high farming population, while Region ten record the lowest farm visits but an overall increase when compared to 2018.

Several outcomes were produced as a direct result of farm visits which were conducted in various forms, of which, ninety percent 90% were routine visits, five (5%) percent request visits, three percent (3%) high alert mechanism activation, two (2%) percent crop damage assessment and other support services. The outcomes includes increased acreage cultivation, crop diversification, rupture of mono-cultivation, increase yield in citrus and passion fruit, effective identification and management of various pest and diseases, preparation of damage assessment report, dissemination of early warning messages, monitoring of flood situation, adaptation of climate smart practices by farmers, management of Acoushi ant, circumvention of social dilemma amongst farmers, aid the establishment and monitoring of CFF traps, establish and monitor demonstration plots and monitoring of certified farms.

While conducting farms visits extension officer are also tasked with the responsibility of registering new farmers, gathering production data and distribution of chemical for the treatment of RPM.

(v) Farmers Group meeting

Farmers group meeting continue to be a major component of extension service since it is the platform used by extension officers to establish linkages between resource agencies and the group itself. A total of two hundred and seven (207) farm group meetings were conducted in 2019; this represents a one hundred and eighteen

(118%) percent achievement. This achievement is directly related to the sprout in group formation throughout the coastland with Region six (6) outstanding fourteen (14) new groups established in Corentyne, Canje, New Amsterdam and East Bank Berbice. In Region five, four groups were revamped and three groups were formed in Region three, one group was formed in Regions four and ten.

Extension officers were very instrumental in the establishment of linkages between these farmers group and the following organizations UNDP/FAO, Food for the Poor Guyana Inc., Ministry of Social Protection, Ministry of Public Telecommunications among the many, these linkages afforded farmers to benefit from small grants, farm tool and machineries and shade houses establishment.

(vi) Farmer's Clinic

Farmer's clinic continues to be an important platform where farmers and Extension staff meet to discuss agriculture related issues. Farmers' clinics were conducted in the field and offices. It provided the opportunity for extension officers to have one-on-one sessions with farmers. Among the activities conducted in farmer's clinic were pest and disease identification, dissemination of general agricultural information, agro chemical application recommendation, and demonstration session.

Our department was able to achieve ninety-one (91%) percent of the set targets with Region five contributing more than forty five percent (45%) of the total. These sites were established in twenty-one (21) locations across the coastland and were geared towards the achievement of the following objective:

Capture farmers who:

1) May not be present on their farm during routine farm visit by the Extension Officer or Agent and has an Agricultural related issue; and

2) Are limited by time and other factors to visit the main station in their respective Regions and have Agricultural related issue.

(vii) Farmers Field School

A total of fifty (50) farmers field school/day were conducted during the reporting period which is reflected as eighty five percent (85%) achievement of the target and a two hundred and thirteen percentage (213%) increase when compared to 2018. Notwithstanding, the challenges encountered imposed steady set-back for the timely commencement of several farmers' field school, since the dependency of farmer field school was directly related to the establishment of demonstration plots which was hampered by adverse weather conditions.

Farmer field schools were conducted in conjunction with demonstration plot mainly to demonstrate the effectiveness of many of the new farming techniques and methodologies that were introduced to the farmers. In most cases, the farmers themselves demonstrated the new approaches or ideas that were introduced to them by the extension officers within the Region. This methodology of farmers' involvement was employed to ensure positive uptake of new ideas and implementation.

(viii) Acoushi Ants Control

The distribution of Acoushi ant bait significantly decreased during 2019, fifteen percent (15%) of the target was achieved, due to the implementation of a tactical decision to counter-effect the infestation of the pest on farms through the application of a holistic approach that incline towards environmentally friendly practices. Although the adoption rate of the new approach was slow among farmers, desirable results were obtained especially in Canal #1, Region three. Fifty percent (50%) of the total bait distribution and/or sold was done in Region two followed by Region four with (20%), Region ten (19 %) Region three (8%) Region five (2%) and Region six (1%).

(ix) Soil Sample

The coastland recorded a total of sixty-one (61) soil sample with a percentage of twenty eight (28). Soil sampling was done based on request and urgency such as intrusion of saline waters. Majority of the soil

sampling was done for farmers who intended to commence farming on virgin or rested lands while on spot soil testing was done on cultivated lands mainly to diagnose soil acidity. In instances where soil acidity was detected soil amendment was recommended and some farmer's group benefited from the distribution of low-grade rock phosphate by NAREI. Packages were prepared for those farmers commence farming on virgin or rested lands; the package included a farm lay out, drainage and irrigation design, suitable crop type, soil amendment and fertilization regime.

(x) Water Sample

A total of seven water sample/ water testing were carried in 2019, since this activity was based on request and urgency it can safely be stated that our department have served the needs of the farming community in this regards, however a replenishment of the EC meter across the Regions would provide for routine sampling/testing in the future.

(xi) Pest and Disease Sample

Fifty four percent (54%) of the set target was achieved for pest and disease sample during the reporting period, but unlike the activities that were based on request, this activity was done based on situation. Since majority of our extension staffs are competent and verse in pest and diseases identification there were few cases where sample collection was necessary. There were neither recorded new pests nor disease in the coastal region however an uncommon increase infestation of coconut cockle was noted in Regions two and three. It was also noted according to reports that the distribution and intensity of the Black Sigatoka Disease has reduced during the reporting period while the incidence of the common pests and diseases were minimal.

(xii) Meetings/ Outreach Program

Ninety percent (90%) of the set target of meeting and outreach program was achieved during 2019. These outreaches were carried out in all the Region of the coastland and served as the forum that provided farmers

and other stakeholders with the opportunity to have their concerns/ issues / problems aired and for the Extension officer to provide the farmers with practical solutions to their problems.

5.1 Demonstration Plots

5.1.1 Coastal Regions

Title	Objective	In put	Output to date	Out come to date	Duration/ Phase	Location
Application of good agricultural practices for sustainable production of Chili Peppers (*Capsicum annual*).	To demonstrate the relative performance of Chili peppers over an entire growing season, including growth rate, production, marketability and severity of insect and disease injury	Planting material Pesticide Fertilizer Limestone Transportation Labor	Establishment of a 0.20-acre Demo plot cultivated with Chili pepper	Adoption of tech pack by at least 4 farmers by 2020. (two farmers adopted to date)	Two years with a four months interval	Region 2
Use of inoculum (*Rhizobium*) in the propagation of beans seeds to improve germination percentage and increase production.	To increase beans production through the application biotechnology in Region 2.	Planting material Inoculum Pesticide Fertilizer Limestone	1 acre of land cultivated with legumes for demonstration purpose	Adoption of tech pack by at least 3 farmers by 2020. (two farmers adopted to date)	Two years with a four months interval each year	Region 2
Introduction of Black Pepper, Spice in the Region	To encourage crop diversification and maximize land use on	Planting material Plum wood Labor	0.1-acre coconut plot intercropped with black pepper for	Increase black pepper/ coconut intercropped acreage	Three years	Region 2

	coconut plantation.	Pesticide Fertilizer Limestone	demonstration purpose.	from the current 0 acre to 0.15 achieved to date.		
Citrus Production on sandy soils.	To improve Citrus Production on the Coast.	Irrigation system Pesticide Fertilizer Limestone Transportation Labor	Establishment of an improved system for citrus production.	The previous19 kg/plant has increase to 23/kg/plant on the selected farmer's plot.	Three years	Region 2
Improved plantain production with the application of Black Sigatoka Management.	To improve the plantain production and management of the Black Sigatoka disease through the application of appropriate tech pack.	Planting material Pesticide Fertilizer Limestone Transportation Labor	Establishment of one acre of plantain crop for DEMO purpose.	Reduction of the previous 80% distribution of infection to 40 % in the district.		Region 2
Integrated management for sustainable citrus production in Suddie-Supenaam.	To improve the production of the old existing citrus orchard by means of using good practices.	Planting material Pesticide Fertilizer Limestone Transportation Labor	Establishment of an improved system for citrus production	Yet to be achieved	Three years.	Region 2
Cultivation of Bastard	To determine the	Planting material	Establishment of a 1-	Development of	Three years	Region 2

variety Coconut on Sandy soil.	suitability of Bastard variety of coconuts on Sandy soil, with a 3 years' fertilization program.	Pesticide Fertilizer Limestone Transportation Labor	acre plot cultivated with bastard variety coconut.	appropriate tech pack with the research department.		
Production and use of compost booting green agricultural practices.	To reduce the use of synthetic fertilizers	Compost material Transportation Labor	Establishment of an active compost bin.	Yet to be achieved	Three years	Region 3
Production and use of Vermi compost advancing green agriculture.	To enhance the quality of tomato production.	Planting material Construction material Vermi worms Pesticide Labor Transportation	Establishment of a Vermicompost bin and 0.25-acre Tomato plot	Yet to be achieved	Three year	Region 3
Integrated pest management to curb the incidence of scarlet tip in pineapple.	To reduce the incidence of scarlet tip infestation among pineapple cultivation.	Planting material Fertilizer Pesticide Mulch plastic Labor Irrigators	Establishment of 1-acre pineapple cultivation.	20% reduction in the distribution of scarlet tip Canal Polder #1	Three years	Region 3

		Transportation				
Sustainable production of cole crops.	To encourage sustainable agriculture through crop diversification and crop rotation.	Planting material Fertilizer Pesticide Labor Irrigators Transportation	Establishment of 0.25-acre cole crops cultivation	Cultivation of Cole crop during intervals of crop rotation realized by farmers.	Two years	Region 3
Use of inoculum in bora production	To increase bora production in bio friendly economical manner.	Planting material Fertilizer Inoculum Pesticide Labor Irrigators Transportation	Establishment of 2 acre of bora cultivation	Reduced input cost for bora production by 10% on 8 farmer's farm by 2020.	One year	Region 3
Cultivation of Peanuts within the Pakuri community.	To improve livelihood in the Pakuri community by increasing the production of peanut.	Planting material Fertilizer Gypsun Pesticide Labor Transportation	Establishment of 2 acre of peanut cultivation	1 acre of land cultivated with peanut in Pakuri.	Three years	Region 4
Application of IPM for sustainable production	To reduce the use of toxic pesticides for pest control	Planting material Fertilizer	Establishment of 0.5 acre of bora cultivation	10 farmers adopt tech pack.	Two years	Region 4

of bora at Beehive / Good Hope.	in bora cultivation.	Pesticide (synthetic and natural) Labor Transportation				
Introduction (Sweet corn) production at Hope Estate	To encourage crop rotation using an economically viable crop	Planting material Fertilizer Pesticide (synthetic and natural) Labor Transportation	Establishment of 0.5 acre of sweet corn cultivation	0.5 acre cultivated with sweet corn.	Three years	Region 4
Inter-cropping in coconut plantation	To maximize land usage on coconut plantation in Hope Estate	Planting material Fertilizer Pesticide (synthetic and natural) Labor Transportation	Establishment of 1 acre of sweet corn cultivation	Three acres of coconut plantation inter-cropped (yet to be achieved)	Two years	Region 4
Kuruku Rural Development Project	To improve livelihood of farmers and homestead in Kuruku and East Bank	Planting material Construction Material	Yet to be established	Yet to be achieved	Five years	Region 4

