LIST OF ABBREVIATIONS

AVDRC	-	Asian Vegetable Research and Development Centre
CARDI	-	Caribbean Agricultural Research and Development Institute
CESO	-	Canadian Executive Services Organisation
CIAT	-	International Centre of Tropical Agriculture
CTV	-	Citrus tristeza virus
DTBIA	-	Direct Tissue Blot immuno assay
EEZ	-	Ecological Economical Zoming
ELISA	-	Enzyme Linked Immuno Sorbent Assay
FAO	-	Food and Agriculture Organisation
GINA	-	Guyana Information News Agency
IICA	-	International Institute for Cooperation in Agriculture
IPGRI	-	International Plant Genetic Resources Institute
IPM	-	Integrated Pest Management
ITEC	-	India Technical and Economic Cooperation
IVAG	-	*In vitro* Active Genebank
LUP	-	Land Use Planning
MFC&L	-	Ministry of Fisheries, Crops and Livestock
NARI	-	National Agricultural Research Institute
NGMC	-	"New" Guyana Marketing Corporation
PRCSSP	-	Poor Rural Communities Support Services Project
PRSV	-	Papaw Ringspot Virus
VSO	-	Voluntary Services Overseas

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HUMAN RESOURCES REPORT

PROGRAMME: **FRUIT AND PERENNIAL CROPS**

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INTRODUCTION

This programme aimed to improve production in the fruit section by:-

i) The investigation and transfer of appropriate technologies, including improved post harvest procedures, into the farm production process

ii) The provision of improved pest and disease free planting material from selected local germplasm as well as from suitable imported varieties.

During 2002, research and development work was done in the areas of germplasm evaluation and management, crop production evaluation and post harvest studies. The area of production involved activities of the plant nurseries located in various regions of Guyana.

1. GERMPLASM EVALUATION AND MANAGEMENT

This entails the identification, selection, collection, establishment, maintenance and monitoring of field collections of local and imported varieties.

Project Title

The establishment, maintenance and monitoring of field collections.

Objectives

1. To establish orchards of fruit cultivars obtained locally and from overseas in different locations of the country.
2. To compare the suitability of these cultivars for adaptation to local conditions.
3. To serve as a germplasm source for propagation.

Justification

A wide genetic base of material having both local and foreign origins plays a crucial role in the development of any fruit industry. Scientists can manipulate these materials to produce new and improved fruit species, which can ultimately impact significantly on production and quality.

In Guyana, genetic material is confined to a few species that have been in production over a continuous period of time. There is also the tendency of some farmers to utilise seedling material for propagation purposes, which can impact negatively on production and quality.

The production of new and improved fruit species combined with advanced propagation techniques can perpetuate and sustain fruit quality and market stability.

Methodology

Germplasm plots and pilot orchards of both foreign and local fruits were established in different locations of the country and a revised list of the surviving plants was prepared

Results and Achievements

General

The two rainy periods of this year were extreme cases in that the mid year period was particularly intense, while the end of year period was much curtailed. Both of these conditions adversely affected the supplying and maintenance of germplasm plots, which continued, to a limited extent during the year. Scion, budwood and other seed material were also collected on a regular basis for propagation and production purposes.

The plant types in germplasm plots and pilot orchards were:

PLANT TYPE	TOTAL NUMBER OF PLANTS
Avocado	410
Cashew	70
Citrus	2,588
Mango	106
Passion Fruit	454
Pineapple	325
Sour Sop	183
Other Fruit	1,404

The other fruit were breadfruit, breadnut, bilimbi, carambola, cashew nut, cherry (Suriname), cherry (W.I.), cocoa, dunk, genip, golden apple (dwarf), guava, jack fruit, jamoon, malacca apple, monkey apple, neem, papaw, pomegranate, plum rose, psidium (local), sapodilla, sea grape, star apple, sugar apple and tamarind.

More specific operations were:

Avocado:

Fourteen of the twenty-four grafted plants with Brazilian scion material, that were eventually planted out at Kairuni, survived to the end of the year.

Data of the harvested fruit collected over the years 1999 to 2001 from the producing trees were recorded as follows:

- Average amount of fruits harvested from each tree per year of each variety
- Average weight (kg) of the fruit of each variety
- Average over years 1999-2001 of fruit collected each month of each variety

Cashew:
In an attempt to combat the chronic fungal infestation of the cashew plants at Kairuni, a new spray regime of Trimiltox Forte in rotation with Benlate or Phyton commenced at the beginning of the year. However, probably due to the extreme adverse weather, little change was observed.

Citrus:
Maintenance work of the budded and seedling plants in the multiplication blocks and orchards at Mon Repos, Kairuni and Timehri continued during the year. Growth measurements of the new plants also started at Kairuni.

Mango:
Maintenance work of the grafted plants, with scion material from Brazil and Puerto Rico, planted at Mon Repos, continued during the year.

However, adverse weather conditions coupled with a fire that razed through the mango plot, left only 27 plants of the 47 previously planted. The fire also burnt all the long mango seedlings, which were however replanted later in the year.

Passion Fruit:
All of the Passion Fruit plants, both the local and the Brazilian variety, in Field 18 at Mon Repos, died during the year to a disease infestation (primarily *Alternaria* Leaf Spot). These are to be replanted.

At Kairuni, maintenance work continued on the experimental plot of both Brazilian and local varieties.

Pineapple
Over the years, the pineapple plants, mainly of indigenous varieties in the museum plot at Mon Repos, showed poor growth and development. Furthermore, due primarily to praedial larceny, fruits were lost before they had attained maturity, when proper evaluation of type and other

characteristics could be recorded. Replanting material also became scarce as only the occasional side shoot was left available.

A decision was therefore taken to relocate this plot to Kairuni and this was achieved during this year.

Sour Sop

Maintenance work of the local and Brazilian varieties continued at Kairuni. During the year, two of the Brazilian varieties as well as the local variety started fruiting, and a summary of the fruiting data collected by year-end, is presented at Table 1.

Table 1: Sour Sop at Kairuni – Fruiting Data for 2002

VARIETY	NUMBER OF FRUITING TREES	TOTAL FRUITS	TOTAL WEIGHT (kg)	AVERAGE FRUIT WT (kg)
Blanca	2	7	5.7	0.81
Morada	7	13	32.4	2.49
Local	1	1	1.8	1.80

2. CROP PRODUCTION EVALUATIONS

This entails the evaluation of crop production practices.

Project Title

The selection and propagation of two phenotypes of Montserrat variety of pineapple.

Objectives

- To select conical and cylindrical plants of the Montserrat pineapple according to a selection criteria and to use them to propagate new plants that would conform to the selected type.
- Eventually to produce a pure stand of the cylindrical phenotype of the Montserrat pineapple.

Justification

The commercial variety of pineapple grown in Guyana is the Montserrat. In this variety, the traditional and more common fruit shape is conical. However, a cylindrical shaped fruit, which is better suited for processing, also occurs but is less common. It would therefore be a distinct advantage if the cylindrical type could be produced in pure stands, while still retaining the other properties of the Montserrat pineapple.

Background

Work was initiated in late 1998 and continued into 1999. However, as previously reported, it became impossible to obtain fruits of the progeny of the selected parent material planted at Mon Repos. The verification of the phenotype and other characteristics therefore, could not be made. Eventually, the parent material from standard vegetative propagation was lost, and the project was suspended.

However, with the selected parent material produced by tissue culture becoming available and the relocation of the pineapple plot to Kairuni, the project was revived.

Methodology

The selection of the plants, according to the set criteria, was conducted on farms on the Soesdyke-Linden Highway and Canal No.1. The main fruit characteristics were recorded and basal slips, rapid vegetative multiplication and as tissue culture were used to propagate plants of each of the selected types.

At the end of 1999, plants from the first two propagation methods were planted out at Mon Repos where observations on the progeny were to be made. This did not materialise.

Eventually, plants from the tissue culture propagation of each type became available. These were planted out at Kairuni during the year for observation on the fruit type and other main fruit characteristics at fruiting time.

Results and Achievements

Plants were maintained at Kairuni during the year.

Project Title

Influence of organic and inorganic fertiliser on growth and yield response of three varieties of papaw (*Carica papaya*), on pegasse soil.

Objective

To determine whether organic or inorganic fertiliser is best utilised by plants and the response of different varieties of papaw to these fertilisers.

Background

No recorded work on papaw was found in Guyana although Trinidad worked on Santa Cruz Giant, Cedros and Singapore Pink. Hawaii developed the Solo strain in 1919. Florida produced Betty Blue, Blue Stem, South Africa produced Hortus Gold. India produced Coorg Honey. (Weir et al, 1982).

Fertiliser range are N= (1.10 – 1.40) %, P= (0.15 – 0.18) %, K= (2.5 – 3.5) %. (Nakasone et al, 1998). For young plants 5:7:4 at 0.5 kg/plant was used while for bearing plants 10:2:16 at 150 g/plant was used. (Nakasone et al, 1998).

Methodology

The experiment was carried out on Mr. M. Sooklall's, farm at Naamryk, East Bank Essequibo, on a pegasse type soil.

A completely randomised block design of four replicates was employed using three papaw varieties (Local Open Pollinated, Tainung No 1 Hybrid and Sunrise Hybrid) with three fertiliser applications as follows:

- No Fertiliser
- Inorganic Fertiliser – 5:7:4 mixture was applied to young plants up to flowering at the rate of 0.5 kg per plant every three months. After flowering a 10:2:16 mixture was applied at the rate of 0.15 kg per plant every three months.
- Organic Fertiliser – Filter Press was applied at the rate of 2.3 kg per plant every three months.

The plot size consisted of four plants planted at 1.8 m by 2.1 m (6 ft by 7 ft).

Results and Achievements

The experiment started in November, 2001and was prematurely terminated December 2002, after only three months of harvest, due to unauthorised harvesting by the farmer.

Indications were that at this stage the best yielding variety was sunrise and then Tainung No. 1. It also seemed that fertilizer applications increased yield with inorganic fertilizer being superior to organic.

Project Title

The production of Citrus Tristeza Virus (CTV) free plants from clean parent material.

Objectives

- To establish the infrastructure to continually conduct the test on the foliage of parent material.
- To establish rapid multiplication blocks of selected CTV free varieties at different locations of the country.
- To obtain planting material free from CTV.

Justification

CTV free plants have the potential to establish rapidly and produce high yields. This can only be achieved if the parent stock, from which the material is taken, is free from the disease.

Background

Serological testing of plants at various plant nurseries site, as well as, at various farms in the country, showed that all plants were infected with a severe strain of CTV. A training programme on testing techniques was also conducted through the FAO for the staff at NARI.

Methodology

Selected varieties of plants with CTV free buds were close planted and maintained in a block (multiplication block) for the sole purpose of providing CTV free budwood for propagation.

At least once per year appropriate tissue samples are to be taken from the foliage of target plants for serological assay. This assay is necessary to verify the plants are CTV free, as infected plants have to be removed from the block.

Facilities to conduct the assay locally are to be put in place.

Results and Achievements

General maintenance was done on the multiplication blocks with CTV Free plants at Mon Repos and Timehri. The selected mother plants were also maintained at the Screen House.

With the use of imported custom-made direct Enzyme Linked Immunosorbent Assay (ELISA) kits, it was possible to conduct serological assays for CTV on a certain number of plants.

However, the indirect Direct Tissue Blot Immunoassay (DTBIA) modified assay for CTV is still to be brought on stream at NARI.

The results from the small number of plants indicated that the plants in the Screen House are still CTV free, but some plants in the multiplication block at Mon Repos are now infected with CTV.

Project Title

The evaluation of three hybrid and several local papaw varieties for tolerance/resistance to the Papaw Ringspot Virus (PRSV).

Objective

To determine the tolerance/resistance of some papaw varieties to the PRSV.

Justification

Papaw is rapidly becoming a major fruit crop grown in Guyana with enormous export potential. Large-scale production first started in the Parika area where farmers established pure stands of Red Lady, Tainung 1 and 2 hybrid varieties. Now farmers throughout the country are showing interest in producing the crop.

R. Persaud (2001) identified in Guyana a new virus disease, which can destroy the local papaw industry as fruits that are infected cannot be exported since the virus is present in the flesh and skin of the fruit. This disease is caused by the Papaya Ringspot Virus (PRSV), which is already a serious constraint to the papaw industry in countries such as China, Thailand, Barbados, Trinidad and Tobago, and Brazil among others.

At present only genetically modified plants are known to be resistant to the virus in Guyana, but it is possible that some local papaw varieties may be tolerant. No previous work of this nature was done at NARI, therefore, this trial aims at identifying the tolerant varieties.

Methodology

So far, only the hybrid varieties Sunrise, Tainung I, and Red Lady of Known You origin were used. Work is to continue with the local varieties.

Seeds of the different varieties were planted in a predetermined sterile potting medium contained in planting bags, which were kept in a screen house, an environment free from winged aphids (the transmitter of PRSV).

Eight weeks after germination, four plants of each variety were inoculated with an inoculant that was obtained from the sap of papaw plants tested positive for the Papaw Ringspot Virus. Four untreated plants served as the control.

The plants were then monitored for disease symptoms and serological testing of all the plants was conducted via ELISA, three weeks after inoculation to verify the presence or absence of PRSV.

Results and Achievements

The disease symptoms of PRSV are characterised by a shoestring appearance of leaves, oily and fish eye spots on stem. A scoring system was devised for recording the intensity of the disease as follows:

Score

0 – no symptoms
1 – slight signs of infection
2 – high signs of infection
3 – death of plants

A summary of the ELISA test result and the disease scores are presented in Table 2.

Table 2: Summary Papaw Ringspot Disease Data

VARIETY	ELISA RESULT	DISEASE SCORE			
		1 mth	2 mths	3 mths	4 mths
Redlady	Positive	0	0	0	1
Tairung I	Positive	0	1	2	3
Sunrise	Positive	2	3	-	-
Control	Negative	0	0	0	0

It was found via ELISA test that all inoculated varieties were susceptible. Although infested, the Redlady variety did not show any symptoms until four months after inoculation. Tainung I showed progressive signs of infection and died in the fourth month. Sunrise variety was highly infected in the first month after inoculation and died in the second month. The control that was not inoculated tested negative and showed no symptoms of infection up to the fourth month.

It should also be noted that after the fourth month, the four Redlady plants were field planted, allowed to grow and were able to produce fruits. However, the ELISA test showed that the infection persisted with the fruits testing positive for PRSV.

It is clear that the Redlady variety has some tolerance to PRSV, while Sunrise is highly susceptible.

Project Title

An integrated pest management (IPM) strategy to control Aphids in Papaw.

Objective

To determine the effect of management practices on the control the Aphid vectors that transmit the Papaw Ringspot Virus (PRSV) in Papaw.

Justification

In Guyana Papaw is rapidly becoming a major fruit crop grown with enormous export potential. Large-scale production first started in the Parika area where farmers established pure stands of Red Lady, Tainung 1 and 2 hybrid varieties. Now farmers throughout the country are showing interest in producing the crop.

In 2001, R. Persaud, identified in Guyana a new virus disease, which can destroy the local papaw industry as fruits that are infected cannot be exported since the virus is present in the flesh and skin of the fruit. This disease is caused by the Papaw Ringspot Virus (PRSV), which is already a serious constraint to the papaw industry in countries such as China, Thailand, Barbados, Trinidad and Tobago, and Brazil among others.

At present only genetically modified plants are known to be resistant to the virus in Guyana, but it is possible that some local papaw varieties may be tolerant.

The virus is known to be transmitted by aphids. With the presence of the PRSV, it is now mandatory that strategies to control the vector be put in place to prevent infection.

Methodology

The trial was sited on three farmers' holdings in the Naamryk/Parika area, which was known to be heavily infested with aphids and consisted of three plots, one in each holding. The first plot was a 0.6 ha (1 acre) block planted with Red lady, Tainung I hybrid varieties and a local open pollinated variety. The second plot was a 0.3 ha (0.5 acre) block planted with the Sunrise hybrid variety. The third plot of approximately 1.2 ha (2 acres) was planted with Red lady and Tainung I varieties, and served as the control.

The IPM strategy used consisted of a combination of the following activities:

- *Agronomic*
  With the intercropping of the papaws with corn as well as the planting of corn plots in nearby fields.
- *Sanitary*
  With the removal and burning of all plant debris including plants showing infection signs, as well as maintaining a weed free environment including a weed free perimeter of 6 m (20 ft) wide around the plots.
- *Chemical*
  With the application of insecticides cyhalothrin @ .01 % active, alphacypermethrin @ .05 % active, fipromil @ .05% active and pyraclofos @ .04% active in rotation in the order presented. The applications were conducted every three weeks and continued for nine months just prior to flowering.

The control plot received the farmer's normal cultural practice, which did not include sanitation measures while weed and pest control was minimal.

For the duration of the trial, all plots received a standard fertiliser application as per the recommendation of Nakasone et al, 1998, which was 0.5 kg/plant of a 5:7:4 mixture.

The papaw seedlings were transplanted in November 2001 and the operations were terminated in December 2002.

Results and Achievements

Samples were taken from each plot three months, six months and 12 months after transplanting and subjected to serological testing using ELISA to determine the presence of PRSV. The findings are presented in Table 3.

Table 3: ELISA Results on the Presence of Papaw Ringspot Virus (PRSV)

TREATMENTS	PRESENCE OF PAPAW RINGSPOT VIRUS		
	3 Months	6 Months	12 Months
1. Planted with Red lady, Tainung I, and a Local Variety and subjected to IPM strategy.	Negative	Negative	Negative
2. Planted with Sunrise Variety and subjected to IPM strategy.	Negative	Negative	Negative
3. Control - Planted with Red lady and Tainung I Varieties and not subjected to any IPM strategy.	Positive	Destroyed	_____

It is clear that the IPM strategies resulted in the control of PRSV transmission.

It was also observed that the aphids preferred to feed in the corn fields rather the papaw fields.

Project Title

Evaluation of organic plant extracts for the control of anthracnose in passion fruit.

Objective

To compare the effect of extracts of Bellyache (*Jatropha gossiiflora*), Red River Gum or Eucalyptus (*Eucalyptus camaldulensis I),* Tulsie (*Ocimum canumlin*) and Vetiver *(Vetiveria zizoniodes)* in controlling Anthracnose in Passion Fruit.

Justification

Anthracnose is a serious disease affecting many crops, including passion fruit, causing damage to leaves, stems, flowers and fruits and eventually resulting in yield reduction. Thus the control of this disease is highly desirable.

On the whole synthetic chemical fungicides are expensive for the average farmer and could present a hazard for the environment. Thus an organic control method is worth exploring for it could be less expensive and definitely more environmentally friendly.

This exercise is aimed at evaluating the organic extracts of certain plants in controlling anthracnose.

Methodology

To ensure the development of the disease, selected mature passion fruit growing on the vines in Field 30 at NARI were inoculated with a spore suspension of *Colletotrichum gloeosporioides*, the causal agent of anthracnose disease.

The suspension was made from a pure culture of the fungus, which was developed and maintained for the duration of the trial. To achieve this, small pieces of tissue (0.3-0.6 cm) were cut from anthracnose infected fruit, sterilised by submerging for one minute in a 1% solution of sodium hypochlorite, triple washed with distilled water and then placed in a petri dish containing 15 ml of water agar. After seven days, some of the mycelia of the growing fungus were transferred to a petri dish containing 15 ml of potato dextrose agar (PDA) where a pure culture soon developed.

