A.3931

✓ 13/5/96

BCCCA

THE BISCUIT, CAKE, CHOCOLATE & CONFECTIONERY ALLIANCE

To: Members of the Cocoa Research Sub-Committee

From: E.T. Beauchamp

12th February 1996

Prospecting in Guyana

At last week's meeting I mentioned that a full report from Dr. Mark Johnston (University of the West of England) was expected on the visits to Guyana made by his team last year. This has now been received and I am circulating it herewith for information.

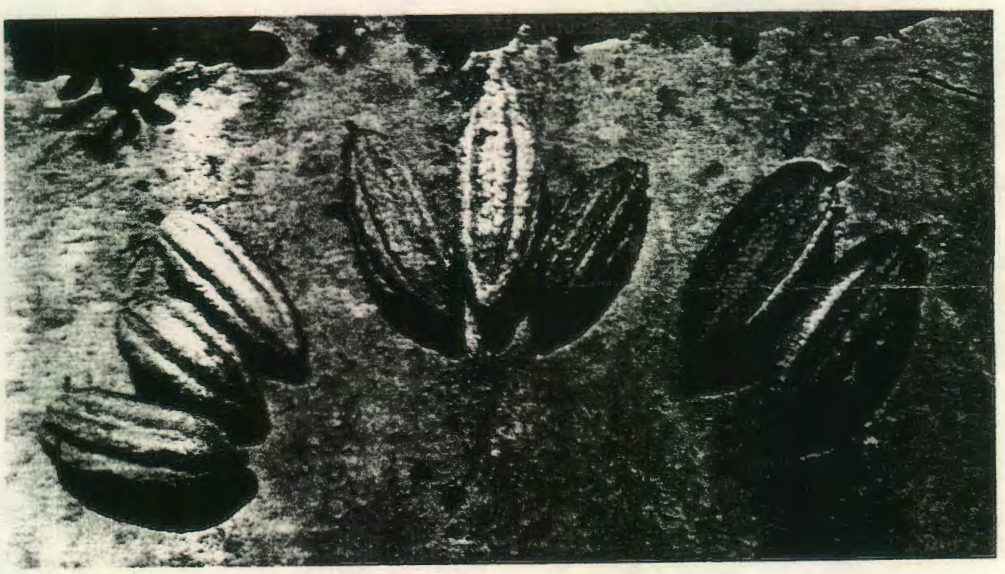
E T Beauchamp

37-41 BEDFORD ROW LONDON WC1R 4JH
TELEPHONE: 0171-404 9111
FAX: 0171-404 9110 email: bccca@cix.compulink.co.uk

University of the West of England

BRISTOL

Guyana Cocoa Diversity Project



January 1996

Front cover: Three cocoa *Theobroma cocoa* varieties found at the IICA cocoa germplasm bank, Timehri, Guyana (M. Johnston)

Phase I Feasibility Report & Phase II Research Proposal

Guyana Cocoa Diversity Project

Clare Watkins
Owen Knowles
Dr Mark Johnston

The Biscuit, Cake, Chocolate and Confectionery Alliance
The British Ecological Society
Co-Channel Electronics Ltd
University of the West of England, Bristol

Abstract

Cocoa *Theobroma cacao* L. is of immense economic importance, hence the conservation of the genetic diversity of cocoa is of paramount importance. During studies undertaken from July to October 1995, preliminary assessments were made on the current distribution and abundance of cocoa in Guyana, South America. The objective of this phase I study was to assess the feasibility of further studies into the genetic variation of cocoa, with the possible establishment of a cocoa germplasm bank.

These studies identified at least 23 localities where cocoa is currently growing, this includes wild populations, old Dutch plantations, an abandoned commercial plantation in the Hosororo Hills, and scattered cultivated cocoa along the coast of Guyana. Four of these localities were visited where detailed descritptions were taken and cocoa descriptors measured. A brief description of the remaining sites is given.

All current production of cocoa is on a small-scale farming basis, with cocoa occasionally being sold in local markets. An important re-documentation was the IICA cocoa germplasm bank at Timehri. A total of 41 trees were tagged and measured at Timehri, where at least four different cocoa varieties were identified in relation to mature and immature pod colour, pod texture, and stamen and sepal anthocyanin intensity.

One of the old Dutch plantations, Primo's Inlet, was visited and detailed studies undertaken. A total of 347 trees were measured, described and tagged. Trees at this locality were all of one variety, thought to be *Amelonado*, and appear to corrospond with one of the varieties held at Timehri. A small cultivated cocoa population at Kurupukari also on the Essequibo was studied. Wild cocoa was documented from southern localities of Guyana in the Upper Essequibo and Rupununi river systems, where at least 10 localities have been identified.

From these studies it would appear that Guyanese cocoa represents an important source of genetic material, and further detailed investigations would be advantageous. It is proposed that a phase II project should involve the systematic collection of plant material from all cocoa localities. Genetic fingerprinting analysis may then be undertaken on the material collected. In collaboration with University of Reading, specialist training may then be provided to a Guyanese for the invested interest in cocoa genetic diversity.

Acknowledgements

We are indebted to Dr. L. Chandrapal of the Office of the President for providing us with permission to undertake these studies in Guyana. We also wish to thank the Ministry of Home Affairs for permission to visit the interior.

The project would not have been possible without financial assistance from the Biscuit, Cake, Chocolate and Confectionery Alliance (Eric Beauchamp), the British Ecological Society, and Co-Channel Electronics Ltd. Administrative support was provided by the Faculty of Applied Sciences, University of the West of England.

We are very grateful for technical assistance from Dr. Paul Hadley (University of Reading) Dr. Tony .Lass (Cadbury Ltd) and Dr. Michelle End (University of Reading). Also Dr. David Cowell (Bristol Biotechnology Centre) for assistance with the phase II proposal.

We would also like to thank all those who gave us their valuable time in discussing the development of this project in Guyana; Mrs. Ford (NARI), Dr. Henry Tschinkel (IIRP), Dr. Kenneth Hall (CARICOM), Dr. Crawford (IICA), Dr. Ramdass and Head of Agriculture (University of Guyana), Mr. Ford (Horticulture Research Station, Timehri) and the Chief Agricultural Officer (Ministry of Agriculture).

Local Guyanese contacts were essential in assisting us focus our research activities, notably Mr. & Mrs. E Hopkinson. Lastly we would like to thank all those who made our project a success, notably the Amerindians at Kurupukari, Annai and Apoteri for their invaluable knowledge of the interior, Preshad as an inspiring source of friendliness, and Wayne Adonis for his admired assistance and persistence throughout.

Thank you.

Table of Contents

Further details

Further details regarding any aspect of the Guyana Cocoa Diversity Project are available from:

Dr. Mark Johnston
Faculty of Applied Sciences
University of the West of England (UWE)
Coldharbour Lane, Bristol
BS16 1QY
Tel: 0117 9656261 xt 2486
FAX: 0117 9763871
e-mail: m-johnst@uwe.ac.uk

Section 1

Phase I Feasibility Report

1.1. Introduction

Cocoa (*Theobroma cacao* L.) is of immense economic value with current world production at 2,443 thousand metric tonnes (Anon. 1994), at a value of US$1428 per tonne. However, one of the main restrictions on the production of cocoa is the high frequency and low resistance to numerous fungal pathogens, including *Crinipellis perniciosa*, the causal agent of 'Witch's Broom' (Anon. 1993).

The establishment of cocoa germplasm banks for the conservation of genetic variation of cocoa is essential (Soria 1975; Allen & Lass 1983; Allen 1987; Warren 1994). Concern for the collection of genetic material has been focused on the largely neglected areas of north South America (Thorold 1994). Moreover, the recent discovery of a cocoa genotype reportedly resistant to *Crinipellis perniciosa* in the state of Baha, Brazil (New Scientist March 1995) has highlighted the importance of research and conservation of the genetic diversity of cocoa in the region.

Cocoa *Theobroma cacao* is known to originate from eastern equatorial regions of the Andes (Cheesman 1944). However, since the cultivation of cocoa, predominantly within Central America more than 2,000 years ago, its distribution is now widespread and it is apparent that confusion often occurs between wild and cultivated stocks of Cocoa (Myers 1930). The spread of cocoa within the Guiana region (Guyana, Surinam and French Guiana) was predominantly due to cultivation by the Dutch over 200 years ago.

The objectives of this feasibility study were:

- Discuss the project development proposals with Guyanese authorities in order to maximize the projects efficiency and effectiveness.
- Undertake preliminary surveys of key localities to obtain further information on the distribution and abundance of *Theobroma cacao*.
- Propose the development of a phase II study to involve detailed analytical investigations into the genetic diversity in Guyanese cocoa.

1.2. Cocoa in Guyana

Information on the history of cocoa in Guyana, as well as the present status, has been very poorly documented. Only a few key text refer to Guyanese cocoa, and records kept by the Guyana National Archives are limited.

1.2.1. History of Cocoa in Guyana

It would seem likely that a majority, if not all, of the cocoa currently grown in Guyana originated from two localities. Both localities are thought to be old Dutch plantations established in the early 1700's, namely at Primo's Inlet on the Essequibo River and Coomacka Creek on the Berbice River (see section 1.4).

Cocoa from Coomacka Creek was taken to the Hosororo Hills in 1929 for the establishment of a commercial plantation. Trees from here were then thought to have serviced the establishment of cocoa farming along the coast of Guyana. These coastal farms may then have been the source of cocoa found even further into the interior, such as the one isolated patch of cocoa at Kurupukari (see section 1.4.2).

Wild cocoa is reported to occur along the river tributaries in southern Guyana, and was first collected and described by Schomburgk in the late 19th Century (in Myers 1930).

Previously known distribution of Guyana cocoa.

- Black Creek, Upper Essequibo (Ogilvie in Myers 1930; wild stock)
- Primo's Inlet, Upper Essequibo (Melville in Myers 1930; wild stock?)
- Kurupukari, Essequibo (Johnston pers. obs; cultivated by Amerindians)
- Rewa Creek, Rupununi River (Ogilvie: In Myers 1930; wild stock)
- Quitaro Creek: Rupununi River (Schomburgk in Myers 1930; wild stock)
- Kuyuwini River, Essequibo (Ogilvie in Myers 1930; wild stock)
- Coomacka, Berbice River (Harrison 1913; Dutch cultivated plantations)
- Hosororo Hills, NW. (Dash 1929; commercial plantations)

* not to be confused with Kumaka (same pronunciation) on the Essequibo River.

1.2.2. Current status

There is no current or intended future interest in the commercialization of the cocoa industry in Guyana. The priority of the Government of Guyana lies with key economic crops such as rice and sugar. The current use of cocoa in Guyana is restricted to individual farmers manufacturing and selling cocoa on a highly localized scale. However, cocoa remains relatively wide-spread with scattered populations along the coast of Guyana, notably on West Bank Demerara, the Courantyne, and banks of the Essequibo. It would seem apparent that there is sufficient cocoa material in Guyana to re-establish cocoa as a commercial crop if the government identified this as a possible investment. In the meantime the documentation and conservation of cocoa in Guyana would prove to be most worthwhile.

1.3. Distribution of Cocoa in Guyana

The localities listed here may only, of course, represent a small proportion of the actual distribution of cocoa in Guyana. However, we are certain that the main populations have now been located. Only those localities where two or more independent sources of information are listed.

Several other species of tree are locally named 'cocoa', but are not *Theobroma cacao*. For example *Pachira aquatica* (Bombacaceae) is called 'cocoa' by Arawak Amerindians at Kurupukari, which produces similar shape pods to *T. cacao*.

Map 1. Map of Guyana illustrating the 21 cocoa localities identified during the study. Exact locality information is given in table 1, with brief description of each locality outlined in section 1.4.