	Demerara by extension.	Fertilizer Pesticide (synthetic and natural) Labor Transportation				
Best practices to curb the occurrence of blossom end rot in sweet pepper Vereeniging.	To improve the quality of sweet pepper produce Vereeniging.	Planting material Fertilizer Pesticide Limestone Labor Transportation	Establishment of 0.25 acre of Sweet pepper crop.	50% Reduction in distribution of blossom end rot and improved quality of sweet pepper produces Vereeniging	Five year with a four months interval	Region 4
Formulation and application of ideal crop calendar for farmers of Friendship, ECD.	To reduce the factor affecting marketing of cash crop produced in improving the quality of sweet pepper produce Vereeniging.	Planting material Training material Fertilizer Pesticide Limestone Labor Transportation	2 ideal crop calendars formulated.	yet to be achieved	Two years with three months interval.	Region 4
Improve management practice of coconut	To improve the production and to	Planting material Fertilizer	3 acre of coconut plantation	Improved production from 2.6 lbs/per nut to	Five years	Region 5

plantation (2-year-old variety and 18 months variety) Mahaicony	demonstrate good management practices in coconut.	Pesticide Limestone Labor Transportation	reestablished and manages using good agricultural practices.	3 lbs / nut on each plot in Mahaicony (yet to be achieved)		
Fertilization using coconut husk and other organic matter	To demonstrate the benefits of using coconut husk and other organic matter in coconut production.	Planting material Fertilizer Pesticide Limestone Labor Transportation	3 acre of coconut plantation reestablished and manages using good agricultural practices.	3 farmers adopt tech pack.	Two years	Region 5
Increased production of purple cabbage	To increase the production with intentions to reduce the importation cost of this high value crop.	Planting material Fertilizer Pesticide Limestone Labor Transportation	0.5 acre cultivated with purple cabbage	3 farmers adopt tech pack.	Two years	Region 5
Agro processing of garden herbs and fruits	To demonstrate an increase in markets, turnover and profits by adding value to farm produce through further processing	Planting material Fertilizer Pesticide Limestone Labor Transportation	Yet to be achieved	Yet to be achieved	Three years	Region 5

Expansion of onion production	To increase the production and to demonstrate good management practices in onions.	Planting material Pesticide Fertilizer Limestone Labor Transportation	0.1 acre cultivated with onion.	Yet to be achieved	Two year with a four months interval	Region 5
Use of inoculum	To improve the production and to demonstrate good management practices using high value planting material.	Planting material Inoculum Fertilizer Pesticide Limestone Labor Transportation	0.25 acre cultivated with NAREI Minica	1 farmer adopted the tech pack	Three year with a four months interval	Region 5
Establishment of demonstration plots and a plant nursery at Moraikobai	To demonstrate good farming practices, seeding production and farm management using demo plots.	Construction Material Planting material Pesticide Fertilizer Limestone Labor Transportation	Establishment of a plant Nursery at Moraikobai.	Yet to be achieved	Three years	Region 5

Black Sigatoka Management	To increase production of plantain through the management of practices.	Planting material Fertilizer Pesticide Limestone Labor Transportation	Establishment of a 0.25 acre of sucker cultivation Crabwood creek Cortland, Canjie and East Bank Berbice	Increase plantain production by 2%.	Three years	Region 6
Increase spice production	To promote the production of spices throughout the region.	Planting material Fertilizer Pesticide Limestone Labor Transportation	Establishment of a 0.19 acre of suckers Sandvoort, Giberaltor, Black Bush Polder and Canji	Notable Production on spice	Four years with a three months interval	Region 6
Increase production of Cole crop	Increase production of Cole Crop throughout the Region	Planting material Fertilizer Pesticide Limestone Labor Transportation	Establishment of a 0.19 acre of suckers Sandvoort, Giberaltor, Black Bush Polder and Canji, Manchester, Upper Corentyne	Produce 5 acre of cole crops twice biannually.	Three years three four months Interval	Region 6
Introduction of Vermi and Kitchen waste composting	To promote Green practices for sustainable agriculture	Planting material Construction Material Vermi Worm	Establishment of 4 Compost Bin in Black Bush Polder Bush Lot, Fyrish and, Upper	Reduce usage of synthetic fertilizer in the respective district.	Five years	Region 6

		Fertilizer Pesticide Limestone Labor Transportation	Corentyne			
Green Agriculture Cultivation of Ginger in open field	To promote the growth of ginger on various soil types common to Linden To establish a management system for the growth of the crop from cultivation to harvesting	Planting material Fertilizer Pesticide Limestone Labor Transportation	A target group of 15 persons was identified on how to cultivate and manage crop to harvesting stage	Target group was able to expand production from a subsistence level to a medium scale operation	Five years	Region 10
Cultivation of Bell Peppers inter cropped with beets Cultivation of Bell peppers utilizing Creole Corilla as shade crop	Supply niche market and restaurants with beets and bell peppers Utilize composted materials in project 3 as an alternate source of fertilizer.	Planting material Fertilizer Pesticide Limestone Labor Transportation	yet to be achieved	yet to be achieved	Three years	Region 10

Green Agriculture Composting of Garden and Yard Waste	To provide an alternative and cheap means of fertilizers for crop production	Planting material Construction material Fertilizer Pesticide Labor Transportation	Target group remains the One Mile Extension CDC group. Initial target amount- 8 group members.	Each group member was able to provide the group with enough materials to establish and maintain a sustainable supply of compost	Three years	Region 10
Coconut Orchard Management	To increase coconut production through improve management practice	Planting material Construction material Fertilizer Pesticide Labor Transportation	Target group remains the Block 22 Extension CDC group. Initial target amount- 8 group members	Each group member should be able to increase production in by 1.5 % before the end of 2021 (50 % achieved)	Four years	Region 10
Open field production of Broccoli and cauliflower	1. To cultivate broccoli and cauliflower in open field 2.To establish the formation of uniform and sizable heads of the crops	Planting material Construction material Fertilizer Pesticide Labor Transportation	Target group remains the Extension CDC group. Initial target amount- 8 group members.	increased production of cole crop in region 10	Three years	Region 10

5.1.2 HINTERLAND REGIONS

The department goals and objectives for 2019.

1. Provide technical information and support to facilitate activities in crop development.
2. To promote diversification of crops with the aim of food security and sustainability.
3. To promote the expansion of crop production with the aim of supplying the school feeding programs.
4. Discuss and demonstrate appropriate pest control methods with farmers in boosting crop production in the Hinterland Regions.
5. Promote post-harvest handling, marketing and processing of fresh fruits and vegetables.
6. Promote and integrate approach to Acoushi Ants Control.

In fulfilment of the goals and objectives these activities were implemented under the following:

a. Demo plots of new crop types and technologies.
b. Farmers Clinics
c. Farmers Training
d. Staff Seminars.
e. Routing farm visits.
f. Pest and disease sampling.
g. Soil and water sampling.
h. Acoushi Ant Control
i. National events.
j. Climate smart agriculture.

Summary of DEMO projects:

In 2019 there were 21 planned DEMO projects across the Hinterland Regions and base on reports we would have accomplish 85 %.

Status update on DEMO project:

Region 1

DEMO Projects	Status	Remarks
Root and Tubers Production - Carrots (*Daucus carota* var New *Kuroda*).	Completed	This demo was completed, with some poor survival rate recorded which was due to the climatic conduction. As a result of which it was recommended that this crop be grown under shaded cultivation especially in the hinterland regions.
The cultivation of Bora (*Vigna unguiculata sesquipedalis*) variety- Yard length using Rhizobium Inoculum	Completed	This project was successfully completed. Farmers are now adapting the use of inoculum, since they have reorganized its usefulness and that less UREA fertilizer was required. It was noted that the inoculum was only accessible from NAREI.
The cultivation of Cauliflower (*Brassica oleracea*)	Completed	This project was successfully completed. Farmers harvested an average of 0.6 to 1 lb. per plant. Marketing seems to be an issue. However, farmers are willing to expand.
Orchard Establishment and Management (Citrus)	In Process	This project is still in progress, Extension Officer will continue to monitor same.
Cultivation of Sweet pepper (*Capsicum frutascens* Var California wonder)	Completed	This project was successfully completed. More farmers wish to be involved in production of sweet peppers.
The cultivation of Cauliflower (*Brassica oleracea*)	Completed	This project was successfully completed. Same assessment applied here as in Mabaruma.

Region 7

DEMO Projects	Status	Remarks
Cultivation of Onion	Completed	This project was successfully completed. Poor survival rate was recorded. It was recommended that this crop be planted under shade house since the climate conduction was not favorable for its development.
Cultivation of Pigeon pea	Not completed	
Cultivation of sweet cassava	Completed	The project was successful, farmers are now keen on the cultivation of other sweet cassava varieties especially those that are drought tolerant.
Production of cash crop seedlings	Not Completed	

Region 8

DEMO Projects	Status	Remarks
Production of organic tomato	Completed	150 farmers were involved, yield grew from 1 to 1.5 and 2 lbs per plant (total production was 32,000 lbs). The planting strategy (staggered planting) was considered the key factor for increased yields, along with the increase in rainfall.
Production of Peanut	Completed	This project was successful, and farmers are eager to have more diversification of peanuts varieties.
Production of Legume (Feijo)	Completed	This project was successful and the expansion of the feijo production is

		considered necessary to fulfill the requirements of the school feeding program within the nearby communities.