With the aid of a haemocytometer and appropriate dilutions, a final spore suspension containing approximately 10,000 spores per ml was made up using spores from the pure culture. Inoculation was conducted with a sprayer calibrated to deliver 3 ml of the inoculum to each selected fruit, after which perforated plastic bags were placed over the fruits to control contamination.

Fourteen days after inoculation and just prior to treatment with the organic extracts, the bags were removed.

The extracts of the various plants were prepared as follows:

Bellyache: (Jatropha gossiiflora), Family: Euphorbiaceae
A leaf extract was made from this plant by first collecting and sun drying fully mature leaves. After drying for four days, 200 leaves were ground into a powder and then soaked in distilled water where for every gram of powder, 1 ml of distilled water was used. After three days the extract was prepared for use by filtering with a No. 6 filter paper.

Red River Gum or Eucalyptus (Eucalyptus camaldulensis I), Family: Myrtaceae
Tulsie (Ocimum canumlin), Family: Lamiaceae
For the above plants, seed extracts were used. Five hundred grams of dry Eucalyptus and two hundred grams of dry Tulsie seeds were collected. The seeds of each type were ground into powder and then further prepared as for Bellyache.

Vetiver (Vetiveria zizoniodes) Family: Gramineae
In the case of Vetiver, the roots were used. The branched "spongy " roots were collected from Mon Repos backlands, thoroughly washed to remove all soil and debris, and then sterilised by submerging for one minute in a 1% solution of sodium hypochlorite. After sun drying for four days, the roots were ground into a powder and then further prepared as for Bellyache.

Five inoculated fruits comprised the treatment unit and there were four replicates. For comparison, Benomyl at 0.2% active was included as a treatment, while a plain distilled water treatment served as the control.

Results and Achievements
Observations were made at 7, 10 and 14 days after treatment and a scoring system was devised for recording the intensity of the disease as follows:

Disease Score

0 = No Disease Lesions 1 = 01-03 Disease Lesions 2 = 04-06 Disease Lesions
3 = 07-15 Disease Lesions 4 = 16-30 Disease Lesions 5 = > 30 Disease Lesions

A summary of the disease scores are presented in Table 4.

Table 4: Anthracnose Disease Score Averages on passion fruit, Mon Repos, 2002

TREATMENTS	DISEASE SCORE AVERAGE		
	7 Days after Treatment	10 Days after Treatment	14 Days after Treatment
Benlate	1.067 [b]	1.333 [c]	3.700 [b]
Tulsie	1.067 [b]	1.133 [c]	3.067 [c]
Eucalyptus	1.167 [b]	1.167 [c]	3.200 [c]
Vetiver	1.133 [b]	1.567 [b]	3.567 [b]
Bellyache	1.000 [b]	1.333 [c]	3.033 [c]
Control	1.600 [a]	2.367 [a]	5.000 [a]
LSD @ 5%	0.196	0.268	0.217

The results show that at seven days after treatment, all the treatments were significantly better than the untreated but there was no difference between the treatments. At 10 days after treatment, all the treatments still maintained significant control, while Bellyache and Tulsie were better than Vetiver. Fourteen days after treatment, all the treatments remained significantly better than the control with Bellyache, Tulsie and Eucalyptus being outstanding even better that Benomyl.

Indications are that the extracts of Bellyache, Eucalyptus and Tulsie can control *Colletotrichum gloeosporioides*, the causal agent of Anthracnose disease and should be further investigated.

Project Title

The use of postharvest calcium in extending shelf life of Spice mango.

Introduction

The mango*, Mangifera indica* L., is considered one of the choicest fruits produced in Guyana. The main variety, *Spice*, is very popular on the local market and even overseas, particularly Canada, where a large population of people of Guyanese and West Indian origin reside.

The *Spice* has a very high consumer appeal, primarily due to its attractive shell colour, excellent taste and flavour. However, it is a highly perishable commodity and deteriorates rapidly after 3 –

5 days after harvest. The fruit loses its firmness quite rapidly and is readily attacked by fruit spoilage organisms. This is a severe constraint to exporters and shippers who require additional and prolonged periods for delivery of the produce in a desirable condition to overseas consumers.

In the tropics the possibilities for low temperature storage of perishables can be very costly. Many of the commodities also suffer from chilling injury at low temperatures. As a result, an alternative appropriate technology has to be investigated and developed that will have similar desirable results as low temperature in extending the shelf life and reduce postharvest losses in mango.

Calcium is known to be an essential plant nutrient involved in a number of physiological processes involving membrane structure and function. In addition, calcium compounds have shown promise in the quality retention of fruits and vegetables through maintaining firmness, reducing respiratory rates and ethylene evolution and decreasing storage rots. Work in Trinidad and Tobago on the use of calcium chloride dips as a means of extending the shelf life of Julie mango has indicated desirable results in fruit quality.

This study was undertaken to investigate the effects of different concentrations of calcium chloride dips on the shelf life and quality of the Spice mango, the most popular variety grown and consumed in Guyana.

Materials and methods

Spice mangoes were harvested at the green mature stage from a farmer's orchard located on the East Coast of Demerara. The fruits were transported directly to the postharvest laboratory at NARI. The following treatments were applied to the fruits:

1) Fruits were washed thoroughly in clean water, air dried and allowed to adjust to room temperature.
2) Calcium chloride solutions were prepared (0, 2, 4 and 6 %) and placed in cold storage at 5^0 C (temperature differential method).
3) Fruits were submerged in the cold solutions for two hours.
4) Fruits were then air dried and held at room temperature (30^0 C, RH 80 %) and 13^0 C and RH 90 %.
5) Fruits were analysed at 0, 3, 6 and 9 day intervals for firmness, brix, TTA, shell colour, weight loss, storage rots and organoleptic conditions.

A total of 200 fruits were used with 24 fruits randomly assigned to each treatment.

Fruit ripening was evaluated by assessment of skin colour development and textural softening at three-day intervals. Skin colour development was scored on the following scale :

1 – dark green
2 – light green
3 – more green than yellow
4 – more yellow than green
5 – yellow.

Textural softening was scored using the following scale:

1 – very firm
2 – more firm than soft
3 – more soft than firm
4 – soft
5 – over soft

Shelf life was taken as the number of days that fruits remained in a marketable condition. Fresh weight loss was calculated based on the initial weight and at the three day intervals. Taste was evaluated at ripeness for organoleptic acceptability using the following 6 point scale:

0 – very poor
1 – poor
2- fair
3 – good
4 – very good
5 – excellent.

A completely randomized design was used in this trial.

Results and discussion

Weight loss (%)

Examination of results revealed that for both storage temperatures there was a

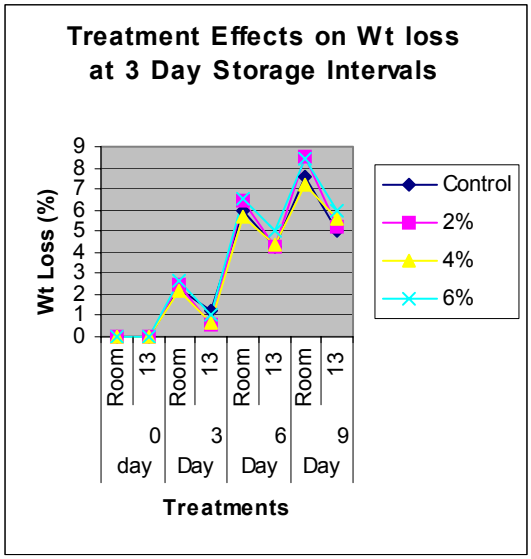

Figure 1: The effects of temperature and post harvest calcium on weight loss of Spice Mango, Mon Repos, 2002

progressive loss in fresh weight for both treated and untreated fruits (Figure 1). The rate of moisture loss was not significant for the treatments under study. However, fruits stored at room temperature showed a higher rate of moisture loss than those stored at 13 degrees C. This can be attributed to the low temperature retarding the loss of moisture and increasing shelf life.

Fruit firmness

Textural softening was significantly retarded in calcium treated fruits compared to the control for both storage temperatures (Figure 2). This indicates that the temperature differential method was effective in increasing calcium concentrations in the fruit tissues resulting in strengthening of the cell walls and maintaining firmness.

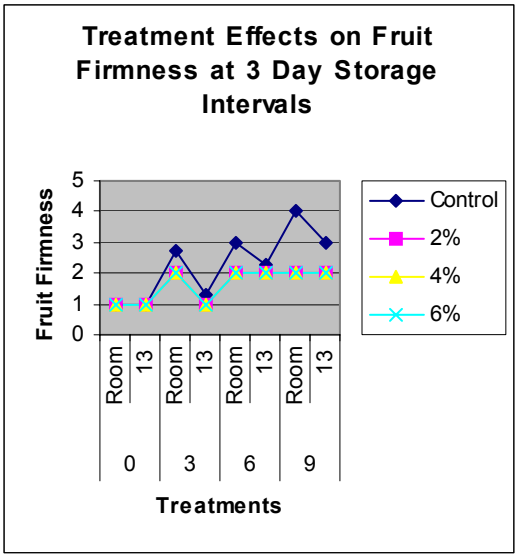

Figure 2: The effects of post harvest calcium and temperature of Spice Mango, Mon Repos, 2002

Skin colour development

There appeared to be no significant difference in treated and untreated fruits for both storage temperatures (Figure 3). However, fruits stored at low temperature showed a slower rate of colour change from green to yellow than in fruits stored at room temperature. This implies the effective nature of low temperature in prolonging the shelf life and quality of fruits.

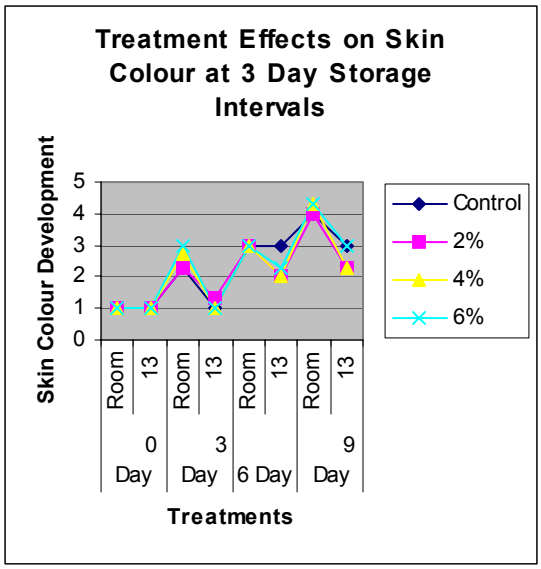

Figure 3: The effects of post harvest calcium and temperature on skin colour of spice mango, Mon Repos, 2002

Brix and TTA

There seemed to be no significant difference in brix and TTA values in treated and untreated fruits at both storage temperatures (Figures 4 and 5). No difference was also detected in fruits stored at room temperature compared to those stored at 13^0C. This shows that in this trial low temperature had no effect in maintaining the brix and TTA levels throughout the shelf life of fruits. There was a progressive increase in sugars and a decrease in TTA throughout storage.

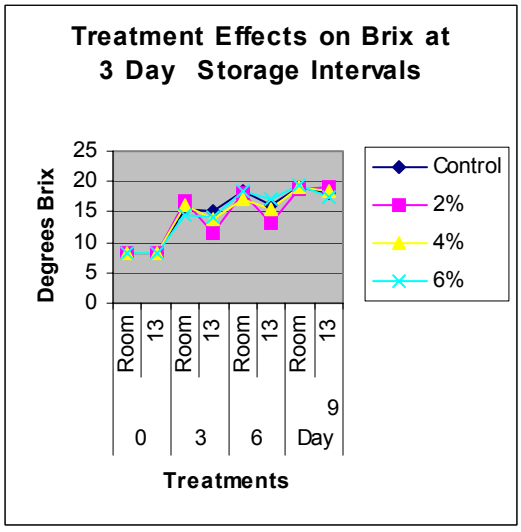

Figure 4: The effects of post harvest Calcium and temperature on Brix of spice mango, Mon Repos, 2002

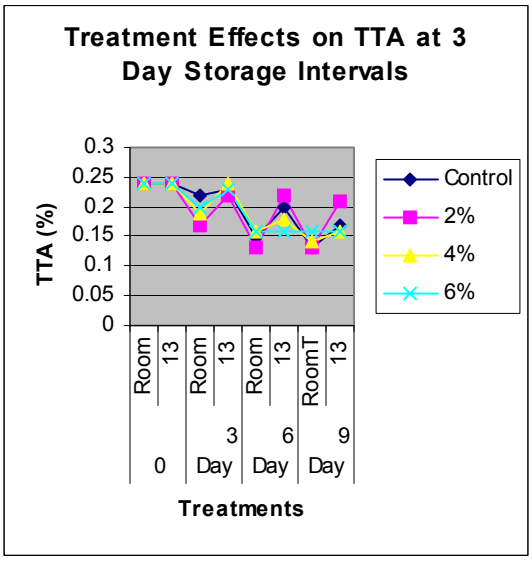

Figure 5: The effects of post harvest calcium and temperature on TTA of spice mango, Mon Repos, 2002

Taste / Organoleptic development

Organoleptic ratings showed no significant differences in treated and untreated fruits held at both storage temperatures. The accumulation of calcium in fruit tissues had no effect on the eating quality of fruits.

Shelf life

Fruits treated with calcium had a longer shelf life of 15 days with good external appearance compared to those that were untreated which began to show signs of decay after six days at room temperature. Calcium has been implicated in reducing decay in stored fruits by stabilizing or strengthening their cell walls, making them more resistant to decay by fungal enzymes. Low temperature storage (13^0 C) extended the life of fruits for 21 days.

Conclusions

The results of this trial indicate the optimum concentration of calcium chloride for the extension of shelf life in Spice mango is 2%. This shows good promise for the use of postharvest calcium chloride dips to extend the shelf life and quality of Spice mango.

Project Title

The use of postharvest coatings in extending shelf life of spice mango.

Introduction

The Spice mango can be indisputably considered as the most popular and dominant variety of mango produced and consumed in Guyana. It commands a significant position in agricultural trade, establishing its importance on both the local and overseas market.

The spice variety is characterised by a high level of perishability, suffering from spoilage and rapid deterioration 3-5 days after harvest. This undesirable quality almost invariably results in high levels of spoilage on the export markets. Exporters incur substantial financial losses due to the poor quality fruits that result after shipping. Consumers experience dissatisfaction over the improper quality of produce offered to them on the market.

The main objective of this study is to develop suitable methods of retarding the process of deterioration of the Spice mango by utilising fruit coatings applied to the surface of the fruits. Fruit coatings, besides promoting attractiveness in commodities offer other beneficial scientific features, which include reducing moisture loss from fruit surface, lowering the rate of respiration and prolonging shelf life of commodities.

Materials and Methods

Spice mango fruits were harvested at the green mature stage from a farmer's orchard on the East Coast of Demerara. The fruits were transported directly to the post harvest laboratory at NARI. Fruits were exposed to the following treatments:

- Fruits were washed thoroughly in clean water, with a 10% bleach solution.
- Fruits were air-dried.
- Fruit coatings including mineral oil, vegetable oil, wax and rice mar were applied to the surface of the fruit by a soft brush. The control had no treatment.
- Fruits were separated and placed at two different storage temperatures; room temperature and 13^0C.
- A total of 200 fruits were used with 24 fruits randomly assigned to each treatment.
- Fruits were analysed at 0, 3, 6 and 9 days intervals for fruit firmness, brix, shell colour, weight loss and shelf life.

Skin colour development was scored on the following scale (1-5).

1-dark green	2-light green	3 more green than yellow
4-more yellow than green	5-yellow.	

Textural softening was scored using the following scale (1-5).

1-very firm	2-more firm than soft	3-more soft than firm
4-soft	5-very soft.	

Shelf life was taken as the number of days that fruits remained in a marketable condition.

Fresh weight loss (%) was calculated based on the initial weight loss at the 3-day intervals.

Taste was evaluated at ripeness for organoleptic acceptability using the following 6 point scale;

0-very poor	1-poor	2-fair
3-good	4-very good	5-excellent.

Brix was measured using a hand held refractometer.

TTA was measured using titration techniques.

A complete randomised design was used in this trial.

Results and Discussion

Weight loss (%).

The loss of moisture calculated as % weight loss was more pronounced in the control for fruits stored at both room temperature and 13^0C (Table 5). Mineral oil applications to fruits seemed to retard moisture loss much more effectively than the other treatments. The lower temperature (13^0C) was also effective in lowering the loss of moisture from fruits in all cases.

Table 5: The effects of post harvest coatings and temperature on mean weight loss (%) of fruits at three day storage intervals, Mon Repos, 2002

Treatment	Storage Temperature	Mean Weight Loss (%)		
		3 Days	6 Days	9 Days
Control	Room	3.6	8.3	10.7
	13^0C	1.0	4.3	5.0
Mineral oil	Room	1.4	4.0	5.7
	13^0C	0.3	2.3	2.7
Vegetable oil	Room	3.1	5.1	8.1
	13^0C	0.5	2.1	4.7
Wax	Room	2.3	5.1	6.7
	13^0C	1.0	3.7	3.9
Rice mar	Room	2.9	7.2	9.7
	13^0C	0.8	3.5	4.4

Fruit Firmness

The results indicate that fruit firmness progressively reduced with time (Table 6). Fruits in the control showed a higher level of fruit softening than those that were treated. This suggests that the treatments other than the control retarded the process of ripening and hence prolonged the inhibition of textural changes in the fruits.

Table 6: The effects of post harvest coatings and temperature on textural changes in fruits at three-day storage intervals, Mon Repos, 2002.

Treatment	Storage Temperature	Textural Softening*		
		3 Days	6 Days	9 Days
Control	Room	3.0	3.0	4.0
	13^0C	1.3	2.3	3.0
Mineral oil	Room	2.0	2.0	2.0
	13^0C R	1.0	1.0	2.0
Vegetable oil	Room	2.3	2.3	2.3
	13^0C	1.0	1.0	2.0
Wax	Room	2.3	2.3	2.7
	13^0C	1.0	1.7	2.0
Rice mar	Room	2.0	2.0	2.0
	13^0C	1.7	2.0	2.0

* Score on scale of 1 – 5

1 – Very Firm 2 – More firm than soft
3 – More soft than firm 4 – Soft
5 – Very soft

Shell Colour.

The shell colour change in fruits was affected in this trial with the treated fruits showing less rate of change than the control for both storage temperatures (Table 7). Storage at 13^0C in all cases reduced the rate of shell colour change. This indicates that low temperature and the different fruit coatings slowed the rate of ripening and hence the rate of shell colour changes from green to yellow in fruits.

