CEDROS WILT DISEASE OF COCONUTS

by

Reginald Griffith D.Sc.

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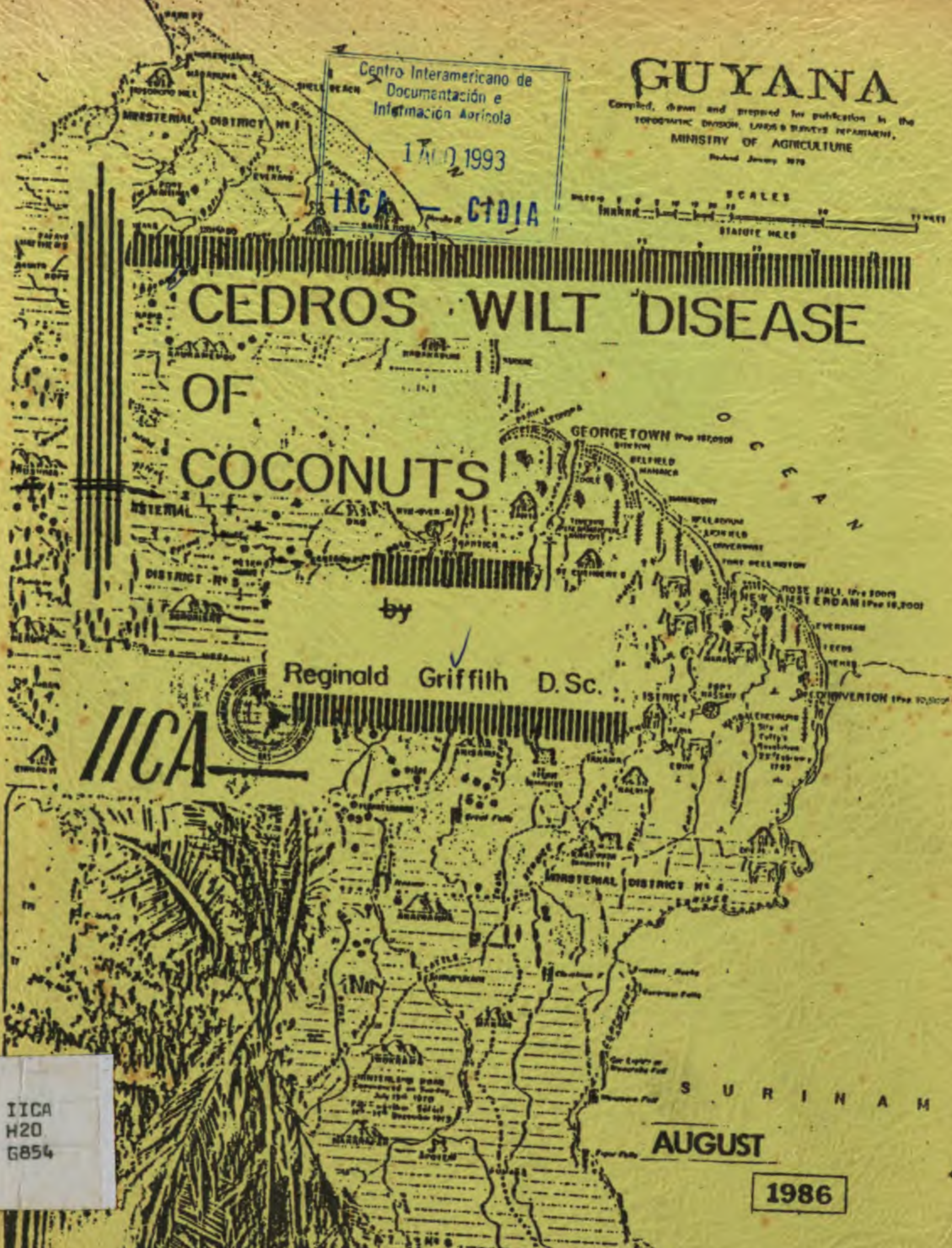

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THE CONSULTANCY

The Consultant, Reginald Griffith, D. Sc., having been invited by the I.I.C.A. (Trinidad) to visit Guyana from July 20 - July 26, 1986, given the following terms of reference:

a. To evaluate the survey of the incidence of Cedros Wilt in Guyana and to advise of what steps are necessary to halt the spread of the disease.

b. To evaluate the proposed research of the National Agricultural Research Institute with respect to this disease.

c. To evaluate the training needs for effective control of the disease in Guyana.

d. Should you agree that a coconut rehabilitation project is one of the necessary actions needed by the industry to indica te the basic components of such a project

submits the following conclusions and recommendations based on the visit for which the report: "Guyana: Cedros Wilt Disease of Coconuts" covers in greater detail.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Cedros Wilt disease which is endemic in Guyana is now in epidemic phase. From the Survey, the most reliable samples, those from farms less than 5 acres, show that the overall average of the disease for the country is 2.61% S.E. 0.43. Other samples show the frequency to range from 0.0% to 40%. The epidemic is greatest in Region No. 4 which requires a 'cordon sanitare' and intensive control activity. The nature of the pattern of spread of the disease indicates that the secondary vector is responsible

for the epidemic.

Research activities should relate therefore to:

1. The determination of the vector (if it is different from the Pentatomid in Trinidad).

2. Relation of control measures to the rate of pathogenesis:-

   a) stage of migration for vectors.

   b) rapid wilt and vectors on fallen leaves

   c) chemical insecticidal treatment of both.

3. Research of a more fundamental type may relate to serological typing of the protozoan parasite.

Cedros Wilt has developed to epidemic proportions in Guyana, at this time, to some measure because of over crowding of trees and the abundance of old and non-bearing palms. A rehabilitation programme should be planned to eliminate such predisposing conditions. Immediate control measures should, during this time, attempt to eliminate old and non-productive trees which may act as foci. The most important factor in control measures by tree removal is timing to prevent vector migration.

Control measures represent an economic exercise for the farmer. His interest alone is not enough. Therefore, a rehabilitation programme which allows for multiple-cropping in small farms and mixed-cropping on medium-size and large farms would facilitate the future exercises, especially as the disease is notifiable.

The Industry needs, more than anything else at this time, comprehensive organizing which may be had with a competent Coconut Authority. Elements of the production process which would benefit immediately would be:

1. Disease control measures.

2. Copra-drying for quality of produce.

3. Factory organization

4. Marketing and product diversification.

Generally, the industry in Guyana produces less per acre than its counterpart countries in the CARICOM despite the same varieties of coconut, similar spacing and the same pests and diseases. The major problem is management. Cedros Wilt disease at epidemic levels is an indicator of farms in semi-abandonment.

Recommendations:

A. Cedros Wilt

1. The formation of a 'cordon sanitare' in Region No. 4 and an acceleration of control measures.

2. Active campaign for control in other regions.

3. Monitoring of the disease by farmer returns.

B. Coconut Rehabilitation

4. The formation of a Coconut Authority with powers to institute in a rehabilitation programme:-

   a. Mixed-farming programmes.

   b. Mixed-cropping programmes.

   c. Organised artificial copra-drying.

   d. Accelerated marketing and product diversification.

C. Research

Assistance in research on Cedros Wilt disease by provision of the following:

   a. Laboratory equipment suited for micro-biology

and serology.

1. Autoclave (one)

2. Clean Air Flow Chamber (one)

3. Chemical Reagents and bacteriological and blood agars.

4. Glassware/petri dishes

5. Oven (one)

Total Cost: $8,000. U.S.

D. **Training**

b. Training periods of one month each for:

An Entomologist.
A Plant Pathologist
at the Red Ring Research (Trinidad).

c. Training periods of 1 week for 2 owners of large farms (over 600 acres) - Trinidad for Coconuts & Cattle and Mechanization.
- Jamaica for Coconuts & Bananas etc. Mixed-cropping.

d. Training in Factory Management and Product diversification (one week) for 2 factory Managers in Trinidad - at the Coconut Grower's Association.

E. **Consultancy**

1. Assistance from a consultant: P.C. Catanoan for building copra-drying stations.

2. Renewed advice from a Coconut Consultant with Latin American Ecperience..

PROGRAMME OF VISIT

Sunday	1986.07-20.	Arrival in Guyana.
Monday	1986.07.21.	Visit to I.I.C.A. Office, Georgetown.