Region 9

DEMO Projects	**Status**	**Remarks**
Onion Production	Completed	This project was not successful as a result of the low survival rate of the onions which was due to the weather pattern. One recommendation is for future cultivation of this crop to be done under shaded conditions (shade house strategy).
Tomato Production	Completed	This project was successful, and farmers have indicated their willingness to continue and be part of the initiative, however, input supplies are very costly.
Cost of production in cassava	In process	Extension staff will continue to monitor in 2020.
Hot Pepper Production	Completed	This project was successful. Informal training programme for farmers was conducted. All the necessary information and assistance will be provided to all interested farmers who wish to produce hot pepper.
Ginger Production	Not started	
Cabbage production	Completed	This project was successful, farmers express their satisfaction and will to expand their production.
Tomato production and citrus	Completed and	Staff will continue to manage and monitor this project.

management	in progress	
Minica IV production.	Completed	Farmers have requested other varieties in an effort to diversify.

Summary of Targets and achievements of various field activities:

Main Components	**Achievements**	
	Target Set for the year	**% Achieved (complete or ongoing)**
Farm visits	11,935	67%
Farmers Clinic	1,100	97%
Visits to remote communities	780	113%
Farmers meeting	240	128%
DEMO - Projects	21	85%

Special collaborative projects and Programs with other Agencies and Ministries.

- **Climate Smart Agriculture (Indigenous People Affairs, RDC):**

In support of climate smart agriculture, a number of training programs were conducted in Regions 1, 8 7 and 9 in colaboration with the Indeginous People Affairs. For 2019 there were three (3) shade houses that were newly constructed and operationalized within the hinterland region.

- **Sun dry tomato (IAST):**

- In collaboration with IAST, NAREI has distributed approximately 25,000 tomato seedlings in Parmakatio and surrounding community which benefitted with approximately 150 farmers. The project was successful with 100% increase of production in 2019 with increases from 18,000 lbs to 32,000 lbs.

- **Acoushi ant control (RDC):**

NAREI continued to work with farmers in the control of the Acoushi ant. Technical advice and Fogging exercises were done in various hinterland communities and in collaboration with the village councils and farmers. In Region # 9, NAREI collaborated with the Regional Democratic Council (RDC) in the distribution of Acoushi ant baits (Blitz).

- **Working with Women's group:**

Extension services were extended to the Wowetta woman's group of 45 members, for the production and processing of cassava. Technical guidance in pest management was given to the group of farmers. Informal training sessions were held in open fields in relation to good agronomic practices in cassava production.

Working with Paruima Women's group:

NAREI's Extension Officers from Region 7 and Georgetown conducted training sessions and practical exercises in crop production with twenty -three (23) women farmers.

- **Hydrometherology**:

Extension staff collaborated in climatic data collection and the dissemination of bulleting and other relevant information for farming. NAREI's extension staff collaborated with Hydromet Dept in carrying out field and data collection works in Regions # 7, 8, and 9.

- **F.A.O**

NAREI Extension staff and the M & E department engaged with FAO in Disaster Risk Reduction Best Practice Project in Regions 7, 8 and 9. Projects included; Cassava Seeds Bank, Rearing of Black Giant and the production of Vegetables under shade house.

- **New Guyana Marketing Cooperation**

With the help of NAREI's extension staff, New GMC was able to achieve its objective for data collection, where NAREI staff facilitated meeting and farm visits in various communities.

5.0 NATIONAL PLANT PROTECTION ORGANISATION (NPPO)

(i) PLANT QUARANTINE SERVICES

Inspection of Imports

Inspection of imported agricultural commodities and all regulated articles for the year 2019 continued as a matter of routine the various ports of entry, wharves, bonds, storage facilities, etc. As usual these activities were conducted to facilitate the importation for the various agricultural commodities and resulted in a total of three thousand three hundred and fifty-five (3,355) inspections being recorded. Some of the major imported commodities included: potatoes, onion, garlic and spices. Commodities that met import requirements were allowed entry. The newly implemented system by the Guyana Revenue Authority (GRA), Automated System for Customs Data (ASYCUDA), undoubtedly brought about an increase in the number and quantity of imported commodities now captured by the NPPO. The difference showed an increase of one hundred and thirty-five (135) inspections or a 4 % increase over the corresponding year 2018.

Rejection of Imports

The Quarantine department continued its surveillance activities for agricultural commodities that were illegally imported. Rejected commodities were those that were imported without the requisite documentation, Import Permits, or were pest infested and unfit for human consumption. For the reporting period, January to December 2019, a total of two hundred and forty-eight (248) such interceptions/rejections were recorded. This reflects a 7% decrease in interceptions and rejections of imported commodities over the corresponding year 2018.

Import Permits Issuance

A total of six hundred and thirty- six (636) Import Permits were issued for the importation of various agricultural commodities. Permits were issued for exotic fruits (apples, grapes, berries, etc.), vegetables,

potatoes, onion, seeds, fertilizers, garlic, wooden furniture, etc. The issuance of permits for importation for the year 2019 has increased by forty-four percent (44%) when compared to the corresponding year 2018.

Inspection of Ships

A total of one thousand six hundred and twenty-six (1,626) ocean going and local vessels were subjected to inspection to ensure compliance with phytosanitary requirements for all vessels entering and plying the territorial water of Guyana. All the vessels so inspected were permitted to enter or operate within Guyana since they all met the requirements for entry and/or for operation. The inspections of vessels increased by twelve percent (12 %) when compared to the corresponding year 2018.

Inspection of Flights (Passenger, Cargo, etc.)

A total of two thousand six hundred and eighty- five (2,685) flights were inspected at both Cheddi Jagan and Eugene F. International Airports. Quarantine officials inspected flights upon arrival and also included were passengers, passenger' baggages, cargo to ensured that international garages were appropriately disposed.

Inspections of vehicles at Ports of entry

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 twenty-eight thousand three hundred and fifty-one (28,351).

Inspection of Rice Fumigation (Containers, Etc)

For the reporting month a total of three thousand two hundred and two (3,202) fumigations were supervised for the export of rice and rice products. No non-compliance report was received for the reporting period.

(ii) Inspection of exports

Number of inspections

'A total of four thousand nine hundred and forty-five (4,945) export inspections were carried out during the reporting period for both commercial and non-commercial commodities.

Number of Phytosanitary certificates issued

'A total of four thousand four hundred and seven (4,407) phytosanitary certificates were recorded as issued for the year 2019.

(iii) Trade negotiation

During this reporting period a total of two (2) trade negotiation meetings were held. One with the Republic of Trinidad and Tobago, Ministry of Agriculture officials. The purpose of the meeting was to address trade issues and barriers that were in place against Guyana fresh fruits and vegetables. Guyana was able to have removed several SPS measures that were hindering trade in fruits and vegetables. Another meeting was held with officials of the Ministry of Agriculture, Brazil. Discussions centered on possible bi-laterial activities and programmers to control and eradicate the Carambola Fruit Fly (CFF), trade in meat and meat products, trade in fruits and vegetables. This resulted in the execution of a training programme of the CFF for the Lethem NAREI Extension and NPPO staff and the joint monitoring (Teams from Guyana and Brazil conducted surveillance and trapping within the Lethem and surrounding communities).

(iv) WTO/ IPPC Enquiry and Notification Points

Number of Enquiries answered

'The NPPO was able to continue to provide information to trading partners and potential trading partners on Guyana’s requirements for trade in agricultural commodities. Seventeen (17) countries had submitted queries

and the NPPO team provided details as per request. Some of the enquires that were addressed with our trading partners:

(i) Fraudulent re-export phytosanitary certificates for lumber originating from Suriname and being re-exported to India (certificates nos. 2321 - 2326);

(ii) Trinidad for the inclusion of import permit numbers on phytosanitary certificates issued by the GOG;

(iii) IPPC granted approval for Guyana to be included in the Global ePhyto Hub;

(iv) CABI granting Guyana to free access to Pest Risk Analysis (PRA) Tools, renewable every year henceforth;

(v) Request for India to honour the requirement as per Plant Quarantine Order (PQ 2003), which allows for the use of Aluminum Phosphide for the treatment of lumber and timber before entry into India.

Number of Notifications to WTO/ IPPC

Three (3) notifications were submitted to the WTO for the reporting period. These were submitted on behalf of the Guyana Livestock Development Authority (GLDA) on their legislations and regulations.

Number of Comments, Reviews and/or Questionnaires submitted to WTO/IPPC

Twenty-four (24) questionnaires/ standards were submitted to Guyana for completion and in some cases for comments/ review from the WTO and IPPC. These were all filled out/ commented on or reviewed and the information resubmitted. During the year 2019, two (2) draft standards were reviewed and submitted to the National Codex Contact Point: (1) Proposed draft guidance for the labelling of non-retailer containers of food, and (2) Proposed draft guidelines on front -of-pack nutrition labels. This invitation for comments was through the Sub-committee on Labelling. There was also a Trade Facilitation Survey completed and submitted to UNCTAD.

(v) Pest Risk Analysis (PRAs)

Number of PRAs conducted

For the reporting period a total of three (3) PRAs were conducted.

Number PRA Data/ Information sheets provided to countries to initiate trade

Two (2) Market access information were prepared and sent to Trinidad on peppers and pineapples for the island to conduct PRAs. Information was also sent to Antigua and Barbuda with regards to banana importation.

(ii) PLANT PROTECTION SERVICES

Surveillance Programmes

The National Plant Protection Unit conducted surveillance activities in keeping with International Standard for Phytosanitary Measure (ISPM) 6 and other appropriate ISPMs when necessary. An ISPM describes the components for effective and efficient survey and monitoring programmes that are essential for pest detection and the supply of information for use in pest risk analyses, the establishment of pest free areas/areas of low pest prevalence, and in some cases, the preparation of national pest list.

For the year in review, specific pest surveys were carried out for four quarantine pests, namely: the Carambola fruit fly, Mediterranean fruit fly, Red Palm mite and the Red Palm weevil. While host surveys were conducted for Carambola, Mediterranean and Anastrepha species of Fruit flies.

Pest Surveys - Carambola Fruit Fly

Scientific name: Bactrocera carambolae (Drew & Hancock) (Insecta: Diptera: Tephritidae)

The carambola fruitfly (CFF) is known to be polyphagous and causes tremendous economic losses of fruit crop (Koswanudin, et al., 2018); with its reintroduction and spread into Guyana has resulted in embargoes, yield and

production losses inter alia. The introduction, establishment and spread of exotic genera of fruit flies such as Bactrocera in Guyana is mainly due to: traffic of contaminated fruits between areas with and without presence of the pest, abundance of hosts in the country, prevalence of favorable climatic conditions to the establishment and reproduction of species, and absence of natural enemies.