Table 7: The effects of post-harvest coatings and temperature on skin colour change in fruits at three-day storage intervals, Mon Repos, 2002

Treatment	Storage Temperature	Shell Colour*		
		3 Days	6 Days	9 Days
	Room	2.7	3.3	3.7
Control	13^0C	1.7	3.7	3.0
	Room	2.0	2.0	2.0
Mineral oil	13^0C	1.0	1.0	1.0
	Room	2.0	2.0	2.0
Vegetable oil	13^0C	1.0	1.0	2.0
	Room	2.0	2.3	2.7
Wax	13^0C	1.0	1.7	2.3
	Room	2.0	2.0	2.7
Rice mar	13^0C	1.0	2.7	3.0

* Skin colour scored on scale of 1 – 5

1 – dark green 2 – light green
3 – more green than yellow 4 – more yellow than green
5 – yellow

Brix (degrees)

The increase in brix (degrees) was the highest in the control when compared to treated fruits at both storage temperatures (Table 8). Low temperature storage reduced the rate of sugar conversion for all treatments. The fruit coatings also slowed down the rate of conversion to sugar, particularly when placed in low temperature storage. This suggests that both low temperature storage and fruit coatings slowed down the rate of ripening and hence the process of conversion of starch to sugar in fruits.

Table 8: The effects of post-harvest coatings and temperature on mean brix values (degrees) in fruits at three-day intervals, Mon Repos, 2002

Treatment	Storage Temperature	BRIX (degree)			
		0 Days	3 Days	6 Days	9 Days
Control	Room	8.3	14.0	15.2	17.1
	13^0C	8.3	13.8	14.3	17.3
Mineral oil	Room	8.3	11.9	11.5	12.1
	13^0C	8.3	9.7	9.8	12.0
Vegetable oil	Room	8.3	9.5	12.8	14.2
	13^0C	8.3	10.2	11.8	11.5
Wax	Room	8.3	13.7	14.1	16.0
	13^0C	8.3	11.1	13.0	14.6
Rice mar	Room	8.3	13.1	13.3	13.9
	13^0C	8.3	13.5	15.7	17.0

Total Titratable Acidity (TTA)

TTA (%) was progressively reduced as the storage intervals increased (Table 9) with the control showing a more marked decrease than treated fruits. It has been shown that as the mango fruits ripens the sugar in the fruit would increase with a simultaneous decrease in acidity. Fruit coatings had the tendency of suppressing ripening and hence the accumulation of sugars. At the same time the acidity of the flesh remained almost the same throughout. On the contrary, the untreated fruits experienced natural ripening with a steady increase in sugars and with a corresponding decrease in acidity as the storage interval lengthens.

Table 9: The effects of post-harvest coatings and temperature on mean TTA values (%) in fruits at three-day intervals, Mon Repos, 2002

Treatment	Storage Temperature	TTA (%)			
		0 Days	3 Days	6 Days	9 Days
Control	Room	0.24	0.18	0.14	0.13
	13^0C	0.24	0.23	0.17	0.17
Mineral oil	Room	0.24	0.23	0.19	0.16
	13^0C	0.24	0.23	0.21	0.19
Vegetable oil	Room	0.24	0.23	0.22	0.21
	13^0C	0.24	0.23	0.21	0.19
Wax	Room	0.24	0.23	0.20	0.15
	13^0C	0.24	0.22	0.17	0.17
Rice Mar	Room	0.24	0.20	0.20	0.18
	13^0C	0.24	0.22	0.21	0.20

Taste

Organoleptic readings indicated that the control had a higher value than the treated fruits (Table 10). These values were taken at the nine-day interval when fruits were assumed to be in a ripened state. Fruit coatings tend to reduce ripening and hence the formation of sugars which can affect taste. In addition treated fruits experience fermentation resulting from anaerobic activity. This indicates that the minimal level of oxygen required for respiration was hampered. This also affected the taste of the treated fruits.

Table 10: The effects of post-harvest coatings and temperature on mean taste value in fruits at three-day storage intervals, Mon Repos, E.C.D

Treatment	Storage Temperature	Taste Value* at 9 day
Control	Room	3.7
	13^0C	3.7
Mineral oil	Room	2.0
	13^0C	2.0
Vegetable oil	Room	2.0
	13^0C	2.3
Wax	Room	2.3
	13^0C	3.3
Rice Mar	Room	2.0
	13^0C	3.3

Taste Value scored on scale of 0 – 5

0 – Very poor 1 – Poor 2 – Fair

3 – Good 4 – Very good 5 - Excellent

Shelf life

The untreated fruits showed signs of decay between 4-6 days in storage. However, those that were treated remained in storage for up to 14 days.

Conclusion

It can be concluded that fruit coatings applied to the Spice mango retarded ripening and prolonged the shelf life of fruits. However, at the same time the attractiveness of the fruit was reduced, the increase in sugar content was restricted and the taste was affected.

Project Title

The use of Ripening Agents on the Degreening of Orange Fruits.

Introduction

Orange fruits play a significant role in the diet of the Guyana population as an important source of vitamin C.

One of the problems associated with the orange fruits produced in this part of the world is the sustenance of the green colour, which impacts negatively on its attractiveness. The climatic conditions have a great influence on the function and production of pigments in the fruit crops. For the orange fruits these factors inhibit the formation of the characteristic orange colour in fruits.

The purpose of this trial was to test several ripening agents on orange fruits to induce an unnatural colour change. Consumers tend to appreciate highly coloured and attractive fruits. As a result, it is intended once some of these agents can be identified in promoting this colour change efforts can be made to implement them commercially. This can be very important for the export market, not only for citrus but other fruit types.

1 Material and Methods

Orange fruits were purchased from a selected farm on the West Bank of Demerara. Fruits were transported directly to the Postharvested Laboratory at N.A.R.I. and the following preparation and treatments were done:

1. Fruits were washed thoroughly in clean water and 10% bleach solution, and allowed to dry naturally

2. The following treatments were prepared:
    - 15 c.c Ethrel in one gallon water
    - 50 ml Ethrel in 20g NaOH
    - 100 ml Etrhel in 20g NaOH
    - 10g calcium carbide wrapped in newspaper wrappings.
3. Boxes were obtained to place the fruits in
4. Fruits were dipped in the solution of Ethrel and water, and placed in the boxes
5. The method for the Ethel and NaOH application involved the use of glass beakers containing the solution in the boxes of fruits
6. The calcium carbide in the newspaper wrappings were paced directly in the boxes containing the fruits
7. A total of 90 fruits was used with five treatments including the control.
8. Fruits were stored in room conditions and at zero, three and six-day intervals, tests were done on Brix, TTA, colour change, degreening time and decay incidence.
9. Colour change in the fruits was scored from 1-4 with 1 being green and 4 being brightly coloured.

2 Results and Discussion

The Brix and TTA value remained in a relatively stable state throughout the storage period (see Table 1). This can be attributed to the chemical constitutional nature of the citrus fruits, having a negligible proportion of carbohydrates to be converted to sugars with a corresponding reduction in acidity during storage.

The control fruits remained green throughout the storage when compared to the treated fruits. However, fruits dipped in Ethrel and water had the greatest proportion of fruit surface colour change. The average time for colour change was 72 hours for most of the treatments. The untreated fruits showed a change of surface colour after six days.

Fruits treated with Ethel, NaOH and calcium carbide showed signs of damage during the later stage of storage. This can be attributed to the explosive nature of three substances which probably produced ethylene in a rapid short burst causing damage to the fruits. Ethylene gas may also have been directed only at a particular area of the fruit in too high a concentration, which may have influenced the low proportion of surface colour. On the contrary, the fruits dipped in Ethrel and water had total surface area contact with the solution and hence the activity of ethylene was much more substantial producing a higher proportion of surface colour change.

Table 11: The effect of ripening agent on mean values of Brix, TTA, colour change, degreening time and damage in fruits of orange at zero, three and six day intervals

Treatment	Interval (days)	Brix (°)	TTA (%)	Colour Change*	Surface Colour Change(%)	Degreening Time (hrs)	Damage
Control	0	8.0	0.4	1.0	0	0	Nil
	3	6.9	0.3	1.3	0	0	Nil
	6	6.0	0.3	2.0	5-10	144	Nil
Ethrel + Water	0	8.0	0.4	1.0	0	0	Nil
	3	7.0	0.4	4.0	90	72	Nil
	6	6.1	0.3	4.0	90-95	72	Nil
Ethrel (50ml) + NaOH (20g)	0	8.0	0.4	1.0	0	0	Nil
	3	6.9	0.3	4.0	30-40	72	Yes
	6	6.9	0.5	4.0	40-45	72	Yes
Ethrel (100ml) + NaOH (20g)	0	8.0	0.4	1.0	0	0	Nil
	3	6.3	0.3	4.0	30-40	72	Yes
	6	6.3	0.3	4.0	40-45	72	Yes
Calcium Carbide (10%)	0	8.0	0.4	1.0	0	0	Nil
	3	6.0	0.4	3.0	40-45	72	Yes
	6	6.7	0.3	4.0	45-50	72	Yes

* Colour change on a scale of 1 – 4, with 1 being green, and 4 being brightly coloured

Conclusion

This trial indicated that ripening or degreening agents can be used to promote the characteristic orange colour in orange fruit and contribute to its attractiveness. The results showed that Ethrel and water solution can be used successfully to artificially degreen orange fruits. This may have implications for commercial usage.

3. PLANT NURSERIES

Objective

To propagate quality plants at the various plant nurseries.

Justification

To make available quality planting material of fruits and to a lesser extent ornamentals as well as vegetables.

Beneficiaries

The fruit farming community in particular and the population in general.

Background

Considerable rehabilitation was completed to the infrastructure of all the plant nurseries. Under the FAO Project – TCP/GUY/8821, plant nursery personnel also received training in plant propagation and general nursery management.

Results and Achievements

General

Routine work continued at all Plant Nurseries.

A meeting of Plant Nursery Heads to review the work of year 2001 was held at the Conference Facility of NARI in March, 2002.

From this, the following could be highlighted:

- All the Plant Nurseries, with the exception of Bartica, Hosororo and Timehri recovered their operating costs. The best being Mon Repos with Charity as the first Runner-up.
- Only Charity followed by Benab was able to meet the Plant Sales Target.
- In maintaining the best operating standards, Benab was the leader followed by Charity.
- Charity was adjudged the overall winner having placed in all the categories.

It was recommended that awards be given to the winners of each category as well as the overall winner.

In June, the facility at St. Ignatius was brought on stream and was officially opened in October. However, some remedial work on the infrastructure, including the roof and water supply system, has to be undertaken.

Ornamentals:

The propagation of ornamental plants continued at Timehri and Mon Repos and to a lesser extent at Charity and Pouderoyen. No sale of ornamental plants was achieved at Benab.

Communications:

During the year the Charity Plant Nursery was supplied with a standard telephone link, greatly improving the communication between this facility and the Horticulture office. This also enabled the transfer of the radio from Charity to St. Ignatius, bringing the latter into daily contact.

Production:

A summary of the total production from all the plant nurseries is presented at Table 10.

Table 12: Summary of Plant Production[1] at All Nurseries, 2002

HEADINGS	2001	2002			
	Total Production	Sales	Stock	Total Production	Sales Target
Citrus	52,693	27,921	71,092	99,013	58,200
Other Fruit	58,575	20,906	42,882	63,788	32,845
Total	**111,268**	**48,827**	**113,974**	**162,801**	**91,045**

OTHER PROJECTS IN PROGRESS DURING 2002

1. Influence of organic and inorganic fertilizer on growth and yield responses of two varieties of grated mango (*Mangifera indica*)
2. A comparative study between the yield of pruning and non-pruning of three types of passion fruit (*Passiflora edulis*)
3. A preliminary evaluation of baited fly traps for the control of fruit fly (*Anastreplia* sp) in Guava (*Psidium guajava*)
4. The cultivation of edible mushroom

PROGRAMME: ROOT, TUBER AND OTHER FOOD CROPS

Programme Leader: Ms. B. Forde

Project Officer: Mr. C. Paul
Ms. M. Roberts•
Mr. E. Willabus
Dr. J. Martin•
Ms. K. McAllister
Mr. M. Livan
Ms. A. Peters

[1] Production = Sales + Stock
• Left NARI during 2002

INTRODUCTION

The objective of the Root, Tuber and Other Food Crops Programme is to increase production and productivity by addressing:

a) Crop improvement
b) Crop management
c) Management of pest and diseases
d) Improvement of post harvest handling

During 2002, research projects were conducted in the areas of genetic improvement, crop management and pest and disease management

The crops involved were cassava (*Manihot esculenta Crantz*) sweet potato (*Ipomoea batatas (L.) Lamk*), yam (*Dioscorea spp*) and plantain (Musa sp).

1. CROP IMPROVEMENT

Project Title

Collection of cassava, sweet potato, yam, plantain, banana and aroid germplasm.

Objective

To collect, monitor and maintain component plant types of *in situ* cassava, sweet potato, yam, plantain, banana and aroid germplasm from landrace mixes that are of potential use and/are threatened.

Collection

Two yam accessions were collected during 2002. The table following shows the present number of accessions in each germplasm collection

CROP	NUMBER OF ACCESSIONS
Cassava	48
Sweet Potato	38
Eddo	7
Yam	3

Monitoring and germplasm maintenance

Sweet Potato

These accessions were stored at the Fort Wellington Plant Nursery

Cassava

The cassava accessions were stored on station, in Field 17, Mon Repos and at the Pouderoyen Plant Nursery.

Yam

The yam accessions were stored at the Kairuni Crop Station

Project Title

In vitro maintenance of germplasm collection of selected crops

Objectives

1) To complement the storage of germplasm collection of selected crops
2) To protect stored plant material against adverse biotic and abiotic factors
3) To maintain plant material under conditions suitable for transport within and outside Guyana

Achievements

From the experiments on slow growth media, conducted in 2001,the recommended modification, using full amounts of MS macro-nutrients instead of ½ MS, was implemented.

Three new accessions of yam were collected and work has started on the identification of suitable growth media for these accessions.

A list of all the accessions in the collection is presented at Table 13.

Table 13 Accessions held in the *in vitro* active genebank, Mon Repos, 2002

CROP	ACCESSION NAME
Sweet Potato (*Ipomoea batatas*)	Black Rock Black Potato English Potato Iarena Jamaica # 1 John Thomas Dundee Korean # 1 Maputa Orlando # 1 Rodrigues Springer Strongman

	Tapato Vanilla Viola Warruni White Stem White Stem Wild Potato
Yam (*Dioscorea trifida*)	Bell
Cassava (*Manihot esculenta*)	Pomeroon # 1 Pomeroon # 2 Butter Stick # 20

Characterisation

The main achievement in this area was the completion of a manual of descriptors of all the sweet potato accessions in the germplasm collection. The manual contains detailed descriptions (including photographs) of each accession and is the first manual for sweet potato done in Guyana. This document will facilitate exchange of material, evaluation and also utilization.

Preliminary work was done on the adaptation to local growing conditions of an introduced yam variety. The work was done at the Kairuni Crop Station.

Yields per hill of yam

One hundred and twenty two hills were evaluated. The mean number of tubers per hill was 1.84 and the mean tuber yield per hill was 1.98 kg. The data suggest that this variety may have a tendency to produce larger than usual tubers which may pose some limitations in marketing it for direct use as food. However, it may be possible that planting at higher densities may result in smaller size tubers which may be more acceptable to domestic consumers. On the other hand, larger sized tubers may have more appeal for industrial use.

Further evaluation will be done in 2003

2. CROP MANAGEMENT

Project Title

Determining the optimal time to harvest of two cassava cultivars

Objective

To establish the optimal time to harvest of two cassava cultivars

Methodology

The trial was established in Field 17, Mon Repos. Experimental design was randomized complete block with two replications. The two cassava cultivars were M Mexico 59 and Four Month and there were four harvests between six and ten months.

Results and Conclusions

Table 14 gives a summary of the data collected at the four harvests

Table 14: The effect of time to harvest on the yield and yield parameters of two cassava cultivars

CULTIVAR	HARVEST	AVERAGE NO. OF TUBERS	AVERAGE TUBER LENGTH (cm)	ROOT WEIGHT (g)
M Mexico 59	1	3.9	15.9	743.4
	2	4.7	20.7	1068.6
	3	4.9	19.9	952.3
	4	3.4	11.7	1592.2
Four Month	1	3.6	12.7	444.5
	2	4.3	16.7	723.7
	3	3.9	14.5	1078.6
	4	3.9	14.2	1837.7

The results showed that the yield of both cultivars continued to increase into the tenth month with the largest increase occurring between the eight and tenth month after planting. The data suggest that both these cultivars should be harvested between eight and ten months after planting. Therefore the cultivar Four Month does not seem to be earlier maturing than the cultivar M Mexico 59.

3. MANAGEMENT OF PESTS AND DISEASES

Project Title

Developing a strategy for the management of sweet potato weevil (*Cylas formicarius*)

Objective

To examine different strategies for the management of sweet potato weevil.

Methodology

The trial was conducted in Field 17, Mon Repos. The statistical design was randomized complete block with three replications. There were three sweet potato cultivars – Amjad pumpkin potato, Korean # 1 and Viola. Five treatments were used on the cultivars. These were a control and four treatments involving two chemicals – Admire and Vydate L and the cultural practice of "hilling up"

Results and Conclusion

None of the treatments had any significant effect at managing the sweet potato weevil. An important observation was made. It was noted that there were three anthills in one replication. Those tubers that were close to the anthills were undamaged by the weevil. Research indicates that this observation was supported by work in other parts of the world. In 2003, further trials will examine integrated management including biological control measures.

OTHER PROJECTS IN PROGRESS AT DECEMBER, 2001

1. Varietal comparison trial of four yam varieties
2. Plant density observation trial with four yam varieties
3. Influence of soil type and fertility on plant growth and tuber yield of sweet potato

PROGRAMME: VEGETABLE CROPS

Programme Leader: Mr. E. Ralph

Project Officers: Ms. G. Parris•
Mr. C. Kissioonchand
Dr. A. Rosenfeld – V.S.O

INTRODUCTION

During 2002, work continued on the vegetable types introduced in 2001. These vegetables were cauliflower, broccoli, carrot and onion. Several trials were conducted with tomato and assessment of the cultivation of vegetables under shelter continued. Seed was multiplied for tomato and bora.

• On study leave in 2002

The following presents a summary of the activities of the vegetable programme

CAULIFLOWER

Introduction

Cauliflower is a member of the *Cruciferae* family. The edible part is known as the 'curd' and is a form of arrested flower development. Cauliflower is traditionally grown in a temperate environment where cool temperatures induce a change from vegetative growth to reproductive growth and a curd is initiated. Some varieties initiate curds earlier that others, and varieties suitable for growing in a tropical environment are usually early maturing varieties that have very little dependence on cool temperature for curd initiation. The choice of variety is critical. If a variety initiates a curd too early, then there is insufficient leaf structure to support the growth of the curd and a very small unmarketable curd is produced. Other late maturing varieties may continue to grow vegetatively in a tropical environment and not produce a curd at all (Hanada, 1990).

Little work has been done on growing cauliflower in Guyana although a few farmers have had some success in growing it on a small scale. Farmers have successfully grown cauliflower on a number of Caribbean Islands (CARDI, 1986). The objectives of the trials conducted at N.A.R.I. were to select suitable varieties of cauliflower for growing in Guyana according to the following criteria.

- Percentage of curd formation
- Quality of curds (colour, compactness)
- Curd size
- Resistance/tolerance to pests and diseases

General Methodology

Unless otherwise stated, the following methodology was used.