Met with:

Dr. Franz. C. Alexander,
Director, I.I.C.A.

Mr. Clarence Wilson,
Com. of A.I.T.C. (Min. of Agriculture, Guyana).

Mr. Leslie Monroe,
(Entomologist, N.A.R.I.)

Mr. Fred Jones,
(Phytopathologist, N.A.R.I.)

Ms. Bernice George,
Programme Co-ordinator,
A.I.T.C.C..

Mr. Peter Ramsammy,
(Tech. Consultant, I.I.C.A.)

Mr. Emmanuel Dayaram,
(Asst. Chief Crops & Livestock)

Lecture Meeting:

Slide demonstration of Cedros Wilt and other coconut diseases.

Tuesday 1986.07.22

Visits:

Ministry of Agriculture, Guyana

Mrs. Elsie Croal, Programmes Co-ordinator.

Consultations:

Mr. Fitz Dorway, Permanent Secretary
Ministry of Agriculture

Dr. Michael Granger, Soil Scientist

Tuesday	1986.07.22.	**Visit to N.A.R.I.**
		Meeting with N.A.R.I. Scientists.
		Evaluation of progress in Cedros Wilt and related research activities viz.
		Mite control studies
		Entomological aspects of Cedros Wilt programme.
		Techniques for Trypanasoma extraction and storage.
		Update on transmission studies
		Techniques of Trypanosoma extraction from insects.
		Update on host range studies (weeds).
		Radio Interview
		1st interview on Guyana Broadcasting Company.
Wednesday	1986.07.23	Departure for Pomeroon River, Region No. 2
		Field Walk - Coconut farms in the Pomeroon River, Mr. John Clowers, Co-ordinator.
		Visits with:
		Mr. Ivor Allen (Hampton Court) Mr. Dalip Singh (Farmer) Mr. Walter Joseph (Agr. Asst.) Mr. Glendon Chritchlow (Agr. Asst).
Thursday	1986.07.24	Talk to farmers on Pomeroon River.
		About 150 farmers present along with Government and I.I.C.A. personnel - Video Presentation.
		Talk. Management of Cedros Wilt - Field Demonstration Station.

Friday	1986.07.25	a.m.	Visit to Farms in Region No. 4
			Field day with Farmers and Coconut Technicians - Identification and control of Cedros Wilt.
		p.m.	Inhouse - Training of Technicians.
			Analysis of Survey Methodology.
			<u>2nd Radio Interview</u>
Saturday	1986.07.26		Departure.

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A MAJOR PERSPECTIVE FOR CEDROS WILT DISEASE

IN GUYANA

The major coconut diseases affecting Guyana are: Red Ring disease, Cedros Wilt disease (Hartrot), Bronze Leaf Wilt disease, Bud Rot disease and Coconut Fruit Stunting (caused by the Coconut Mite). The wilt diseases will be analyzed from the point of view of their epidemiology so as to indicate the relationship to control measures currently applied or applicable to each. A major feature which will always be alluded to, in the context of the wilt diseases is the relationship between epidemiology and symptomatology which, though specific to a particular pathogen, has sufficient intrinsic variability, depending on the cultivar, to cause confusion in field identification when many symptoms overlap. Still, however, as in the case of Cedros Wilt, the particular pattern in which the disease spreads corresponds to the mode of dispersion of its vector, even if unknown, and can in fact be utilized in its classification, differentiation and control.

Wilt diseases of the coconut palm have been grouped traditionally into two classes. At present, some wilt diseases like Bronze Leaf Wilt and the Brazilian counterpart Queima das Folhas, are still only very conveniently regarded as physiological diseases influenced by soil-water relations in the absence of any positively known biotic pathogen which will classify them as infectious. About 1900, all diseases of the coconut palm with a rotting bud were grouped together under the general name of Bud rot. However, the work of Stockdale and Nowell, between 1910 - 1920, allowed this complex of Latin American coconut diseases to be then separated into three categories. They were:

1. Bud rot due to Phythophthora palmivora

2. Red Ring disease

3. Wilt disease (called West-end Bud rot of Jamaica or bacterial Bud rot, Lethal Yellowing and Bronze Leaf Wilt.

A review of the literature on coconuts of Guyana up to 1976 shows that the various coconut diseases were grouped according to this pattern. In that Bud rot due to *Phythophthora palmivora* always had been recorded; similarly, Red Ring disease and also Bronze Leaf Wilt disease. By 1977, however, Griffith demonstrated that some of what was thought to be Bronze Leaf Wilt was in fact Cedros Wilt disease which had, over the years, been destroying large tracts of coconuts in several regions of Guyana.

THE ENDEMIC STATUS OF WILT DISEASES IN GUYANA

It appears very reasonable to assume a Latin American origin for Red Ring disease which is present only in this region especially since its vector and the believed ectoparasitic form of the nematode pathogen are localised here. The obligate parasitic form of *Rhadinaphelenchus cocophilus* Goodey, is found only in these parts; whereas other species of the genus *Rhyncophorus*, the vector, abound in South East Asia, India and Ceylon from where the coconut palm migrated to the west. A similar origin appears to be the case with Cedros Wilt disease (or Hartrot) which is only known in the Latin American areas and associated with *Phytomonas elmassiani*, the protozoan present in the milkweed plant *Asclepias curassavica* which reportedly is Latin American in origin. These diseases, therefore, have been endemic in Guyana and developed epidemic proportions from time to time when the ecosystem allows for it. The world distribution for Bud rot due to *Phythophthora palmivora* Butler, is different. The pathogen is world-wide and disease arises under conditions of high humidity and optimal temperatures favourable for infection by the wind-borne spores.

TEMPORAL CHARACTERISTICS FOR OUTBREAKS IN BRONZE LEAF WILT AND CEDROS WILT

BRONZE LEAF WILT

Bronze Leaf Wilt resembles Cedros Wilt excepting that it is not fatal. Soil conditions interact with weater conditions, in the first instance, to restrict normal root growth and plant function throughout both wet and dry seasons. However, in the hot weather, when drought conditions obtain, leaves show their characteristic bronzing or browning coloration according to the genetic nature of the plant population. Tall varieties show bronze and dwarf crosses, brown discoloration in the leaves.

CEDROS WILT

One might look at a feature of climate as it relates with other biotic factors to climax situations within the agroecosystem when such can affect the outbreak of Cedros Wilt disease in an otherwise overtly stable regime. Such is apparent when one considers Cedros Wilt disease where the collateral host for the protozoan flagellate is the weed *Asclepias curassavica*. In the natural pastures, or certain unkept regions in coconut estates, the epidemic of Cedros Wilt can begin in adult palms with the natural abundance of *Asclepias* and its insect partner, *Oncopeltus*, which migrates when its population becomes too dense (and a space in which to live becomes scarce) and it feeds temporarily on coconut leaves to transmit the protozoan flagellate. In such conditions, outbreaks are not annual but relate to ecological climax conditions which trigger off the disease within the coconut estate. This type of epidemic can run until the available inoculum subsides below the threshold limit when insects do not have to migrate.

Similar situations must necessarily arise with the vectors of certain other pathogens. Very often, palm weevils are not sufficiently

abundant to produce surviving vector weevils to spread Red Ring disease. Alternatively, abundance of insects might relate directly to the abundance of Red Ring disease after a certain threshold level of the population though only about 16% of the field population are vector types for the Red Ring nematode. The ecological variation in the number will determine the level of disease at any time. With Cedros Wilt disease, the abundance of Oncopeltus can relate directly to the initiation of initial foci for disease since the presence of Mecistorhinus sp. on the infected trees is important to continue the spread of infection from tree to tree in close clusters. This form of the epidemic depends on other factors as the density of palms per acre and absence of parasites for the second vector, Mecistorhinus (in Trinidad).

CEDROS WILT AND ITS EPIDEMIOLOGY

The disease called Cedros Wilt in Trinidad and Guyana, and 'La Marchitez de Cedros' in Ecuador, Venezuela and Colombia, is also recognised in Surinam as Hartrot disease. The symptoms are overtly not unlike Lethal Yellowing disease when they are expressed in the tall variety of coconuts but different from those of Red Ring disease where there is no putrefaction of the bud, necrosis of the inflorescence and blackening of the unopened spathes. It is different from Bronze Leaf Wilt in that this disease is physiological and rarely fatal. Nevertheless, it is often confused with Red Ring disease since it has so far been found only in countries where Red Ring disease occurs. Internal symptoms are quite different in both diseases since in Red Ring there is a band of red tissue forming the ring which is characteristic of the disease. In Cedros Wilt the stem is without discoloration.