CFF infestations have also cause direct impact to the social sphere, generating income reduction and unemployment in the rural population, especially in those small farming communities highly dependent on the fruit sector.

In view of the importance of the Bactrocera genera as an encumbrance to international fruit export and its adverse effect on the local fruits of Guyana, a strategic approach has been developed towards its control and eradication utilizing guidelines established by the ISPMs.

For the period under review, the Plant Protection Unit strategy execution entailed the following:

i. Surveillance

ii. Management and control

iii. Public outreach

iv. Capacity building of technical staff and relevant stakeholders

v. Cooperation with trading partner (with vested interest)

CFF Surveillance

During the period under review, CFF survey and surveillance activities were increased to cover both coastland and hinterland areas. These activities were executed in eight administrative Regions: 1,2,3,4,5,6,8, and 9 with the support of the Crop Development and Support Services; and included actions such as the distribution and

monitoring of pest populations by use of Jackson traps impregnated with methyl eugenol and a killing agent (malathion) and multi-lure McPhail traps with protein baits (with water as the killing agent).

The population density of fruit flies in an area is directly related to the availability of hosts, since they have a life cycle where their larvae develop especially inside the fruits, serving as eggs deposit and food for adult flies. Thus, it is crucial to identify hosts for an integrated management of the pest (Cavalho, 2003). Based on results obtained through the monitoring component of the program the Unit has recognized the need to implement Control measures in areas highly infested with CFF with the aim of reducing the population.

The results from these actions have indicated the CFF was found to be absent in the entire Regions 5, and confirmed present within Regions; 1, 2, 3, 4, 6, 8, 9 and 10. Region 7 is unknown. There were sporadic cases of pest detection in some villages in regions which were never previously recorded, while in others the population were high.

CFF Management and Control

Management and control actions entailed the use of an integrated strategy. In 2019, the unit conducted baiting, distributing fibre board blocks immersed in a mixture of methyl eugenol and malathion distributed in affected areas, to reduce the male population. This action was followed by mass trapping utilizing McPhail Traps (specific to attract both mature male and female flies), Fruit stripping, collection and rearing (host surveys).

Additionally, there was the spraying of host plants Organic pesticide, Success (containing the bacterium, Spinosad) in the St. Ignatius community.

CFF Public Outreach

Public outreach initiatives were executed in all affected regions. These activities catered for a wide audience: general public, farmers, students and field staff. These actions were supported by the Inter American Institute for Cooperation on Agriculture (IICA) and the CDSS teams in the respective regions/districts involved.

In 2019, formal sensitization sessions were conducted in Georgetown (region 4), Orealla and Siparuta (Region 6), Mahdia (Region 8) and St. Ignatius (Region 9) – these aforementioned sessions targeted the general public, farmers and residents in all regions. The session in Region 9, however, included sensitizing of students in the St. Ignatius Secondary School.

Apart from the formal sessions, the unit continued to have one-on-one discussions with farmers and residents whenever they interface during surveillance activities. Additionally, radio and social media were also used to disburse information on the pest.

Carambola Fruit Fly Capacity Building

During the period under review, there was one (1) formal capacity building activity conducted between the Governments of Brazil and Guyana, in collaboration with the Brazilian Agency for Cooperation (ABC) for NAREI staff from Region 9, NPPO Protection Unit, other government agencies and community development organisation within the Lethem and St. Ignatius Municipalities.

This exercise is the action from Results Area 2: Activity 2.1 of the Cooperation project with the ABC entitled, "Capacity Building in Support of the Control and Eradication of the Carambola Fruit Fly in Guyana," which is a two year project that seeks to build the capacity within the Ministry of Agriculture Guyana to support actions to control and eradicate the CFF.

For a period of 10 days, 17 Guyanese Technicians were trained in Phytosanitary practices (CFF identification, control and Eradication), CFF biology and Phytosanitary Education through theoretical and practical exercises. The curriculum workload covered was 64 credit hours and certificate of participation were distributed to those successful participants.

Carambola Fruit Fly Future Outlook

A major challenge was the unavailability of adequate resources locally to effect eradication efforts, the porosity of Guyana's borders (note that all our geographical neighbours are found to have this pest) and the domestic movement of commodities from affected areas to pest free areas.

However, this pest can be successfully eradicated through consistent actions and cooperation. Two planned initiatives include the realization of:

1. Bilaterally: Technical Cooperation between Guyana and Brazil through the biennial project entitled, "Capacity Building in Support of the Control and Eradication of Carambola Fruit Fly in Guyana." Knowledge is power, and this project seeks to keep technical staff of the Ministry of Agriculture informed of effective methodologies to employ in the eradication efforts.

2. Tri-lateral: This is a proposed 10-year project that seeks to eradicate the CFF from Guyana, Suriname and Brazil through a collaborative approach, given the movement of goods and people between the countries.

Additionally, consideration to be placed on:

- Regulatory controls: domestic movement of host materials
- Alternative methods of controls, utilizing local substitutes, environmentally safe chemicals

Mediterranean Fruit Fly

Scientific name: Ceratitis capitata (Wiedemann) (Insecta: Diptera: Tephritidae)

The Mediterranean fruit fly is considered one of the most destructive of the fruit flies in the tropics and subtropics due to its high dispersive ability, extensive host range (more the 200 host species inclusive of fruits and vegetables), and tolerance to a wide temperature range. This pest has its origin in Sub-Saharan Africa, and has spread to a number of territories in almost all the continents (CABI, 2014). Notable mentions of those affected in Latin America and the Caribbean include our geographical neighbours (Brazil and Venezuela), USA, Jamaica, the Netherland Antilles, and Belize; given Guyana's proximity and susceptibility to this pest, the unit has embarked on an active survey and monitoring programme to determine the country's pest status and to maintain surveillance activity to in an effort to ensure early detection and effect regulatory actions if necessary.

The Survey and Surveillance Unit commenced surveillance activities for Ceratitis capitata, commonly referred to as Mediterranean fruit fly or Med fly in 2017. Active surveillance for the Mediterranean fruit fly entailed the use of Multi-lure traps impregnated with an organic pheromone (Trimedlure) distributed in "high priority areas. The initial focus for surveillance was centralized around common tourist points, such as airports, gardens, hotels and business places with potential host presence in administrative region number four (4). The primary objective of Med fly surveillance is to encourage early detection and control measures on interception, since it has never been recorded in Guyana.

The methodology employed for Mediterranean fruit fly surveillance was centered on the multi-lure trap. This trap constitutes a yellow base with an opening in the centre, a transparent oval shaped plastic cover that consist

a depression at its apex for the insertion of the lure and a cotton thread that acts as the hanger for the trap. The primary lure used in this trap is the Trimedlure.

The Unit sought to widen the surveillance area of target for the Mediterranean fruit fly by extending the trapping line in the present administrative region and establishing new trapping lines within the other administrative regions. This is to enhance the validity of data collection records and officially establish Guyana as pest free for this pest.

Red Palm Mite

Scientific name: Raoiella indica

The Red Palm Mite is an economic pest of the palms, Musa spp and Heliconicas, and was discovered in the late 2013 on the island of Wakenaam, Guyana and since its introduction the NAREI has embarked on a concerted effort to monitor and control the spread, with the eventual aim of eradication.

The NPPO in 2019 carried out four monitoring surveys for RPM along the Lower and Upper Pomeroon River, Region 2.

- A total of 120 random leaflet samples were collected and transported to the laboratory to conduct population counts. The aim of the survey was to determine the effectiveness of integrated pest management practices on reducing the effects of RPM on coconut production. The Results obtain showed reduce population of RPM on trees exposed to IPM Strategies.

- Efforts to contain the pest where it was found resulted in 1,322 quarantine treatment or measures being implemented on the Island of Wakenaam during 2019.

- Information dissemination sessions where held with 1,376 farmers, residents and other concerned parties about the threat of RPM and how to deal with same. These sessions took the form of one on one conservations, group discussions, and distribution of brochures.

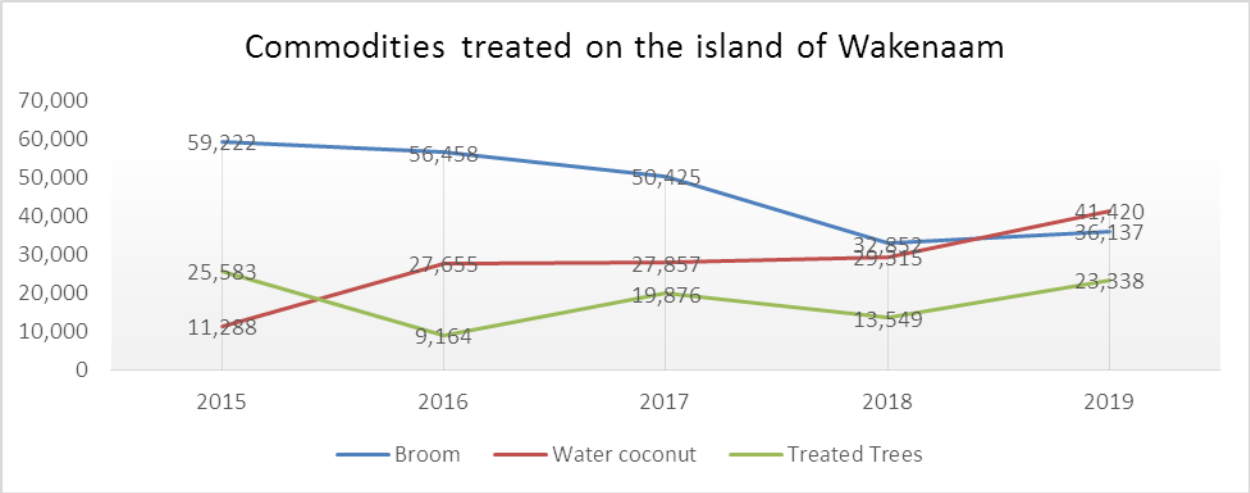
Internal Quarantine Measures:

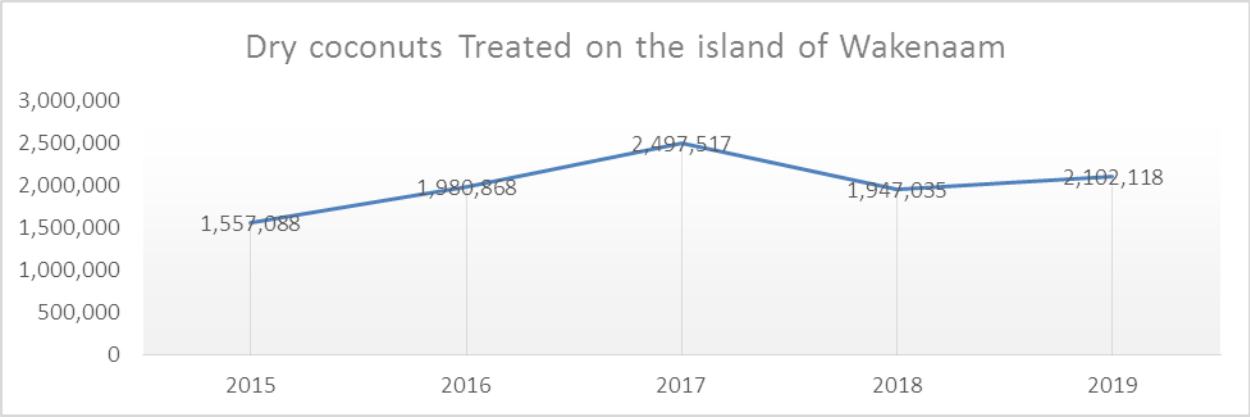
Internal Quarantine continues to be an important aspect in the efforts to contain the spread of RPM to unaffected areas. Measures were implemented on Wakenaam Island, Region 3. This area accounts for a significant percentage of Guyana's coconut export production and coconut by-products.

The implementation of internal quarantine measures resulted in a total of 36,137 brooms and 2,102,118 dry coconuts being fumigated with phostoxin tablets, 41,420 water coconuts washed in bleach solution and 23,338 coconut palms treated with Monocrotopus, Abamectin and Triazophos.

Chemical Treatment of Red Palm Mite

The Second phase for the distribution of chemical concluded in 2018 for the control of Red Palm Mite where 715 Farmers benefited from 3860.7 liters of Chemicals. Chemicals distribution occurred only during the first two months of 2019 where 17 farmers on Wakenaam Island received a total of 47 liters of chemicals.





Results:

- There is an increase in the quantity of brooms treated as compared to 2018
- There has been a significant increase in the quantity of water coconut harvested.
- There has been a slight increase in the quantity of dry coconuts treated when compared to 2018.
- The second highest number of trees treated within the last four years occurred during 2019. The continuous treatment of coconut trees has seen an increased production and harvesting of dry coconuts, water coconut and brooms during 2019

Public Awareness also played an integral role, information was disseminated via sessions with farmers, residents and other concerned parties about the threat of RPM and how to deal with same. These sessions took the form of one on one conservations, Group discussions, and distribution of Brochures.

Red Palm Weevil

Scientific name: Rhynchophorus ferrugineus (Oliver)

The red palm weevil originated in tropical Asia but has spread through the Middle East and the Mediterranean where it has severely damaged commercial and ornamental palm trees (Faleiro, 2006). In 2009 this destructive palm pest was first reported in the Caribbean islands of Aruba and Curacao (Brochert, 2009), by 2014 it had further spread to the Netherland Antilles (CABI, 2018); given the high pest population in Curacao, coupled with the increased trade of fresh agricultural produce by smallholder boats between Curacao and Venezuela, there is an increased risk for its introduction and spread into the Caribbean and South America (Roda, et al., 2011). Hence, the Plant Protection Unit has established an official survey and monitoring programme in major coconut producing areas to determine the pest status of defined areas in Guyana.

The preliminary focus for surveillance was placed around active/ functional coconut estates. The primary objective of these activities is to confirm the status of Red Palm Weevil in Guyana and where present introduce early control and eradication measures. This pest is one of great economic importance since it poses a threat to Guyana's vibrant coconut industry.

The methodological approach utilized for red palm weevil surveillance is centered primarily on the bucket ferrolure trap. This trap constitutes the following components; bucket, bucket cover, mesh, ferrolure pheromone (P028 Ferrolure), water and a killing agent (sodium percarbonate in washing powder). Additionally, a food lure (stem of coconut branch) is added to enhance the efficacy of the trap in attracting the pest of concern. The

bucket traps are established within close proximity of the base of coconut tree (approx.1- 2ft) and inserted approximately 2-4 inches in the soil.

The Unit sought to widen the surveillance area of target for the Red Palm Weevil by extending the trapping line in the present administrative region and establishing new trapping lines within the other administrative regions. Further, focus was also placed on some inactive coconut estates as they may also be hosts for this pest.

For the period 2019; the surveillance team embarked on a strategic regional surveillance approach for Red Palm Weevil. The bucket traps with ferrolure was the primary trapping tool in the process. The unit focused primarily on extending the trapping line in administrative region # 5. This method of approach was employed to establish an organized way of assessing the status and geographic distribution of red palm weevil across Guyana by regional distribution. The unit presently has its surveillance line from region 4 (Mahaica) stretching to Plantation Phoenix, West Coast Berbice Region #5. During this period the new traps and previously established traps serviced indicated no evidence of red palm weevil within these regions.

Pink Hibiscus Mealybug

Scientific name: *Maconellicoccus hirsutus (Green)*

Passive countrywide surveillance conducted throughout the year has indicated that both the *Pink Hibiscus Mealybug* and *Papaya Mealybug* remain below the economic threshold.

This low population count remains in check due to the presence of the biological control agents *(Anagyrus Kamali, Cryptolaemus montrouzieri)* that were released during PMB Control and Management Programme. Passive surveillance continues countrywide

Host Surveys

Tephritidae (Genus: Anastrepha, Bactrocera, Ceratitis and any emerging fruit flies)

The Carambola Fruit Fly Laboratory was established in September, 2014 within the National Agricultural Research and Extension Institute (NAREI) under the National Plant Protection Organization, to directly aid the efforts of Carambola fruit fly survey and surveillance. Further, the fruit fly laboratory function expanded and is recognized as the Survey and Surveillance laboratory, which renders pertinent assistance towards the Survey and Surveillance of Pests and Plant Quarantine measures.

From the initial commissioning of the Fruit Fly (FF) laboratory, it has served as a critical arena in acquiring information in relation to the status of FF across the various geographic regions of the Republic of Guyana. More so, the laboratory places it focuses towards quarantine pests within the context of Guyana. The major pests under surveillance of the laboratory are the Carambola Fruit fly and Mediterranean Fly scientifically acknowledged as the Bactrocera carambolae and Ceratitis capitata respectively. These are exotic pest of economic importance (Quarantine pests) in Guyana. Their presence holds significance to the NPPO since they possess the potential to hinder trade within a Regional and International context that may alternately stymie the progress of Guyana's agricultural sector. The laboratory also directs its focus towards a native pest that has been found to disseminate adverse impact on the local fruit crops within Guyana's territory; namely the Anastrepha spp.

For the period 2019; the surveillance team embarked on the strategic regional surveillance of Fruit Fly via fruit sampling. This methodology was employed to establish an organized way of assessing the status and geographic distribution of fruit flies across Guyana.

During this period, surveys were conducted within administrative region 3, 4 and 6 to achieve the aforementioned objective. The laboratory saw a total of 15 batches submitted that resulted in the examination of 287 individual fruit samples. Fruits that were investigated included; *Persea americana, Bligia sapida, Averrhoa bilimbi, Averrhoa carambola, Anacardium occidentale, Anacardium spp., Prunus avium, Eugenia*

uniflora, Ziziphus mauritiana, Chrysobalanus icaco, Aegle marmelos, Ribes uva-crispa, Psidium guajava, Syzgium cumini , Citrus aurantifolia, Citrus limon, Mammea americana, Mangifera indica, Citrus sinensis, Carica papaya, Passiflora edulis, Prunus domestica, Punica granatum, psydium, Manilkara zapota, Annona muricata, Chrysophyllum cainito, Tamarindus indica, Citrus reticulata and Inga feuillei.

An analysis of the acquired data from the examination of fruit sample revealed the emergence of 1107 pupa and the evolution of 1057 fruit flies; more specifically 603 Bactrocera spp, 431 Anastrepha spp, 0 Ceratitis spp, 23 Unverified

Table 1
Total Fruit Fly Emergence per Region 2019

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	249	511	483	142	320	0	23
4	29	596	572	289	283	0	0
6	9	0	0	0	0	0	0
Total	287	1107	1055	431	603	0	23

RESULT

The following tables represent critical data extracted from the fruit sampling surveys carried out in the various regions and data attained from the finding thus far:

Table 2
Pupa Development from Fruit Sampling Surveys by Administrative Region

Administrative regions	Number of pupa	Number of *Anastrepha spp*	Number of *Bactrocera spp*	Number of *Ceratitis spp*	Number of Other	Mortality
3	511	142	320	0	23	26
4	596	289	283	0	0	24
6	0	0	0	0	0	0
Total	1107	431	603	0	23	50

Table 3
Total Percentage of Fruit Fly by Genus Retrieved from Fruit Sampling Surveys

Types of Fruit fly	Number of fruit fly	Percentage
Anastrepha spp	431	40.77%
Bactrocera spp	603	57.05%
Ceratitis spp	0	0
Unverified	23	2.18%
Total	1057	100%

Table 4
Survival Percentage of Pupa Reared

Number of pupa	Number of adults emerged	Percentage of survival	Percentage of Non survival
1107	1057	95.48%	4.52%