- Seeds were sown at 1 cm depth in trays containing a mixture of 3:1 cow manure and sand.
- Transplanting took place at the 4-5 leaf stage into 60 cm rows at 50 cm spacing
- Limestone was applied to the beds where necessary
- Fertilizer was applied as 80kg/ha N as urea, 100 kg/ha P_2O_5 as TSP, 80 kg/ha K_2O as MOP two days after transplanting, then 50 kg/ha N + 40 kg/ha K_2O at two weeks and four weeks after transplanting.
- Irrigation was applied twice a day as necessary

- Crop protection was applied (using Halt or Fastac) against diamond back moth, bud worm, *Cercospora* (using Trimiltox) and Black Rot.

Head formation was judged to have taken place when the head was first visible from above without parting the leaves. Plants were harvested sequentially as heads became mature.

Results

Evaluation of cauliflower varieties, Field 17, Mon Repos

Seeds were sown August 13. Plants grew very slowly and were not transplanted until October 23. The reason for this slow growth is not clear but may have been due to a nutrient deficiency in the potting medium, as when liquid fertilizer was added, plant growth improved. Table 15 shows selected characteristics of varieties tested.

Table 15: Characteristics of Cauliflower varieties tested in Field 17, Mon Repos, 2002

Variety	Fengshan Extra Early	Maya	Monte Perle
50 % curd formation (DAT)	60	67	97
Harvest range (DAT)	62-94	62-109	94-120
Average curd wt (g)	99	225	255
No. leaves below curd	38	39	61
Riceyness (%)	71	18	0
Buttoning (%)	43	9	0
Discoloration (%)	71	0	80
Curd Colour	White	Cream	Cream

Fengshan Extra Early was the earliest maturing variety. In this evaluation it produced small curds that tended to separate before reaching marketable size. Maya matured only slightly later but produced much larger curds of a better quality. Monte Perle was the latest maturing variety that produced a lot of vegetative growth before head formation. Average curd size was the largest of the varieties with reasonable few defects although there was a tendency for slight purple coloration in most of the curds.

Evaluation of cauliflower at Naamryck

The varieties, Farmer's Extra Early and Maya were evaluated on Farm at Naamryck. In the first trial, Farmer's Extra Early produced a reasonable yield of curds of consistent quality. However in subsequent trials, during the rainy season, the variety showed high susceptibility to *Cercospora* leaf spot and head quality was poor. The variety Maya showed a more consistent quality of head and better resistance to *Cercospora*.

Conclusions

Of the trials completed, Maya looked to be the most promising variety. Further work is currently being done to test a wider range of varieties for growing in the climate in Guyana.

BROCCOLI

Introduction

Like cauliflower, the edible part of broccoli, the 'floret' is a form of arrested flower development. As with cauliflower, broccoli is traditionally grown in a temperate environment where cool temperatures induce a change from vegetative growth to reproductive growth and florets are initiated. Therefore there are similar problems to cauliflower in selecting varieties that initiate florets at an appropriate stage of development in a tropical environment.

Little work has been done on growing broccoli in Guyana although a few farmers have had some success in growing it on a small scale. Farmers have successfully grown broccoli on a number of Caribbean Islands (CARDI, 1986).

As with cauliflower, the primary objective of the trials was to select suitable varieties of broccoli for growing in Guyana according to the following criteria:-

a) Percentage of floret formation
b) Quality of floret (colour, compactness)
c) Floret size
d) Resistance to pests and diseases

General Methodology

Unless otherwise stated, the methodology was as for cauliflower.

RESULTS

Evaluation of broccoli varieties, Field 17, Mon Repos

Seeds were sown August 13. Plants grew very slowly and were not transplanted until October 23. The reason for this slow growth is not clear but may have been due to a nutrient deficiency in the potting medium, as when liquid fertiliser was added, plant growth improved. Table 16 shows selected characteristics of variety Green King No. 2.

Table 16: Characteristics of Broccoli Variety Green King No.2, Mon Repos

50 % head formation (DAT)	83
Harvest range (DAT)	62-92
Average head wt (g)	105
Buttoning (%)	50
Discoloration (%)	25

The variety Green King No. 2 attained 50 % head formation at 83 days after transplanting (DAT). By 88 DAT 61 % of plants showed visible head formation but no further plants initiated heads. Average head weight was small as a high percentage of small unmarketable 'buttoned' heads was produced. The other variety tested, Premium Crop produced severely misshapen heads which made them unmarketable.

Evaluation of broccoli at Naamryck

The variety Green King was evaluated on farm at Naamryck. A good yield of quality heads was produced.

CARROTS

Introduction

Carrots are traditionally grown in a temperate environment although there are a number of varieties that are suitable for growing in a tropical environment. Although little work has been done on growing carrots in Guyana farmers successfully grow carrots on a number of Caribbean Islands (IICA, 1990).

Previous work indicates that germination may be a problem at high temperatures and also that roots may become shortened at temperatures above 21°C (Ware and McCollum, 1986). It is therefore important to select appropriate varieties that are better adapted to growing at higher temperatures. The objective of the trials was to select suitable varieties of carrot for growing in Guyana according to the following criteria:-

a) Total yield
b) Quality of product
c) Resistance to pests and diseases

Work was also carried out to optimise agronomic practices affecting carrot production including factors affecting germination, optimum seed rate and soil conditions.

General Methodology

Unless otherwise stated, the following methodology was used.

- Seeds were sown directly into the seed bed, at a depth of 0.5 cm in 30 cm rows at a density of 0.5 g per m^2.
- Fertilizer was applied as 30 kg/ha N as urea, 100 kg/ha P_2O_5, 30 kg/ha K_2O directly before planting then 30 kg/ha N as urea+ 30 kg/ha K_2O at two and four weeks after emergence. Limestone was applied where necessary. Crops were irrigated to maintain soil moisture at a constant level according to ET demand.

Crop protection measures were applied against root knot nematodes (using Vydate L.), mole crickets (using Diazinon) and *Alternaria* (using Trimiltox) when necessary**.**

Harvests of 1 m length were taken at 90 days after sowing. Measurements of tap root length, diameter (taken 1 cm from the top of the tap root), and an IPGRI shape rating were taken. The IPGRI shape rating is a scale of 1 to 5 where 1 is very rounded and 5 is a very tapered.

RESULTS

Carrot Varietal Trial, Mon Repos

Eleven varieties of carrot were sown at Field 37 (sandy clay loam), NARI, Mon Repos on October 5, 2001.

Varieties were Amazonia, Danvers 126, Danvers Half Long, Japan Cross, KCH-1, Nantes Takii, New Kuroda, Royal Cross, TC-1, Terracotta and Yardley II.

Varieties were arranged in a randomised block design with three replicates. First emergence was observed October 19. Emergence was generally poor owing to capping of the soil surface. It was particularly poor in the varieties Japan Cross and KCH-1 and best in the varieties Amazonia, Royal Cross, Terracotta and Yardley II. Plots were harvested February 20.

Table 17 shows the yield s and characteristics of carrot varieties grown at Mon Repos. Although most varieties achieved full ground cover, the uneven emergence resulted in bunching and uneven root spacing. This contributes to variability in tap root size and shape.

Table17: Yields and characteristics of carrot varieties grown at Mon Repos

Variety	Total Yield (t/ha)	Marketable Yield (t/ha)	Achieved Plant Density (000 /ha)	Root Length (mm)	Diameter (mm)	Shape rating (1-5)*
Amazonia	13.2	9.3	528	168	26.4	4.3
Danvers 126	8.1	4.8	222	183	32.1	2.7
Danvers Half Long	9.4	6.6	244	211	28.1	4.3
Japan Cross	0.5	0.5	5	190	34.5	5.0
KCH-1	3.9	2.4	61	224	32.7	4.0
Nantes Takii	4.2	2.4	150	165	22.0	4.0
New Kuroda	8.5	5.8	205	205	31.2	4.0
Royal Cross	19.1	14.5	369	235	30.1	5.0
TC-1	15.4	12.8	325	204	27.3	4.7
Terracotta	15.9	12.0	461	201	27.0	4.7
Yardley II	10.3	6.8	344	193	28.6	3.3
L.S.D. (p=0.05)	8.1	6.1	324	32	8.5	1.4

* 1 – Very rounded 5 – Very tapered

Total yields were generally less than that achieved in a previous trial at Fort Wellington. This was a consequence of achieving a lower plant density. The best yielding varieties were Royal Cross, TC1 and Terracotta. The low yields of the varieties, Japan Cross, KCH-1 and Nantes Takii was a result of poor germination and low plant density. Root lengths were generally greater than that at Fort Wellington as there was a greater depth of soil with low penetration resistance. Varieties, KCH1 and Royal Cross produced the longest roots. There was no effect of variety on root diameter. Although the effect of variety on IPGRI shape rating was not significant, Danvers 126 tended to produce a more rounded root shape whilst Royal Cross tended to produce a more tapered shape.

Carrot Germination Trial

With a view to improving the germination, a germination trial was carried out to assess the effects of sowing depth and soil type on the germination of carrot seed.

Methodology

The trial comprised three depths of sowing: surface, 0.5 cm and 2 cm and three soil types: white sand, sandy clay loam and pegasse. The three treatments were combined factorially in a randomised block design with three replicates.

Small trays were constructed of size 30 cm x 20 cm and filled to a depth of 5 cm with soil. Any large clods were broken up. Fifty seeds were sown in each tray. In the surface treatment, seeds

were placed on the surface of the soil, then a very fine layer of soil, sprinkled over the top. In the 0.5 cm and 2 cm depth treatment, seeds were placed in holes of predetermined depth.

Results

Emergence was most rapid when seeds were sown at the 0.5 cm depth on all three soil types (Figure 6). When seeds were sown at a depth of 0.5 cm, 50 % emergence was achieved *c*. three days earlier than when sown at a depth of 2 cm (***Table*** 18).

Table 18: Effect of depth of sowing on germination of carrot, Mon Repos, 2002

Depth of sowing (cm)	0	0.5	2	LSD (p=0.05)
Days to 50% emergence	9.7	8.7	12.3	2.12

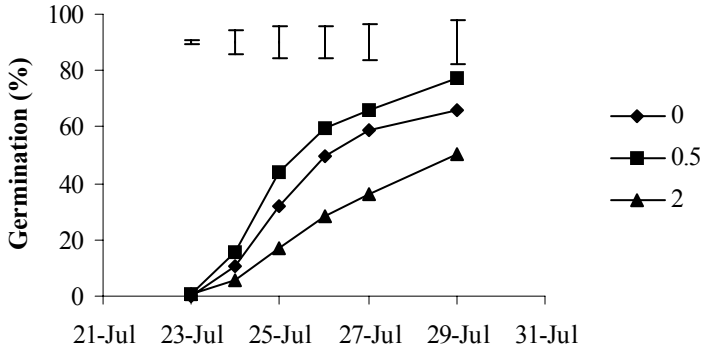

Figure 6: Effect of depth of sowing on germination of carrot, Mon Repos, 2002

[All error bars on graphs are LSD (p=0.05) unless otherwise stated]

Although seeds initially emerged more rapidly in the pegasse soil than the other two soil types, by the time 60% emergence had been reached, these differences were small and not significant (Figure 7).

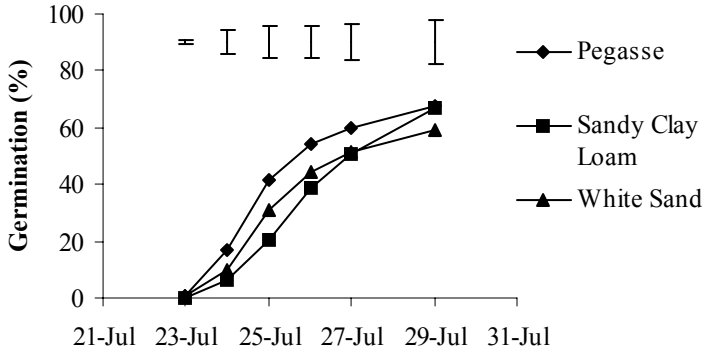

Figure 7: Effect of soil type on germination of carrot, Mon Repos, 2002

Evaluation of carrot variety 'Short Top' at Kuru Kururu.

A trial to evaluate the carrot variety, 'Short Top' was carried out at Kuru Kururu. The soil was white sand with poultry manure incorporated into the beds. Seeds were sown 4 April. Germination was better than in previous trials and plants were thinned to 5 cm spacing 22 May. A good canopy was established achieving full ground cover. Two harvests were taken, 3 July and 17 July (Table 19).

Table 19: Characteristics of Carrot Variety, Short Top, Kuru Kururu, 2002

	3 July	17 July
Density (000/ha)	307 ± 67.7	307 ± 52.1
Yield (t/ha)	3.6 ± 1.01	5.2 ± 0.61
Length (mm)	76 ± 11	8.2 ± 0.69
Diameter (mm)	15 ± 1.05	17 ± 1.49

(Results ± S.E., 3 reps)

Despite producing a good canopy, the yields of tap root were poor, and the shape and appearance were not attractive, suggesting that this variety would not be suitable for growing in this climate.

Varietal evaluations of carrot at Naamryck and Kuru Kururu

It was not possible to evaluate the best performing varieties from the earlier trials as further samples of seed were not readily available. Therefore, evaluation of more readily available varieties Amazonia, Brasilia, Danvers 126, New Kuroda was carried out at different sites. The soil at Naamryck was a pegasse and the soil at Kuru Kururu was black sand. Although not a normally recommended practice, some growers had reported success with transplanting carrot seedlings, so a comparison of direct seeded and transplanted was included in the evaluations.

Seed of each variety was sown directly into the seed bed and seed trays on 19 August and 21 August at Naamryck and Kuru Kururu respectively. Seedlings were transplanted into 30 cm rows with 5 cm spacing on 9 September at Naamryck and 16 September at Kuru Kururu.

Germination in the trays was rapid and uniform at both sites. At Naamryck, the direct sown plants in the pegasse soil also showed reasonable uniform germination. However, very few plants germinated in the black sand at Kuru Kururu and those that did were damaged by mole crickets. The poor germination may have been a result of inadequate watering in a soil that possesses poor water retention.

A uniform canopy, achieving full ground cover was produced from the transplanted plants at both sites and from the direct sown crop at Naamryck.

Samples were taken 25 November at Naamryck and 12 December at Kuru Kururu (Table 20).

Table 20: Yield and properties of carrots grown at Naamryck and Kuru Kururu, 2002

Variety	Total Yield (t/ha)	Marketable Yield (t/ha)	Achieved Plant Density (000/ha)	Root Length (mm)	Diameter (mm)	Shape rating (1-5)
Naamryck						
Direct sown						
Amazonia	7.4	2.9	440	156	16	5
Brasilia	9.7	5.1	320	169	21	4
Danvers 126	5.4	2.4	300	125	19	4
New Kuroda	13.9	6.3	440	146	23	5
Transplanted						
Amazonia	8.9	0.0	440	123	25	2
Danvers 126	4.9	0.0	380	88	17	2
New Kuroda	12.9	0.0	420	139	22	2
Kuru Kururu						
Transplanted						
Amazonia	9.6	1.0	230	149	33	4
Danvers 126	7.1	0.0	400	55	20	3
New Kuroda	13.2	1.4	180	179	35	4

A reasonable total yield was produced at both sites. Although caution must be exercised when comparing results taken from unreplicated demonstration plots, some consistent trends were evident. New Kuroda produced the largest yield and Danvers 126 the shortest tap roots at both

sites. Marketable yields were lower than in previous trials. Transplanting resulted in a very high proportion of deformed and split roots resulting in a very low marketable yield. Although this method resulted in the establishment of a good canopy in the black sand, these results confirmed that it could not be recommended as a commercial practice. The establishment of a good canopy on black sand must be achieved by improving germination of direct sown seed.

Investigating the effects of soil compaction on carrot yield and quality

This project was carried out by a final year student at the University of Guyana. The trial was carried out in drainpipes filled with sandy clay loam and comprised of three levels of irrigation and three levels of compaction combined factorially. The work showed that levels of soil penetration resistance greater than 1 MPa significantly increased the proportion of split and deformed carrot roots. A full report is available in the NARI library.

Conclusions

The trial at Mon Repos suggested that there are varieties which can perform better than those which are currently available in Guyana. Further work should be done to test those varieties when seed is available. In many trials, uneven germination and canopy establishment was a problem, especially on very light sandy soils which retain little moisture and become very hot during the dry season. Further work should be done to find ways of improving germination on such soils.

ONIONS

Introduction

Onion is a widely consumed vegetable in Guyana, but the vast majority are currently imported. Although some work was done on growing onions at NARI in 1986 and 1987 (Thiruketheeswaran, 1987) little work has been done recently on growing onions in Guyana.

Onions are traditionally grown in a temperate environment and many varieties require long days of 12 – 16 hours to induce bulb formation (Messiaen, 1994). Although there are some varieties which will form bulbs under shorter days, many of these traditional varieties such as Texas Yellow Grano, have very poor storage quality (e.g. Thiruketheeswaran, 1987). A range of new varieties have been tested in both the Caribbean (CARDI, 1993) and Asia (AVDRC, 1998), and these should be tested for growing in Guyana.

The main objectives of the trials were to select suitable varieties of onion for growing in Guyana according to the following criteria:-

a) Total yield
b) Quality of product (colour, shape, defects)
c) Resistance to pests and diseases
d) Good shelf life

A trial was also conducted to investigate the optimum nitrogen requirement.

General Methodology

Unless otherwise stated, the following general methodology was used for growing onions.
Seeds were sown into a mixture of three parts manure and one part sand in trays at 1 cm depth. When the seedlings were 2 cm high they were transplanted into 20 cm rows (four rows per 1 m bed) at 10 cm spacing.

Prior to planting, limestone was applied to the soil if necessary. Fertiliser was applied as 50-100-50 kg /ha of NPK – at planting. The remainder of N and K was applied as two side dressings of 50 kg/ha before bulb formation took place.

The soil insecticide, Diazanon was applied at transplanting to control mole crickets where necessary.

Onion varietal trial, Field 37, Mon Repos

Sowing of the varieties Elad HA9, Galil HA7, Hi Grano 2000, Sivan 202, Superex, and Texas Grano 502 was done on 23 August. More than 50 % germination was achieved within six days. Plants were transplanted into Field, a sandy clay loam. Varieties were arranged in a randomised block design with four replicates.

Twenty to fifty percent of plants were lost shortly after transplanting in all varieties. By harvesting, further losses were shown in Galil, Grano and Sivan due to neck rots during bulb formation. Superex and Texas Grano had the highest number of plants remaining one month after transplanting and few plants were lost between this time and harvest.

Superex showed early rapid growth, consistently having taller plants than the other varieties earlier in the season but these differences were reduced later in the season.

By November 26 all varieties showed bulb initiation. Superex matured earlier than the other varieties, with 90 % of plants senesced by January 14. This variety was harvested on this date as subsequent bulb growth would have been minimal. The other varieties were harvested a week later, January 22. The percentage of mature bulbs (necks bent over) is presented below. The ideal time for harvesting is considered to be when just over half of plants have bent necks. Galil, Hi Grano, Sivan and Texas Grano were not quite mature when they were harvested but an early harvest was necessary to avoid spoilage since there was heavy rain.

Yields were considerably better than a previous trial; however they were low by commercial standards (Table 21).