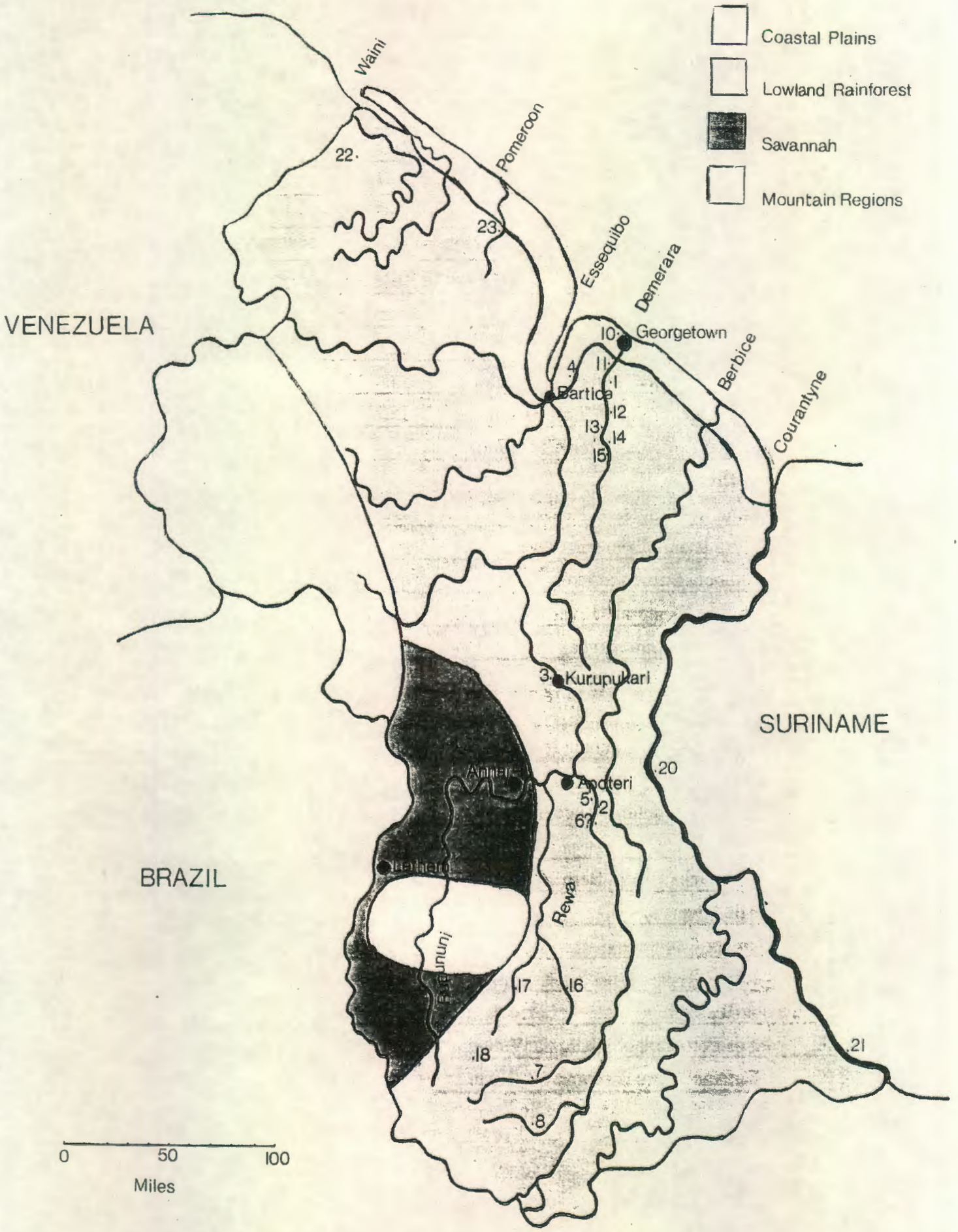


Table 1 Identified localities of cocoa divided by the six river systems or districts with source of information and GPS readings. *The exact locality of these areas are unknown, descriptions are provided in the literature (Myers 1930), but they cannot be found on available maps or of knowledge to local Amerindians. GPS readings given in parenthesis are *approximations only* and given as a guideline for locating the river system involved. See individual locality descriptions for further details.

Key	Locality	Source of information	GPS Reading
Georgetown			
1	IICA Germplasm Bank	Obs	06°30.46'N; 58°16.15'W
Essequibo River			
2	Primo's Inlet, Essequibo River	Obs	03°53.26'N; 58°22.57'W
3	Kurupukari, Essequibo River	Obs	04°39.01'N; 58°41.13'W
4	Bonasika River, Lower Essequibo	Pers. com.	(06°37.40'N; 58°31.00'W)
5	Kumaka, Essequibo	Pers. com	03°53.38'N; 58°22.59'W
6	Black Creek, Essequibo	Lit.	Unknown*
7	Kuyuwini Creek, Upper Essequibo	Lit.	(02°15.5'N; 58°55.0'W)
8	Kassikaityu River, Upper Essequibo	Lit.	(01°45.5'N; 58°50.0'W)
9	Shewdikar Creek, Upper Essequibo	Lit.	Unknown*
Demerara River			
10	Canal 1, West Bank Demerara	Obs	06°44.46'N; 58°12.6'W
11	Third Island, Demerara River	Pers. com.	06°34.21'N; 58°17.2'W
12	Dunoon, Demerara River	Pers. com.	06°25.8'N; 58°20.98'W
13	Leydon, Demerara River	Pers. com.	06°20.87'N; 58°20.97'W
14	Dora, Demerara River	Pers. com.	06°18.03'N; 58°16.00'W
15	Blenheim, Demerara river	Pers. com.	06°11.10'N' 58°21.20'W
Rupununi River			
16	Rewa Creek, Rupununi River	Lit.	(03°08.50'N; 58°38.00'W)
17	Quitaro Creek, Rupununi River	Lit.	(03°08.50'N; 58°57.00'W)
18	Marudi Mountain, Parabara	Pers. com.	(02°14.50'N; 59°12.40'W)
Berbice River			
19	Coomacka Creek, Berbice River	Lit.	Unknown*
Courantyne River			
20	Lower Courantyne	Pers. com.	Guyana/Suriname border
21	Kutari River, Upper Courantyne	Lit.	(02°05.50'N; 56°48.00'N)
Pomeroon District			
22	Hosororo Hills, Mabaruma, Wanaina	Lit; pers. com.	08°11.80'N; 59°49.50'W
23	Dutchman Creek, Pomeroon River	Pers. com.	(07°20.00'N; 58°39.20'W)

1.4. Brief description of cocoa localities

Over the duration of the study period four locations were visited within Guyana. The remaining localities are known from personal communications and available literature.

1.4 1. IICA Timehri cocoa germplasm bank (locality 1)

The cocoa found at Timehri was located in the Agriculture Research station, East Bank Demerara. The purpose of the germplasm was to provide information to farmers on the cultivation of cocoa as a commercial crop. This was not followed up and the information held on the cocoa trees at Timehri no longer exists.

A total of 41 trees occur at Timehri IICA germplasm bank. Local sources informed us that the germplasm was established in the early 1960's. However, it is evident that the trees at Timehri are in the order of at least 60-70 years old. This may suggest that the trees could have originated from the old Dutch plantation at Coomacka on the Berbice, as trees from Coomacka were collected in the early to mid-1920's. However, this is purely speculative as no documentation occurs on the cocoa origins at Timehri. Four trees were in the lower tree girth size classes (<25cm gbh), and this may be consistent with the notion that trees were propogated in the early 1960's, as well as trees being in the bank before this date.

Of the 41 cocoa trees at Timehri, 28 were described (see section 1.5.2). These were all located in a plot which was intersected by drainage ditches. The ground was swampy and vegetated. The station is currently used for the cultivation of citrus fruits, coffee, rice and bananas. Research into the cultivation of cocoa is no longer carried out.

1.4.2. Primo's Inlet (locality 2)

Primo's Inlet is on the East bank of the Upper Essequibo. The Inlet is approximately one kilometre long and 200 metres wide. The nearest settlement to Primo's inlet is the Amerindian settlement of Apoteri which is approximately 35 kilometres down stream. The cocoa found in Primo's Inlet was restricted to approximately 1km^2. This could be attributable to the fact that the cocoa area is bordered on one side by the river and on the other three sides it is bordered by swampy areas with thick understorey growth.

This site has been described as a wild population (Myers 1932). However, small pieces of clay plots were observed, and an Amerindians at Apoteri believed the site to be an old Dutch plantation dating back to the 18th Century. There is, however, no documented evidence to compound this fact. A total of 347 trees were described at Primo's Inlet.

The area around Primo's Inlet has been used for bleeding Balata *Manilkara bidentata* (Sapotaceae) rubber tapping in the past. This is no longer carried out as there is no longer a rubber industry in Guyana, although seeds of the crabwood are still collected by the Amerindians as they use the nuts to produce medicinal oils. Collection of cocoa has also been undertaken at Primo's by the Amerindians of Apoteri. This is then used for the small scale production of cocoa tea. Little human activity occurs at Primo's Inlet due to the isolation of this site.

The locality included many large trees and as well as self-seeded saplings. The habitat type is typical low-diversity forest, with canopy up to 30m. The cocoa trees were scattered in a forest dominated by canopy trees of Mora *Mora excelsa*, Wallaba *Eperua* sp., and Crabwood *Carapa guianensis*.

1.4.3. Kurupukari (locality 3)

Kurupukari is an Amerindian village on the West bank of the Essequibo River 90 miles South from Georgetown. Kurupukari is a small settlement with approximately 70 villagers. The original village was located on the east bank of the Essequibo, however, in the 1920's the villages moved to the west bank of the river. All the cocoa described at Kurupukari were found in the village and the trees were within 20 metres of the river. The prevalent habitat type found in the village of Kurupukari is forest garden (an area immediately surrounding a village used to cultivate commonly used food and medicinal plants). Most of the trees found within the village are used by the Amerindians. Amongst the cocoa other fruit trees were recognised, such as oranges, limes, coconuts, mangoes, star fruit, pawpaw, bananas and soursop. There was little ground vegetation as this is cleared to discourage mosquitoes in the village. Thirteen trees were described at Kurupukari.

Cocoa at Kurupukari is thought to originate from trees taken from the Demerara River during the 1920/30's (Alicott *pers. comm.*), this would be consistent with size of the trees at Kurupukari compared to those at Timehri (Figure 1).

1.4.4. Canal 1, West Bank Demerara (locality 10)

Canal 1 is situated on the East bank of the Demerara River. Canal 1 is a residential area with small farms situated on both sides. This area is also used for the commercial cultivation of sugar cane. Cocoa has been grown on farms in Guyana for many years for the production of cocoa tea, which is produced and consumed locally. One farm was visited in this area. The farm itself is a narrow strip of land which is no more than 20 metres wide and several kilometres long. This particular farm was overgrown and contained tropical fruit trees, such as oranges, limes, bananas, and plantain. The farm boundaries were small drainage canals. Farms like this are typically found throughout the coastal regions of Guyana, and collectively may represent a significant proportion of the cocoa currently grown.

Other localities

The remaining known localities of cocoa (identified in table 1), can be divided with respect to the main river systems involved.

1.4.5. Essequibo River system

Bonasika River, Lower Essequibo (locality 4): Small scale farming of cocoa, probably similar to that at Canal 1. Cocoa produced for local consumption and sold in local markets at Parika.

Kumaka, Essequibo (locality 5): Located approximately 2 miles north (downstream) of Primo's Inlet. Local Ameridians are aware of cocoa growing here but only in small numbers. It is likely that the cocoa at this locality is from the same origin as the Primo's Inlet cocoa.

Black Creek, Essequibo River (locality 6): Situated south of Primo's Inlet along the Essequibo River, although the exact locality is unknown and undocumented. First described by Myers (1930) as an old Dutch plantation with cocoa being 'plentiful'.

Kuvuwini (Kuduwini) Creek, Essequibo River (locality 7): Described by Myers (1930), situated on the border between the Essequibo and the Rupununi which runs from the Essequibo south west to the Brazilian border. This may be linked to the cocoa reported from the Marundi Mountains (locality 18).

Kassikaitvu (Dewar Wow) Creek, Upper Essequibo (locality 8): Similar to Kuyuwini Creek, situated in the upper Essequibo. Myers (1930) only briefly described these last three localities, with cocoa being 'plentiful'.