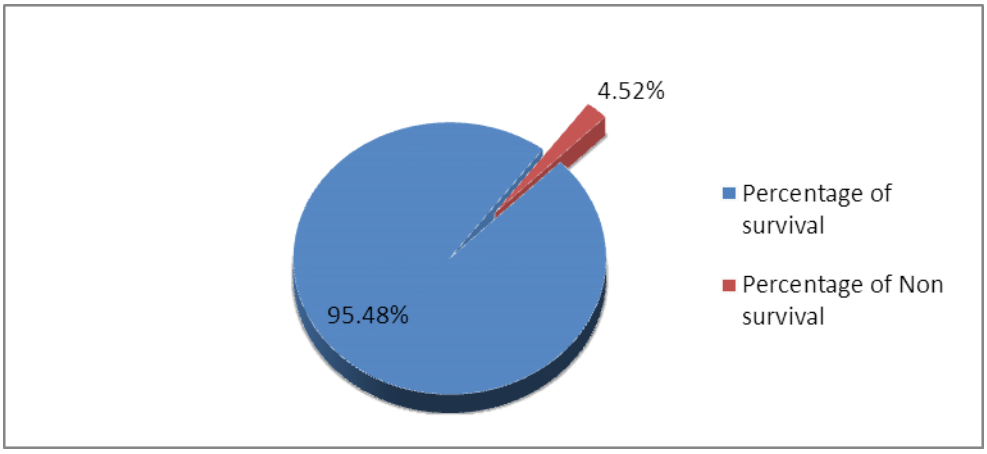


Figure 1. Survival Percentage of Pupa reared from Fruit Sampling Surveys

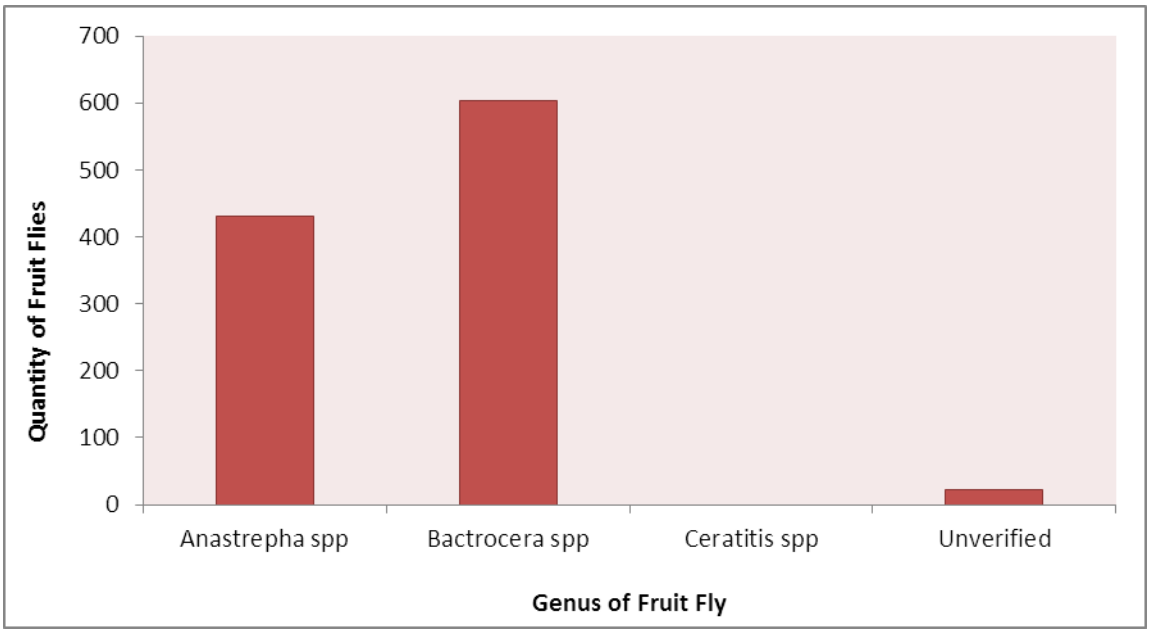


Figure 2. Genus of Fruit Flies reared from Fruit Sampling Surveys

The presence of fruit flies in Guyana continues to adversely impact the agricultural sector. The data accumulated during the year from fruit sampling surveys is consistent with that of the previous years, in that fruit flies (Anastrepha spp. and Bactrocera spp.) continues to affect major farming communities in Regions 3 and 4 (Laluni and Kururukururu). However, though no fruit samples were submitted from Region 5, surveillance via trapping line indicates continued pest free status of region 5 as supported by previous year data. These fruit flies continue to exhibit preferential behavior in the presence of multiple hosts. More specifically, the Carambola fruit fly (Bactrocera carambolae) continues to only proliferate primarily in Averrhoa carambolae, Psydium guajava, and Prunus avium in field. Albeit approximately thirty different fruits were sampled during this period and often time in orchards with varying fruit types, CFF was found only affecting the aforementioned. It is essential to observe and understand the biological and behavioral pattern of

these pests to effectively control them. The *Anastrepha spp*. was found affecting primarily *Averrhoa carambolae, Psydium guajava, Prunus avium,* and *Whitee* as compared to the CFF.

Figure 1 depicts information regarding the laboratory processing and rearing of fruit flies. More, specifically, it provides information into the successful maturation of fruit flies from larva to adults under laboratory conditions, albeit many limitations that arose during this year, the fruit fly laboratory successfully recorded 95.48% morbidity of fruit flies from larvae to adult sages. The successful maturation of fruit flies allowed for preliminary morphological identification of specific flies affecting hosting plants.

The information represented on **Figure 2** creates a comparative assessment of the various fruit flies found in host fruits based on the region surveyed. It was observed that the Carambola fruit fly displayed greater dominance in the samples collected as compared to the native *Anastrepa spp*. However, both flies appear to exhibit a high presence in region 3. This data concurs with information gathered in the previous year. Hence, region 3 and 4 appears to be highly affected by these pests of economic importance and requires rigorous control measures to alleviate this problem. The economic impact of these fruit flies is a burden the local farmers face daily and serves to deter many from fruit farming.

The fruits that were found to be prolific hosts for *Bactrocera carambolae* and various *Anastrepha spp.* included; *Averrhoa carambolae, Psydium guajava, Prunus avium*, and *Whitee Citrus sinensis*. The hosts most affected were *Averrhoa carambola* and *Cherry Psydium guajava*. These hosts have repeatedly been prime targets to the local fruit flies over the past three years. They seem to possess character traits that support fruit flies proliferation. Hence, it is expected that these hosts and others will be monitored throughout the year as a means of suppressing their population and towards control of these pests.

Liposcelies and other storage pests of grains

The FF lab provides significant service towards upkeeping the phytosanitary measures applied to rice export. Further, through the collection, preparation and investigation of rice samples early detection of rice pest along with emergency actions would be implemented as necessary. Some of the major export points that samples are collected prior to exiting are A.C Hakh Rice Inc, Alesie mills, Corentyne Rice mills, Kissoon Dyal Rice Mill, Saj mills, Fairfield mills, Stock feeds, and Techno mills. These samples are collected by quarantine Officers/Inspectors and submitted to the lab for preparation and continuous examination for the presence of insect pests that would degrade its quality in any form. The lab has received 14 rice sample entries which consisted of a total of 30 individual samples.

Table 5

Breakdown of Rice Entries 2019

Officers	Number of entries	Number of Samples	Type of pest(s) found	Number of infected Samples
A. Charles	4	7	0	0
K. Critchlow	3	7	0	0
P. Dawson	2	4	0	0
D, Greene	1	1	0	0
C. Noble	2	6	0	0
Samples without name	2	5	0	0
Total	14	30	0	0

WTO/IPPC Enquiry and Notification Points

Involvement in the work of the WTO SPS Committee and the recognized International Standard Setting bodies are integral for effective implementation and ultimate benefits for the provisions contained. During the period under review, a total of seventeen (17) draft standards were received by NPPO Guyana for review and comments. Additionally, questionnaires and surveys as well as numerous enquiries were answered by varying levels of stakeholders.

The NPPO continued to provide information to trading partners and potential trading partners on Guyana's requirements for trade in agricultural commodities. Seventeen (17) countries had submitted queries and the NPPO team provided details as per request. Some of the enquires that were addressed with our trading partners:

(i) Fraudulent re-export phytosanitary certificates for lumber originating from Suriname and being re-exported to India (certificates nos. 2321 - 2326);

(ii) Trinidad for the inclusion of import permit numbers on phytosanitary certificates issued by the GOG;

(iii) IPPC granted Approval for Guyana to be included in the Global ePhyto Hub;

(iv) CABI granting Guyana to free access to Pest Risk Analysis (PRA) Tools, renewable every year henceforth;

(v) Request for India to honour the requirement as per Plant Quarantine Order (PQ 2003), which allows for the use of Aluminum Phosphide for the treatment of lumber and timber before entry into India.

6.0 HUMAN RESOURCES REPORT FOR YEAR ENDED DECEMBER 31, 2019.

1. **RECRUITMENT – Fifteen (15) persons were recruited in 2019 as follows:**

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Date of Employment
1. Orwin Emmanuel	District Crop Extension Officer	2019-12-09
2. Priscilla Brummell	District Crop Extension Officer	2019-12-09

B. GENERAL ADMINISTRATION AND FINANCE

Name	Designation	Date of Employment
1. Kevin Bowen	Accounts Clerk	2019-01-15
2. Patrick Singh	General Worker	2019-01-07
3. Neil Hernandez	Driver/Boat Operator	2019-04-23
4. Charles Hendricks	Heavy Duty Operator	2019-05-29
5. Devindra Nandkumar	General Worker	2019-05-20
6. Derrick Watson	General Worker	2019-05-20
7. Casey Ault	Human Resources Clerk	2019-06-24
8. Alicia Wallerson	General Worker	2019-09-01
9. Lloyd Doorga	Security Guard (Temp)	2019-10-14

C. NATIONAL PLANT PROTECTION ORGANIZATION

Name	Designation	Date of Employment
1. Kevin Seetram	Plant Quarantine Officer	2019-12-09
2. Carlisa Adridge	Plant Quarantine Officer	2019-12-16

D. RESEARCH AND DEVELOPMENT

Name	Designation	Date of Employment
1. Gayatri Mohanlall	Research Technician	2019-11-12
2. Diana Bruce	Research Assistant	2019-12-09

2. **RESIGNATION – Four (4) persons tendered their resignations as follows:**

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Quincy Scotland	Regional Crop Extension Officer	2019-05-01

B. GENERAL ADMINISTRATION AND FINANCE

Name	Designation	Effective Date
1. Andrea Joy Lyte	General Worker	2019-01-01
2. Louanna Rodney	General Worker	2019-08-23

C. RESEARCH AND DEVELOPMENT

Name	Designation	Effective Date
1. Somwattie Pooran De Souza	Research Scientist	2019-08-12

3. **DISMISSAL – Two (2) persons were dismissed as follows:**

A. GENERAL ADMINISTRATION AND FINANCE

Name	Designation	Effective Date
1. James Rodney	General Worker	2019-10-01
2. Phulmattie Budhram	General Worker	2019-09-05