Table21 Yield and characteristics of onions at harvest, Mon Repos, 2002

Variety	Yield (t/ha)	Av bulb diam (mm)	Rots (%)	Dry matter (%)
Elad HA9	7.7	40.9	12.6	6.5
Galil HA7	8.1	37.2	0.0	7.2
Hi Grano 2000	10.6	41.5	6.5	7.1
Sivan 202	12.1	48.1	1.6	7.3
Superex	14.8	44.1	1.5	6.8
Texas Grano 502	19.1	46.1	0.0	7.5
LSD (p=0.05)	5.5	7.41	11.9	0.55

Texas Grano 502 and Superex produced the highest yields. As there were not large differences in average bulb size between varieties, differences in yield could be attributed primarily to the proportion of plants producing harvestable bulbs. There were also significant differences in the dry matter content of the bulbs, Elad HA9 producing the lowest dry matter, and Texas Grano 502 producing the highest dry matter. There were low numbers of rots at harvest but this did not differ significantly between varieties.

Samples from all plots were put into storage on wooden racks at ambient temperature, and were assessed every week for weight loss, rots and scale development (skin set). Skin set was most rapid in the variety Sivan where 80 % of bulbs showed complete skin set in less than two weeks. Other varieties took *c*. 6 weeks to achieve 80 % skin set.

Hi Grano 2000 showed the most rapid weight loss in storage (including losses due to rots), with only 35 % of original harvested weight remaining after seven weeks. Superex showed the smallest loss in storage, retaining 86 % of harvested weight at seven weeks.

Evaluation of onion varieties at Naamryck

Seven varieties of onion were grown on a pegasse soil at Naamryck. A harvest was taken at 77 days after transplanting in all varieties except Red Creole which was harvested at 105 days. Yields were very poor compared to previous trials conducted on the same varieties (Table 22). This was a result of both a low percentage survival and small bulb size. Both of these could be attributed to heavy rain and the soil remaining waterlogged for parts of the growing season.

Table 22: Yields of onion varieties at Naamryck, 2002

Variety	Plants remaining (%)	Yield (t/ha)	Adjusted yield (t/ha)
Elad HA9	9	0.8	9.5
Galil HA7	27	2.1	7.9
Hi Grano 2000	34	4.5	13.0
Red Creole	46	4.1	8.9
Sivan 202	11	0.8	7.1
Texas Grano 502	36	2.8	7.9
Texas Yellow Grano	51	2.9	5.7
Yellow Sweet	13	0.5	3.7

This was a result of both a low percentage survival and small bulb size. Both of these could be attributed to heavy rain and the soil being waterlogged for parts of the growing season. The highest yield (4.5 t/ha) was achieved by the variety Hi Grano 2000 while the variety Yellow Sweet obtained the lowest (0.5 t/ha).

Samples were kept to assess their potential for storage. Weight loss (including losses due to rots) was more rapid than in the trial grown at Mon Repos, with most varieties losing more than 50 % after forty days. This could be attributed to the wet conditions at harvest favouring conditions for rots. Results were consistent with the previous storage trial, Elad showing reasonably good keeping qualities and Hi Grano showing poor qualities. Texas Yellow Grano showed particularly rapid losses in storage, declining to *c* 20 % within 20 days.

Onion bulbs were also assessed for skin set. As in the trial at Mon Repos, all varieties attained more than 80 % skin set after 40 days after harvesting. Red Creole had the most rapid skin set, with all bulbs showing complete skin set at harvest. Texas Grano 502, Sivan and Galil showed more rapid skin set than the other varieties.

Determining Optimum Rate of Nitrogen Application on the variety Texas Grano 502

This trial was carried out by a final year student of the University of Guyana on a sandy loam at Fort Wellington. The rate of 175 kg/ha nitrogen produced the best yield. Higher rates reduced yield.

Conclusions

In the trials performed so far, the varieties Superex and Texas Grano 502 produced the best yields. The varieties Elad HA9, Galil HA7, Hi Grano2000 and Sivan 202 all produced poor yields as a consequence of a small proportion of plants remaining to produce harvestable bulbs. Superex was an earlier maturing variety, ready for harvesting at 100 days after transplanting. Texas Grano 502 required a season of more than 110 days. From observation, Superex produced a far more attractive glossy skin finish than the other varieties which would enhance its marketability. Yields need to be improved to make growing onions in Guyana profitable and this should be achieved through improved husbandry. Further testing needs to be done to investigate optimum fertiliser rates, planting density and the evaluation of varieties.

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TOMATO AND OCHRO

Effect of removing initial flower buds at various stages on the yield of tomato

Introduction

An initial observation with tomato (new varieties), indicated tat tomato plants tend to increase in plant height, number of fruits per plant, fruit weight and result in increase yield when flower buds are removed at first and second flowering stage. This trial sought to determine whether there is any advantage in the removing initial flowers.

Methodology

The experiment was carried out at NARI, Mon Repos, where the soil type is predominately Onverwagt with a pH of 5.5.

Design: Randomised complete block
No. Trts: 4
No. Reps.: 3
Plot Size: 16.2m^2
Plants/plot: 60
Sample Size: 12 innermost plants

Treatments were

T1 - Control (no removal)
T2 - Flower removal five weeks after transplanting
T3 - Flower removal five and six weeks after transplanting
T4 - Flower removal five, six and seven weeks after transplanting

Results and Discussion

Table 23 shows the yield of fresh tomato fruit in response to flower removal at various stages

Table 23: Fresh tomato yield in response to flower removal at various stages, Mon Repos, 2002

Treatments	Mean Yield (t/ha)	Letter Indicates sign. Diff.
T0	24.6	A
T1	26.1	A
T2	17.4	B
T3	16.4	B

Statistical analysis was done using the ANOVA table to test whether there was any significant differences among the treatment at P=0.05

There was significant difference among the treatments (P=0.05). The differences were observed between T0 and T3; T0 and T4; T1 and T3 and T1 and T4.

This implies that it does not matter whether flower buds are removed at week five or no flower buds are removed, even though T1 gave 1.5t/ha more than T0.

T0 produced more flowers than T1 (>5%) but the fruit size was smaller than that of T1; 17g for T0 compared to 26.4g for T1. Also the plants in T1 were much taller and with a vigorous growth than T0. This suggests that in T0 the plants were unable to supply enough nutrients for fruit development, hence smaller fruits produced. T1 produced larger fruits but fewer in number as compared to T0, also T1 recorded a higher percentage fruit set rating as compared to the other treatments.

Treatment 4 and 5 also produced large fruits, however the number of fruits was less than treatment 1.

Conclusion

It can be concluded that the variety did not respond with increased yield when flower buds were removed at week six and seven. It also does matter in terms of yield whether flowers were not removed or when they are removed at week five. However it is recommended that during the dry period when plants are under stress that flowers buds be removed at week five, since this will increase the overall performance of the variety.

On-farm testing of new varieties of ochro and tomato

Ochro and tomato are popular vegetable crops grown commercially for the fresh markets and account for about 30% of the vegetables grown commercially in Guyana. It is well suited to production in the tropics and also adapted to production at high temperatures and range of rainfall.

Recent studies in varietal evaluation have identified a few varieties of ochro that may be suitable for the fresh market. These showed good cooking qualities and better yield than the local varieties in Guyana. While the tomato varietal evaluation have identified four varieties of tomato, which may be suitable for the fresh market. These varieties are of the smooth type, sweet to taste, firm and showed some tolerance to wilts (Giles, 1999). These varieties of tomato and ochro were tested on farmers' field in Region 4.

A site was selected at Enterprise, on the East Coast Demerara, where the soil is predominately Onverwagt clay with a pH of 5.6. Four varieties of tomato (TA, TB, TC and Alafua Winner) and five varieties of ochro (Santa Cruz, Emerald Green Velvet, Louisiana Green Velvet, Artist and Clemson Spineless) were planted in a single block with 100 plants per block for ochro and 200 plants per block for tomato. The crops were grown according to the farmers' cultural practices.

Plant growth and fruit production was good when compared to the farmer's local varieties. However farmers felt that the tomato fruits were not large enough for acceptance by consumers. The ochro varieties Santa Cruz and Emerald Green Velvet performed outstandingly.

Evaluation of introduced varieties of tomato

Introduction

Tomato is economically important among the vegetable crops grown commercially in Guyana. It occupies 20% of the estimated total area under vegetable production and production is mainly

for the fresh market. Of the cultivars grown locally many are susceptible to two of the most common diseases found here i.e. bacterial wilt caused by *Pseudomonas solanacaerum* and fusarium wilt caused *Fusarium sp*. Local varieties are also acidic in taste and hence used mainly for cooking; their horticultural characters make them unsuitable for use as a vegetable.

Therefore, there is need for the development of range tomato cultivars with good horticultural characteristics suitable for the fresh market. This study evaluates the adaptability of introduced cultivars of tomato to the local environment.

Objectives

- To develop improved varieties of tomato for the fresh marker with
  + High yield
  + Good horticultural characters such as
    * fruit firmness
    * good colour development
    * good taste
  + Resistance to main pests
  + Resistance to bacterial wilt and fusarium wilt

Methodology

Fifteen introduced varieties from Israel, Cuba and Petoseed Company were compared to local varieties including recently tested varieties. These varieties have been selected for heat tolerance and disease resistance. The crop was grown during the dry period, January – April.

Plants were transplanted five weeks after sowing. The beds were arranged in a demonstration plot. Each plot contained 45 plants/varieties, from which yield and characterization assessment were made.

Spacing used was 60 cm between rows 45 within rows.
Limestone and pen manure were incorporated two weeks prior to transplanting.

Fertilizer application were as follows:

Urea – 180 kg/ha:	30% at transplanting, 40% at flowering and 30% at fruit set
TSP – 80 kg/ha:	all at transplanting
MoP – 120 kg/ha:	50% at transplanting and 50% at flowering

Crop management

It was necessary to spray for thrips and leaf miners; for which a combination of Vydate L and Vertimec was applied and fungal leaf spots; for which Trimilox forte was used.

A sprinkler system was used for irrigation and mulching was used to control weeds.

The varieties were assessed for yield, fruit setting rating, horticultural characteristics and pest and diseases incidence.

Table 24 shows the yield and yield components of the cultivars.

Results and Discussion

Table 24: Yield and yield components of several introduced varieties of tomato tested at Mon Repos, 2002

Varieties	Tonnes/ Ha (t/ha)	Yield/ plant (g)	Marketable yield (%)	Fruit Weight (g)	Fruits/ Plant
Catherine	12.6	307	57	40.9	7.5
Francesca	12.0	293.2	32.8	25.8	11.3
Aro 8479	7.5	183.9	24	12.8	14.4
Alafua winner	22.3	543	89.6	16.6	32.7
Dominique	21.1	514.8	0.8	36.3	14.4
Larissa	10.8	262.5	26	18.4	14.3
Colette	8.1	198.3	51.8	10.3	19.3
Gem pear	13.3	323.6	19.3	20	16.2
Ta 332	15.7	382.3	65.8	30.8	12.4
Rilia	3.4	83.3	6.5	22.7	3.6
Aro 8472	4.6	111.7	50	19.7	5.7
Brillante	4.7	115	50	25.5	4.5
Lignon	4.3	104.8	28.7	26.2	4.0
Ta 325	2.6	63.3	57.1	27.5	2.3
Gem pride	12.4	303.3	21.8	12.5	24.3

Discussion

Alafua Winner (control) and Dominique produced the highest marketable yields, 89.6% and 80.8% respectively. In contrast to the other varieties, a very low percentage of marketable fruits were recorded ranging from 65.8 (TA 332) to 6.5% (Rilia). This was due to high incidence of blossom end rot occurring in these varieties. Alafua Winner and Dominique therefore showed resistance to blossom end rot.

Several varieties produced larger fruits than Alafua Winner; these include Catherine, Dominique and TA 332 which had fruit weighs greater than 30g compared to 16 g for Alafua Winner.

A short shelf life was exhibited by all the introduced varieties, because of the high incidence of blossom end rot, compared to the variety Alafua Winner.

Fruit appearance of the following varieties was particularly good, i.e. they showed a bright red colour and fruits if an even size: Catherine, Dominique, TA 332 and Alafua Winner.

Fruit set rating was low for most of the varieties. Varieties Alafua Winner, Dominique, Gem Pear and Gem Pride were the only varieties that produced a high number of flowers which set fruit.

All varieties showed a low incidence of growth cracks and fruit splitting. The fruits were also examined for bacterial soft rot; the variety showing the highest incidence was Alafua Winner with 4.6%.

Incidence of major pests and diseases was examined. There was no incidence of bacterial or fusarium wilt in any of the varieties. Incidence of Blossom End Rot was extremely high in this trial and this was due mainly to the unseasonable weather change.

All varieties except Alafua Winner showed some susceptibility to thrips damage, particularly Catherine and Francesca. The local variety Alafua Winner showed resistnce to thrips damage.

Conclusion

In conclusion, the variety Dominique showed improved horticultural characteristics and high yield potential compared to the local variety. In addition the large fruits produced by some varieties would make them attractive for production. More work should be done with these varieties under different growing conditions.

Determining the water requirement of tomato

Introduction

The objective of this trial was to investigate factors determining the water requirement of tomato growing on Onverwagt clay. Efficient irrigation of the crop ensures that the correct amount of water is applied at the correct time, maximizing yield and quality and reducing the labour requirement.

Objective

To determine the water requirement of the variety Alafua Winner growing on Onverwagt clay.

Methodology

There were three irrigation regimes

- W1 was irrigated when the available soil water fell to 50% of field capacity
- W2 was irrigated when the available soil water fell to 65% of field capacity
- W3 was irrigated when the available soil water fell to 80% of field capacity

In W2 and W1, the intervals between irrigations were gradually increased throughout the season, as the rooting depth increased and a greater volume of water was available to the plant.

An area of plants was left un-watered from November 15 onwards and soil samples taken to determine permanent wilting point.

The design was a randomized complete block; plot size was $42m^2$ with 140 plants per plot and a sample size of the 10 innermost plants. The trial was established in October 2001 and completed in 2002.

The survival rate after transplanting was poor and as a consequence a gappy canopy was produced. Round cover was assessed throughout the season as a measure of crop growth. For each plot, the area with the most uniform stand was selected for measurement. However it was not always possible to find an area with a completely uniform stand in each plot and the irregular canopy contributed to a large variability and confounded any possible effects of the irrigation treatments. A high incidence of Gemini virus also contributed to variability within the canopy. The crop was also heavily affected by thrips.

Results and Discussion

Treatment W3 gave the highest yield of 17.2 t/ha followed by treatment W1 with 13.9 and W2 with 13.3 t/ha (Table 25). The higher yield was a consequence of producing more fruits per plant and a greater mean fruit weight. However, these differences were small and differences in yield, number of fruits and mean fruit weight were not significant at the p=0.05 level.

Table 25: Yield data for three irrigation regimes

Treatments	Yield (t/ha)	Yield/ plant (g)	No. Fruits/ plant	Mean Fruit Weight
W1	13.9	417.8	21.2	19.7
W2	13.3	397.9	21.5	18.5
W3	17.2	510.5	23.2	22.0

It was observed that a number of fruits showed fruit cracking and splitting resulting from high availability of water. Treatment W3 (the most frequently irrigated treatment) had the lowest marketable yield (93.1%) as compared with W1 and W2 with 94.4% and 94.9% respectively. However, there was not significant difference (P=0.05) among the treatments.

Ground cover increased at a similar rate in all treatments and reached a maximum 50 days after transplanting and then declined. None of the treatments attained full ground cover, a consequence of the poor stand establishment. Although W3, the most frequently irrigated treatment apparently attained a larger maximum ground cover that W2 and W1, this difference was not significant. Nevertheless, the more frequently irrigated treatment consistently produced the largest ground cover and the highest yield.

Leaf length was measured every week, as leaf expansion is often restricted when the plant is short of water, so is a good indicator as to when the plant is experiencing water stress. The length of the tenth, fifteenth and twentieth leaves were measured on marked plants in each plot. By the time measurements started the tenth leaf had almost fully expanded and irrigation had no effect on leaf length. The small differences between irrigation treatments in the fifteenth leaf were not significant, as there was a very large degree or error. This error could be attributed to the effect of Gemini virus on the plants. In W1 the twentieth leaf did not expand at all, whereas in W2 and W3 there was some expansion of the twentieth leaf but this was quite limited.

Soil moisture content was measured gravimetrically prior to irrigation. Soil moisture deficits did not change much throughout the season, but decreased after heavy rainfall which occurred four weeks after transplanting. Prior to irrigation, the soil moisture deficit increased after this period in W1, the least frequently irrigated treatment. There was a high degree of sampling error owing to spatial variation in soil water content.

The water content of the soil measured at field capacity (FC) was 51.0% (v/v), which is similar to the value found for Onverwagt clay by Paul (1982). There were small changes in the water content at field capacity with depth but these were not significant. Plants appeared severely wilted when the soil moisture content had fallen to an average of 15.4% in the top 30cm of soil. This is much lower than the value of 27% found by Paul (1982) at 15 bars.

Depth of rooting was measured by digging a pit close to the plant and scraping away the side of the soil to expose the root system. This was done on four occasions and the data are shown in Table 26.

Table 26: Depth of rooting of tomato growing on Onverwagt clay.

Date	Dept of Rooting (cm)	S.E. (12 reps)
12-Oct	11	0.46
19-Oct	13	0.49
08-Nov	21	0.66
12-Dec	33	0.83

In practical terms the data would suggest that for every 10 cm of rooting depth there is a total of c. 20 mm available to the plant. Previously published data suggest that tomato plants can use 40 % of total available water before they begin to experience stress. Therefore there would be 8 mm of readily available water for every 10 cm of rooting depth.

Early in the season when the crop has a shallow rooting system (c.10 cm) there is only 8 mm water readily available. Mid season when it has a root depth of c 20 cm there will be 16 mm of water readily available and towards the end of the season, when the crop has a rooting depth of c. 30 cm there will be 24 mm water readily available.

Further work is needed to establish the rates that the plant use water at different stages of plant growth, as the sampling errors in the soil gravimetric measurements were too large to establish this. This will allow us to determine the frequency of irrigation. Data is also needed to establish the percentage of available water at which the plant begins to experience stress. Further work could also be done to establish depths of rooting at different stages in farmers' crops for a range of soil types.

Seed Multiplication

Tomato

Two crops of basic seed of variety Alafua Winner were produced at Fort Wellington and these yield 382g of seed. This was equivalent to a seed yield of 97kg/ha. Some plants were lost to mole cricket while some were rogued for disease mainly Gemini virus. Some fruits were also discarded due to bacterial soft rot.

One crop of the variety TA was also cultivated for basic seed. Yield of basic seed obtained was 24.1g, equivalent to 45 kg/ha. This crop suffered greatly from mole cricket damage where only 12 plants out of 50 survived.

Bora

Two crops of bora, variety yard long were cultivated for seed at Fort Wellington. Plant selection to maintain uniformity and the removal of diseased plants was integral to the production of good quality seed. Indications are that each successive crop stand produces a greater number of uniform pods. Total yield obtained over the two crops was 57 kg. Seed yield in the first crop was equivalent of 1445 kg/ha while yield in the second crop was equivalent to 261 kg/ha.