Shewdikar Creek, Upper Essequibo (locality 9): Mentioned by Myers (1930), but the exact locality is unknown.

1.4.6. Demerara River system

Third Island, Demerara River (11): Likely reminance of old Dutch cocoa grown about 200 year ago, with few isolated trees (*pers. comm.*).

Scattered along the Demerara River are a variety of localities where cocoa is known to have been grown on a relatively localized scale. These are probably similar to the cocoa grown at Canal 1. Known localities include Dunoon (12), Leydon (13), Dora (14), and Blenheim (15). The cocoa at these localities are thought to have originated from the Hosororo Hill plantation (locality 22).

1.4.7. Rupununi River system

Rewa Creek, Rupununi River (16): Myers (1930) described the occurrence of wild cocoa on the Rewa and the Quitaro Creek (17), although Amerindians at the village of Rewa were not aware of any growing in the region (*pers. comm.*). However, Schomburgk (in Dash 1929) also referred to wild cocoa occurring near the Quitaro, with "..large melon shaped fruits bearing up to 60-70 seeds per pod with trees attaining a height of 50 feet,...making the most delicious cup of cocoa I ever tasted."

Marudi Mountains (18): Local Amerindians refer to cocoa growing at this locality (*pers. comm.*).

1.4.8. Berbice River system

Coomacka Creek, Berbice River (19): An old Dutch plantation thought to have been planted in early 1700's. Cocoa trees were first described by Harrison (in 1913, Director of Agriculture). The plantation is described with trees growing up to 70 feet in height, and 30-40 inches in girth (in Dash 1929). In a 1917 Department of Agriculture report, the plantation is described to consist of about 200 trees in approximately 1.67 acres. Harrison (1913) first described the cocoa at Coomacka as

being of one type, the Golden Caracas. However, this is later disputed by Dash (1929) and Myers (1930), who describe a mixture of two types, *Criollo* (referred to Pod A) and *Forastero* (Pod B). Witch's Broom is noted to be wide spread throughout the Coomacka plantation.

1.4.9. Courantyne River system

Lower Courantyne River (20): Similar to the Demerara, cocoa is grown by local farmers and occasionally sold in markets.

Kutari River, Upper Courantyne (21): Situated at the source of the Courantyne. The only reference to this locality is an observation made by Myers (1930).

1.4.10. Pomeroon district

Hosororo Hills, Mabaruma, Wanaina River (22): A plantation established in 1929 from cocoa seeds taken from Coomacka Creek (22 of pod A and 15 of pod B), and is the most well-known of the cocoa growing area in Guyana. The plantation was established with the objective of commercial growing of cocoa. By 1938 it was still noted that Witch's Broom had not yet been recorded in the plantation (Anon. 1938).

Dutchman Creek, Pomeroon River (23): Similar to other cocoa farms, cocoa is grown on a small scale and sold in local markets at Charity.

1.5. Detailed description of cocoa localities

1.5.1. Study method

At each of the four localities, individual trees were measured (girth at breast height, gbh) and the cocoa descriptions taken (see list in section 4.1). The descriptors used were selected for ease, given constraint on equipment availability and expertise.

In addition to the descriptors, brief notes were taken on the occurrence of pests and diseases. The occurrence of the following were noted: capsid attack on cocoa pod (presence/absence), thrips (presence/absence), ant damage (expressed as the percentage of leaves removed by leaf-cutter ants), mealy bugs (presence/absence), witch's broom (presence/absence of the broom), and 'black pod disease' (presence/absence or % of fruits infected). Regarding black pod disease, it should be

noted that this is used in non-specific terms, in that the causal agent of the black rotten pod could not be determined in the field.

1.5.2. Comparisons in cocoa descriptors

Locality 1: IICA germplasm bank, Timehri

Of the 41 trees, we have attempted to recognise different cocoa types primarily based on the anthocyanin intensity in the immature and mature pods, followed by the stamen anthocyanin intensity, peduncle anthocyanin intensity and pod texture. These are only preliminary and subjective assessments of the possible genotypes represented in the Timehri collection. An outline of the general characteristic of the different types are presented in table 2 & 4, for details on individual tree descriptions see appendix 4.3. All trees at Timehri have now been tagged, and genetic analysis may be undertaken as part of phase II of the project (section 2).

	Pod colour (immature)	**Pod colour (mature)**	**Pod texture**
Type I	green	yellow	smooth (Ia) or warty (Ib)
Type II	green/yellow	dark orange	smooth (small pods)
Type III	dark red	red/orange	warty

Table 2. General characteristics represented in the cocoa at Timehri germplasm bank. See descriptions below for details.

Type I: Immature green pod, turning to yellow at maturity. A distinction is made between those producing smooth pods (type Ia, with small & rounded pods) and warty pods (type Ib, larger and elongated pods). See table 4 for descriptor means.

Tree numbers: 2(Ia), 8(Ia), 10, 11, 12, 13, 14, 15, 33, 34, 39,

Leaves: No leaf flush on three of the five trees, the remaining two with anthocyanin intensity of 2 and 5. Leaf length varied from 30 to 41cm, and width 9.6 to 14.8.

Flowers: Three type I trees in flower (tree no: 2, 8 & 33). Bud anthocyanin intensity was moderate to high (4 to 7), and peduncle anthocyanin high (6-7)

in all three flowering trees in the abscission zone, but absent (0) in two of the trees in the basal zone (type Ia). Anthocyanin in the sepals was absent, while the anthocyanin in the stamens was high in all three trees (7).

Pods & seeds: Only two mature pods found (tree no. 2 & 8). Pod length was 20 and 21cm, width 8.5 and 10.5cm, and weight 500 and 650g respectively. The pods contained 34 and 46 seeds. Seeds in the larger pod weighed slightly less, with six seeds weighing 35 and 34g. Seed colour was light (3) to dark purple (5). Anthocyanin was absent in both immature and mature pods.

Type II: green immature pods turning dark orange at maturity, pods small, rounded and intermediate between smooth and warty.

Tree numbers: 3, 9, 27, 38

Leaves: Leaf flush absent except in one tree where intermediate intensity (5) was recorded. Leaves slightly smaller than type I, ranging in length from 27 to 34cm, and width from 10.5 to 12.0cm.

Flowers: Three trees in flower. Bud anthocyanin was intermediate (3 to 5), as was peduncle anthocyanin (4 to 5) and sepal anthocyanin (3 to 5). Stamen anthocyanin remained high in all three trees (7).

Pods & seeds: Only one tree bearing mature pods. Similar pod size to type Ia, with length 21.5cm, width 10.5cm, but slightly heavier at 775g. A total of 45, dark purple seeds in the pod, with six seeds weighing a total of 40g.

Type III: Dark red immature pod turning a slightly lighter red (sometimes orange in pod furrow) in mature pods. Pods warty. These can be divided further into type IIIa and type IIIb with respect to the anthocyanin intensity in the stamens and sepals (high and absent respectively).

Tree numbers: 1(IIIa), 4(IIIa), 5(IIIa), 6(no flower), 7(IIIa), 16(nr), 17(nr), 18(nr), 19(nr), 20(nr), 21(nr), 22(IIIb), 23(IIIb), 24(no flower), 25(IIIb), 26(IIIb), 28(no flower), 36(no flower), 37 (IIIa), 41(IIIa).
nr - cocoa descriptor not recorded, only pod colour.

Leaves: Leaf flush was variable from absent (0) to high (6). Type IIIa generally appeared to exhibit a higher leaf flush than type IIIb trees. Leaf length ranged from 23 to 41cm and width 9 to 14cm.

Flowers: No distinction in bud anthocyanin between type IIIa and IIIb could be made, although intensity ranges from 3 to 7. Peduncle anthocyanin intensity was generally higher in type IIIb (in abscission zone intensity 7; intensity 3 to 7 in basal zone) than type IIIa (abscission zone intensity 3 to 5; basal intensity 0 to 5). However, sepal anthocyanin intensity in type IIIb was slightly lower than IIIa (intensity of 2 to 3 compared to 3 to 5). These generalizations are, however, complicated further by the fact that in two type IIIa trees anthocyanin in the sepals was absent. This may be interpreted as sub-types of IIIa (IIIai and IIIaii, see table 3).

Anthocyanin in the stamens was absent in type IIIb, but high in IIIa.

Pods & seeds: Mature pods ranged in length from 16 to 26cm, width from 9 to 15cm and weight from 400 to 925g. The number of seeds per pod ranged from 32 to 48, and the weight of six seeds ranged from 14 to 44g. All seeds were dark purple, except for two trees (no. 4 and 24) which were mottled (6) purple and white. Only one type IIIb mature pod showed no anthocyanin in the pod (yellow when mature), but still had the dark red warty pods when immature, otherwise similar pod and seed characteristics to type IIIa.

Type	**IIIa**	**IIIa**	**IIIb**
sub-type	**i**	**ii**	
stamen anthocyanin intensity	high (7)	high (7)	absent (0)
sepal anthocyanin intensity	absent (0)	low (2-3)	intermediate (3-4)
tree number	37, 41		

Table 3. Classification of type III cocoa trees at Timehri, based on the intensity of the stamen anthocyanin and sepal anthocyanin.

Unknown types

The following trees could not be classified into types due to the absence of pods or flowers: 29, 30, 31, 32, 35, 40.

Table 4. Summary of cocoa description from Timehri IICA Germplasm Bank in accordance with the different types discussed in the text.

		Tree girth (cm)	Leaf flush	Leaf length (cm)	Leaf width (cm)	Imm. Fruit Furrow Anth. intensity	Imm. Fruit Ridge Anth. intensity
Type I	**Mean**	31.9	1.2	34.4	12.4	0	0
	n	11	11	11	11	5	5
	SE	3.4	0.5	1.5	1.8	0	0
Type II	**Mean**	43.2	1	31.8	11.4	4.50	5.0
	n	4	4	4	4	4	4
	SE	9.0	0.9	1.4	0.3	0.25	1.2
Type III	**Mean**	49.2	2.6	36.2	12.9	6.85	7
	n	14	14	14	14	14	14
	SE	4.9	0.6	1.4	0.5	0.09	0

		Mature Fruit Length (cm)	Mature Fruit Width (cm)	Mature Fruit Weight (g)	MatureFruit Furrow Antho. intensity	Mature Fruit Ridge Antho. intensity	Pod wall thickness (cm)
Type I	**Mean**	20.5	9.5	575	0	0	20
	n	2	2	2	2	2	2
	SE	0.3	0.7	53	0	0	3.5
Type II	**Mean**	21.5	10.5	775	3	5	24.0
	n	1	1	1	1	1	1
	SE	0	0	0	0	0	0
Type III	**Mean**	22.1	11.2	644.1	3.4	4.8	19.5
	n	7	7	7	7	7	7
	SE	1.1	0.8	67.8	0.8	0.9	2.1

		Seed Number	Seed colour	Pulp colour	Seed fresh weight (of 6 seeds, g)
Type I	**Mean**	40	4	2	34.5
	n	2	2	2	2
	SE	4.2	0.7	0	0.35
Type II	**Mean**	45	5	2	40
	n	1	1	1	1
	SE	0	0	0	0
Type III	**Mean**	41.1	5.3	1.6	30.0
	n	7	7	7	7
	SE	1.7	0.2	0.3	3.8

		Bud Antho. intensity	Peduncle length (mm)	Peduncle Abc. Antho. intensity	Peduncle Basal Antho. intensity	Sepal Antho. intensity	Sepal length (mm)	Sepal width (mm)	Stamen Antho. intensity
Type I	**Mean**	3.7	16.5	5.8	3.5	0.5	5.8	3.6	7
	n	7	6	4	4	4	4	4	4
	SE	2.1	2.3	0.8	1.8	0.4	0.8	2.7	0
Type II	**Mean**	3.7	21	4.7	1.7	3.3	9.7	2.1	7
	n	3	3	3	3	3	3	3	3
	SE	0.5	3.6	0.3	2.4	0.5	2.7	0.3	0
Type III	**Mean**	3.9	18.7	5.3	3.6	2.5	6.6	4.1	4
	n	11	10	10	10	10	10	10	10
	SE	0.5	1.8	0.5	0.8	0.4	1.1	0.9	1.0

		Ants (% of leaves eaten)
Type I	**Mean**	5.1
	n	11
	SE	0.7
Type II	**Mean**	3.3
	n	4
	SE	1.3
Type III	**Mean**	4.5
	n	14
	SE	0.8

	No. of trees	Capsids	Black pod	Thrips	Mealy bugs
Type I	11	1	7	none	1
Type II	4	none	2	none	none
Type III	14	none	12	none	2

Locality 2: Primo's Inlet, Essequibo

A total of 347 trees were recorded from Primo's Inlet, of these 93 were saplings (less than 15cm gbh). The size-distribution (Figure 1) was relatively even, with the majority of trees between 10 and 45cm gbh. A mean height of 11.6m was recorded for four trees (Table 5). A total of 85 trees were found bearing fruit, but only seven trees with mature fruit were recorded. This was partly due to the quick removal of near-mature fruits by primates, notably Black Spider Monkey *Ateles paniscus*. No trees were found bearing flowers. The cocoa descriptors given here indicate that all the trees at Primo's were the same variety, thought to be *Amelonado*. These tree varieties at Primo's were not typically represented in the Timehri bank, although Type I cocoa at Timehri did appear similar to the Primo's cocoa. Obviously further studies are required to illucidate these difference.