The epidemiology of both diseases however shows differences and Red Ring disease is normally associated with adolescent trees whereas Cedros Wilt is associated with trees of any age. With Red

Ring disease spread is confined to nearby young trees in any direction from a diseased tree; however, clusters of diseased trees that are nearly contiguous are formed with Cedros Wilt. Pathogenesis is shorter in Cedros Wilt. Diseased trees die within one month to six weeks from the time definite leaf symptoms are seen. In Red Ring disease death occurs between six weeks to three months on the average. In Trinidad, Venezuela, Ecuador, Colombia, Guyana, and Surinam the flagellate protozoan is also associated with a bacterium Micrococcus (agilis) roseus, which occasionally gives a red tinge to the diseased stem or inflorescence internally or alse the coconut meat. This bacterium caused the rotting of the bud after the tissue has died from starvation and/or toxins due to the rapidly growing population of flagellate in the phloem. The physical dimensions of the phloem apparently restrict the growth numbers and the plant dies from starvation. Micrococcus roseus is also present in the insect vectors and Asclepias.

The stink bug, Mecistorhinus sp. Palisot de Beauvois, is responsible for the outbreaks due to clusters in Trinidad when it is present on coconut palms. It takes the flagellate around from tree to tree when the leaves of the palms are contiguous. Crawling juveniles infected from one tree pass the flagellates over to the phloem of the healthy neighbouring contiguous palm of the same age or size. The eggs of Mecistorhinus sp. are heavily parasitised by the egg parasite Phanuropsis semi-flaviventris Giralt (Hym. Scelionidae). A heavy influx of these parasites can sometimes cause a dramatic reduction in the diseased clusters.

The primary vector, Oncopeltus, does not live on the coconut palm, it is merely an itinerant feeder on the leaves. It, however, also lives on Nerium oleander (Oleander, Apocynaceae) a shrub, originally a native of the Mediterranean, which is cultivated in Guyana as an ornamental

plant with white, pink and crimson flowers. Its leaves are poisonous to cattle. The flagellate P. elmassiani, also survives in the latex vessels of those plants without causing any overt ill-effects. From here it may be transmitted to the coconut palm by Oncopeltus during migration.

In situations where a study of the epidemiology shows that infection and the development of the epidemic is from a primary source, then the shrubs or weeds (Asclepias) represent the major focus of attack for control.

A special situation arises with the Pentatomid, the secondary vector, which lives on the leaves of the coconut palm. This relates to the rate of pathogenesis. When the wilting is rapid as a result of a huge initial inoculum from a large number of juvenile vectors, the leaves of the coconut tree fall to the ground when they are still capable of sustaining the development of the juvenile pentatomids. In the case of Mecistorhinus where the females exhibit 'parental care', large numbers of juveniles (over 100) develop during the incubation of the pathogen in the infected tree to infect the contiguous palm. As the leaves fall, their infected progeny survive on them on the ground. Eventually, in an epidemic, fallen leaves with infected juveniles which remain developing on the ground among grasses or other weeds become a major source of randomly dispersed extra cluster foci. At this time, control measures which utilize insecticides on the fallen leaves and at the bases of diseased trees can reduce significantly new foci of disease during the logarithmic phase of the epidemic.

Control measures directed to cluster formation relate to the immediate poisoning of infected trees which show the main positive symptoms of the disease i.e. nut-fall and rapid wilt. Immediate poisoning is directed to the insect vectors developing on the leaves

rather than to the flagellates which will eventually die as the functioning parts of the plant are killed. Since the pathogen is not known to sporulate or form cysts, then the dead tree is not a source of inoculum.

CEDROS WILT - NATIVE DISEASE, ENDEMIC DISEASE AND POSSIBLE CAUSES OF SPORADIC EPIDEMICS

That Cedros Wilt is native to the South American continent is a satisfactory concept. The age-long co-existence of hosts and collateral hosts (coconut palm, oil palm, Nerium sp. Asclepias) with their appropriate vectors dispersed throughout the continent permits a plausible hypothesis that the disease is also native to Guyana as well as endemic. In other words, the likelihood that a weed source which contains the pathogen is an essential requirement for the epidemic to begin, or even for the disease to be initiated in any district in Guyana, is now remote. On the other hand, this does not preclude the possible regularity of a collateral weed host being the cause of an outbreak. The statement therefore implies that both circumstances are possible and neither is mutually exclusive. However, it indicates that the epidemic will begin with only the conditions necessary to increase the population of the secondary vector. The situation is not unusual since, in Red Ring disease, the causal nematode multiplies only in the coconut palm, and does not survive after the death of the diseased palm. The nematode does not multiply in its insect vector and outbreaks depend on the increase in vector population.

Since, in Cedros Wilt disease, the pattern of spread is related to the phase of the transmission and also the vector, it will be easy to determine the conditions which were responsible for the outbreak of the disease and consequently the measure of control required. Of fundamental importance is the economic consequence of the outbreak related to the secondary phase of transmission, as with the Pentomid whose habitat is

the coconut palm. Such native diseases which become epidemic when the subsistence balance between host, pathogen and vector is disturbed, should always be made notifiable by legislation.

TO EVALUATE THE SURVEY OF THE INCIDENCE OF CEDROS WILT IN GUYANA AND TO ADVISE ON WHAT STEPS ARE NECESSARY TO HALT THE SPREAD OF THE DISEASE.

Survey Methodology

1. It was proposed to sample 10% of the coconut farms in each area (region) of the main producing areas of the country.
2. It was proposed that 50% of the sample should be farms of less than 5 acres; 25%, farms of 5-20 acres and 25%, of the farms above 20 acres.
3. This procedure resulted in a sampling of 5% of the small farms, 2.5% of tha medium size farms, and 2.5% of the large farms.
4. The farms were to be identified from maps to give a random distribution within the respective areas.
5. The actual sampling of the selected farms was carried out by trained coconut technicians who visited the farms individually and followed an imaginary diagonal transect counting the number of diseased trees per hundred trees for the required distance on the farm.
6. The coconut technicians made one count only on farms less than 5 acres and 3 counts on those larger than 5 acres. Large farms ranged in size to nearly 1000 acres.

TABLE 2

EXPECTED DISTRIBUTION
OF FARMS TO BE SAMPLED

Region	Total No. of farms	No. of farms to be sampled	Small farms less than 5 acres	Medium farms between 5-20 acs.	Large farms above 20 acres
1	135	13	13	—	—
2	412	41	20	11	10
3	398	39	20	10	9
4	672	67	34	17	16
5	525	52	26	13	13
6	718	71	36	18	17
	2,860	283	149	69	65

GENERAL RESULTS OF SURVEY BY INSPECTION

The survey concentrated on 5 out of the 6 coconut-growing regions in Guyana. The Regions are political divisions numbered from 1 to 6. Results from Region 1 were not available.

Most of the palms were of the tall (over 95%) variety and trees varied in age from 5 years to 80 years. The trees in the sample were generally on the mature side (above 40 years) and normally over-crowded in the larger fields. The smaller farms were conversely more sparsely populated. The incidence of disease ranged from 0.0% to 40.0% of the sampled areas. The higher percentage seemed nearly more frequently found in farms above 5 acres.

Field sanitation was the most prevalent means of attempting to control the disease i.e. farmers were cutting down diseased trees. Many conceded that in the short-run such measures were effective. A few farmers injected monocrotophos. Some farmers were attempting to control the weeds on their farms.

The disease showed a general picture of being in the logarithmic phase of its epidemic since individual control measures were not enough to contain the spread of the infection. The impression was that farmers had some education about the disease and were aware of what was to be done. Further analysis of the results will be done after a study of the sampling methodology.

COMMENTS ON SUGGESTED SAMPLING METHODOLOGY

As it is not normally possible to count all the diseased trees in a coconut growing zone or region, it is often necessary to estimate the population by sampling. This estimate, therefore, should have the highest degree of accuracy possible commensurate with the amount of money expended on such a programme. The sampling programme should, accordingly, lay down the distribution, size and number of samples which would be required. As there is no known universal method of sampling, the sampling

to determine the extent of Cedros Wilt should be resolved with the known pattern of distribution of the disease in mind. In short, some preliminary work should be done for the researcher to have quite clearly in his mind the exact nature of the problem that he is attempting to investigate. It may be useful to look at the pattern of spread of the disease and relate this to the suggested sampling methodology.