Sheltered Cultivation

Sweet pepper, cauliflower, broccoli and poi were cultivated under the shelter. During fruit production of sweet pepper flooding occurred and completely destroyed the crop before full maturity. Some harvest was obtained and this yielded 4340g from 111 fruits; average mature fruit weight was 60g over 70% since fruits harvested were immature.

Two varieties of cauliflower (Farmers' Extra Early and Fengsham Extra Early) were cultivated. Fengsham Extra Early did not perform well producing very few, small harvestable heads and succumbing to a discolouration and rot of the head. Farmers' Extra Early produced 64% harvestable heads. Mean weight per head was 135g with a range of 53 – 280g. Fifty three percent of heads harvested weighed more than 150g while the total yield was equivalent to 3.1 t/ha.

Two varieties of broccoli (Green King and Early Value) were grown and only Early Value produced heads of significance. Plant growth of Green King was poor and very few heads were initiated. Seventy two percent of Early Value was harvested. Mean weight per head was 73g with a range of 4 – 181g.

Poi was harvested as a fresh vegetable and for seed production.

OTHER TRIALS DONE IN 2002

1. Determining optimum seed rate for carrots on sandy loam.

PROGRAMME: **LIVESTOCK AND FORAGE**

Programme Leader: Mr. R. N. Cumberbatch

Programme Officers: Mr. R. Austin
Mr. J. F. Q. Solomon

Farm Supervisor: Mr. J. Gonsalves

Research Technician: Mr. E. Seaforth

INTRODUCTION

The Livestock programme was beset by a number of problems during the reporting year. There was a drastic decline in duck production caused mainly by a marked reduction in the number of eggs collected which subsequently had a significant effect on the number of ducklings sold. During the reporting year only 35,000 ducklings were sold as compared to 86,000 for the previous year.

The problems relating to the decline in egg production may be related to the age of the parent flock. Efforts are being made to acquired new parent ducklings. A number of other theories have also been postulated and these include the possible contamination of the duck ponds by agricultural chemicals, which may have been used by the farms in the surrounding community. These chemicals may be responsible for some form of physiological disturbance in the metabolic system of the birds, hence the reduction in the level of egg production. Efforts were made to contact a laboratory to test for the heavy metals in the water and tissue of the ducks but the cost of such tests was prohibitive. A third theory was the possible use of genetically modified plant ingredients in the feed on offer to the birds, but an extensive review of the literature related to feed and feedings of poultry did not indicate that there was any effect of genetically modified plant material on egg production of poultry.

The sheep programme suffered some minor setbacks as well, mainly as a result of the dry conditions experienced during the latter part of the year, and coupled with the fact that the sheep pastures are overstocked, the dry conditions only served to highlight the extent of this bad management practice currently employed in this programme.

The extensive dry weather also stymied efforts at pasture expansion and pasture renovation, attempts were made to expand the forage resource base by bringing into production fields 37 and 42, however, this effort proved futile mainly as a result of the lack of moisture to effect planning of pastures.

The Livestock Farm activities remain the main focal point of the Livestock programme of the National Agricultural Research Institute. In 2002, these activities included duck breeding,

duckling production, sheep breeding and forage production. These projects were designed mainly to provide services to the farming community and by so doing provide quality breeding animals. The Livestock programme was therefore able to provide in excess of 35,000 ducklings and 76 breeding rams to the farming community. The programme also generated G$4M in revenue during the reporting year.

The forage production programme successfully maintained the protein bank, established in 2001, for the sheep production unit. The programme utilized a shandy of legumes, with leucaena being the main species. A forage germplasm collection, which was also established during the previous reporting year, was also maintained and expanded.

The transfer of technology was another important aspect of the Livestock Programme. Apart from officers making farm visits, various groups visited the Livestock Farm.

The Duck Unit

The production parameters of the duck programme were not as impressive as the last reporting year. Fertility for the hatching eggs was 74.29% as compared with 90% for the previous year, with hatchability being 65.4% as compared to 75% for the last reporting year. The overall mortality percentage of the ducks on the farm was less that 1 percent. The production parameters are presented below.

DUCK PRODUCTION PARAMETER'S FOR 2002

Fertility Percent

PERIOD	PEKIN	KUNSHAN	MUSCOVY
Jan –Dec 2002	77.08	72.9	72.9

Hatchability Percent

PERIOD	PERKIN	KUNSHAN	MUSCOVY
Jan – Dec 2002	68.6	61.4	66.2

Tables 27 and 26 show monthly egg and duckling production. Towards the middle of the latter half of the year, there was a decline in egg production from the breeding flock, resulting not only in a short fall of hatching eggs but also in a short fall in duckling production and revenue.

Table 27: Egg Production at the Livestock Farm. Mon Repos, 2002

PERIOD	F1			PARENT STOCK			F2		TOTAL
	Perkin	Kansan	Muscovite	Perkin	Kansan	Muscovite	Perkin	Kansan	
16 Dec-15 Jan	7302	435	1676			89	10	5	9517
16 Jan-15 Feb	7639	1029	1850	1	2	155			10676
16 Feb-15 Mar	5408	1693	2538	6	6	133			9784
16 Mar-15 Apr	3308	2203	2338	10	20	147			8026
16 Apr-15 May	3247	1865	2592	3	20	144			7871
16 May-15 Jun	2577	1201	2740	7	16	130			6671
16 Jun-15 Jul	2172	911	1942	1	17	112			5155
16 Jul-15 Aug	1983	434	1620			120			4157
16 Aug-15 Sep	3532	238	2449			181			6400
16 Sep-15 Oct	867	69	1339			52			2327
16 Oct-15 Nov	1375	67	1934			131			3507
16 Nov-15 Dec	1310	133	1532			185			3160
16 Dec-15 Jan	969	109	805			66			1949
TOTAL	41590	10387	25355	28	81	1645	10	5	79101

SUMMARY

PEKIN	KUNSHAN	MUSCOVY
41623	10478	27000

Table 28: Ducklings produced at the Livestock Farm, Mon Repos, 2002

PERIOD	PEKIN	KUNSHAN	MUSCOVY
16 Dec-15 Jan	4717	140	1178
16 Jan-15 Feb	3413	180	1078
16 Feb-15 Mar	3379	373	631
16 Mar-15 Apr	2976	685	1301
16 Apr-15 May	1503	1088	1466
16 May-15 Jun	1171	622	1118
16 Jun-15 Jul	767	333	806
16 Jul-15 Aug	882	392	928
16 Aug-15 Sep	440	85	484
16 Sep-15 Oct	1870	58	766
16 Oct-15 Nov	805	27	1339
16 Nov-15 Dec	367	2	774
16 Dec-15 Jan	184	4	598

Duckling sales generated G$ 2.8 as compared to G$6.9M during the year 2001.

Sheep Production

The sheep production programme was stared in October 1999, with the transfer of 48 animals for the Intermediate Savannahs Field Research Unit, Ebini, Berbice River. In addition 17 animals were purchased from farmers.

At the beginning of the reporting year there were 252 animals the breakdown of which is reported in Table 29. There were 284 animals at the end of the reporting period. There were also 206 births, (106 males and 100 females) and a lamb mortality percentage of 16% as compared with 13.1 for the previous year. The overall lambing % was 147.

Table 29: Flock size of sheep at the Livestock Farm, Mon Repos, 2002

PARAMETERS	OPENING STOCK	CLOSING STOCK
Breeding males	3	6
Breeding females	77	140
Weaned males	11	31
Weaned females	30	22
Male lambs	54	47
Female lambs	77	38
TOTAL	**252**	**284**

The average birth weight of the lambs was 2.18 kg for the females and 2.6 kg for the males, as compared to an average birth weight of 2.5 kg, with the birth weight ranging from 2.4 – 3.8 kg, for the previous reporting period. The average daily gains of the weaned males was 119.4g per day for the males and 108.7 for the females as compared to 118.8g per day for the males and an average daily gain of the female lambs of 105.2g for 2001.

The programme was able to sell 77 male breeding animals and 10 breeding ewes as compared to 67 breeding males during the previous reporting year. The average weight of the rams was 30 kg. In addition, 253 kg of mutton were sold.

Revenue Generation

The Livestock Farm generated total revenue of G$4,767,449 as compared to G$9,059,123 for the year 2001.

PROGRAMME: **SOILS AND THE ENVIRONMENT**

Programme Leader: Mr. M. Livan

Project Officers: Mr. David B. Fredericks
Ms. Gaitri Nanku
Ms. Michelle Lutchman

Project Technicians: Mr. S. Paul
Mr. S. Hollingsworth
Ms. G. Todd

Support Staff: Ms. M. Joseph

Objectives

1. To execute soil and land use surveys to identify "kinds of soils", characterizing these soils in terms of their biological.
2. To ameliorate the physical and chemical properties of soils to enhance crop production.
3. To develop sustainable agricultural production.

SOIL AND LAND USE SURVEYS

There were five major activities during this year. This included routine computerisation of existing data on Soil and Land Use, conducting Soil and Land Use Surveys and documenting the findings and collaborating with local natural resource institutions (including the University of Guyana). In addition, Mr. David B. Fredericks collaborated with the Guyana – Germany – Natural.

Resources Management Project as the Head of their Land Use Planning Unit and Land Use Planner. This collaboration resulted in the production of a Regional Land Use Plan and several supporting documents.

Project Title

Digitising if Maps on Soil and Land Use.

Objective

To create a digital database on Soils and Land Use for Guyana.

Status

The department produced three major maps this year. The first was a map showing 'The Various NARI Locations In Guyana'. The map was prepared following a request from the Communication Unit of NARI.

The second, 'A Map Showing The Location of a Soil and Land Use Survey in Canal # 1, Region 3' was produced. This map supported the publication of the report on a "Semi Detailed Soil and Land Use Survey of Canal # 1".

Finally, 'A Map Showing Areas Under The Influence of Rip-Rap Sea Defences' was produced. This map supported the publication of the report on " An Assessment of Salinity in Land and Waterways on Areas Under the Influence of Rip-Rap Sea Defences". This assessment was conducted by the Soil and Land Use Survey Department of NARI in Collaboration with the Sea Defence Board of Guyana.

Project Title

Computerising of Soil and Land Use Survey Reports.

Objectives

(i) To have easy access to Information on Soil and Land Use.
(ii) To quickly produce tables and maps of interpreted information.
(iii) To improve the decision-making process.

Status

Eighty-seven out of 107 reports were typed, rechecked for errors and corrected. These reports will eventually be placed on NARI's web site.

Project Title

Collaboration with the Guyana Germany Natural Resource Management Project.

Objective

To produce a Regional Land Use Plan for a Pilot Area in Guyana.

Outputs

This activity had four main documented outputs.

These included:

- *"A Baseline Document for Regional Land Use Planning in Guyana"*. This document presents all social, economic and ecological information that is needed for the elaboration of a Land Use Plan.
- *"The Application of the Ecological-Economical Zoning (EEZ) Methodology and Land Use Planning (LUP) in Guyana"*. This document assessed the suitability of the EEZ methodology to LUP in Guyana. Further, it made recommendations on the nature of data sets and approaches that may be adapted from the EEZ approach.
- *" A Manual for LUP in Guyana"*. This document outlines the steps to be followed in elaborating a LUP. The lessons learnt during the preparation of the LUP are presented and recommendation made on suitable approaches in elaborating a LUP.
- *"A Land Use Plan for a Pilot Area in Guyana"*. This document examines several planning scenarios and presents Land Use options for natural resources in a Pilot Area comprising parts of Region 3, Region 7 and Region 10.

  All outputs of this project are in press. In the near future, copies of these reports will be placed in NARI's Library.

Project Title

Semi Detailed Soil and Land Use Survey of Canal #1 Polder, W.B.D.

Objectives

(i) To identify the different kinds of Soils and document the Land Uses in the Canals #1 Polder W.B.D.

(ii) To recommend the most appropriate agricultural land use and management systems for the area.

Status

The Canal #1 Polder is bordered on the East by the Demerara River, West by the Boerasirie Conservancy, North by La Grange and South by the Canal No.2 Polder. The soils cover approximately 5651.7ha and are generally of poor crop production potential. However, with proper drainage, irrigation, tillage and large quantities of limestone and complete fertilisers,

these soils could be brought into productive use. Owing to the high content of acid sulphate, Mara Clay and Stewartville Clay need special reclamation practices for leaching or neutralising them before they could be productive. Anira Peat, however, could only be used for the production of a limited number of crops even after exorbitant management costs.

Presently, frequent flooding keeps 70% of farmland areas out of regular cultivation. The crops cultivated include, rice, sugarcane, ground provision, fruits and vegetables. Backyard livestock is common and a few commercial livestock operations exist.

This report is in press at NARI's Communication Unit. Copies will be placed in NARI's Library subsequent to publication.

Project Title

An Assessment of Salinity in Land and Waterways in Areas Under the Influence of Rip-Rap Sea Defences.

Objectives:

(i) To determine land areas and waterways under the Influence of Rip-Rap Sea Defences in Region II, III, IV and VI.

(ii) To determine salinity levels in land areas under cultivation, drainage channels and irrigation canals influenced by the Rip-Rap Sea Defence Repairs.

Status

A map and report were prepared for presentation to the Sea Defence Board. The map showed areas under the influence of the Rip-Rap Sea Defence repairs. The report presented an assessment of the salinity levels in the land/land uses and waterways under the influence of the Rip-Rap Sea Defences. The report also made recommendations on sea defence management and methods of reduction of salinity in the affected soils.

SOIL MANAGEMENT

Project Title

Evaluating the efficacy of different strains of *Rhizobia* on nodulation of and nitrogen use by cowpea on
a clay soil.

Justification

Yields and quality of cowpea can be significantly increased if farmers use proper soil management techniques. Fertilizer – a soil management tool is seldom used in cowpea production and those areas where it is used it is used haphazardly. Nitrogen is one of the major nutrients used by the plant and supplied mainly through the use of commercial fertilizer. Legumes through a symbiotic relationship with the *Rhizobia* bacteria have the ability to transform atmospheric Nitrogen (N) to a form that can be used by the plant. The increase production of cowpea (bora and MINICA IV) on the coast, the need for good quality products on the local and export market along with the need for a lower cost of production of these crops, make it imperative to source a cheap and reliable fertilizer for their production. Inoculating the seeds with the *Rhizobia* bacteria can serve this purpose. In the soil are various strains of *Rhizobia* and even though their inoculating ability may be high, their ability to fix N may be poor. Hence the need to introduce a strain that has a high nodulating ability and a high N-fixing potential. This project, therefore, aims at examining four strains of *Rhizobia* and their effect on the growth of cowpea on a heavy clay soil.

Objective

To identify the most effective *Rhizobia* strains for cowpea production on the coastal clay soils of Guyana.

Methodology

The experiment was a completely randomised block design with four replicates. The treatments were the four rejuvenated strains (Tha 30, Tal 420, 086 and 072), the free living strains found in the field #19 of NARI, Mon Repos and Nitrogen (N) at the rate of 50 kg/ha.

Each plot was 3m by 4m and seeds inoculated and uninoculated were planted 8 cm within rows and 60 cm between rows. Destructive plant sampling was done at four, six, and eight weeks after planting (WAP) to determine nodule number and dry matter yield. Microscopic examination of the strain was done at each sampling. Appropriate pest management practices were adopted where and when necessary.

Results

The table below shows the nodulation and some yield parameters of cowpea as affected by the different strains of *Rhizobia*.

Table 29: The effects of different strains of Rhizobium on mean nodulation and yield parameters of cowpea, Mon Repos, 2002

Treatment	Plant Dry Matter Weight (g)	No of Nodules at 6 WAP	% Effective Nodules at 6WAP	Pod Length (cm)	# Pods/ Plant	# Seeds/ Pod	100 Seed Weight	Yield/ ha (kg)
Tal 420	13.65	23	90	43.0	15	9	17.6	1584
072	12.27	30	90	42.5	16	8	17.8	1519
086	9.97	19	91	43.8	15	9	16.9	1521
Tha 301	14.75	28	89	43.3	15	9	16.5	1485
Control	15.55	26	76	42.5	16	8	17.9	1527
Fertiliser N	9.67	21	73	44.6	17	9	17.0	1734

At six WAP the treatment with the Rhizobium strain 072 seemed to have the most nodules while strain 086 seemed to have the most effective nodules, however these characteristics did not translate to overall yields as these strains along with THA301 all yielded lower than the native strains existing in the soil. Tal 420 seemed to be the best of the four strains as its overall yield seemed to be higher than the control. These data confirm the results of previous work where Tal 420 always seemed to out yield the other strains and the control. This strain will now be compared with the other strains in storage.

In December 2002another experiment was set up comparing Tal 420 with three other strains.

SOIL CHEMISTRY RESEARCH

Project Title

A comparison of four extractants for the determination of available phosphorous (P) and uptake of (P) on three kinds of soils in Guyana based on growing corn (*Zea mays*) – Paper 2.

Objectives

1. To compare Olsen's Truog's, Bray's extractants, and the modified Olsen's method (Routine method) for (P) extraction of three kinds of soils in Guyana.
2. To determine the most appropriate extracting solutions(s) for Ebini sandy loam, Mara clay, and Litchfield clay.
3. To look at the correlation of available (P) by the different methods, plant uptake, and plant growth.

Phosphorus (P) has two essential roles in plants; structural components and in the energy relations of cells.

The National Agricultural Research Institute Soil Chemistry Laboratory has adopted the routine laboratory method for routine analysis of Guyana soils. This (standard) method of (P) extraction was compared with Olsen's, Truog's and Bray's extractants for available (P) on three of Guyana's soil (fertilized 880 kg/ha T.S.P. = 409.2 kg/ha P2O5 and unfertilised) with respect to growing corn (*Zea mays*).

The plants were grown for six weeks (4^{th} leaf stage), after which they were harvested, oven dried and dry weight taken.

The statistical design used was a Complete Ramdomized Design with three replicates.

RESULTS

Effects of soil type on plant dry matter

Plants grown on Ebini sandy loam showed significant difference in dry weight when compared to those grown in Litchfield clay. However, there was no significant difference in dry weight of plants grown on Ebini and those grown on Mara clay.

Plant grown on Litchfield clay had the highest dry matter yield (DM) while those grown on Ebini sandy loam had the lowest.

Plants grown on Ebini sandy loam displayed P deficiency symptoms. This was also the case of plants grown on Litchfield and Mara clay.

In all soil types, there were significant differences in DM of fertilized and unfertilised plants.

Effects of soil type on plant tissue P.

There were significant differences in P uptake between Ebini sandy loam and Litchfield clay and Ebini sandy loam and Mara clay. Furthermore, plants grown on Litchfield clay showed the highest plant tissue P and dry matter content. Significant differences existed in plant tissue P according to soil types (Table 30).

Table 30: The effect of added Phosphorous on plant dry weight and plant tissue Phosphorous.