Leaves: Leaf flush was variable, and difficult to measure, but was generally low (mean of 2.9 when 0 flush was excluded). The mean leaf length was 35.8cm and width 12.0cm.

Pods & seeds: All pods were small, round and green when immature then turning yellow at maturity. Mean mature pods length was 21.6cm (n=7), width 15.4cm, and pod weight 442.8 (+/- 38.0). The mean number of seeds per pod was 47.1, and the mean weight of six seeds 9.0g. Seed colour was consistently mottled purple and white.

Pests & Diseases: Leaf damage caused by leaf-cutter ants was relatively high, with the mean leaf loss at 8.67% the only other recorded pest problem was black pod, which was seen to infect 70 trees.

Locality 3: Kurupukari, Essequibo

A total of 13 trees were recorded from the area immediately surrounding the village, of these, five were in flower, three in fruit, and three cocoa saplings (less than 15cm gbh). The size distribution (Figure 1) of fertile trees indicate two size classes, those greater than 40cm gbh and those 15 to 30cm gbh, although it would appear that all trees at Kurupukari were the same variety. These tree varieties at Kurupukari were similar to Type I cocoa at Timehri, although morphological differences were noted.

Leaves: Leaf flush was high in three of the trees (5), but low to intermediate in the remaining trees (0 to 3).

Flowers: Bud anthocyanin intensity ranged from 0 to 7 (mean of 2.4), sepal anthocyanin was low at 0 to 2 (mean of 0.75), and peduncle anthocyanin in basal and abscission zone was low (0 to 2; mean of 2.2. and 1.2 respect.) in all except one tree with intense anthocyanin intensity (6 & 7). Stamen anthocyanin intensity was also consistently high at 6/7 (mean of 6.75).

Pods & seeds: No mature pods were found. The largest immature pod was green, 17.2cm in length, 12cm in width and weighing 725g, and contained 38 purple seeds. Anthocyanin intensity was absent in both ridges and furrow in all pods.

Pests & Diseases: Black pod infected a mean of 5% of the fruit bearing trees. Ants, capsid damage to the pods and mealy bugs were all present.

Locality 9: Canal 1, West Bank Demerara

A total of five mature trees were recorded with no natural regeneration, and were similar in size to those trees held at Timehri (Figure 1). Three fruiting trees all bearing immature pods. No trees were found with flowers. These tree varieties were consistent with **type III** identified in the Timehri bank (Table 7).

Leaves: Leaf flush was absent in all trees. All five trees appeared to be the same variety.

Pods & seeds: Anthocyanin intensity in the pods was high in two trees (5 to 7) in both furrows and ridges, and absent in the other (0). No mature pods were found.

Pests & Diseases: The percentage of leaves eaten was relatively consistent, with a mean of 3.8% of the leaves eaten. The only other problem being black pod disease which infected four of the five trees.

Table 5. Summary of cocoa description from Kurupukari (see section 4.3 for raw data)

	Tree girth (cm)	Leaf flush	Leaf length (cm)	Leaf width (cm)	Leaf L:W ratio	Imm. Fruit Furrow Anth. intensity	Imm. Fruit Ridge Anth. intensity
Mean	28.9	2.2	34.2	13.3	2.6	0	0
n	13	13	13	13	13	3	3
SD	26.3	1.8	5.6	5.6	0.3	0	0
SE	7.3	0.5	1.6	1.6	0.08	0	0

	Bud Antho. intensity	Peduncle length (mm)	Peduncle Abc. Antho. intensity	Peduncle Basal Antho. intensity	Sepal Antho. intensity	Sepal length (mm)	Sepal width (mm)	Stamen Antho. intensity
Mean	2.4	16.8	2.2	1.2	0.75	7.25	1.75	6.75
n	5	5	5	5	4	4	4	4
SD	2.5	2.6	2.5	2.4	0.8	0.8	0.25	0.4
SE	1.1	1.2	1.1	1.1	0.4	0.4	0.12	0.2

	Black Pod (% of fruits infected)
Mean	5
n	3
SD	0
SE	0

	Capsids	Ants	Thrips	Mealy bugs
Number of trees infected	1	4	none	1

Table 6. Summary of cocoa description from Primo's Inlet (see section 4.3 for raw data).

	Tree girth (cm)	Tree height (m)	Leaf flush (incl. 0)	Leaf flush (excl. 0)	Leaf length (cm)	Leaf width (cm)	Leaf L:W ratio
Mean	25.3	11.6	0.6	2.9	35.8	12.0	3.0
n	347	4	347	72	347	347	347
SD	13.3	7.0	1.2	0.6	5.1	1.6	0.6
SE	0.7	3.5	0.06	0.07	0.3	0.09	0.03

	Imm. Fruit Furrow Anth. intensity	Imm. Fruit Ridge Anth. intensity	Mature Fruit Length (cm)	Mature Fruit Width (cm)	Mature Fruit Weight (g)	Mature Fruit Furrow Antho. intensity	Mature Fruit Ridge Antho. intensity	Pod wall thickness (mm)
Mean	0	0	21.6	15.4	442.8	0	0	18.3
n	55	54	7	7	7	7	7	7
SD	0	0	1.8	4.4	100.6	0	0	6.5
SE	0	0	0.7	1.6	38.0	0	0	2.5

	Seed number	Seed Fresh Weight (g)	Pulp colour	Seed colour	Seed shape	Seed length (cm)	Seed width (cm)	Seed thickness (cm)
Mean	47.1	9.0	1.8	6	2.8	3.1	2.2	0.8
n	7	7	7	7	7	7	7	7
SD	5.6	2.3	0.6	0	0.3	0.3	0.7	0.1
SE	2.1	0.9	0.2	0	0.1	0.1	0.3	0.05

Table 6. continued/...

	Ant damage (% of leaves eaten)
Mean	8.67
n	347
SD	9.9
SE	0.5

	Capsids	Black Pod	Thrips	Mealy bugs
Number of trees infected	none	70	none	none

Table 7. Summary of cocoa description from Canal 1 (see appendix 4.3 for raw data).

	Tree girth (cm)	Leaf flush	Leaf length (cm)	Leaf width (cm)	Leaf L:W ratio	Imm. Fruit Furrow Anth. intensity	Imm. Fruit Ridge Anth. intensity
Mean	31.6	0	40.6	17.4	2.5	4.6	4.0
n	5	5	5	5	5	3	3
SD	4.8	0	4.7	6.6	0.6	3.3	2.9
SE	2.1	0	2.1	2.9	0.3	1.9	1.7

	Ant Damage (% leaf eaten)
Mean	3.8
n	5
SD	1.3
SE	0.6

	Capsids	Black pod	Thrips	Mealy bugs
Number of trees infected	none	4	none	none

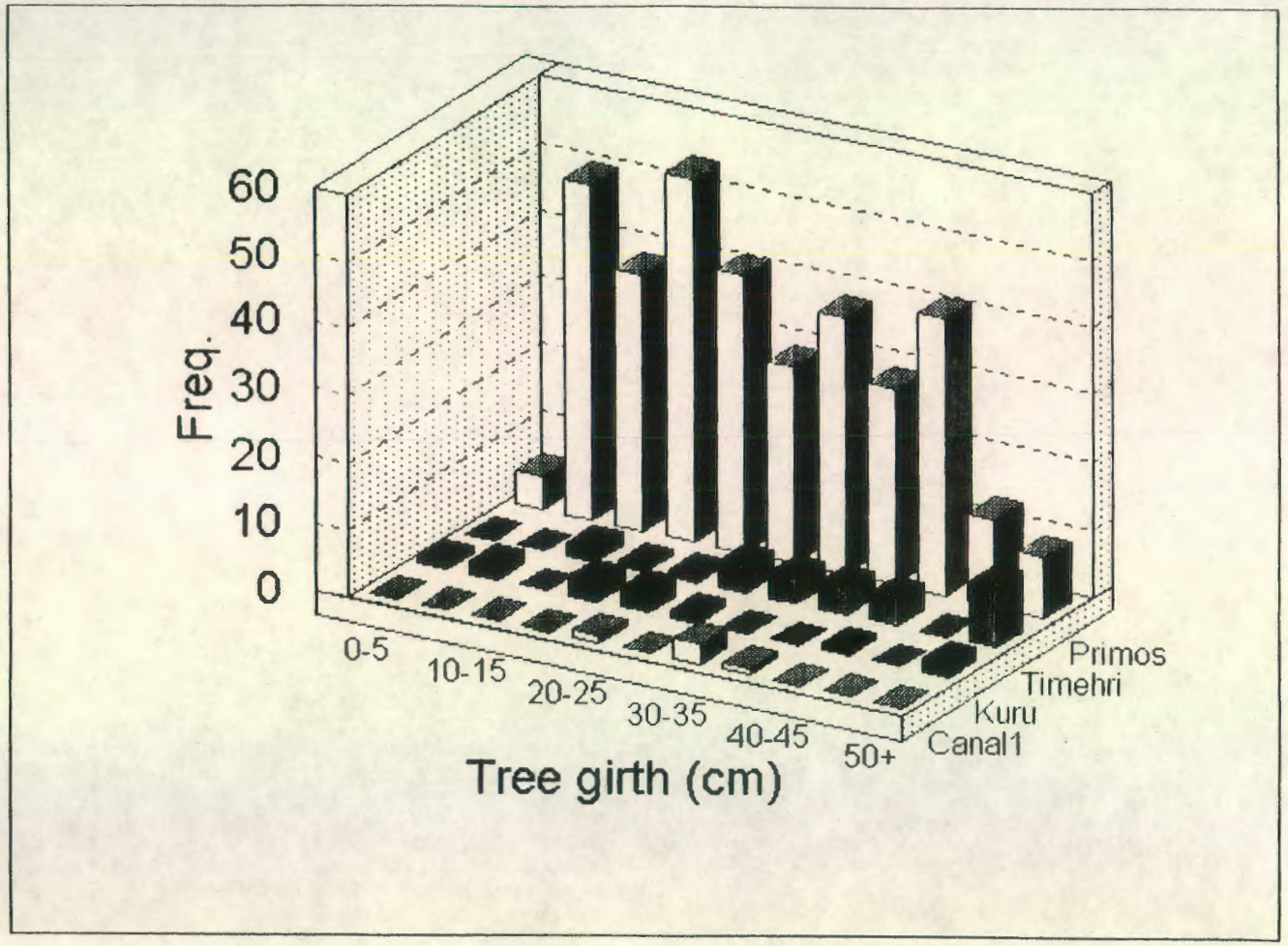


Figure 1. Comparisons in the tree girth (cm) distribution at intervals of 5cm gbh between the four sampled localities. See text for further details.