The Pattern of Distribution of Cedros Wilt

Quite certainly, there have been established 2 basic and distinct patterns in the form of the distribution of the disease. First, there is the more or less random distribution found with isolated individual trees; and secondly, there is a contagious pattern. The type of mathematical model that has been normally proposed to describe the random distribution in such situations as in Cedros Wilt is the Poisson series. It is important to understand that this does not imply an even or a uniform distribution; it, however, requires that the presence of one diseased tree does not unusually influence the position of another in the sampling area. This is obviously not the case when a clumping or concentric pattern obtains.

When a contagious or clumping distribution is the mode, the Poisson distribution cannot adequately describe the pattern using the single parameter as the variance which is equal to the mean. Instead, another parameter is necessary to describe the amount of clumping. A parameter referred to as dispersion exponent is often utilized. The negative binomial distribution is often used to describe this pattern since the insect vector of the pathogen crawls from the infected tree over to the contiguous healthy one and infects it to begin the clumping process. This would mean that the method of sampling must be one which would incorporate data for the dispersion exponent.

Sampling Regime

In most habitats a random sample can be selected by numbering the habitat on a grid system and using random numbers, either generated by a computer or found in the well-known table of random numbers. If coconut farms are to be randomly sampled and a map is to be used as the source of these discrete sampling units, then, of course, these should be numbered and selected by a random fashion. The reliability of the map must be consummate. Generally, the most serious limitation to the accuracy of the method of sampling a number of small estates or farms from maps, as has been suggested by the methodology, is the scale of the map versus the overall acreage to be surveyed. Small farms of less than 5 acres which are required to represent 50% of the sample population can become points on a map and may not even be represented individually at the most convenient scale for overall inspection of the zone under consideration. Moreover, when they are destined to represent such a large proportion of the population, their inaccurate determination will affect the entire sampling programme.

Another problem usually associated with monocropping zones, is that many small farms are virtually inseparable spacially from each other on a map, despite the fact that they belong to separate owners. If management practices on the farms do not have any independent and significant effect on the spread of the disease then, as far as the disease is concerned, such individualization of sampling units is without any serious significance if a standard sample size correlated with the overall volume to be sampled is established instead. A convenient method can be first, to randomize the names of the farm owners instead. After having selected the required number of farms, using the required size grid, sampling areas are then found at random per farm on location. Generally, with the appropriate sample size, the method of counting for diseased trees should be determined as that which would give the most reliable estimate for the amount of work expended and the nature of the statistical method required to analyse the estimate. The two patterns of distribution of the disease

should have been considered in the method of counting. In the event, as in this case, where the intention is to determine an estimate of the number of diseased trees in the coconut zone, an advantage would be gained by using total counts in the appropriate sample.

The Proposal to sample coconut farms instead of sampling coconut acreage

A random sample of 10% of the coconut farms may or may not be equivalent to 10% of the actual coconut growing acreage dependent on the size-distribution of the farms. The likelihood is that this is not itself randomly distributed. If, however, apart from 10% of the farmers, which in fact '10% of the farms' means, 10% of the coconut area is also required then some direct weighting should be done in order to ensure this. The prescribed sampling requirements indicate that 283 farms would be sampled to represent 10% of the population of farms with pure stands of coconuts. The estimated total of such farms in the country is 2,861. The estimated number of farms less than 5 acres from the national survey in 1978, is 2,354; 10% of this number being 235 out of a required 283 farms for the total sample. However, sampling instructions require only 149 of these farms (an estimated 250 acres). Sixty-nine medium farms (using an average acreage of 15 acres per farm. 5-20 acres) would give 1,035 acres. In the next category, the national survey shows that there are 26 farms over 50 acres (no maximum is given), 37 farms between 30 and 50 acres and 32 farms between 20 and 30 acres. If, as required, only 65 of the farms are selected randomly for the Cedros Wilt study (using 30 acres as a reasonable mean) the estimated acreage covered would be 1,950 acres. The overall total acreage to be sampled then would be estimated as 3,135 acres. From all appearances, therefore, the intention of the organisers of the Cedros Wilt Survey was also to sample about 10% of the acreage since the estimated acreage for the total 2,861 farms with pure stand of coconuts is 21,691 acres and 10% of this would be 2,169 acres. The surveyed figure is 14%.

Reliability of Sampling Procedure

Basically, in sampling accurately the required 10% of the coconut area for the purpose of making a reasonably valid extrapolation, the actual number and location of the sampling sites become important. The recommended technique was that one count should be made on farms less than 5 acres. That is one count per 5 acres as a base. If this were logically continued on a sampling grid, then a large farm of 20 acres should have 4 counts, and one of 50 acres should have 10 counts and so on. Instead, the recommended procedure indicated that only 3 counts should be done on all farms larger than 5 acres. Clearly, therefore, the estimated 250 acres or so occupied by the 149 small farms would have received intense sampling with 149 counts. Generally, with the spacing of coconuts on these small farms, 70-100 trees per acre, the entire area might have been counted because the sample required 100 prees per site. On the other hand, the other estimated 2,885 acres approximately would have received only 400 samples. This of course, does not include the possibility of the sample having some farms of several hundred acres as obtains for the largest class of farms.

Available and Reliable Data for Analysis of Prevalence Survey

Generally, therefore, the results from the smallest class of farms, i.e. farms less than 5 acres would be the most reliable to utilize in any form of statistical interpretation of the survey. The major limitations to this would have been the ease of location of these farms on a map for randomization and then their exact location on the ground. The analogy might be the use of a point transect on a large map and transferring this to the terrain to be sampled. The 250 acres approximately represent 1.15% of the coconut area irrespective of Regional demarkations and the Peisson distribution might be applied to the data. Finally, despite the fact that the sampling for the large farms is not particularly reliable, since accurate counts of diseased trees were made, the total of all these counts may be regarded usefully as the minimum total of disease that there is in the 3,000 acres or so that have been sampled. It, however cannot be extrapolated with any known degree of accuracy.

ANALYSIS OF RESULTS

Tables 1A and 1B show the recorded intensity of disease as a percentage of the sample of trees counted in farms of less than 5 acres. In the Poisson series the mean equals the variance. Thus, the variance divided by the mean should be equal to one. In this series, Table 1B shows the quantity (variance/mean) is 6.40; considerably greater than unity. Thus the diseased palms were distributed less evenly than is expected with a random distribution. In other words, there is great clumping associated with the diseased trees giving a patchiness in the overall distribution pattern. Table 1A confirms this by showing the actual frequency of samples with diseased trees of 12-16% is 8, whereas the expected amount is 0.004. Thus clumping of diseased trees has been previously referred to and is normally associated with the development of the epidemic in Cedros Wilt. The mean % of disease throughout the country is 2.61 utilizing 4.9 acres as maximum sample size.

The model referred to here is associated with the secondary vector, the Pentatomidae-Mecistorhinus sp., which crawls from coconut tree to coconut tree at the nymphal stage and so infects contiguous palms. The other model of the epidemic which is due to primary vectors associated with the milkweed plant Asclepias curassavica when it is present in abundance in certain farms represents a more even distribution of diseased trees which when analysed by the Poisson distribution generally gives a variance/mean ratio of less than unity before the epidemic. However, both patterns can show the Poisson distribution when the insect vectors first inoculate the initial palms. The pattern of spread of the disease during the logarithmic phase of the epidemic is therefore associated with the source of the inoculum and the particular vector. Therefore, in these farms of Guyana, the Pentatomidae or secondary vector is the agent of transmission with the diseased tree being the original source of the inoculum. The milkweed plant, or any other weed, therefore, is not important here during this phase in the spread of the disease.