Soil Type	Plant Dry Weight (g)		Plant Tissue Phosphorus (%)	
	Fertilized	Unfertilized	Fertilized	Unfertilized
1. Ebini	0.60	0.54	0.06	0.06
2. Litchfield	0.65	0.63	0.07	0.07
3. Mara	0.61	0.57	0.06	0.06

Effects of soil type and method of analysis on initial P

Based on the various methods used, significant differences existed in initial P in the various soil types. Ebini sandy loam recorded the highest % P when using the Bray's method. Litchfield clay recorded the highest % P when using the Troug's method but the lowest % P when using the Olsen's method. Troug's method showed the highest % P extraction followed by the routine method, then Olsen's method and finally Bray's method. The routine and Troug's methods were significantly different, while Olsen's and Bray's were not significantly different (Table 31).

Table 31: The quantity of available Phosphorous extracted by the four different method.

Method	Soil type/Available Initial P (ppm)			Soil type/Available Final P (Fertilized Soils) (ppm)			Soil type/Available Final P (Unfertilized Soils) (ppm)		
	1	2	3	1	2	3	1	2	3
Bray	2.57	0.15	0.11	1.63	1.34	0.8	0.45	0.25	0.08
Truog	5.27	40.63	14.67	5.0	14.53	7.23	4.47	13.93	8.0
Olsen	2.30	0.95	1.93	0.38	0.56	0.32	0.31	0.35	0.28
Routine	16.39	11.29	23.14	32.52	29.84	31.59	12.22	5.41	2.46

1 – Ebini loamy sand; 2 – Litchfield clay; 3 – Mara clay

Effects of soil type and method of analysis on final P

For the various soil types the following method(s) gave the highest extraction P:

a) **Fertilized soils:**

Ebini sandy loam (Routine + Truog's), Litchfield clay (Routine + Truog's), and Mara clay (Routine + Truog's)

b) **Unfertilized soils:**

Ebini sandy loam (Routine + Truog's), Litchfield clay (Truog's) and Mara clay (Truog's)

Recommendations

Truog's method should be recommended for P extraction in both fertilized and unfertilised soil types (Ebini sandy loam, Litchfield and Mara clay.

Routine method is recommended for P extraction in fertilized soil types. This method can also be used for P extraction in unfertilised Ebini sandy loam.

OTHER TRIALS IN PROGRESS, 2002

1. Characterising the physical and chemical properties of the soil of Guyana.
2. A project proposal for the revegetation of a mined out area in Linden

PROGRAMME: **AGRICULTURAL SERVICES**

Programme Leader: Dr. O. Homenauth

Project Officers: Ms. K. McAllister
Mr. E. Willabus
Mr. S. Rutherford
Ms. A. Peters
Ms. M. Lutchman
Ms. J. Garnett
Ms. I. Badal
Mr. R. Chan
Ms. N. Hutson

INTRODUCTION

The Agricultural Services Programme provided support to farmers, agencies in the agricultural sector and to NARI's research effort. The specific objectives were to provide these clients with the following services:

i) Soil, plant tissue, fertilizer and feed analyses
ii) Soil physical analyses
iii) Plant disease identification and management
iv) Insect identification and management
v) Production of acoushi ant bait
vi) Library and documentation
vii) Communication
viii) Information technology

Project Title

Routine chemical and mechanical analyses

Objective

To determine the chemical/physical status of soil, water and plant tissue in order to detect nutrient deficiencies for corrective measures.

Status

Chemical Analyses

Table 32 shows the types and number of samples analysed in 2002. The total number of samples analysed was 1073, of these, 707 were soil samples were soil samples, 331 tissue and 35 water.

Table 32: Status of chemical analyses of samples, Mon Repos 2002

Sample Type	Number of Samples Received	Number of Samples Processed
Soil	721	707
Tissue	331	331
Water	35	35
T o t a l	**1,081**	**1,073**

PLANT PATHOLOGY

1. Plant disease diagnostic and advisory service

Eighty-four samples were submitted and processed in the Plant Pathology Laboratory. These included soil samples which were tested for pathogens of quarantine importance. Most of the samples came from Region 4.

Table 33 shows the sample types and the number of each type processed.

Table 33: Plant disease samples (by type) processed during 2002

SAMPLE TYPE	NUMBER OF SAMPLES
Fruit and Orchard Crops	16
Vegetables	40
Root and Tubers	10
Field Legumes	02
Ornamentals	03
Weeds	02
Soil	10
Forest Species	01
TOTAL	**84**

Table 34 shows the pathogens isolated from the samples.

Table 34: Plant pathogens isolated from samples, Mon Repos 2002

PLANT TYPE	PATHOGEN ISOLATED
Tomato	Colletotrichum sp, Blossom End Rot, Viral infection, Bacterial wilt, Fusarium sp, Verticillium Wilt.
Broccoli	Negrospora sp.
Cocoa	Colletotrichum sp.
Celery	Cercospora leaf spot
Cowpea (Minica)	Bacterial Wilt
Watermelon	Colletotrichum sp., Choanophora rot
Pak choi	Black rot
Hot pepper	Viral infection, Bacterial Wilt, Southern Blight
Citrus	Colletotrichum sp., Greasy spot
Sweet pepper	Colletotrichum sp.
Avocado	Phytoptora sp.
Sour Sop	Greasy spot
Pineapple	Gummosis
Pepper (Seed)	Aspergillus sp.
Bora	Cercospora leaf spot
Poi	Bacterial Wilt

2. FIELD VISITS

Several visits were made to locations in Regions 1, 2, 3, 4, and 5. These visits were in response to request by farmers for diagnostic and advisory services for various crop types.

3. DISEASE MONITORING

Routine monitoring of crop material on and off station was conducted. This included plantain and banana plantlets in the Tissue Culture Laboratory, germplasm material in Field # 17, citrus mother plants in the Screen House and the Mon Repos, Kairuni and Timehri nurseries.

4. BIOASSAY STUDIES

Disease specimen were collected and ten important fungal pathogens have been isolated and multiplied for use in bioassays. The pathogens included isolates of Colletotrichum species, Fusarium species, Curvularia species, Botryiodiploida species and Cercospora species.

ENTOMOLOGY

Project Title

Diagnostic and advisory services

Objective

To diagnose insect problems experienced by farmers and researchers and advise on proper management strategies

Status

i) Insect Identification

During 2002, several samples were brought to the Entomology Laboratory for identification of insects and advice on their control.

Table 34 lists the samples submitted, the diagnoses made and the chemicals recommended.

Table 34: Samples processed in the Entomology Laboratory, Mon Repos, 2002.

CROP	DIAGNOSIS/ES	RECOMMENDATION/S
Bora	Aphids	Malathion, Admiral
Boulanger	Mealy bug, aphids, whiteflies, thrips, fleabeetles	Safer, Fastac, Vydate-L. Admiral
Citrus	Leafminer	Admire
Poi	Scale insects	Ground neem leaves or neem, seed extract
Tomato	Aphids, mealy bug	Fastac
Sweet pepper	Aphids, whiteflies	Safer
Hot pepper	Thrips	Vydate-L and Admiral
Watermelon	Thrips	Vydate-L and Admiral
Hibiscus	Pink mealy bug	Neem-X
Cherry	Mealy bug	Neem-X
Sour Sop	Mealy bug	Fastac

ii) Field Visits

During 2002, one field visit was organised by the Ministry of Agriculture. Staff of the Entomology laboratory visited several farms and "on the spot" diagnoses were done.

Project Title

Acoushi ant bait production

Objective

To produce an attractive and effective bait for the control of acoushi ant.

Status

During 2002, a total of 991 packets (200g each) was produced (Table 35)

Table 35: Production of acoushi and bait, Mon Repos, 2002

MONTH	QUANTITY PRODUCED (200g PACKETS)
March	248
April	743
T O T A L	**991**

Table 36 shows the distribution of bait for 2002. A total of 1,076 packets of bait was distributed

Table 36: Distribution of acoushi ant bait, 2002

LOCATION	QUANTITY (Packets)
Region 1	62
Region 4	279
Region 5	50
Region 7	40
Ebini, NARI	100
Horticulture, NARI	515
Ministry of Agriculture	30
T O T A L	**1,076**

Project Title

Maintenance of Insectarium

Objective

To upgrade the insect reference collection at NARI in order to improve local identification of insect pests and their natural enemies.

Status

During 2002, all specimen were placed in alphabetical order according to orders and families.

OTHER PROJECTS

1. Pest management in organic crop production

LIBRARY AND DOCUMENTATION CENTRE

Objective

To supply timely, and current information service to researchers and others in the agricultural sector.

Processing of Materials

- The physical layout of the library was rearranged to facilitate easy access for users and monitoring by library staff.
- Work continued on the Guyana Collection
- Cataloguing of backlog continued

- WINISIS system continued to be updated
- Re-checking all entries in the naril (monograph) database was started with just about 250 completed, at present the database has 9,292 monograph records
- Books received for this period totalled 102
- Journals and institutional publications totalled 416
- FAO documents received totalled 86

Reference and Information Dissemination

- Circulation of content pages could not be carried out due to lack of a photocopying system, due to this also the drafted SDI system drafted could not be implemented.
- No photocopies were done during this period.
- Persons made use of the CD-ROMS and the Internet for bibliographic searches.
- Book titles lists were done for the year.

Sharing resources with Agricultural Information Services/Systems

- A system to facilitate interlibrary loans was established with several local libraries including the Public Library and University of Guyana Library.
- Free publications from sister institutions were received (Guyana School of Agriculture)
- One box of materials was received from BookAid International (51 books and 4 journals)
- Ms. Eslyn Hardin and Mr. Walter Rodney of IICA spent three days at NARI's library being briefed on the basics of the AGRIS/CARIS categorization scheme

Training

Mr. Robert Harris (CESO Volunteer) visited for two weeks in 2001, The objective was to provide instruction on the library software (separate report filed).

COMMUNICATION UNIT

Objectives

i) To assist in the dissemination of information to the general public via electronic and printed media.

ii) To assist in the promotion of the programmes and activities of the Institute

Status

During 2002, the Communication Unit undertook a number of activities. These included the preparation and/participation in exhibitions, video recordings, printing, photography, press briefs and release of information via print and electronic media.

i) **Exhibitions**

The unit assisted in the preparation and participation at a number of exhibitions. The exhibitions in which NARI participated were:-

- Guyexpo 2002
- MFC&L and NGMC "Guyana Nights" in Berbice and Georgetown
- World Food Day Exhibition
- GINA Organic Agriculture Exhibition
- Ministry of Trade Organic Products Display
- Commemoration of the 50th Anniversary of Blairmont Village
- U.K/Caribbean Forum staged by the Ministry of Tourism

ii) Video Recordings

A video on budding and grafting was completed

Recordings were done of the digging of soil pots at Fort Wellington, Kairuni, Ruby and Parika.

Complete video coverage was provided to the programme "Educating the Community through Organic Agriculture", when the Hosororo/Mabaruma Cocoa Producers Association staged a two days sensitisation programme. Some of the material was used to prepare a video "Profile of a cocoa Farmer". This was presented to Mr. E. Glover, former British High Commissioner.

iii) Photography

A total of 96 digital and 346 still photographs was taken.

iv) Publications

The following publications were completed and printed:

SUBJECT	FORM OF AND NUMBER OF PUBLICATIONS
Cauliflower	450 brochures
Mushroom	350 leaflets and 10 booklets
Ochro	500 brochures
NARI	1,000 brochures
Duck Production	2,900 leaflets
Ornamentals	15 booklets
Phytopshore Blight Disease	300 leaflets, 75 booklets, 100 brochures
Caterpillar Moth Borer	300 brochures
Sheep Production Systems	100 booklets
Organic Agriculture	45 booklets

v) Tours

Thirteen school tours were conducted. The main areas of interest were Plant Pathology, budding and grafting and the forage germplasm collection.

OTHER ACTIVITIES IN 2002

1. Production of the radio programme "NARI in focus".
2. Completion of a draft of "Sheep rearing"
3. Several visits to the Essequibo Coast and Hogg Island where photographs and video recordings were made of a disease affecting vine crops.

INFORMATION TECHNOLOGY

Conversion of peer – to – peer network to client server network

Objective

To create a client – server network for use by NARI's staff, researchers and students

The seven computers that had already been networked using a peer-to-peer configuration were converted to a client server network with the acquisition of two additional computers, a server and a router. Along with these the department received one laserjet, three stablizers and three UPS.

Maintenance of NARI's computers and their peripherals

Objective
To ensure the availability of computers, their peripherals and any relevant software for use by the staff of NARI.

- All computers were continually updated with Norton Antivirus
- A number of computers received minor repairs
- Five monitors were sent for repairs
- One scanner was sent for repairs.

Maintenance of NARI's Website

Objective
To keep the general public, researchers and students abreast with the research work that has been and is being carried out by NARI and to educate then on the services offered to them.

- The website was last updated September 6th , 2002.

ORGANIC AGRICULTURE PROGRAMME

Programme Leader: Dr. O. Homenauth

Project Officers: Dr. P. Chesney
Ms. S. Pooran
Mr. E. Patram

INTRODUCTION

The general objective of the organic agriculture programme is to utilize the principles and practices of organic agriculture to produce selected agricultural commodities and promote organic agriculture as a viable alternative to high external input based conventional agriculture.

The specific objectives of the programme are:

- To develop feasible and sustainable organic agriculture techniques for the farming community.
- To demonstrate organic farming practices.
- To select crops with market potential for organic farm production
- To develop technical policy guidelines and training programmes for organic agriculture
- To develop a model organic farm.

Commodities targeted for organic production in 2002 were cocoa, pineapple and heart of palm. A demonstration farm for organic vegetable production was also initiated at Mon Repos.

Consultancy – Evaluation of potential for organic agriculture in Guyana.

A Consultant, Mr. John Myers, from the Soil Association Certification Limited, UK visited Guyana during the period February 11 – 15, 2002 to evaluate the potential for organic agriculture in Guyana.

The Terms of Reference for the Consultancy were as follows:

- To evaluate the existing proposals for the development of an organic agriculture programme for Guyana, taking into account crop variety, local conditions, agricultural practices and local processing and marketing practices.
- To examine potential sites for extensive organic farming in Guyana, the standards to be applied and practices used.
- To examine proposals for an acceptable national regulatory framework and its implementation, as well as, the maintenance of standard
- To identify or recommend possible government actions or initiatives which could contribute to a national policy fostering the growth of organic agriculture
- To consider certifying options
- To make recommendations

A summary of the recommendations as given is presented below:

1. Existing organic producers should be encouraged to expand and diversity, where appropriate.
2. A full survey of the organic production potential and infrastructure requirements should be made
3. The Guyana Office for Investment should conduct this survey in collaboration with NARI.
4. The number of overseas certifiers should be reduced

5. Group certification systems should be developed as a means of giving smallholder farmers access to the market.
6. Consideration should be given to the establishment of a local certification body. This should include consideration of a regional body
7. Local inspectors should be trained at the first stage of this programme.
8. NARI should be given the responsibility of drafting organic standards for Guyana and for setting up any local certification body
9. The Government of Guyana should fund the implementation of the recommendations of this report, either directly or indirectly.
10. The Government of Guyana should draft an organic regulation.

a) COCOA

A summary of the activities undertaken with reference to organic cocoa production in Region 1 is provided below:

- Of the 65 cocoa accessions morphologically characterized in 2001, 10 were identified to have good yield potential (dry bean weight$\geq$ 1.2g; pod index $\leq$ 21), 14 were of good flavour potential and four accessions combined both selection traits.
- Most of the improved germplasm imported from the International Cocoa Germplasm, Trinidad (ICG.T) in the 1950s were identified including, ICS 1, 8 39, 40, 46, 48, 84 and 95, IMC 57 and 67 and PA 121 and 125. A cocoa varietal pictorial guide of these and other varieties was prepared.
- On-farm cocoa disease survey identified seven pathogens of which the most important was *Phytophthora*, the causal agent of Black pod disease (BPD). Based on field data collected on 14 farms, the potential cocoa dry bean loss to BPD is 0.1 kg/tree/yr. No evidence of Witches' Broom Disease (WBD) was observed. Increasing incidence of WBD presents a serious and immediate threat to the global cocoa industry.
- Two cocoa demonstration plots were established on forested lands at NARI, Hosororo. One plot was fear-felled and planted with cocoa, permanent shade trees (cedar, *Gliricidia*, Immortelle) and temporary shade plants (Musa spp. *Manihot esculenta*). The other plot was selectively felled and planted to cocoa only.
- Over 18,000 cocoa seedlings were produced at the NARI Hosororo Plant Nursery. About 3,675 budded plants were distributed to 13 farmers. Additionally, shade plants propagated at the Nursery were distributed to farmers in the following numbers:
  - *Cedrela odorata* (cedar) 128
  - *Gliricidia sepiu* 140
  - *Erythrina poeppigiana* 188

- Collaboration with the Cocoa Research Unit (CRU) in Trinidad was maintained. The Head of CRU, Dr. David Butler met with the NARI's Director to review the progress of the collaboration based on an existing MOU. As part of this collaboration, two NARI technicians were trained in cocoa pathology at CRU. NARI successfully negotiated for the visit to the Project site of the CRU expert on post harvest technology.

b) PINEAPPLE

In association with Amazon Caribbean Guyana Limited (AMCAR), a project on the research and development of organic pineapple was initiated. One organic pineapple germplasm and demonstration plot was established at Mainstay, Region #2 in collaboration with AMCAR and Mainstay/Whyaka Village Council. At least 14 varietal accessions acquired from Amerindian communities was included in the collection.

c) HEART OF PALM

NARI was associated with the Project "Strengthening National Capacity for Income Generation and Poverty Eradication" by executing a Pilot Private/Public Partnership to establish at Heart of Palm Plantation in Region 1. This project, funded by the UNDP is being conducted in collaboration with the Ministry of Amerindian Affairs and AMCAR. NARI is responsible for developing the technology in the organic aspects of heart of palm cultivation, soil analysis to determine the suitability for heart of palm cultivation, and technology transfer.

d) ORGANIC DEMONSTRATION FARM

Attempts were made to establish an organic demonstration farm for vegetable production at Mon Repos. Commodities tested included bora, boulanger, leafy vegetables, cucumber, pumpkin, sweet potato, cassava, squash, ochro, corilla and peppers. Based on preliminary observations, several commodities have been identified for organic production in 2003.

PROGRAMME: INTERMEDIATE SAVANNAHS

Programme Leader: Dr. O. Homenauth

Project Officer: Mr. L. Chester

Germplasm

A germplasm plot continues to be maintained. In it are nine mung, four peanut, one pigeon pea, one soybean, three sorghum, one maize, fourteen cowpea and four rice accessions. The mango

collection needs to be pruned and a power saw is needed to accomplished that because the trees are very old.

All the rice accessions appear to be susceptible to blast disease.

Sheep and Goat

During the past year, production was severely hampered by the death of twenty animals. These animals died from various infections and attacks from wild animals. There were also severe cases of pink eye and respiratory infections, which were eventually controlled after treatment by a veterinary officer of the Ministry of Agriculture, during December.

Twenty weaner rams were transferred to the livestock farm at Mon Repos. As a sheep population continues to increase, there is a need to have the unused pens repaired to house the sheep. Mineral supply and the various animal health products continue to be essential for sheep production in the Intermediate Savannahs. Another ram is also needed to facilitate the three flocks having their own ram. This is also important in preventing the rams from serving their progeny. The sheep count at the end of the year was sixty-three adult females, two rams, seven weaner females, three weaner males, seven female lambs, eleven male lambs and two adult rams. There were also seven female and five male goats.