1.6. Institutional framework

The main institution responsible for research into crop production, and therefore germplasm research, is the National Agricultural Research Institute (NARI) established in 1984. NARI is governed by the Agricultural Research Committee. NARI is responsible for the management and running of the propagation unit at Timehri; where the IICA cocoa germplasm bank is housed.

NARI comprises of three units;

1. Mon Repos Field Research Unit (MRFRU)
2. Coastal Plains Field Research Unit (CPFRU
3. The Intermediate Savannahs Field Research Unit (ISFRU)

NARI currently undertakes research into the genetic varieties of several different agricultural crops, including rice, root and tuber crops, vegetable crops, grains, orchard crops and research activities covering biological pest control and microbiological techniques. NARI holds the only laboratory in Guyana with plant tissue culture facilities.

1.7. Summary

Phase I of the Guyana Cocoa Diversity Project acted as an important initial step in the documentation and conservation of cocoa, and the findings from these studies can be summarised thus:

- A total of 23 different cocoa localities were identified; one locality represented an abandoned commercial plantation, two old Dutch plantations, ten wild cocoa localities and the remaining ten site as small-scale farms.

- Guyanese cocoa is thought to have originated from the old abandoned Dutch plantations at Coomacka Creek, Berbice River, and possibly Primo's Inlet, Essequibo River.

- Cocoa from Coomacka was taken to the Hosororo Hills in the 1920's to establish a commercial plantation. Trees from this plantation were then scattered across the coastal plains for small-scale cocoa production, where cocoa still remains. Cocoa at Hosororo is known to have originated from two varieties.

- The IICA Cocoa germplasm bank at Timehri was re-documented, and found to contain 41 trees covering a possibility of 4 or more different cocoa varieties. The origin of these trees, and history of the germplasm bank, is unknown.

- The different varieties at Timehri can been classified in accordance with the pod colour, pod texture, stamen anthocyanin intensity and sepal anthocyanin intensity.

- The different types identified at Timehri are summarized thus;

  Type I Green immature pods turning yellow at maturity
  a. pods smooth
  b. pods warty

  Type II Green immature pods turning dark orange at maturity, pods rough

  Type III Red immature pods turning lighter red on ridges and orange in furrows, pods warty.
  a. stamen and sepal anthocyanin intensity high
  b. stamen and sepal anthocyanin intensity absent

- At the old Dutch plantation at Primo's Inlet a total of 347 trees were measured, all the trees were of one variety, thought to be Amelonado, similar to type Ia.

- At Kurupukari, a small Amerindian village on the Essequibo river, a total of 13 trees were measured. Trees here were similar to type I, although morphological differences were noted.

- While cocoa may not presently be of commercial interest, sufficient material does exist in Guyana if the government identified cocoa as possible future investment.

- The objective of this study was to assess the feasibility of further research into the cocoa of Guyana. It is now clear that further more detailed genetic studies are required. Guyana houses a significant quantity of cocoa which may be of high interest in the conservation and documentation of the genetic diversity of cocoa.

Section 2

Guyana Cocoa Diversity Project

Phase II Research Proposal

On the basis of the information obtained from the feasibility study, and available literature on Guyana Cocoa, the development of the next phase is proposed. The objectives of phase II can be summarized as follows;

- to undertake systematic collection of cocoa plant material from all localities identified in the phase I of the project.
- to investigate the variation on the genetic diversity of cocoa within each of these localities using fingerprinting techniques.
- provide training to a Guyanese counterpart in plant genetic diversity studies, including the collection of material in Guyana and the genetic analysis of the material in the UK.
- to assist in the re-establishment of the cocoa germplasm bank currently housed at the Horticultural Station, Timehri.

2.1. Justifications

The importance of the conservation of genetic diversity of agricultural crops is now internationally recognized, for instance as emphasized by the Biodiversity Convention (1992). The importance of the documentation and conservation of Cocoa *Theobroma cacao* is also well recognized (Allen 1987; Bartley 1994; Bekele 1993; Bekele *et al* 1994; Thorold 1994).

In Guyana, evidence from the feasibility study (section 1) clearly shows a relatively wide distribution and abundance of cocoa. Most of the cocoa would seem to originate from the old-Dutch plantations in the south of Guyana. However, other cocoa varieties which are absent in the Dutch plantations, are present certainly elsewhere in Guyana. These cocoa localities represent an important source of genetic material of cocoa varieties. The development of a well co-ordinated Guyana cocoa research project would be an invaluable contribution to the long-term conservation of this diversity.

The documentation of the genetic diversity of Guyanese cocoa, and the possible re-establishment of the germplasm bank, would be important for two reasons;

1. to act as an important source of genetic material for any possible future agricultural develops in Guyana.

2. to provide material to international cocoa breeders.

The importance of a germplasm bank would be significantly increased if genetic resistance to Witchs' Broom was discovered.

2.2. Project recommendations

Part 1. (July to December 1996) Extensive field sampling for the collection of cocoa material from those localities identified in phase I (Table 1). Two 3-month collection sessions are advised. The first collection concentrating on the localities within the Upper Essequibo and Rupununi river system, and the second collection in the remaining localities.

Part 2. (January to March 1997) Genetic fingering-printing analysis of cocoa plant material using micro-satellite technology at the University of Reading. Recommend a period of 3 months, allowing the training of the Guyanese graduate and analysis of the cocoa material.

As a central component of Phase II, a Guyanese graduate will be invited to become actively involved in all aspects of the studies. This would include training in the collection and collation of cocoa material in Guyana (part 1), assistance with the re-establishment of the cocoa germplasm bank at Timehri, and the training of genetic fingering printing techniques at the University of Reading, UK (part 2). The graduate would be fully endorsed by the project (see supplement section 2.4).

2.3 Requests from Guyanese Authorities

Permission to undertake phase II from the Office of the President and the National Agricultural Research Institute. Permission to export cocoa specimens from Guyana in order to undertake genetic fingerprinting studies at the University of Reading.

Negotiations with NARI and Ministry of Agriculture regarding the appointment of the Guyanese graduate. Discussions will also be required with the British High Commission in order to obtain visas for the student to research in the UK.

I recommend a 2-3 week reconnaissance to Guyana in April 1996 in order to formally make these requests, and to ensure that the necessary steps are undertaken in Guyana, and through the relevant authorities.

Section 3

Bibliography

Allen, J.B. (1987) London Cocoa Trade Amazon Project. Final Report Phase II. *Cocoa Growers Bulletin* No. 39.

Allen, J.B. & Lass, R.A. (1983) London Cocoa Trade Amazon Project. Final Report Phase I. *Cocoa Growers Bulletin.* No. 34.

Anon. (1938) Report on the Experimental Cultivations in the North West District - 1928-1938.

Anon. (1993) Summary Report of the International Witches' Broom Project (IWBP). *Cocoa Growers Bulletin* No. 46.

Anon. (1994) ICCO Quarterly Bulletin of Statistics XXI, 1 Dec. 1994.

Bartley, B. (1994) The Chocolate (i.e. Cacao) Gene Pool Controversy. *Tropical Agriculture Association Newsletter* Sept, 5-8

Beggon, J. Funk, V. & Kelloff, C. (1992) *Checklist of the Plants of the Guianas.* Smithsonian Publications.

Bekele, F.L. (1993) Conservation. Characterization, and the Utilization of Cocoa Genetic Resources in the 21st Century. *Trop. Agric.* 70 (2), 193-194.

Bekele, F.L., Kennedy, A.J., McDavid. C., Lauckner, F.B, & Bekele, I. (1994) Numerical taxonomic studies on cacao (*Theobroma cacao* L.) in Trinidad. *Euphytica* 75: 231-240.

Berry, D. & Cilas, C. (1994) Etude genetique de la reaction a la pourriture brune des cabosses chez des cacaoyers (*Theobroma cacao*) issus d'un plan de croisements diallele. *Agronomie* **14,** 599-609.

Cheesman, E.E. (1944) Notes on the nomenclature, classification and possible relationships of cacao populations. *Trop. Agriculture, Trin.*, **21:** 144-159.

Dash, J.S. (1929) Historical Cacao in British Guiana. *Agric. Journal of British Guiana* VII, 76-79.

FAO (1986) *Food and fruit-bearing forest species 3: Examples from Latin America.* FAO Forestry paper 44/3.

Farnsworth, N.R. (1990) Screening plants for new medicines. In *Biodiversity* (ed. E.O.Wilson), pp. 83-97. *National Academy Press, Washington.*

Gupta, M.P., Jones, A. Solis, P., & Mireya, D.C.A. (1992) Ethnopharmacognostic study of Kuna Yala.. In *Sustainable harvest and marketing of rain forest products.* (eds., M. Plotkin & L. Famolare), pp. 201-211. Island Press, Washington.

Laker, H.A. & Ram, A. (1992) Investigations on integrated control of witches' broom disease of cocoa in Rondonia State, Brazil. *Tropical Pest Management*, **38(4),** 354-358.

Laker, H.A., Trevisan, O. & Bezzera, J.L. (1993) Fungi associated with pods of cocoa (*Theobroma cacao.* L.) attacked by the borer *Conotrachelus humeropictus* Fiedler in Rondonia State, Brazil. *Tropical Agriculture*, **70(4),** 332-336.

Mennega, E.A., Tammens-de-Rooji, W., & Jansen-Jacobs, M. (1988) *Checklist of Woody Plants of Guyana.* TROPENBOS public.

Myers, J.G. (1930) Notes on Wild Cacao in Surinam and in British Guiana. *Bulletin of Misc. Information.* 1:1-11.

N'Goran, J.A.K., Laurent, V., Risterucci, A.M., & Lanaud, C. (1994) Comparative genetic diversity studies of *Theobroma cacao* L. using RFLP and RAPD markers. *Heredity* **73,** 589-598.

Schulz, B., Becker, B., & Gotsch, E. (1994) Indigenous knowledge in a modern sustainable agroforestry system - a case study from eastern Brazil. *Agroforestry Systems* **25,** 59-69.

Simmonds, N.W. (1986) *Evolution of Crop Plants.* Longman Scientific & Technical, Harlow.

Soria, J. (1975) Recent cocoa collecting expeditions. In O.H. Frankel and J.G.Hawkes (eds). *Crop genetic resources for today and tomorrow*. IBP 2 series. Cambridge University Press, London.

Thorold, C.A. (1994) The Chocolate (i.e. Cacao) Geen Pool Controversy (continued) *TAA Newsletter September* 1994, 8-9.

Warren, J. (1994) Dark days for dark chocolate. *Chemistry & Industry* 7 February, p120.