TABLE 1A SAMPLES OF CEDROS WILT DISEASE IN THE REGIONS OF GUYANA

FREQUENCY OF DISEASED TREES IN SAMPLES TAKEN

IN FARMS LESS THAN 5 ACRES

% DISEASED TREES PER SAMPLE	FREQUENCY OBSERVED	FREQUENCY EXPECTED
0	42	6.70
1	10	17.46
2	11	22.80
3	9	19.81
4	3	12.93
5	1	6.75
6	2	2.94
7	1	1.10
8	3	0.36
9	0	0.11
10	1	0.03
11	0	0.006
12 - 16	8	0.004

TABLE 1 B. **SURVEY OF CEDROS WILT DISEASE IN THE REGIONS OF GUYANA**

(FARMS LESS THAN 5 ACRES)

REGION NO.	INTENSITY OF DISEASE (% TREES INFECTED IN SAMPLE)		
	Individual Samples	Total	Average
2	0 0 2 3 0 2 0 0 0 0 0 0 0 3 2 2 0 8	22	1.21
3	1 0 0 0 2 0 3 0 2 3 3 2 0 1 0 12 3 6	38	1.10
4	0 0 0 0 0 0 8 4 2 2	16	1.60
5	2 4 3 1 1 3 2 16 1 0 1 0 0 0 0 0 0 0 0 1 0 0 10	45	1.90
6	0 7 3 0 3.5 0 1 1 12 8 0 0 0 0 5 1 12 15 15 15 12 6	116.5	5.29

$\bar{x}$ = 2.61

$\Sigma (x)^2$ = 2124.25

$\Sigma (x)^2/n$ = 619.84

$\Sigma (x - x)^2$ = 1504.41

$x (n - 1)$ = 234.90

Mean (x) = 2.61

n = 91.

$\frac{\Sigma (x - x)^2}{x \ (n - 1)}$ = 6.40

$\frac{\text{Variance}}{\text{Mean}}$ = 6.40

The analysis of the data given so far is only an attempt to analyse the information present in individual sampling sites which have been randomly taken throughout the country. The mean 2.61 is a mean for the overall samples available. The fact that the information is non-orthogonal as far as the different Regions are concerned is not important to this kind of treatment of the information. However, any attempt to analyse the data to determine differences between Regions will be too unreliable if missing data were supplied by some adjustment formula. Finally, because these data represent the most reliable class in the sampling procedure, the other classes cannot be analysed in any detail statistically. The major theme in this analysis is the progress of the epidemic, both by the development of clumps and the development of extra-cluster foci for the development of new clusters or clumps. It is assumed from the survey that any level of intensity above 1% refers to more than one palm in the sample of 100 trees surveyed per count. Since there is no alternative, any level above 1% will be regarded as clumping or clustering. It does not matter how many clusters are formed in say 12% incidence, but just that there is clumping through which the epidemic can develop.

On the average, (Table 3) 63.2% of the samples taken show the presence of diseased palms. Region 3 shows the most , 75%, and region 6, the least, 53%. Clusters were observed in all samples (Table 3-A) Region 2 showed 89%; Region 3, 71%; Region 4, 58%; Region 5, 78% and Region 6, 86%. Since it is expected that new foci were formed from extra-cluster migration of the vectors, the potential for the continuation of the epidemic is the ratio of the number of samples without clusters to those with clusters. Thus, (Table 3-B) the disease is raging where the potency is high as in Region 4, and weakening in Region 2 where the potency is 1; with 89% of the clusters already formed.

Table 4 compares the types of spread in Cedros Wilt and Red Ring disease. The method of build-up in Red Ring is almost equivalent to infection due to the <u>Asclepias/Oncopeltus</u> relationship and quite different from cluster formation with the <u>Pentatomidae</u> in Cedros Wilt.

TABLE 3

POTENCY OF CEDROS WILT IN THE COCONUT GROWING REGIONS OF GUYANA

A. SURVEY OF COCONUT AREAS - RESULTS

REGION NO.	SAMPLING PROCEDURE			DISEASE INCIDENCE		
	Total No. of Samples Required	No. of Samples Obtained	% Sampling	No. of Samples with Disease	No. of Samples with Clusters	% of Clusters in Sample
2	41	40	98	27	24	89
3	39	32	82	24	17	71
4	69	52	77	31	18	58
5	52	52	100	31	24	78
6	71	69	97	37	32	86

TABLE 3

POTENCY OF CEDROS WILT IN THE COCONUT GROWING REGIONS OF GUYANA

B. POTENCY OF CEDROS WILT ($\bar{\phi}$)

Region No.	Ratio of Incidence in Samples (a) of Clusters (b)	No. of Extra-cluster foci (c) (a - b) = c	Potential for Clusters (c/b) 100	Index of Potency of Disease ($\bar{\phi}$)
2	24/27	3	12.5	1
3	17/24	7	41.2	4
4	18/31	13	*72.2	*7
5	24/31	7	29.1	3
6	32/37	5	15.6	2

* clusters are very active disseminators of infected vectors.

TABLE 4

FREQUENCY OF INDIVIDUAL PATTERNS OF SPREAD WITH

RED RING DISEASE AND CEDROS WILT DISEASE IN TRINIDAD

Type of Spread	Frequency observed and conditions	
1. SINGLE SOURCE OF INOCULUM	CEDROS WILT	RED RING DISEASE
(a) Unit infection (isolated)	Most common	Normal
(b) Contiguous spread	In crowded fields and close planting.	
(c) Cluster spread	Method of build up	
(d) Extended cluster	Beginning of epidemic	
(e) Extra cluster spread	Very active clusters Logarithmic phase	
2. MULTIPLE SOURCE OF INOCULUM		
(a) Multiple infection	On farms with *Asclepias/ Oncopeltus* as source of inoculum	Method of build up
(b) Random multiple infection	Logarithmic phase of epidemic.	Logarithmic phase of epidemic.

AN ANALYSIS OF REGION #4

The intensity of disease in Region 4 ranges from 0% - 40%. Farms here vary from 1 acre to 1,600 acres in size. One large farm (1,600 acres) is recorded as having no disease, whereas another of 1,000 acres has 40% in one sample, 20% in another, and 15% in a third count. One 6oo-acre farm has only 2% whereas another of 782 acres,5%. The medium-range farms of 100-200 acres show a high intensity between 6%-12%. On the other hand, the accurate counts of farms less than 5 acres show an average of 1.60%, a figure which is significantly below the overall mean of 2.61% for that population. The danger of expansion in the amount of disease lies in the potential of large farms. Some of these are heavily diseased and others are yet to show any incidence. However, because the disease is in its logarithmic phase in this region also, control measures should be intensified here especially among farmers holding large farms. (The Appendix to this section includes Region 4 for easy reference).

A major problem exists because of the close spacing of the trees. Since a rehabilitation programme is being planned, a strategem might be to mark off offending trees, which are old and poorly yielding, for destruction. Generally, these cannot earn their keep on the farm, but may become foci for disease or allow, if contiguous with others, clusters to build up.

CONTROL MEASURES FOR CEDROS WILT

The most effective control line would be to prevent clusters from developing, and, where necessary, enlarging. Normally, the infection rate within a cluster can be defined by the usual equation $dy/_{dt} = ry (1-$ ...... - (i) where y is the proportion of diseased tissue. The rate r is a sort of speedometer which varies as the circumstances change

As diseased plants capable of causing new infection are removed 'r' will drop to zero. Thus, infected palms must be treated in such a manner to prevent them from being a source of the pathogen. This required immediate poisoning (or burning) as the first signs of disease appear. On the other hand, the number of progeny per parent infection (diseased tree) is based on the Pentatomid vectors which may correlate with their efficiency as transmitters, with the disease eventually leveling off at an asymptote L according to a likely equation -

$L = 1 - e^{-iRL}$ - (ii) where iR is the average number of progeny per parent infection (palm). Since this will happen only once in the lifetime of the plant, timing is important for the removal of the infected palm. In other words, the effectiveness of eguation (ii) supercedes that of equation (1). Control measures should therefore be applied before the insect vectors become sufficiently active or before they become infectious, whichever is first (Figure 1).

To a large extent, the factors which cause dispersion of the Pentatomid vectors while they are in the crawling stage as wingless juveniles are not known. In any event, the individual coconut leaf becomes the first place in which to live and provide all the food before the phloem becomes non-functional by occlusion with flagellates. Since these insects are phloem feeders, they are forced to migrate to a healthy leaf which generally is one on a non-infected tree. Thus, in the later stages of the disease, i.e.: as the leaves wilt, the diseased palm cannot support phloem-feeders even though they might support other insect species which occupy a different niche and feed on intra-cellular tissue or chunks of cells as chewing insects do. It is this critical phase which must be addressed in the timing of control measures.