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

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Stacy Cassiano	Crop Extension Assistant	2019-04-06
2. Chevy Bissessar	District Crop Extension Officer	2019-08-06

B. GENERAL ADMINISTRATION AND FINANCE

Name	Designation	Effective Date
1. Christopher Bourne	General Worker	2019-03-25
2. Narine Hetram	General Worker	2019-04-01
3. Alfanso Caripuna	Heavy Duty Operator	2019-03-18

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

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Francis Park	District Cop Extension Officer	2019-06-16
2. Felana Nurse	Crop Extension Assistant	2019-09-01
3. Priscilla Brummel	Crop Extension Assistant	2019-10-01

B. GENERAL ADMINISTRATION AND FINANCE

Name	Designation	Effective Date
1. Mahawattie Goopcharran	Snr. HR Clerk	2019-05-01
2. Sasenarine Parmanand	Driver	2019-11-01
3. Harrichand Persaud	Heavy Duty Operator	2019-08-14

C. NATIONAL PLANT PROTECTION ORGANIZATION

Name	Designation	Effective Date
1. Shamein Moseley	Plant Quarantine Officer	2019-11-01

D. RESEARCH AND DEVELOPMENT

Name	Designation	Effective Date
1. Dork Bess	Crop Extension Assistant	2019-11-01

2. Arifea Hassan	Research Technician	2019-11-17

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

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Reynard Ward	Research Scientist	2019-02-01
2. Charles Romascindo	Crop Extension Assistant	2019-05-01
3.Talica Bristol-Razack	Snr. Crop Extension Asst	2019-05-03

B. NATIONAL PLANT PROTECTION ORGANIZATION

Name	Designation	Effective Date
1. Andrea Charles	Plant Quarantine Officer	2019-05-22

C. RESEARCH AND DEVELOPMENT

Name	Designation	Effective Date
1. Julia McAlman	Nursery Supervisor	2019-05-01
3. Jonathan Melville	Research Scientist	2019-09-01

7. **SECONDMENT – One (1) person was seconded as follows:**

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Gavin Glen	District Crop Extension Officer	2019-09-02

8. **TRANSFER – Two (2) person was transferred as follows:**

A. CROP DEVELOPMENT AND SUPPORT SERVICES

Name	Designation	Effective Date
1. Taseka Blair	District Crop Extension Officer	2019-09-16

B. RESEARCH AND DEVELOPMENT

Name	Designation	Effective Date

1. Andrew Carter,	Research Assistant	2019-08-02

9. **PAID STUDY LEAVE (SCHOLARSHIP) – Four (4) persons were granted PSM scholarship as follows:**

A. CROP DEVELOPMENT AND SUPPORT SERVICESS

Name	**Designation**	**Effective Date**
1. Maleka Russell	Crop Extension Assistant	2019-02-01
2. Carlyle Nunes	District Crop Extension Officer	2019-09-01
2. Talica Bristol-Razack	Senior Crop Extension Assistant	2019-10-01
3. Besham Singh	Crop Extension Assistant	2019-10-01

B. RESEARCH AND DEVELOPMENT

Name	**Designation**	**Effective Date**
1. Padmini Dudnath	Community Development. Offr.	2019-08-19

10. **NO-PAY STUDY LEAVE – Two (2) persons were granted No-Pay Study Leave as follows:**

B. RESEARCH AND DEVELOPMENT

Name	**Designation**	**Effective Date**
1. Bibi Narifa Abrahim	Research Scientist	2019-03-01
2. Amrita Churaman	Research Assistant	2019-07-29

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

A. GENERAL ADMINISTRATION AND FINANCE

Name	**Designation**	**Effective Date**
1. Lennon Bess	Security Guard	2019-10-29
2. John Bruce	General Worker	2019-10-31

12. TRAINING

A. OVERSEAS

1. **Mr. David Fredericks, Research Scientist**, participated in the **Commonwealth 1st Supply Side Cluster Meeting on Medium, Small and Micro-Enterprises (MSME) Participation and upgrading in Plantation Crop Value Chains**, held during the period April 10-11, 2019, in Port Vila, Vanuatu.

2. **Ms. Kene Moseley- Project Coordinator, Ms. Zola Narine- Monitoring/GIS Officer and Mr. Rudolph Adams- Monitoring Officer**, participated in the ***Guianas Regional Mangrove Ecosystem Training Workshop***, held in Suriname during the period May 6-10, 2019.

3. The following persons participated in the **CATIE/IICA Sustainable Crop Production Internship Programme**, held in Cost Rica during the period July 22 to August 09, 2019:

NAME	DESIGNATION
1. Tracy Persaud	Research Scientist
2. Samantha Brotherson	Research Scientist
3. Howard London	Research Scientist
4. Eon Sampson	Coastal Coordinator
5. Keri Eleazer	District Crop Extension Officer
6. Gavin Glen	Regional Crop Extension Officer (ag)
7. Premdat Beecham	Research Assistant
8. Indira Persaud	Research Assistant
9. Anthony Jones	Research Assistant
10. Adrian Mangar	Research Assistant
11. Faron Pearson	Research Assistant
12. Satyanand Ramdowar	Research Assistant

4. **Mr. Brian Sears, Deputy Chief Executive Officer,** participated in a Regional Workshop on **Coordinated Food Standards Setting**, held in Paramaribo, Suriname, during the period July 23-25, 2019.

5. **Ms. Kendra Belgrave-Smartt and Mr. Leon Folkard, Plant Quarantine Officers,** participated in Training Course on **Risk Base Sampling,** held in Brazil during the period August 27 to 30.

6. **Mr. Jonathan Melville, Research Scientist**, participated in a Training Programme on **Climate Change in the Caribbean – Strengthening the Science to Service Interface,** held in Trinidad, during the period November 27 to 29, 2019.

7. **Mr. Rameshwar Raghunath, Research Assistant**, participated in a Training programme on **Seed Science Technology**, held in the United States of America, during the period November 3 to 9, 2019.

8. **Mr. Jonathan Wright, Plant Quarantine Officer**, participated in a Training Course on **Pathology Diagnostic**, held in Florida, during the period December 02 to 06, 2019.

B. LOCAL

1. **Ms. Bhina Paul and Ms. Sunita Chitram, Confidential Secretaries**, participated in a training course on **Principles of Professional Secretarial Practices, Module 1**, held at the Ministry of the Presidency, Department of Public Service during the period, March 11-15, 2019.

2. **Mr. Satyanand Ramdowar, Research Assistant**, participated in a training workshop on **Mini International Programme for Development Evaluation (IPDET)**, held at the Ministry of Finance during the period March 25 to 29, 2019.

3. **Mr. Jankienauth Mohabir, Information Technology Technician**, participated in a Training programme on **Data Communication and Networking**, held at the University of Guyana, during the period April 01 to June 24, 2019.

4. **Ms. Bhina Paul and Ms. Sunita Chitram, Confidential Secretaries**, participated in a training course on **Principles of Professional Secretarial Practices, Module 11**, held at the Ministry of the Presidency, Department of Public Service, during the period April 29 to 30, 2019.

5. **Ms. Adrianna Wellington, Research Assistant and Mr. Jonathan Wrights, Plant Quarantine Officer**, participated in a training programme on **Designing and building a Results Based Monitoring and Evaluation System**, held at the Ministry of Finance, during the period June 24 to 28, 2019.

6. **Ms. Sharon Blair, Senior Human Resources Officer**, participated in a training programme on **Leadership Development for level 111 Managers**, held at the Ministry of the Presidency, Department of Public Service, during the period July 29 to 31, 2019.

7. **Ms. Tandika Harry and Ms. Rebecca Narine, Research Assistants**, participated in a training course on **Project Management**, held at the Ministry of the Presidency, Department of Public Service, during the period September 16 to 20, 2019.

8. The following persons participated in a training course on **Guyana – Brazil joint Carambola Fruit Fly Training Activity, held at Lethem**, Region #1, during the period December 02 to 11, 2019:

NAME	**DESIGNATION**
1, Brian Sears	Deputy Chief Executive Officer
2. Benjamin Frank	Training Manager
3. Adele Pierre	Senior Plant Protection Officer
4. Paul McWatt	Plant Protection Officer
5. Tyon Phillips	District Crop Extension Officer
6. Joylene Hamilton	District Crop Extension Officer
7. Edmund Inniss	District Crop Extension Officer
8. Vitus Spencer	District Crop Extension Officer (ag)
9. Rameshwar Raghunath	Research Assistant

10. Joseph Gonsalves — Farm Manager
11. Romaull Ramkissoon — Crop Extension Assistant
12. Avileno Indach — Crop Extension Assistant
13. Patricia Peters — Crop Extension Assistant
14. Ralph Lovell — Crop Extension Assistant

STAFFING AT NAREI

Categories	**No. of Positions**	**Positions Filled**	**Position Vacant**
Crop Development & Support Services	98	*92	15
General Administration & Finance	244	*179	66
National Plant Protection Organization	52	*35	31
Mangrove	18	14	4
Research and Development	95	66	29
Total	**507**	**386**	**145**

*** Represents overlapping of Five (5) District Crop Extension Officers, four (4) Crop Extension Assistants, one (1) Confidential Secretary, and fourteen (14) Plant Quarantine Officers which is reflected under staffing at CDSS, GA&F and NPPO.**

NON CONTRACTED EMPLOYEES

Extension Agents 21

STAFFING IN THE CROP DEVELOPMENT AND SUPPORT SERVICES DEPARTMENT

Category	**Authorized Positions**	**Positions Filled**	**Vacant Post**
Deputy Chief Executive Officer/Crop Protection and Extension Services	1	1	0
National Crop Extension & Training Coordinator	1	0	1
Training Manager	1	1	0
Regional Crop Extension Officer	12	4	8
District Crop Extension Officer	30	*35	0
Senior Crop Extension Assistant	13	7	6
Crop Extension Assistant	40	*44	0
Total	**98**	**92**	**15**

*represents overlapping of five (5) District Crop Extension Officers and four (4) Crop Extension Assistants

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

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	1	0
Internal Auditor	1	1	0
Projects/PRO	1	1	0
Senior Human Resources Officer	1	1	0
Librarian	1	0	1
Special Projects Officer	1	1	0
Accountant	2	1	1
Human Resources Officer	2	2	0
Administrative Officer	1	1	0
Communications Officer	1	1	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	1	1
Confidential Secretary	2	*3	0
Information Technology Technician	2	1	1
Senior Secretarial Assistant	1	1	0
Cashier	3	0	3
Accounts Clerk	6	5	1
Secretarial Assistant	6	3	3
Human Resources Clerk	2	1	1
Data Entry Clerk	2	1	1
Library Assistant	2	0	2

Heavy Duty Operator	10	4	6
Drivers/Office Assistants	20	8	12
Well Operator	1	1	0
Welder	1	0	1
General Workers	125	109	16
Senior Security Guard	2	2	0
Security Guard	30	19	11
Total	**244**	**179**	**66**

* Represents overlapping of one (1) confidential Secretary.