Section 4

Appendices

4.1. Cocoa descriptors

The following cocoa descriptors were used in the phase I study. Taken from the ICGT, Trinidad database.

tg	tree girth (cm)	
a	Leaf, flush colour	0=absent, 3=slight, 5=intermediate, 7=intense.
b	Leaf, length (mm)	
d	Leaf, width (mm)	
e	Leaf length:width ration	
h	Flower, bud anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
i	Flower, peduncle length (mm)	
j	Flower, peduncle, anthocyanin intensity in abscission zone	0=absent, 3=slight, 5=intermediate, 7=intense.
k	Flower, peduncle, anthocyanin intensity in basal zone	0=absent, 3=slight, 5=intermediate, 7=intense.
m	Flower, sepal colour	0=absent, 3=slight, 5=intermediate, 7=intense.
n	Flower, sepal length (mm)	
o	Flower sepal width (mm)	
p	Flower, glandular hairs	presence/absence
w	Flower, stamen filament anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
a	Fruit, immature, ridges, anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
b	Fruit, immature, furrow, anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
e	Fruit, mature, length (cm)	
f	Fruit, mature, width (cm)	
g	Fruit, mature, weight (g)	
k	Fruit, mature, ridges, anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
n	Fruit, mature, furrow, anthocyanin intensity	0=absent, 3=slight, 5=intermediate, 7=intense.
p	Fruit, mature, wall thickness (mm)	
t	Seed, number	
w	Seed, (unpeeled) fresh weight (g)	weight taken of sixe seeds
x	Seed, pulp (mucilage) colour	1=white, 2=cream, 3=yellowish
y	Seed, colour	1=white, 2=grey, 3=light purple, 4=medium purple, 5=dark purple, 6=mottled
z	Seed, shape	1=oblong, 2=elliptic, 3=ovate
A	Seed, length (cm)	
B	Seed, width (cm)	
C	Seed, thickness (cm)	

4.2. Guyanese Institutions and contacts

Contact	Address
Chief Agricultural Officer	Ministry of Agriculture and Fisheries Regent Street Georgetown Guyana South America
Dr. Henry Tschinkel	Iwokrama International Rain Forest Programme Guyana Natural Resources Agency P.O. Box 1074 41 Brickdam & Boyle Place Georgetown Guyana South America
Professor J. Spence	Cocoa Research Unit University of The West Indies St. Augustine Trinidad
Vish Mooleerdhar	Cocoa Research Unit University of The West Indies St. Augustine Trinidad
Mrs Ford	The National Agricultural Research Institute Mon Repos East Coast Demerara Guyana South America
Mr. I. Ford	Central Horticultural Station Timehri East Bank Demerara Guyana South America
Dr. Ramdass	Dean of Natural Sciences Faculty of Natural Sciences Turkeyen Campus University of Guyana P.O. BOX 101110 Georgetown South America
Eric Beaucamp	The Biscuit, Cake, Chocolate and Confectionary Alliance 11 Green Street London W1Y 3RF
Dr. R Lass	Head of Agricultural and Environmental Affairs Cadbury Ltd PO Box 12 Bournville Birmingham B30 2LU

Dr Michelle End & Dr Paul Hadley	School of Plant Sciences University of Reading Whiteknights P.O. Box 221 Reading RG6 2AS
Secretary	Education & Careers Committee Bristish Ecological Society Blades Court Deodor Road Putney London SW1
Mr and Mrs E. Hopkinson	Hopkinson Street Republic Park Guyana South America
Dr L Chandrapal	Office of the President New Garden St & Regent St Georgetown Guyana South America
Dr J.H. ter Welle	Rijksuniversiteit te Utretcht Heidelberglaan 3584 CS utrecht The Netherlands
High Commissioner	Guyana High Commission 3 Palace Court Bayswater Rd London W2 4LP
Dr K. Hall	Deputy Secretariat-General CARICOM Bank of Guyana House Georgetown Guyana South America
Dr Crawford	IICA Brickdam Georgetown Guyana South America

4.3. Cocoa descriptions for the four localities visited.

IICA Timehri Germplasm Bank
GPS: 6.30.46.N58.16.05.W
Date 2nd August 26th Sept.

Tree no.	Tree Girth (cm)	Lvs Flush 0-7	Length (cm)	Width (cm)	L/W rat	Fruit - Imm. Ridge ii 0-7	Fur. int. 0-7	Fruit - Ripe Length (cm)	Width (cm)	Weight (g)	Seed Ridge ii 0-7	Fur. int. 0-7	Wall thi (mm)	Numbe	Fresh v (g)	Pulp co 1-3	colour 1-6	shape 1-3	length (cm)	width (cm)	thickne (cm)
Type I																					
30	35	0	30.2	12.5	2.416																
32	16	0	40	13	3.0769																
40	28	0	40.5	12	3.375																
29	27	0	32.5	12.5	2.6																
31	12.5	3	36.5	15.6	2.3397																
35	37	3	26.5	11.2	2.3661																
34	34	0	30	10.5	2.8571	0	0														
33	34	0	40	14.8	2.7027	0	0														
39	31	0	41	14.5	2.8276	0	0														
2	40.5	5	31	10.5	2.9524	0	0	20	8.5	500	0	0	15	34	35	2	3	3	2.8	2.4	1.4
8	56	2	30	9.6	3.125	0	0	21	10.5	650	7	7	25	46	34	2	5	3	3.4	1	1.1
Mean=	31.9	1.18	34.4	12.4	2.79	0	0	20.5	9.5	575	3.5	3.5	20	40	34.5	2	4	3	3.1	1.7	1.25
n=	11	11	11	11	11	5	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SD=	11.2	1.7	5.06	1.84	0.32	0	0	0.5	1	75	3.5	3.5	5	6	0.5	0	1	0	0.3	0.7	0.15
SE=	3.36	0.51	1.53	0.56	0.1	0	0	0.35	0.71	53	2.47	2.47	3.54	4.24	0.35	0	0.71	0	0.21	0.49	0.11
Type II																					
38	24.5	0	34	11.5	2.9565	3	4														
27	28.2	0	27	10.5	2.5714	5	5														
3	51	0	34	11.5	2.9565	6	4														
9	69	4	32	12	2.6667	6	5	21.5	10.5	775	5	3	24	45	40	2	5	3			
Mean=	43.2	1	31.8	11.4	2.79	5	4.5	21.5	10.5	775	5	3	24	45	40	2	5	3			
n=	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1			
SD=	18	1.73	2.86	0.54	0.17	1.22	0.5	0	0	0	0	0	0	0	0	0	0	0			
SE=	9.02	0.87	1.43	0.27	0.09	0.61	0.25	0	0	0	0	0	0	0	0	0	0	0			

Tree no.	Bud Anth. in 0-7	Peduncle Length (mm)	Peduncle Int. Abs 0-7	Peduncle Int. Bas 0-7	Sepal Anth. in 0-7	Sepal Length (mm)	Sepal Width (mm)	Glad. h 1-2	Stamen Anth. In 0-7	Anther Anth. In 0-7	Style Anth. Int. 0-7	Pests Capsid	Thrips	Ants %	Mealy	Black p
Type I																
30														5	#	
32														5		
40														10	#	
29	0	11	7	7	2	3	8	2	0	7				1	#	
31	3	13												5		
35	5	13												5	#	
34														5	#	
33	0	14	7	7	0	7	1.4	1	7					5	#	
39	5													5	#	
2	4	26	6	0	0	7	1.5	2	7		7			#		
8	9	22	3	0	0	6	3.5	2	7		7	#				
	3.71	16.5	5.75	3.5	0.5	5.75	3.6	1.75	5.25	7	7	0		5.11	0	0
	7	6	4	4	4	4	4	4	4	1	2	1		9	1	7
	2.91	5.5	1.64	3.5	0.87	1.64	2.67	0.43	3.03	0	0	0		2.13	0	0
	1.1	2.25	0.82	1.75	0.43	0.82	1.34	0.22	1.52	0	0	0		0.71	0	0
Type II																
38	3	13	5	5	3	16	1.5	1	7					5	#	
27														5		
3	5	28	5	0	4	8	2.5	2	7		7			#	#	
9	3	22	4	0	3	5	2.3	2	7		7					
	3.67	21	4.67	1.67	3.33	9.67	2.1	1.67	7		7			3.33		0
	3	3	3	3	3	3	3	3	3		2			3		2
	0.94	6.16	0.47	2.36	0.47	4.64	0.43	0.47	0		0			2.36		0
	0.54	3.56	0.27	1.36	0.27	2.68	0.25	0.27	0		0			1.36		0

IICA Timehri Germplasm Bank cont./....4

Tree no.	Bud	Peduncle			Sepal				Stamen	Anther	Style	Pests				
	Anth. in 0-7	Length (mm)	Int. Abs 0-7	Int. Bas 0-7	Anth. in 0-7	Length (mm)	Width (mm)	Glad. h 1-2	Anth. In 0-7	Anth. In 0-7	Anth. Int. 0-7	Capsid	Thrips	Ants %	Mealy	Black p
36														5		#
41	0	8	5	5	0	8	2	1	7.					5		#
28	3													7		
26	3	22	7	3	2	3	8	2	0	7				7		#
37	3	14	3	3	0	16	1.2	1	5					5		#'
25	5	13	7	7	3	3	7	2	0	7				5		#
22	7	21	7	7	3	3	10	5	0	7		#		5		#
23	5	23	7	5	3	5	4	2	0	7				5		#
5	3	24	4	0	4	7	2	2	7		7		#		#	#
24	5													10		#
1	4	14	5	5	4	6	2.5	2	7		7					#
4	5	22	4	1	3	8	2.5	2	7		6		#			#
6															#	
7		26	4	0	3	7	2	2	7		7		#			#
	3.9091	18.7	5.3	3.6	2.5	6.6	4.12	2.1	4	7	6.75	0		4.5	0	0
	11	10	10	10	10	10	10	10	10	4	4	1		12	2	12
	1.7297	5.64	1.4866	2.498	1.3601	3.6661	2.9188	1.044	3.3166	0	0.433	0		2.958	0	0
	0.5215	1.7835	0.4701	0.7899	0.4301	1.1593	0.923	0.3302	1.0488	0	0.2165	0		0.8539	0	0

Type III

Tree no.	Tree Girth (cm)	Lvs Flush 0-7	Fruit - Imm. Length (cm)	Width (cm)	L/W rat	Ridge ii 0-7	Fur. int. 0-7	Fruit - Ripe Length (cm)	Width (cm)	Weight (g)	Ridge ii 0-7	Fur. int. 0-7	Wall thi (mm)	Seed Numbe	Fresh v (g)	Pulp co 1-3	colour 1-6	shape 1-3	length (cm)	width (cm)	thick. (cm)
36	53	3	37	13	2.8462	7	7														
41	39	3	36	12	3	7	7														
28	12	0	23	9	2.5556	7	7														
26	42	0	36	13	2.7692	7	7														
37	44	0	46	14	3.2857	7	7														
25	37	3	44	11	4	7	7														
22	39.4	0	34	12	2.8333	7	7														
23	73.5	0	34.6	11.5	3.0087	7	7	23	15	575	0	0	20	48	20	2	5	3	1.4	1.5	0.5
5	58	3	31.5	12	2.625	7	7	20	10.5	500	3	2	24	32	29	2	5	3	2.6	1.4	1
24	25.4	5	35	13.6	2.5735	7	7	26	14	534	5	3	26	43	14	1	6	3	3.5	0.7	0.5
1	76	6	41	17	2.4118	7	6	23	9	850	6	5	12	43	28	1	5	3	3	1.8	1.6
4	75	5	35	13.5	2.5926	7	7	24	11.5	925	6	3	25	43	43	1	6	3			
6	70	3	35.5	14	2.5357	7	7	22.5	9.5	725	7	4	18	41	44	1	5	3	3.5	2.4	1.8
7	45	6	39	15	2.6	7	6	16	9	400	7	7	12	38	32	3	5	3	3.2	2	1
Mean=	49.236	2.6429	36.257	12.9	2.8312	7	6.8571	22.071	11.214	644.14	4.8571	3.4286	19.571	41.143	30	1.5714	5.2857	3	2.8667	1.6333	1.0667
n=	14	14	14	14	14	14	14	7	7	7	7	7	7	7	7	7	7	7	6	6	6
SD=	18.698	2.2235	5.3153	1.8462	0.396	0	0.3499	2.9812	2.2497	179.32	2.3561	2.0603	5.4473	4.6423	10.212	0.7284	0.4518	0	0.725	0.5312	0.4955
SE=	4.9972	0.5943	1.4206	0.4934	0.1058	0	0.0935	1.1268	0.8503	67.777	0.8905	0.7787	2.0589	1.7546	3.8598	0.2753	0.1707	0	0.296	0.2169	0.2023

Kurupukari Cocoa Data

GPS: 04,39.01N 58,41.13W
Date 9th August 1995
Forest Garden

Tree no. K..	Tree Girth	Lvs Flush	Fruit - Imm. Lengtl	Width	L/W ra	Ridge	Fur. ir	Fruit - Ripe Lengt	Width	Weigl	Ridge	Fur. ir	Wall t	Seed Numb	Fresh	Pulp c	colou	shape	lengtl	width	thickn
1	96.5	2	39.5	14.5	2.724	0	0	17.2	12	725	0	0	19	38	3.83	1	5	1	2.9	1.7	1.2
2	40.5	2	37	14	2.643																
3	30	0	40	17	2.353																
4	21	1	26	13	2																
5	17.5	0	33	11.5	2.87																
6	23	1	26	13	2																
7	8	3	43	15	2.867																
8	5.5	2	26	10	2.6																
9	22	2	30	10	3																
10	19	5	32	12	2.667																
11	74	5	37	14	2.643	0	0														
12	17.5	5	39.5	14	2.821	0	0														
13	1.5	0	35.5	14.5	2.448																
Mean	28.92	2.154	34.19	13.27	2.587	0	0	17.2	12	725	0	0	19	38	3.83	1	5	1	2.9	1.7	1.2
n=	13	13	13	13	13	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SD	26.28	1.791	5.618	1.918	0.301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SE=	7.288	0.497	1.558	0.532	0.083	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Kurupukari Data cont/..2