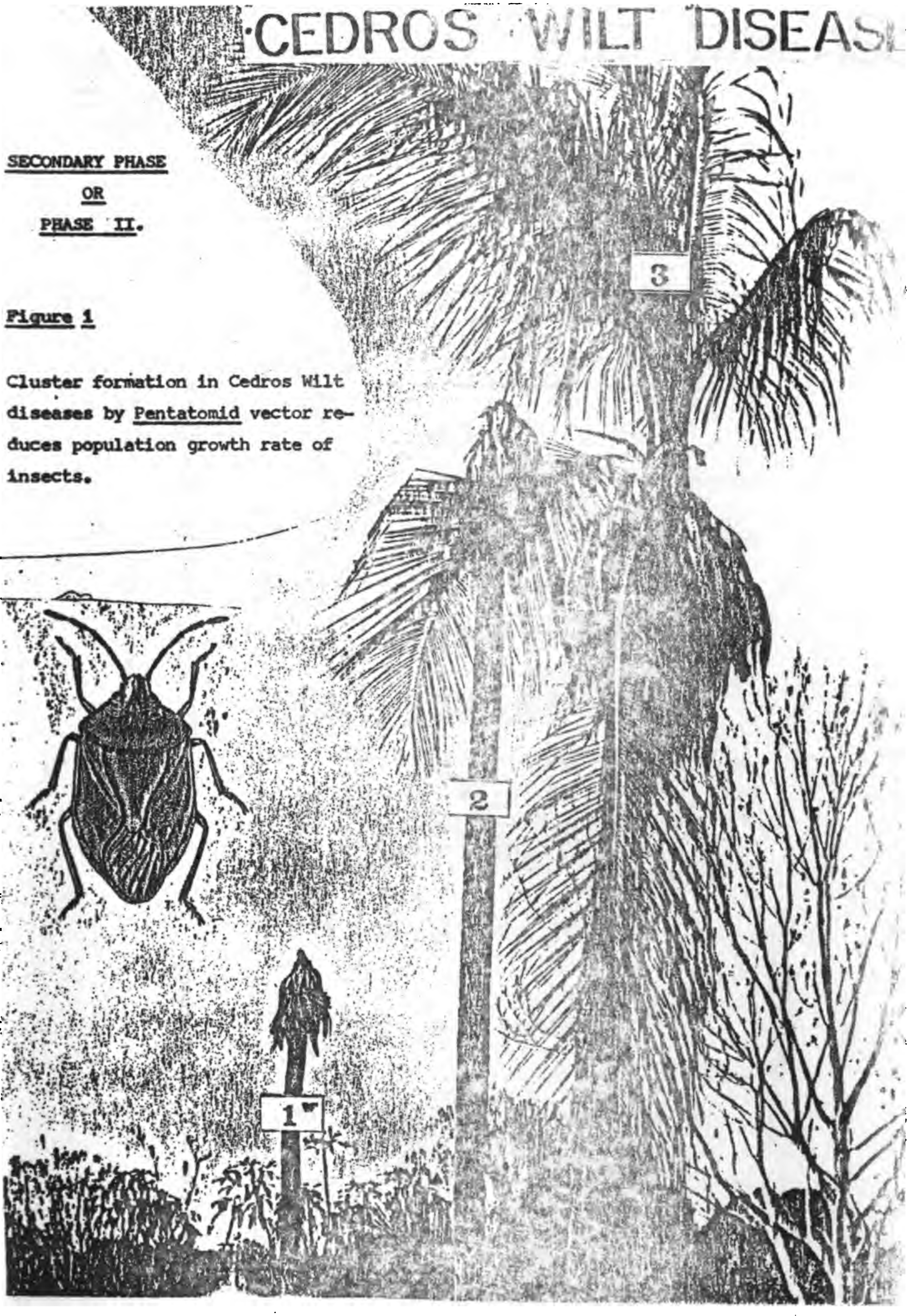
Conversely, the isolated palm which wilts rapidly before the juveniles have wings automatically restricts the spread of the disease, since without nutrients, the vectors are unable to complete their metamorphosis and fly away to mate, oviposit and feed on healthy tissue which becomes infected. It is often because of this, that epidemics fail to

develop when only the secondary phase of spread is the more common form. Nevertheless, the disease can remain at a sub-epidemic level until conditions for vector population increase appear. To a large measure, Cedros Wilt appears in epidemic forms in relatively abandoned estates.

That the Pentatomid species must have the coconut palm as its primary habitat is important to appreciate. Otherwise, isolated palms would serve as outbreak centres. On the other hand, since the population of the Pentatomid can develop naturally on coconut palms with its inherent parasites and predators, the infective vector population becomes a function of the number of diseased palms which, as they increase in number on any farm act, by themselves, as a form of environmental pressure on the increase of the species as a whole.

HYPOTHESIS FOR CEDROS WILT

The hypothesis to be cited is: Given a certain increase in the Pentatomid population (Mecistorhinus sp.) in the presence of Cedros Wilt which is endemic in a country, that the disease will increase to a level such that would bring the vector species back in phase with the other controlling factors of the ecosystem (Phanuropsis semiflaviventris) and cause the disease eventually to level off at an asymptote keeping it endemic without completely destroying the farm. The corollary is that complete destruction of the remaining palms can result from an abundance of weed hosts (Asclepias curassavica) supplying continuously itinerant vectors (Oncopeltus) which feed randomly on individual palms and cause random multiple infection and final destruction of the farm. Thus, the agro-ecosystem by removals and reduction of vector population controls the disease in the secondary phase.



SECONDARY PHASE

OR

PHASE II.

Figure 1

Cluster formation in Cedros Wilt diseases by Pentatomid vector reduces population growth rate of insects.