STAFFING IN THE NATIONAL PLANT PROTECTION ORGANISATION

Category	**Authorized Positions**	**Positions Filled**	**Vacant Post**
Assistant Chief Executive Officer/Chief Plant Protection Officer	1	0	1
Senior Plant Protection Officer	1	1	0
Senior Quarantine and Pest Risk Officer	1	1	0
Plant Protection Officer	5	1	4
Plant Quarantine Officer	5	*19	0
Senior Plant Quarantine inspector	5	1	4
Senior Plant Protection Assistant	4	0	4
Plant Protection Assistant	10	0	10
Plant Quarantine Inspector	20	12	8
Total	**52**	**35**	**31**

* represents overlapping of fourteen (14) Plant Quarantine Officers

STAFFING IN THE GUYANA MANGROVE MANAGEMENT DEPARTMENT

Category	**Authorized Positions**	**Positions Filled**	**Vacant Post**
Project Coordinator	1	1	0
Monitoring Officer	1	1	0
Monitoring Assistant	1	1	0
Community Dev. Officer	1	1	0
Monitoring Officer/GIS Technician	1	1	0
Engineer	1	1	0
Ranger	12	8	4
Total	**18**	**14**	**4**

STAFFING IN THE RESEARCH AND DEVELOPMENT DEPARTMENT

Category	**Authorized Positions**	**Positions Filled**	**Vacant Post**
Chief Executive Officer	1	1	0
Deputy Chief Executive Officer (Research)	1	1	0
Assistant Chief Executive Officer/Chief Research Scientist	1	0	1
Head, Fruits, Vegetables and Other Crops (Senior Research Scientist)	1	1	0
Head, Entomology, Pathology and Weed Science (Senior Research Scientist	1	0	1
Head, Biotechnology and Seed Technology (Senior Research Scientist)	1	1	0
Head, Soils and Farm Mechanization (Senior Research Scientist)	1	0	1

Head, Bio Energy (Senior Research Scientist)	1	0	1
Horticulturist	1	0	1
Research Scientist	15	12	3
Monitoring & Evaluation Officer	1	1	0
Monitoring & Evaluation Assistant	1	1	0
Nurseries Manager	1	0	1
Research Assistant	30	24	6
Nursery Supervisor	5	4	1
GIS Technician	1	1	0
Senior Research Technician	6	1	5
Research Technician	16	13	3
Laboratory Attendant	10	5	5
Total	**95**	**66**	**29**

S. Blair
Snr. HRO

Appendices

Crop Production 2019

	2019 Production (MT)				
Crop	**Q1 2019 (Reported)**	**Q2 2019 (Reported)**	**Q3 2019 (Reported)**	**Q4 2019 (Reported)**	**Total Production**
Oil Crops	**7,892.00**	**6,847.36**	**6,964.36**	**7,057.36**	**28,761.08**
Coconut	3,498.00	3409.09	3516.09	3516.09	13,939.27
Coconut water	4,394.00	3438.27	3448.27	3541.27	14,821.81
Fruits	**56,738.17**	**56,250.04**	**47,635.34**	**54,671.43**	**215,294.98**
Banana	3,522.95	3,503.12	4,416.30	1,409.74	12,852.11
Bread Fruit	198.08	198.30	243.13	234.88	874.38
Cherry	434.71	574.94	2,876.22	594.44	4,480.31
Guava	166.84	166.84	170.72	168.39	672.79
Lemon	465.78	465.78	465.78	514.30	1,911.64
Limes	1,107.01	1,103.91	1,159.71	1,182.79	4,553.42
Mango	2,002.70	2,002.70	2,110.05	2,110.05	8,225.50
Oranges	4,666.46	4,620.00	4,677.22	8,947.41	22,911.09
Papaw	17,175.98	17,232.15	17,634.68	17,027.65	69,070.47
Passionfruit	1,824.35	1,642.63	1,824.35	1,948.67	7,240.00
Pineapples	18,625.04	18,138.62	4,512.20	9,312.52	50,588.37
Tangarine	1,986.60	1,986.60	1,999.50	5,710.20	11,682.90
Water Melon	4,561.67	4,614.45	5,545.48	5,510.38	20,231.98

Roots	**19,501.29**	**19,663.25**	**18,291.87**	**31,944.07**	**89,400.48**
Bitter cassava	6,029.19	6,024.52	4,481.75	11,033.41	27,568.86
Cassava	5,596.99	5,793.13	5,625.00	15,680.16	32,695.28
Eddoes	2,120.00	2,120.00	2,430.00	2,430.00	9,100.01
Sweet Potatoes	5,755.11	5,725.60	5,755.11	2,800.50	20,036.32
Spices	**25,783.85**	**22,245.58**	**19,896.20**	**21,349.29**	**89,274.92**
Celery	3,161.57	2,458.62	2,876.22	3,111.31	11,607.72
Eshallot	837.36	552.58	645.79	824.65	2,860.38
Ginger	8,620.34	8,785.88	8,785.88	6,150.11	32,342.20
Peppers	3,126.00	3,267.96	3,413.24	2,990.67	12,797.87
Sweet Peppers	9,811.03	6,721.53	3,680.00	7,777.47	27,990.02
Turmeric	227.56	459.02	495.08	495.08	1,676.73
Pulses	**162.69**	**100.90**	**151.35**	**133.75**	**548.69**
Beans	162.69	100.90	151.35	133.75	548.69
Cereal	**415.36**	**1,000.00**	**999.90**	**986.48**	**3,401.75**
Corn	415.36	1,000.00	999.90	986.48	3,401.75
Vegetables	**77,514.24**	**81,449.76**	**79,942.62**	**83,499.17**	**322,405.79**
Bora	7,836.10	7,469.90	7,599.34	7,611.39	30,516.74
Boulanger	12,069.01	12,134.45	12,150.81	9,694.47	46,048.76
Cabbages	2,117.03	4,927.55	2,723.08	2,743.01	12,510.67
Carilla	1,969.86	1,967.38	1,967.38	1,948.51	7,853.13

Cucumber	352.85	705.85	721.96	750.54	2,531.21
Lettuce	897.04	855.40	874.80	897.04	3,524.28
Ochro	3,301.19	4,764.07	3,240.84	3,224.71	14,530.80
Pakchoi	1,712.32	1,586.24	1,586.24	1,573.07	6,457.86
Plantain	24,641.30	21,327.56	27,140.40	33,118.67	106,227.92
Pumpkin	15,665.80	15,155.92	15,415.05	15,415.05	61,651.82
Tomatoes	6,951.74	10,555.44	6,522.71	6,522.71	30,552.60
TOTAL	**188,007.60**	**187,556.91**	**173,881.64**	**199,641.54**	**749,087.69**

	2019 Acreages			
Crop	**Q1 2019 (Reported)**	**Q2 2019 (Reported)**	**Q3 2019 (Reported)**	**Q4 2019 (Reported)**
Oil Crops	**28,913.00**	**28,914.00**	**28,915.00**	**28,915.00**
Coconut	28,913.00	28914.00	28915.00	28,915.00
Coconut water				
Fruits	**7,312.32**	**7,647.25**	**7,738.22**	**7,884.68**
Banana	1,005.60	1,260.60	1,260.60	1,409.74
Bread Fruit	21.98	25.98	26.98	27.93
Cherry	140.23	147.14	147.14	147.14
Guava	38.80	38.80	38.80	38.80

Lemon	97.04	97.04	97.04	97.04
Limes	357.10	374.10	374.10	379.10
Mango	466.83	491.85	491.85	491.85
Oranges	867.37	869.37	869.37	870.37
Papaw	561.67	576.67	576.67	558.65
Passionfruit	123.27	123.27	123.27	131.67
Pineapples	2,565.43	2,565.43	2,565.43	2,565.43
Tangarine	462.00	465.00	465.00	465.00
Water Melon	605.00	612.00	701.96	701.96
Roots	**4,157.86**	**4,158.86**	**4,208.86**	**4,208.86**
Bitter cassava	1,401.05	1,401.05	1,401.05	1,401.05
Cassava	1,824.61	1,825.61	1,825.61	1,825.61
Eddoes	341.94	341.94	391.94	391.94
Sweet Potatoes	590.27	590.27	590.27	590.27
Spices	**1,539.36**	**1,411.65**	**1,396.65**	**1,525.70**
Celery	121.13	125.20	110.20	119.21
Eshallot	113.46	80.72	80.72	111.74
Ginger	293.49	299.13	299.13	299.13
Peppers	486.16	530.83	530.83	465.11
Sweet Peppers	505.98	346.65	346.65	501.38
Turmeric	19.12	29.12	29.12	29.12

Pulses	**159.50**	**121.12**	**126.12**	**131.12**
Beans	159.50	121.12	126.12	131.12
Cereal	**280.65**	**200.24**	**270.24**	**266.62**
Corn	280.65	200.24	270.24	266.62
Vegetables	**12,643.60**	**13,216.03**	**12,689.29**	**12,472.58**
Bora	916.50	888.81	888.81	890.22
Boulanger	737.71	742.71	742.71	740.71
Cabbages	212.50	336.40	205.00	206.50
Carilla	230.66	230.37	230.37	228.16
Cucumber	122.86	100.55	100.55	104.53
Lettuce	92.48	90.19	90.19	92.48
Ochro	345.31	498.33	339.00	337.31
Pakchoi	130.02	120.44	120.44	119.44
Plantain	8,042.20	8,190.21	8,190.21	7,971.21
Pumpkin	1,407.53	1,385.00	1,385.00	1,385.00
Tomatoes	405.82	633.00	397.00	397.00
TOTAL	**55,006.29**	**55,669.17**	**55,344.40**	**55,404.56**