	Bud	Peduncle			Sepal				Stamen	Pests			
Tree n	Anth. i	Lengtl	Int. Ab	Int. Ba	Anth. i	Lengtl	Width	Glad. i	Anth. Int.	Capsi(	Thrips	Ants	Mealy	Black pod
K..														
1	0	20	0	0	0	8	2	1	6	#		#		5%
2	3	15	7	6	2	8	2	1	7					5%
3														
4														
5														
6														
7														
8														
9														
10												#		
11	7	14	1	0	0	6	1.5	1	7			#		5%
12	1	20	2	0	1	7	1.5	1	7					
13	1	15	1	0								#	#	
	2.4	16.8	2.2	1.2	0.75	7.25	1.75	1	6.75					
	5	5	5	5	4	4	4	4	4					
	2.498	2.638	2.482	2.4	0.829	0.829	0.25	0	0.433					
	1.117	1.18	1.11	1.073	0.415	0.415	0.125	0	0.217					

Primos Inlet
GPS: 03,53.26N 58,22.57W
Date 28th August to 11th September 1995
Forest

Tree no.	Tree Girth (cm)	Tree Height (m)	Lvs Flush 0-7	Length (cm)	Width (cm)	L/W rat	Fruit - Imm. Ridge 0-7	Fruit - Imm. Fur. in 0-7	Fruit - Ripe Length (cm)	Fruit - Ripe Width (cm)	Seed Weight (g)	Seed Ridge i 0-7	Seed Fur. int 0-7	Seed Wall th (mm)	Seed Numbe	Seed Fresh v (g)	Seed Pulp ci 1-3	Seed colour 1-6	Seed shape 1-3	Seed length (cm)	Seed width (cm)	Seed thickne (cm)	Pests Ants %	BP
1	32		0	39	12	3.25																	10	
2	71		0	38	12	3.1667	0	0															25	
3	33		0	41	14	2.9286																	40	
4	39.7		2	30	12	2.5	0	0															15	1
5	32.1		0	35	15.5	2.2581																	20	
6	31.3		2	39	12.4	3.1452																	15	
7	40.2		1	37.8	12.4	3.0484	0	0															5	
8	43.5		0	33	13	2.5385																	5	1
9	24.4		0	34	14	2.4286																	20	
10	36.6		1	45.9	13.3	3.4511																	20	
11	51.5		0	39.7	12.5	3.176																	10	
12	40.5		0	31	11.5	2.6957																	15	
13	17.5		0	28	10.5	2.6667																	10	
14	24.4		0	31	13	2.3846																	5	
15	42.1		5	39	10.1	3.8614																	5	
16	43		0	43.4	15.1	2.8742																	25	
17	17		0	33	13.1	2.5191																	2	
18	34		0	41	12	3.4167	0	0															10	1
19	39.5		0	27.2	10.3	2.6408																	5	1
20	37.5		3	28	9.5	2.9474																	5	
21	43		1	29	10.3	2.8155																	10	
22	51.5		0	27.5	9.5	2.8947	0	0															5	
23	48		0	30.7	10.2	3.0098																	15	
24	49		0	33	13	2.5385																	20	
25	17		0	33	10.4	3.1731																	3	
26	31.5		0	39.5	12.1	3.2645																	20	
27	45.2		0	34	13	2.6154																	4	
28	45.8		0	31	12.2	2.541	0	0															5	
29	38		0	31	11	2.8182																	5	
30	41.3		0	31	10	3.1	0	0															10	
31	44.9		0	37	12.4	2.9839																	5	

32	33	0	32	13.5	2.3704			5	
33	38.3	0	34.2	11.3	3.0265			20	1
34	16.5	0	31.5	11.9	2.6471			5	
35	47.5	0	29	11	2.6364			5	
36	15.5	0	32	10.3	3.1068			7	
37	26	0	37	12.3	3.0081			5	
38	41	0	27	9.5	2.8421			22	
39	16.3	0	24	7.2	3.3333			10	
40	45	0	31.4	11.1	2.8288			3	
41	39.5	0	30.5	9.5	3.2105			40	
42	36	0	32.2	10.2	3.1569			15	
43	40.4	0	45.5	14.4	3.1597			10	
44	17	0	29	10.3	2.8155			0	
45	45	0	36	14	2.5714			5	
46	44.6	0	32	11.5	2.7826			35	
47	28.8	0	31	11.5	2.6957	0	0	3	1
48	24.2	0	37	11	3.3636			3	
49	16	0	35	10	3.5			2	
50	9.5	0	44.9	13.2	3.4015			7	
51	5	0	43	13.6	3.1618			4	
53	9	0	49	15	3.2667			5	
54	6.5	1	51.5	15	3.4333			50	
55	8	0	37	12	3.0833			15	
56	5.5	0	32	11.4	2.807			10	
57	9.6	0	35	14	2.5			8	
58	10	0	38	11.5	3.3043			15	
59	9.5	0	32	11.5	2.7826			5	
60	9	0	39.8	12.9	3.0853			17	
61	10	0	37.4	9.1	4.1099			10	
62	8.5	0	32.5	12	2.7083			10	
63	7.8	0	39	10.1	3.8614			10	
64	15.5	0	36.3	12.4	2.9274			5	
65	8.5	0	31	10.5	2.9524			7	
66	19.5	0	32	9.5	3.3684			4	
67	41.5	0	39.4	12.3	3.2033			5	
68	25	0	22	9.5	2.3158			5	
69	17	0	23	7.5	3.0667			4	
70	11	0	31.5	11.4	2.7632			13	
71	19.5	0	17	8.5	2			3	
72	18.5	0	25	11	2.2727			4	
73	27	0	31	12.3	2.5203			5	1

74	20		0	29	13	2.2308																5	
75	18.3		0	34	12.5	2.72																5	
76	36.4		0	33	13	2.5385	0	0														4	
77	20		0	37	15	2.4667																4	
78	14.5		0	29	10	2.9																3	
79	19.2		0	33	11.5	2.8696																7	
80	18		0	29	9.5	3.0526																2	
81	25		0	31	11.6	2.6724																3	1
82	23		0	31.5	10.9	2.8899																15	
83	11.4		0	32.6	10.7	3.0467																5	
84	20		0	39.1	14.3	2.7343																10	
85	14.9		3	33.1	11.2	2.9554																5	
86	23.6		0	34.9	13	2.6846																15	1
87	41.5		0	32	11.5	2.7826																10	
88	18.2		3	32.4	11.6	2.7931																5	
89	37.4		0	38.6	13.2	2.9242																20	
90	60	23.3	0	33.7	10.1	3.3366	0	0														15	1
91	31.7		0	35	12.3	2.8455	0	0														5	1
92	34.8		0	33	15	2.2	0	0														5	1
93	43.5		3	41.9	13.1	3.1985	0	0														10	1
94	32.4		0	45.4	14.9	3.047	0	0														10	1
95	47.1		0	37.3	13.7	2.7226	0	0														15	1
96	40.7		3	40.1	13.4	2.9925																5	1
97	42.8		3	31	10.5	2.9524																75	
98	51.2		3	29	10	2.9																5	
99	15.1		0	37.6	12.2	3.082																4	
100	29.2		0	33	14.4	2.2917																5	
101	11.7		0	33.4	10.4	3.2115																5	
102	2		0	31	11.8	2.6271																3	
103	29		0	28.5	9.2	3.0978																10	
104	40.6		0	32	10	3.2	0	0														20	
105	35.6		3	29	9.7	2.9897	0	0														5	1
106	21.9		3	27	13	2.0769																4	
107	20.6		3	33.5	10.4	3.2212																5	
108	36.2		3	42.1	13.2	3.1894																10	
109	38.9		3	37	12	3.0833	0	0														10	1
110	42.2		0	36.5	13	2.8077	0	0	25	12.5	625	0	0	27	43	9.8	3	6	3	3.1	2.1	0.7	5	
111	44.1		0	32.7	11.9	2.7479																20	
112	33.1		0	40.4	12.6	3.2063	0	0														5	1
113	43.4		0	51.6	17	3.0353	0	0														10	1
114	19		3	35.5	12.1	2.9339																6	

115	8.5		0	37	14	2.6429																5	
116	17.2		3	37.2	12	3.1																5	
117	37		3	42.5	14.1	3.0142	0	0														10	1
118	32.8		0	37	13	2.8462																5	1
119	10.5		0	25	9.5	2.6316																2	
120	19.1		0	50	10.5	4.7619																5	1
121	10.4		0	36.5	13.1	2.7863																5	
122	44		3	33.3	9.1	3.6593																5	
123	33		0	37	14.1	2.6241																5	1
124	34		3	44.2	12.9	3.4264																5	
125	36.5		0	31.2	11.1	2.8108	0	0														5	1
126	40.9		5	40.2	11.1	3.6216	0	0														5	1
127	28.7		0	39	9.5	4.1053																5	
128	46.1		3	32	11.9	2.6891																4	1
129	36.4		3	31	10.1	3.0693																5	1
130	41.4		0	39	15.3	2.549																45	
131	17.5		0	25	12.4	2.0161																5	1
132	10		0	37	13.1	2.8244																5	
133	48.2		0	38	13.3	2.8571																30	
134	36.8		3	39.1	12.9	3.031																5	
135	25.1		3	34	11.2	3.0357																55	
136	33.2		2	40	15	2.6667																5	
137	10		0	35.6	13.3	2.6767																5	
138	39.4		0	37.4	12.5	2.992																5	
139	21		0	53	11.6	4.569																5	
140	29		0	31.1	10.5	2.9619																5	
141	29.1		3	32.4	11.2	2.8929																3	
142	17.6		0	31	10.1	3.0693																3	
143	20.4		0	30.9	9.7	3.1856																5	
144	44.5		0	33.2	11.7	2.8376	0	0	21.9	26	275	0	0	7	41	10.1	2	6	3	2.9	0.95	0.65	5	1
145	18		3	36	12.4	2.9032																4	
146	27		0	17	8.5	2																5	
147	37.4		0	28	10	2.8																5	1
148	40.5		3	28	9.1	3.0769																5	
149	25.8		0	34	12.5	2.72	0	0														5	1
150	15.3		0	30	12.4	2.4194																5	
151	35		0	37	14.5	2.5517																5	1
152	33		0	39	10.2	3.8235	0	0														5	1
153	30.3		0	37.5	13.1	2.8626	0	0														5	1
154	30.4	6.13	3	32.7	11.4	2.8684																5	
155	31		0	45.4	15.3	2.9673																3	