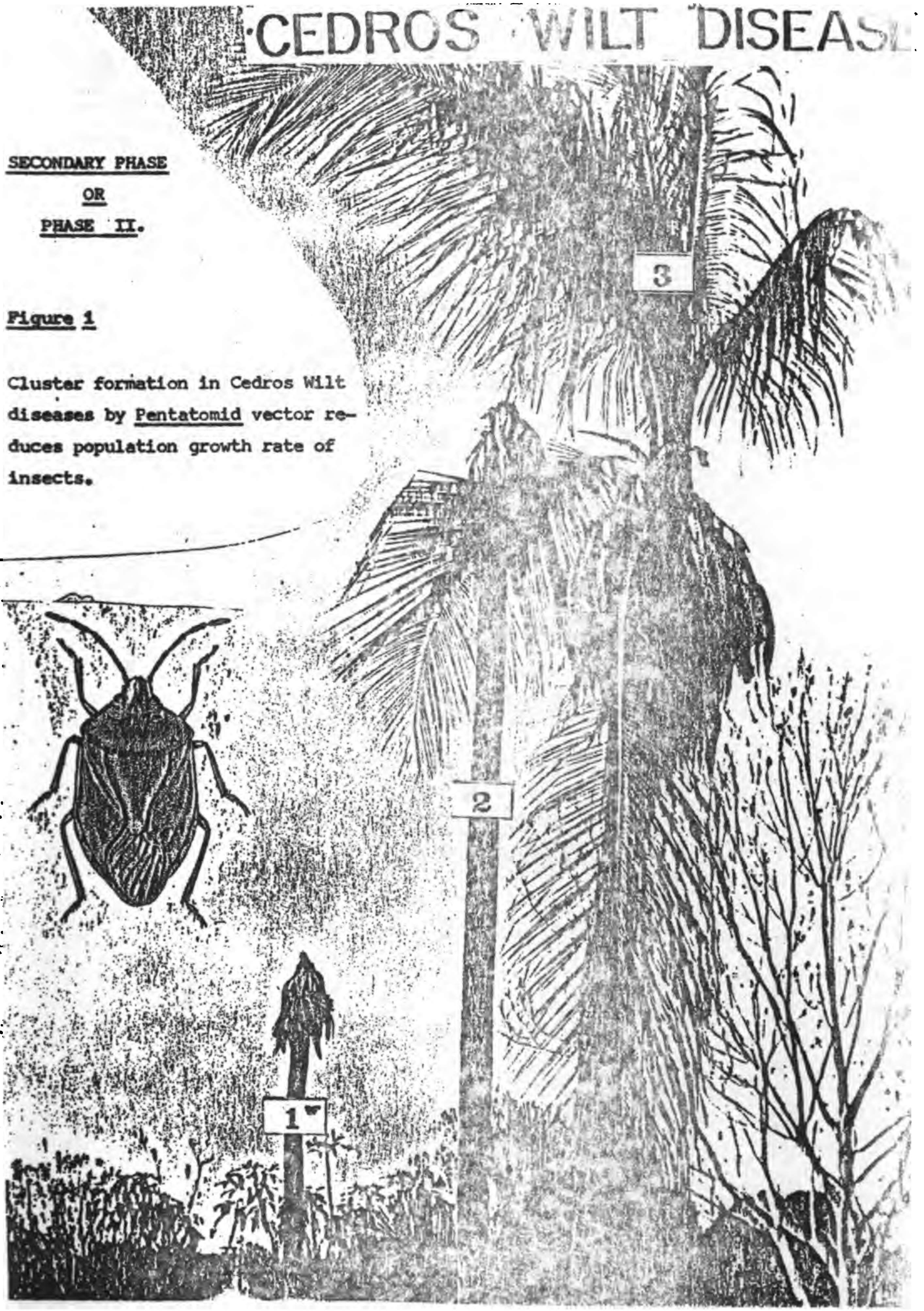
SECONDARY PHASE

OR

PHASE II.

Figure 1

Cluster formation in Cedros Wilt diseases by Pentatomid vector reduces population growth rate of insects.



CEDROS WILT PREVALENCE SURVEY

Name of Technician: Khemraj Persaud. Survey Area: STRATSpey to Belair – Region # 4 Survey Period: 6/3 – 2

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Palms	4. Average Age of Plantation	5. Variety Planted Tall	5. Variety Planted Dwarf	6. Planting Density (Palms/acre)	7. No. of existing palms per acre	8. Cedros Wilt Present Yes	8. Cedros Wilt Present No	9. Disease Intensity	*10. Control Measures Applied N	*10. C/D	*10. O	**11. Farmer Evaluation of Effectiveness E	**11. NE	12. Remarks
Arjun	Mon Repos Line Dam	4.5 acs	25 yrs.	100%	–	38	38	–	✓	–				–	–	
Sam	Annandale Line Dam	4 "	35 "	100%	–	35	34	–	✓	–				–	–	
Eric	Lusignan Line Dam	5 "	35 "	100%	–	35	34	✓	–	1%		✓	✓	✓	–	
Singh	Good Hope Burial Ground	5 "	25 "	75%	25%	40	40	–	✓	–		–		–	–	
Rohanie	Success Back Lands	4 "	25 "	100%	–	30	32	–	✓	–				–	–	
Seetaram	Chateau Margot	4 "	25 "	100%	–	35	35	–	✓	–			–	–	–	
Gulabdeen	B.V Line Dam	5 "	30 "	100%	–	40	39	–	✓	–			–	–	–	
George	Vryheids Lust	5 "	30 "	100%	–	35	34	–	✓	–			–	–	–	
Harrichand	Industry U.G. Rd.	4.5 "	30 "	100%	–	35	30	–	✓	–				–	–	
Bankay	Nando Garden	4.5 "	30 "	60%	40%	25	28	–	✓	–		–		–	–	
Rambissoon	LBI Estate	5 "	40 "	100%	–	25	25	–	✓	–		–		–	–	

*10. N – None; C/D – Cut down; O – Other.
**11. E – Effective; NE – Not effective

YANA CEDROS WILT DISEASE

prepared for publication in the ... LANDS & SURVEYS DEPARTMENT, ... OF AGRICULTURE ... January 1978

GUYANA CEDROS WILT DISEASE

CEDROS WILT PREVALENCE SURVEY

Name of Technician: Ian Adams.....   Survey Area: Belair To East Bank – Region #4   Survey Period: 16/4/..

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Pal:	4. Average Age of Plantation	5. Variety Planted Tall	5. Variety Planted Dwarf	6. Planting Density (Palms/acre).	7. No. of existing palms per acre	8. Cedros Wilt Present Yes	8. Cedros Wilt Present No	9. Disease Intensity	*10. Control Measures Applied N	*10. C/D	*10. O	**11. Farmer Evaluation of Effectiveness E	**11. NE	12. Remarks
Romnarine Budhoo	Kingston			–	100%			✓	✓			✓	✓	✓		(118)
Charles Bowen	"			100%	~~100~~			–	✓			–	–	–		(119)
Parbattie Singh	"			–	100%			–	✓			–	–	–		(120)
Paul Primo	Campbellville			100%	–			–	✓			–	–	–		(121)
R. Seeley	"			100%	–			✓	–	1/1		✓		✓		(122)
Trevor Smith	"			100%	–			✓	–	2/4		✓		✓		(123)
Resident	Meadow Brook			100%	–				✓		✓					(124)

*10. N – None; C/D – Cut down; O – Other.
**11. E – Effective; NE – Not effective

CEDROS WILT PREVALENCE SURVEY

Name of Technician: I.A.W. Adams..... Survey Area: Belair to Fort Berne - Region #4 Survey Period:

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Palms	4. Average Age of Plantation	5. Variety Planted		6. Planting Density (Palms/acre).	7. No. of existing palms per acre	8. Cedros Wilt Present		9. Disease Intensity	*10. Control Measures Applied			**11. Farmer Evaluation of Effectiveness		R...
				Tall	Dwarf			Yes	No		N	C/D	O	E	NE	
Residents	Fourth St. Agricola			100%	–			✓		1/2		✓	✓	✓		
Residents	31/32 Lamaha St.			100%	–			–	✓							
M Johnson	112 Sect. M C/ville.			100%	–			–	✓							
Arthur Thomas	South Ruimveldt Gdns.			100%	–			✓	–	1/4		✓	✓	✓		
Resident	Meadow Brook			100%	–			✓	–	1/2		✓	✓	✓		
"	"			–	100%			✓	–	4/1		✓	✓	✓		
"	"			100%	–			✓	–	1/3		✓	✓	✓		
Edward Stigrattan	Agricola			–	100%			–	✓			L	–	–		
Lawrence Surrender	Agricola			Hybrid 100%				–	✓			–	–	–		
Residents	"			Hybrid "	100%			✓	–	1/3		✓	✓	✓		
Maybel Anstrong	"			Hybrid "	100%			✓	–	1/1		✓	✓	✓		
Hazra	Kingston			–	100%			✓	✓			✓	✓	✓		

*10. N – None; C/D – Cut down; O – Other.
**11. E – Effective; NE – Not effective

CEDROS WILT DISEASE

CEDROS WILT PREVALENCE SURVEY

Name of Technician: Chandrika Persaud   Survey Area: Hope to Enterprise Region #4   Survey Period:

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Palms	4. Average Age of Plantation	5. Variety Planted: Tall	5. Variety Planted: Dwarf	6. Planting Density (Palms/acre).	7. No. of existing palms per acre	8. Cedros Wilt Present: Yes	8. Cedros Wilt Present: No	9. Disease Intensity	*10. Control Measures Applied: N	*10. C/D	*10. O	**11. Farmer Evaluation of Effectiveness: E	**11. NE
Ramchel	Helene #2	14 acres	60 yrs	100%	-	50	41	✓	-	4% 3%		✓	✓	✓	
Ramchal & Sasenarine	Helene #2	14 "	60yrs.	100%		48	44	✓	-	3%		✓	✓	✓	
Sasenarine	Helene #2.	14 "	60yrs.	100%		48	43	✓	-	40%		✓	✓	✓	
P. Billar (3)	Supply	35 "	85 "	100%		55	50	✓	-	3%		✓	✓	✓	

*10. N - None; C/D - Cut down; O - Other.
**11. E - Effective; NE - Not effective

REGION #4

CEDROS WILT PREVALENCE SURVEY

Name of Technician: Chandrika Persaud   Survey Area: Hope To Enterprise Region #4   Survey Period: ..