Orchard Crops

Orchard crops continue to be maintained and produced. Among those being maintained are rough lemon, guava, West Indian cherry, soursop, dwarf cashew and dwarf golden apple. Passion fruit vines started producing during the last two months of the year. Seven bags of passion fruit were delivered to the accounts department for sale. About quarter acre of sorrel yielded one bag of dried sorrel, which amounted to thirteen pounds. That was also delivered to the accounts department for sale. Approximately four thousand pineapple plants should start fruiting during the next year.

Seed/Grain Production

The production of Minica 4, California5, sorghum and maize were severely hampered by the late land preparation, which was due to the 4-wheel drive tractor being inoperable

The unit was still able to harvest enough to make four bags of Minica 4, two bags of maize and one bag of California 5 available to Goldfield Investments. Two bags of Minica 4 were also delivered to the accounts department of sale. Of the four additional bags of maize, which should have been collected by Goldfield Investments, two were used to plant during December and the

other two stored in an attempt to preserve then for the next season. Sorghum was mainly used as animal feed.

During the December season, one hectare maize and one and a half hectares sorghum were planted along with two hectares of Minica 4 and half a hectare of four peanut cultivars and pigeon pea.

TRAINING, OUTREACH AND TECHNOLOGY TRANSFER ACTIVITIES

Project Officers: All staff members

Training

1. *Training Course on Geographic information System (GIS), Mon Repos, October 27 – November 02, 2002.*
   This training course was conducted through a technical cooperation programme between Guyana and Colombia. It was conducted by two staff members of the Colombian Agency "Institute Geographiico Augustin Codazzi" (IGAC) and there were seven participants from various departments of NARI.

2. *Training of Library Staff, Mon Repos, November 18, 2002*
   This activity covered computer disaster recovery methods for WINISIS, training in CDS/ISIS and computer network management. The training was conducted by Mr, Robert Harris, Volunteer of the Canadian Executive Services Organisation (CESO).

3. *Diagnoses and Recommendation for vine Crop Farmers in Regions 2 and 3*
   The diagnoses of fungal problems affecting vine crops (mainly pumpkin) was completed. Training, technical assistance and the appropriate chemicals were provided to the farmers who were affected.

4. *Workshop on Identification of pests and disease of vegetables and other important agricultural crops, Mon Repos, June and September, 2002*
   Participants were agricultural science teachers from Regions 3 and 4. Sixty teachers participated.

5. *NARI in Focus*

This radio programme on the Voice of Guyana is an on-going activity. Relevant and timely information on both crops and livestock production was disseminated to the farming community on a weekly basis via radio.

6. *Weekly Newspaper Article*

A weekly feature was introduced in the print media. These articles are intended to provide relevant information, on all aspects of production of non-traditional crops and livestock.

7. *Farmers and Student Training*

The facilities of the Institute were utilised by both farmers and students as a means of information dissemination. Students from secondary schools were provided with various demonstration and practical sessions related to the CXC Syllabus.

8. *Exhibitions*

NARI participated in a number of exhibitions to highlight its activities. These included:

a) Guyexpo 2002
b) "Guyana Nights" at Berbice and Georgetown
c) World Food Day
d) GINA organic agriculture exhibition
e) Ministry of Trade Organic Products Display
f) Commemoration of the 50th Anniversary of Blairmont Village
g) U.K./Caribbean Forum staged by the Ministry of Tourism

9. *Seminars*

The seminar series which started in 2001, continued in 2002. Staff members presented seminars on topical issues as well as on completed research. Additionally, staff members presented seminars, which were organised by the Extension Services, at various locations.

10. *Donation of baby chicks to residents of Kato, Region 8*

Three hundred and fifty Creole baby chicks were donated by NARI to the residents of Kato in December 2002. The donation was in keeping with a commitment made by the Director, NARI on a visit to Kato in October 2002.

11. *Consultancy – Evaluation of Potential for Organic Agriculture in Guyana*

A consultant from the Soil Association Certification Limited, United Kingdom, visited Guyana during the period February 11-15, 2002, to evaluate the potential of organic agriculture in Guyana. The recommendations especially those related to organic policy and regulation, are currently being implemented.

12. *Technical Assistance, India Technical and Economic Cooperation (ITEC) Programme*

Under the ITEC Programme, NARI is benefiting from the services of Agricultural Economist, Dr. V.C. Mathur. He is attached to NARI as a Crop Planner. Dr. Mathur is involved in research on the domestic and export market potential of fruits and vegetables. He is examining production cycles, reviewing demand potential and cycles, and the export possibilities of various fruits and vegetables.

HUMAN RESOURCES REPORT

1. **RECRUITMENT OF STAFF**

a) **Administration**

1) Mr. Hardeo Sukhai	-	Chief Security Officer	02-12-03

b) **Senior Technical**

1) Mr. Rickford Adrian	-	Research Assistant	02-10-17
2) Mr. Elton Patram	-	Research Assistant	02-03-04

c) **Other Technical and Craft-skilled**

1) Mr. Roxanne Farias	-	Research Technician 1	02-05-02
2) Mr. Brian Siriram	-	Research Technician 1	02-10-14

d) **Semi-skilled Operatives and Unskilled**

1) Mr. Mohamed S. Ali	-	Mobile Equipment Op.	02-12-02
2) Mr. Pativan Livingston	-	General Worker	02-02-11
3) Mr. Ishwar Mukhram	-	General Worker	02-05-20
4) Mr. Charran Singh	-	-do-	02-03-11
5) Ms. Wendera McTurk	-	-do-	02-04-08
6) Mr. Mohamed Muntaz	-	-do-	02-05-13
7) Ms. Yvonne Rose Jacobs	-	-do-	02-05-20
8) Mr. Mohamed Ahmad Alli	-	-do-	02-06-10
9) Mr. Mohamed I. Hamid	-	-do-	02-09-02
10) Ms. Rena Rodrigues	-	-do-	02-09-05
11) Mr. Omar K. Ramlall	-	-do-	02-09-16

2. **PROMOTION**

Semi-skilled Operatives and Unskilled

1) Ms. Seetadai Singh	-	Laboratory Attendant	02-07-01
2) Ms. Lorraine Gordon	-	Laboratory Attendant	02-08-01

3. **RESIGNATION**

a) **Senior Technical**

1. Ms. Michelle Roberts	-	Research Assistant	02-11-16

b) **Other Technical and Craft-skilled**

1) Ms. Seamona Singh	-	Research Technician 1	02-09-16
2) Ms. Tanuja Persaud	-	Snr. Library Assistant	02-11-20

Semi-skilled Operatives and Unskilled

1) Mr. Prince Rodney	-	Handyman	02-10-01
2) Mr. Bhagwandin Shiram	-	Senior Security Guard	02-08-25
3) Mr. Rajenda Chand	-	General Worker	02-09-15
4) Ms. Wendera Mc Turk	-	General Worker	02-08-24

4. **TERMINATION OF CONTRACT**

a) **Senior Technical**

1) Mr. Anthony Ka-on Foo	-	Research Assistant	02-10-28

5. **TERMINATION OF SERVICE**

a) **Clerical and Office Support**

1) Ms. Padmoutie Ramnarine	-	Confidential Secretary	02-05-01

b) **Semi-skilled Operatives and Unskilled**

1) Ms. Latchmin Mohabir	-	Laboratory Attendant	02-06-01
2) Ms. Sarah Lewis	-	Nursery Person 1	02-03-15
3) Ms. Lucille John	-	Nursery Person 1	02-03-03

6. **DEATH**

a) **Clerical and Office Support**

1) Ms. Sharon Jones	-	Telephonist	02-10-06

b) **Semi-skilled Operatives and Unskilled**

1) Mr. Ramdeo Surujnarine	-	Heavy Duty Driver	02-11-08
2) Mr. Ramdhol Mangal	-	Nurseryman 1	02-09-11
3) Mr. Mohamed Muntaz	-	General Worker	02-05-25

7. **DISMISSAL**

a) Semi-skilled Operative and Unskilled

1)	Mr. Lakeram Khemraj	- Equipment Operator	02-02-13
2)	Ms. Carla Jones	- Nurseryman 1	02-02-28
3)	Ms. Santanu Ramjag	- General Worker	02-07-04
4)	Mr. Sarju Persaud Nakuldass	- General Worker	02-02-13
5)	Mr. Charran Singh	- General Worker	02-08-22
6)	Ms. Yvonne Rose Jacobs	- General Worker	02-07-15
7)	Mr. Charran Singh	- General Worker	02-09-16

TRAINING

A. OVERSEAS

Workshops/Meetings/Conferences/Study Tours/Seminars/ Short Courses

Workshops

1) Dr. O. Homenauth, Director, participated in a workshop on '**Status and Performance of Diversification Initiatives of Caribbean States**", held in Trinidad and Tobago from January 14 to 17, 2002.

2) Mr. Ramphal Mohabir, Snr. Research Technician, participated in a Workshop on the '**Identification and Management of Pests of Phytosanitary Significance for the Caribbean Sub-region'**, held in Trinidad from November 18-29, 2002.

3) Ms. Somwattie Pooran, Research Assistant, participated in a Training Workshop on the **'Identification of Scale Insects and their Natural Enemies'**, held in Trinidad from November 24 to December 04, 2002.

4) Dr. Patrick Chesney, Research Scientist, participated in a Workshop on '**The Adaptation of Organic Production among small farmers in Latin America: Opportunities and Challenges**' held in Rome from September 11-12, 2002.

5) Ms. Juneann Garnett, Research Assistant, participated in a Training Course/ Workshop on **'Electronic Production of Documentation and Management of Agricultural Bibliographic Databases'**, held in Jamaica from May 20-23, 2002.

Conferences

1. Dr. Patrick Chesney, Research Scientist, participated in the **Caribbean Organic Conference** held in London, England on March 21, 2002.

Short Courses

1. Mr. Chetram Kissoonchand, Research Assistant, participated in a Training Course on the '**Control of Crop Disease and Pests**', held in China from May 10 to July 09, 2002.

2. Mr. Ramphal Mohabir, Senior Research Technician, participated in a Training Programme on '**Agronomic Practices in vegetables and Cassava Production and Systematic Approaches in Acoushi Ant Control'**, held in Brazil from September 16-28, 2002.

3. Mr. Juan Solomon, Research Assistant, participated in a Training Programme by the China TCDC International Training Class **on 'Animal Husbandry Production and Management**', held in China from September 16 to October 30, 2002.

Study Tours

1. Dr. O. Homenauth, Director, participated in a study tour of the **International Centre for Tropical Agriculture (CIAT),** Colombia from November 18 to 25, 2002.

2. Mr. R. N. Cumberbatch, Senior Research Scientist, participated in a study tour of the **International Centre for Tropical Agriculture (CIAT**), Colombia from November 18 to 25, 2002

B. **LOCAL**

Workshops

The under-mentioned staff members participated in a workshop on "Basic Level – Food and Nutrition and Home Management, held at the Institute's Conference Facility from May 06 to June 28 2002.

a)	Ms. Audrey Dennis	-	Caretaker
b)	Ms. Paulette Beveney	-	Office Attendant
c)	Ms. Leila Chintaman	-	Personal Assistant
d)	Ms. Patricia Durant	-	Sanitation Worker
e)	Ms. Basmat Ramdhani	-	Sanitation Worker
f)	Ms. Deomattie Sukhnandan	-	Sanitation Worker
g)	Ms. Brenda McGarrell	-	General Worker
h)	Ms. Sybil King	-	General Worker
i)	Ms. Sheila Kellman	-	Laboratory Attendant

2.1.1 Short Courses

1. Ms. Gaitri Nanku, Research Assistant, participated in the '**Guyana Integrated National Resources Information Systems** (GINRIS)' level 2 Training Course, held at the NRMP/GINRIS Centre on February 13-14 and 19 2002.

2. The under-mentioned persons participated in a Training Course on '**Agro-ecological Practices for the Control of Acoushi Ants'**, held at the Agricultural In-service Training and Communication Center (AITCC), from August 06 to 09, 2002.

    i) Ms. Aretha Peters, Research Assistant
    ii) Mr. Ramphal Mohabir, Senior Research Technician

3. Ms. Juneann Garnett, Research Assistant, participated in a Training Programme on '**Fundamentals of Information and Library Studies'**, held at the Guyana Library Association, from August 20 to November 02, 2002.

4. Ms. Gaitri Nanku, Research Assistant, participated in a Training Programme on '**Land use Planning'**, held at the NRMP Center from November 04 to 23, 2002.

STAFFING

Table 37 shows the total number of staff members of the Institute in 2002. Sixty-one percent of the total number of positions were filled compared to 63 percent in 2001. The largest decrease was in the semi-skilled and unskilled category. There was a small decrease in the clerical and office support category. The Senior Technical and other technical and Craft Skilled categories both increased and the administration category remained the same as 2001.

Table 37: Staffing at NARI, 2002

Categories	No. of Positions	Positions filled	Positions vacant
Administration	17	12	5
Senior Technical	50	29	21
Other Technical and Craft skilled	70	40	30
Clerical and Office Support	36	17	19
Semi-skilled Operatives and unskilled	304	195	109
TOTAL	**477**	**293**	**184**

Table 38: Staffing in the Administration Category NARI, 2002

Category	Authorized Positions	Positions filled	Vacant Posts
Director	1	1	0
Head-of-Unit	3	2	1
Administrative Manager	1	1	0
Principal Finance Officer	1	1	0
Internal Auditor	1	0	1
Personnel & Industrial Relations Officer	1	1	0
Library/Documantalist	1	0	1
Assistant Librarian	1	0	1
Senior Personnel Assistant	1	1	0
Chief Accountant	1	0	1
Superintendent, General Services	1	1	0
Administrative Assistant	1	1	0
Chief Security Officer	1	1	0
Supervisor, General Services	1	1	0
Deputy Chief Security Officer	1	1	0
TOTAL	**17**	**12**	**5**

Table 39: Staffing in the Senior Technical Category, NARI 2002

Category	Authorized Positions	Positions Filled	Vacant Posts
Senior Research Scientists	8	1	7
Research Scientists	20	13	7
Senior Research Assistants	4	0	4
Research Assistants	18	16	2
TOTAL	**50**	**30**	**20**

Table 40: Staffing in the clerical and Office Support Category, NARI, 2002

Category	Authorized Positions	Positions Filled	Vacant Posts
Confidential Secretary	1	1	0
Registry Supervisor	1	1	0
Personnel Assistant	1	0	1
Secretary	4	1	3
Typist/Clerk 1/11	5	4	1
General Clerk	3	2	1
Assistant Accountant	1	1	0
Assistant Accountant (Audit)	1	0	1
Accounts Clerk 111	1	0	1
Accounts Clerk 11	4	2	2
Records Clerk	2	1	1
Audit Clerk	1	0	1
Cartographic Trainee	1	0	1
Expediter 1/11	1	1	0
Telephonist 1/11	1	0	1
Office Attendant	5	2	3
Stores Clerk	1	1	0
Inventory Clerk	2	0	2
TOTAL	**36**	**17**	**19**

Table 41: Staffing in the Other Technical and Craft Skilled Category, NARI 2002

Category	Authorized Positions	Positions Filled	Vacant Posts
Senior Research Technician	5	2	3
Research Technician 11	11	9	2
Research Technician 1	22	11	11
Senior Field Assistant	1	0	1
Farm Manager	1	1	0
Plant Nursery Supervisor	1	0	1
Livestock Farm Supervisor	1	1	0
Senior Electrician	1	0	1
Mechanical Supervisor	1	1	0
Senior Mechanic	1	1	0
Senior Mechanic/Operator	1	1	0
Senior Storekeeper	2	1	1
Auto Electrician	1	0	1
Carpenter	4	1	3
Electrician	2	2	0
Mechanic	2	1	1
Plumber	2	1	1
Senior Library Assistant	1	0	1
Library Assistant	1	1	0
Mechanic Trainee	1	0	1
Senior Welder	1	0	1
Welder	1	1	0
Senior Carpenter	1	0	1
Senior Plumber	1	1	0
Assistant Plumber	1	0	1
Storekeeper	3	1	2
TOTAL	**70**	**37**	**33**

Positions Created
Other Technical and Craft Skilled

	Position Filled
Communication Officer	1
Communication Information Specialist	1
Information Technology Technician	1

Table 42: Staffing in the semi-skilled and unskilled Category, NARI, 2002

Category	Authorized Positions	Positions Filled	Vacant Posts
Security Guards	49	39	10
Nurseryman 1	15	8	7
Nurseryman 11	10	4	6
Crop Attendant	4	1	3
Plant Operator	2	0	2
Equipment Operator	7	5	2
Mobile Equipment Operator	9	5	4
Toolroom Attendant	1	0	1
Stores Attendant	2	0	2
Heavy Duty Driver	4	3	1
Heavy Duty Mobile Equipment Operator	1	1	0
Driver/Mechanic	3	0	3
Drivers	6	3	3
Sanitation Workers	8	6	2
Personal Assistant	1	1	0
Senior Field Foreman	4	0	4
Senior Nursery Foreman	1	1	0
Senior Stock Foreman	1	1	0
Field Foreman	5	1	4
Nursery Foreman	5	2	3
Foreman	2	1	1
Stock Foreman	1	0	1
Assistant Foreman	3	2	1
Assistant Nursery Foreman	3	2	1
Laboratory Assistant	4	1	3
Laboratory Attendant	9	7	2
Senior Livestock Attendant	1	0	1
Caretaker	2	2	0
Livestock Attendant	4	2	2
Handyman	2	1	1
Porter	2	1	1
Library Attendant	1	0	1
Security Supervisor	3	3	0
Senior Guard	5	3	2
General Worker	120	89	31
Watchman	4	0	4
TOTAL	**304**	**195**	**109**

FINANCIAL REPORT

CAPITAL PROGRAMME 2002

The Institute's capital programme for the year 2002 consisted of two activities presented below.

ACTIVITIES	COST ($)
1. Rehabilitation of Well at Mon Repos	7,393,300
2. Promoting organic agriculture including certification	1,000,000
T O T A L	**8,393,300**

STATEMENT OF INCOME AND EXPENDITURE

FOR PERIOD JANUARY TO DECEMBER 2002

INCOME	**$**
Government Contribution (Current)	188,638,162
Government Contribution (Capital)	8,754,400
Contribution From other Agencies	7,668,998
Sale of Livestock Produce	4,330,529
Sale of Plants	5,759,516
Sale of Papaw	130,947
Sale of Ant Bait	74,550
Sale of Vegetables & Seeds	303,830
Sale of Orchard Produce	71,163
Miscellaneous Revenue	1,209,480
TOTAL CASH INFLOWS	**216,941,575**

EXPENDITURE	**$**		
Wages and Salaries	117,136,519		
Employment Overhead Cost	45,603,792		
		162,740,311	
PROGRAMMES			
Agricultural Services	4,054,449		
Fruits, Perennial Crops and Plant Nursery	8,952,934		
Root, Tuber and Other Food Crops	489,065		
Soils and the Environment	699,663		
Vegetable Crops	813,385		
Livestock and Pasture Development	6,769,617		
Ebini Savannahs	6,504,773		
Administrative Expenses	31,922,278		
		60,206,164	
TOTAL EXPENDITURE			222,946,475
Excess of Expenditure over Income			6,004,900