156	28.8		0	19	8	2.375			3	
157	41.5		0	37	11.2	3.3036	0	0	3	
158	44.1		0	31.3	9.5	3.2947			5	
159	57.1		0	35.5	12.3	2.8862	0	0	5	1
160	19		0	42	14.7	2.8571			5	
161	34.5		0	39.5	12.2	3.2377	0	0	5	1
162	24		0	37	9.7	3.8144			5	1
163	8		0	29	14.4	2.0139			4	1
164	16.7		3	40.1	12.1	3.314			5	
165	10.5		0	31.4	8.5	3.6941			5	
166	16.1		0	22	9.7	2.268			5	
167	34.5		0	24	13	1.8462	0	0	5	1
168	42.5	6.08	0	39.5	11.2	3.5268			5	
169	28.4		3	36	13.2	2.7273			10	
170	32.2		0	45	11.6	3.8793			5	1
171	43.1		0	35	10.4	3.3654			5	
172	46.1		3	29	11.4	2.5439	0	0	5	
173	31.1		0	37.3	10.4	3.5865	0	0	5	1
174	8.4		0	38.6	10.2	3.7843			5	
175	57	11.11	0	33.6	11	3.0545	0	0	5	1
176	23.5		3	38.7	11.8	3.2797			10	
177	21.4		3	39.3	15	2.62			10	
178	49.4		0	44.4	14.8	3	0	0	5	1
179	27.5		0	31	10	3.1			5	1
180	13.2		0	31	10.4	2.9808			5	
181	10		3	37	13.4	2.7612			20	
182	39.7		3	43.4	13.9	3.1223	0	0	5	1
183	12.5		0	34.7	11.2	3.0982			4	
184	6.7		0	35.5	11.5	3.087			3	
185	10.3		0	36.7	11.5	3.1913			5	
186	24.6		0	35.7	12.5	2.856			3	
187	17		3	34	11	3.0909			10	
188	9.6		0	37.9	11	3.4455			3	
189	4.8		0	36.4	13.1	2.7786			10	
190	7.3		0	39.2	13.4	2.9254			2	
191	10.8		0	31.4	11.3	2.7788			10	
192	6.5		0	35.2	13.1	2.687			10	
193	19		0	37	12	3.0833			10	
194	7.1		0	31.2	10.9	2.8624			5	
195	23.3		0	37.2	12.5	2.976			5	
196	24.1		0	37	12.5	2.96			2	

197	12.4	0	33.2	11.1	2.991			15		
198	9	0	32	12.2	2.623			10		
199	23.4	0	39	13.8	2.8261			15		
200	25	3	36.8	13.1	2.8092			5		
201	26.4	3	39	13	3			20		
202	7.4	3	45.1	15.2	2.9671			25		
203	27.5	0	41	13.4	3.0597			5		
204	10.4	0	32	11.2	2.8571			3		
205	40.2	0	32	12.3	2.6016	0	0	7	1	
206	15.8	3	41	15.5	2.6452			3		
207	13.4	3	37.1	13.6	2.7279			10		
208	21	3	35.7	13.2	2.7045			5		
209	18	0	38	12.7	2.9921			3		
210	10	0	33.4	12.3	2.7154			10		
211	13.6	0	41.7	14.7	2.8367			10		
212	23	0	37	12.9	2.8682			3		
213	25.7	0	35	12.6	2.7778			5		
214	11.4	0	35.7	13.1	2.7252			20		
215	10	0	34	11.5	2.9565			10		
216	13	0	37.5	13.7	2.7372			5		
217	8.9	0	40.4	14.2	2.8451			5		
218	36.6	0	41.2	13.7	3.0073			2		
219	39	0	38	3.2	11.875			5		
220	23.4	0	35.4	11.7	3.0256			3		
221	33.5	0	37.6	13	2.8923	0	0	3	1	
222	24.6	0	33.4	11.7	2.8547			2		
223	14.9	0	37.5	12.4	3.0242			5		
224	35.6	0	38.5	13.2	2.9167			4		
225	15.2	0	34.5	12.5	2.76			10		
226	47.5	3	38	12.9	2.9457	0	0	3	1	
227	15.1	0	34.5	11.4	3.0263			5		
228	29.3	0	45.5	14.6	3.1164	0	0	5	1	
229	20.5	3	37.5	11.4	3.2895			10		
230	47.9	3	39.5	13	3.0385			10		
231	10.7	0	36.4	13.5	2.6963	0	0	2		
232	45	3	37	13.4	2.7612	0	0	5	1	
233	43.1	0	32.4	9	3.6	0	0	10		
234	16	0	34.7	11.7	2.9658			15		
235	19.5	0	37.8	12.8	2.9531			8		
236	28.4	0	41.7	12.9	3.2326			3		
237	30.4	0	38	12.4	3.0645			5		

238	18.5	0	38.6	12.3	3.1382																10		
239	24.8	3	33	11.4	2.8947	0	0	22	14	500	0	0	17	47	4.3	2	6	2	2.9	3.7	0.9	3	1
240	54	0	34	10.3	3.301																	5	
241	38.4	0	37	13.2	2.803	0	0															3	1
242	20.5	0	39	13.7	2.8467																	10	1
243	27.5	0	35.5	11.1	3.1982	0	0	19.5	13.5	375	0	0	13	48	6.8	2	6	3	3.2	2	0.7	3	1
244	24	0	38	10.4	3.6538																	5	
245	16	0	35	12.1	2.8926																	1	
246	18	0	38.8	12.7	3.0551																	10	
247	12.7	3	39	11.9	3.2773																	10	
248	36.6	0	38.4	11.5	3.3391																	7	
249	35.5	3	37	13.6	2.7206																	15	1
250	10.2	0	39.5	10.5	3.7619																	5	
251	33.5	0	32	11.3	2.8319			22.7	14	425	0	0	26.3	43	11	2	6	3	3.5	2.3	0.9	5	
252	35	3	48	15	3.2																	15	
253	9.7	0	34	12.5	2.72																	25	
254	9.8	0	30	9.8	3.0612																	10	
255	8.5	0	37.3	12.9	2.8915																	20	
256	14.8	0	45	13	3.4615																	3	
257	31	3	34	13.9	2.446																	20	
258	40.9	0	35	10	3.5																	3	
259	16.9	3	38	11.4	3.3333																	3	
260	8.9	0	38.5	12.5	3.08																	20	
261	21	0	39	12	3.25																	5	
262	16.5	0	36	11	3.2727																	5	
263	44.5	0	40.4	13.2	3.0606	0	0	21	14.5	475	0	0	19	49	10	1	6	3	2.9	1.9	1.1	5	1
264	24	0	39	11.4	3.4211																	3	
265	33	0	35	10.2	3.4314																	2	
266	38.5	0	34.9	12.4	2.8145																	10	1
267	12.4	0	53	15.5	3.4194																	115	
268	9.8	0	35	11.7	2.9915																	15	
269	20	0	33	10.6	3.1132																	5	
270	29.5	3	39	12	3.25	0	0															2	
271	44.8	0	28.3	12.8	2.2109																	10	1
272	22.5	3	37.4	12.2	3.0656																	7	
273	8.1	3	32.5	10.9	2.9817																	10	
274	2.8	0	29.7	11	2.7																	30	
275	33.4	3	42	12.9	3.2558																	10	
276	21.5	3	36	12.9	2.7907																	5	
277	24.9	0	38	12	3.1667																	4	
278	5	0	34.7	12	2.8917																	2	

279	15	0	32.5	11.3	2.8761			2		
280	17.4	0	39	12.5	3.12			2		
281	34.7	0	37.2	10	3.72			5		
282	9.5	0	37.5	12.2	3.0738			10		
283	36.4	0	33.5	12	2.7917			3		
284	31.9	0	37.6	12.5	3.008			5		
285	24.1	0	42	13.7	3.0657			1		
286	25.5	0	34	12.3	2.7642			2		
287	16	0	40	10	4			5		
288	25.5	0	41	12.8	3.2031			9		
289	12	0	43	14	3.0714			10		
290	9	0	40.5	11.5	3.5217			10		
291	18.6	0	38.6	11.6	3.3276			10		
292	11	0	40	12	3.3333			15		
293	40.5	3	38	12.7	2.9921	0	0	5	1	
294	43	0	36	12.5	2.88			4		
295	40.8	0	40.2	13.6	2.9559	0	0	5	1	
296	13	0	34	10.6	3.2075			10		
297	28	0	44	12.1	3.6364			5	1	
298	28	0	41	13.7	2.9927			3	1	
299	13.4	0	37	10.7	3.4579			5		
300	27	3	41	13.4	3.0597	0	0	5	1	
301	20.4	0	35.5	12.7	2.7953			3	1	
302	5.6	3	38	11.7	3.2479			10		
303	33.5	3	37.6	12.4	3.0323			10		
304	21.2	0	37.6	12.3	3.0569			5		
305	18.6	0	40	13	3.0769			2		
306	5.2	0	38.4	11.1	3.4595			10		
307	18.7	3	38	12	3.1667			10		
308	43	0	37	13	2.8462	0	0	5	1	
309	14	0	29	8.7	3.3333			5		
310	28.7	0	39	13.9	2.8058			5		
311	12.5	0	38	11.9	3.1933			2		
312	6.2	0	39	13.7	2.8467			40		
313	10.4	0	33	10.5	3.1429			5		
314	7.3	0	39.9	12.7	3.1417			2		
315	11.6	0	37	12.7	2.9134			5		
316	8.5	0	37	13.2	2.803			5		
317	8.5	0	36.3	14.8	2.4527			2		
318	8.6	0	26	10.5	2.4762			10		
319	9.4	0	34.6	11.4	3.0351			5		

320	25.8		3	38	13.2	2.8788																5	
321	5.2		0	31.1	10.4	2.9904																5	
322	22.7		0	33.1	11.11	2.9793																10	
323	24.6		0	35.4	12.7	2.7874																5	
324	15.5		0	38	12.6	3.0159																7	
325	22.4		3	32.5	11.5	2.8261																15	
326	5.2		0	40.3	12.6	3.1984																5	
327	18		0	35	13.4	2.6119																10	
328	47.5		0	36.5	12	3.0417																10	1
329	10.9		0	39	11.9	3.2773																10	
330	5.7		0	35	11.7	2.9915																5	
331	8.9		0	35	10.9	3.211																2	
332	11.6		3	39	13.2	2.9545																2	
333	34		0	35	12.3	2.8455																5	
334	8.9		0	44.7	13.5	3.3111																10	
335	14.5		0	35	12.6	2.7778																3	
336	14.6		0	38	13	2.9231																4	
337	24.3		0	33.7	12.8	2.6328																15	
338	18.4		0	39	13.7	2.8467																2	
339	34		0	37	13	2.8462																15	1
340	17.4		0	33.8	10.9	3.1009																10	
341	27.9		0	32.8	12.9	2.5426																10	
342	20.7		0	39	13.1	2.9771																5	
343	10.7		3	39	14.3	2.7273																10	
344	23.9		0	39	12.5	3.12																20	
345	34		0	37.6	12.5	3.008																10	1
346	36		0	35	12.6	2.7778	0	0	19.5	13.4	425	0	0	19	59	11.1	1	6	3	3.2	2.4	0.8	5	1
347	33.6		0	32.9	11.5	2.8609																5	
Mea	25.341	11.655	0.602	35.792	12.044	3.0059	0	0	21.66	15.41	442.9	0	0	18.33	47.14	9.014	1.857	6	2.857	3.1	2.193	0.821	
n=	347	4	347	347	347	347	55	54	7	7	7	7	7	7	7	7	7	7	7	7	7	7	
SD=	13.311	7.0269	1.209	5.1631	1.6221	0.6032	0	0	1.78	4.361	100.6	0	0	6.526	5.566	2.336	0.639	0	0.35	0.207	0.756	0.146	
SE=	0.7146	3.5135	0.065	0.2772	0.0871	0.0324	0	0	0.673	1.648	38.04	0	0	2.467	2.104	0.883	0.241	0	0.132	0.078	0.286	0.055	

Canal 1 West Bank Demerara

GPS:
Date 20th September 1995
Orchard plantation

Tree no.	Tree Girth	Lvs Flush	Length	Width	L/W ratio	Fruit - Imm. Ridge int.	Fruit - Imm. Fur. int.	Pests Ants	Black pod
PF..									
1	37.5	0	33.5	12.8	2.617188	0	0	2%	#
2	23	0	42	30	1.4	5	7	5%	#
3	32	0	39.5	12.7	3.110236	7	7	3%	#
4	31.4	0	40	13.5	2.962963			4%	
5	34	0	48	18	2.666667			5%	#
Mean	31.58	0	40.6	17.4	2.551411	4	4.666667		
n=	5	5	5	5	5	3	3		
SD	4.790157	0	4.662617	6.596666	0.604155	2.94392	3.299832		
SE=	2.142223	0	2.085186	2.950119	0.270186	1.699673	1.905159		