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Palms	4. Average Age of Plantation	5. Variety Planted: Tall	5. Variety Planted: Dwarf	6. Planting Density (Palms/acre).	7. No. of existing palms per acre	8. Cedros Wilt Present: Yes	8. Cedros Wilt Present: No	9. Disease Intensity	*10. Control Measures Applied: N	C/D	O	**11. Farmer Evaluation of Effectiveness: E	NE	Re
Boodoo & Sons Ltd.	Spring Hall Mahaica	1000 acres	48 yrs.	100%	-	55	30	✓	-	40%		✓	✓	✓	-	[illegible]
-do-	-do-		48 yrs.	100%	-	55	44	✓	-	28%		✓	✓	✓		[illegible]
-do-	-do-		48 yrs.	100%	-	55	43	✓	-	15%		✓	✓	✓		[illegible]
Jailall Kissoon (3)	Cove & John	125 "	45 "	100%	-	-	-	✓	-	12%	✓		-	-	-	[illegible]
Kaydarnath (3)	Nabaclis Backlands	1 h "	45 "	100%	-	50	46	✓	-	2%	-	✓	✓	✓	-	[illegible]
Robert Chester	Cane Grove	3 "	45 "	80%	20%	45	35	✓	-	4%	-	✓	✓	✓	-	[illegible]
Valentine	Nabaclis	1 acre	~~10~~ 40 "	100%	-	50	47	✓	-	2%		✓	✓	✓	-	[illegible]
Ronald Elias	Nabaclis	3 acres	20 "	100%	-	55	52	✓	-	2%		✓	✓	✓	-	[illegible]
Hope Cnut Ind Ltd.	Pln. (West) Hope	1600 "	2-40 "	28%	72%	15	34	-	✓	-		-	-	-	-	[illegible]
"	Lowland Hope	"	"	100%	-	~~20~~ 24	~~25~~ 35	-	✓	-		-	-	-	-	[illegible]
"	Hope Dochfour	"	"	100%	~~3%~~	~~30~~ 20	~~34~~ 20	-	-	~~2%~~		-	-	-	-	[illegible]
Rana Mara (3)	Cove & John	600 "	60 yrs.	99%	1%	30	34	✓	-	2%		-	✓	✓	-	[illegible]

*10. N - None; C/D - Cut down; O - Other.
**11. E - Effective; NE - Not effective

Other - Weed Control
Spraying cut down Palm with Monocrotophos.
effectiveness of Treatment not yet obvious.

CEDROS WILT DISEASE

YANA

and prepared for publication in the ... DIVISION, LANDS & SURVEYS DEPARTMENT, ... STRY OF AGRICULTURE

Revised January 1978

CEDROS WILT DISEASE

REGION #4

CEDROS WILT PREVALENCE SURVEY

Name of Technician: J. G. Harricharan   Survey Area: Mahaica to Clonbrook - Region #4   Survey Period: 18/3 - 11/4

1. Name of Farmer	2. Location of Farm	3. Size of Plantation or No. of Palms	4. Average Age of Plantation	5. Variety Planted: Tall	5. Variety Planted: Dwarf	6. Planting Density (Palms/acre)	7. No. of existing palms per acre	8. Cedros Wilt Present: Yes	8. Cedros Wilt Present: No	9. Disease Intensity	*10. Control Measures Applied: N	*10. C/D	*10. O	**11. Farmer Evaluation of Effectiveness: E	**11. NE	12. Remarks
(Bharat Latchman) Bobby's Estate (2)	Unity	11 acres	70 yrs.	98%	2%	61	49	✓	–	2%		✓	✓	✓	–	
Jaipargas (2)	Lancaster Village	10 "	50 "	98%	2%	63	60	✓	–	3%		✓	✓	✓		
Harold Rajnarine (3)	Pln. Orange Nassau	219 " ?	100 "	97%	3%	140 (~~1?0~~)	113 (~~120~~)	✓	–	6%		✓	✓	✓		Control/measures to be verified
Jailall Kissoon (3)	Beehive	782 "	30 "	90%	–	40	30	✓	–	5%		✓	✓	✓		
Aleem (1)	Strathaven	3 "	85 "	100%	–	55	34	✓	–	8%		✓	✓	✓		
Denis Rajnarine (3)	Cane Grove / Orange Nassau	219 " ?	100 "	98%	2%	161	122	✓	–	10%		✓	✓	✓		

*10. N - None; C/D - Cut down; O - Other.
**11. E - Effective; NE - Not effective

SHORT COURSE FOR RESEARCH ORIENTED OFFICERS

AN ANALYTICAL APPROACH TO CEDROS WILT DISEASE OF COCONUTS

by

Reginald Griffith D.Sc.

A HANDBOOK OF METHODOLOGY

TRAINING COURSE FOR COCONUT RESEARCHERS

Foreword

The following training programme was undertaken with all the Coconut Assistants. The emphasis in this case being to determine the differences, based on external symptoms, between Red Ring, Cedros Wilt and Bud rot. The identification of Cedros Wilt was stressed at that level. Together with these, demonstrations were made of the nature of the cluster formation and the kind of vector expected. Control measures emphasised here were those which would break the cluster and prevent extra-cluster formation. Timing therefore was emphasised as being critical in the control exercise.

At the level of the coconut researchers, the nature of the protozoan parasite was discussed and its relationship with Micrococcus roseus emphasized in assisting in tracing the secondary vector which was a phloem feeder. The effect of a rapid wilting palm on the development of the vector was related to certain control measures found to be working experimentally in Suriname when the base of the diseased palms were sprayed with an insecticide.

Equipment and training facilities are available at the Red Ring Research Division, Trinidad. Both the Entomologist and the Pathologist working on the programme in Guyana have been invited to visit for adequate periods where practical training can be achieved through working experience with the associated organisms in the disease.

Introduction

Coconut diseases may be classified as those affecting the bud, leaves, stem and roots; and those which are systemic: like the wilts that may eventually cause symptoms to appear on all plant organs. Pathological wilting is often denoted by symptoms of a derangement of water-balance caused by pathological agencies. Eventually, the plant loses vitality and dies. Some fatal diseases of the coconut palm usually involve, and generally terminate with the rotting of the bud. Often the rotting of the bud may be a secondary feature only and not a primary part of the disease syndrome.

I want to emphasize the death of the bud as a visible symptom in many fatal wilt diseases of the coconut palm. This occurs, for example, in Lethal Yellowing of Jamaica, Guam disease of Guam and Cadang-Cadang of the Philippines. The historical background of some of these diseases reveals that the name bud-rot was, at some time, applied to them. This circumstance of the term bud-rot is also of particular importance to the symptomatology of wilt diseases in the Caribbean area.

Around 1900 all diseases of the coconut palm with a rotting bud were grouped together under the general name of budrot. However, the work of Stockdale and Nowell, between 1910 - 1920, allowed this complex of Latin American coconut diseases to be then separated into three categories. They were:

1. Budrot (due to Phythophtora palmivora)
2. Red Ring Disease
3. Wilt Disease (called West-End Budrot of Jamaica or bacterial budrot)

Later on the third category was broken down into:

(a) Lethal Yellowing Disease

(b) Cedros Wilt or Hartrot (the majority of Bacterial Budrot) and the remainder,

(c) Bronze Leaf Wilt. The counterpart in Brazil to the disease was Queima das Folhas.

SYMPTOMS AND DISTRIBUTION OF CEDROS WILT DISEASE

The characteristic symptoms of this disease, Cedros Wilt or "La Marchitez de los Cedros" in Latin America and "Hartrot" in Surinam, are as follows: There is initially, a sudden wilting of the lowest leaves of mature trees progressing in order upwards around the stem, but not affecting the crown leaves. This phase may be very rapid, within a fortnight; or progress slowly during 4 to 8 weeks. The second major characteristic of the disease is the death of the terminal bud and the putrefaction of the heart. This results in the complete breaking-off of the crown with green leaves which are only slightly wilted when the original phase is a rapid wilt. Nut fall is characteristic; calyces ggenerally remain on the inflorescences. There is a dry necrosis of the inflorescence beginning at the tips of the rachis. In advanced cases, the unopened inflorescences are necrotic. The affected mature fruit shows a blackening of the endocarp. Internally, the stem shows no discoloration. The roots show some drying-out with cortical decay. Palms of all ages are attacked.

Usually, the diseased trees are single and isolated among healthy palms. Less frequently, a group of 2 or 3 contiguous palms develop symptoms, in tandem, within 2 months of each other. Infrequently, clusters of 6 - 8 trees are found to reveal a similar succession of infection and death. In cases of outbreaks, large tracts of disease develop following the same pattern to destroy several hundred hectares.

The international distribution of the disease coincides with that of the milkweed, Asclepias curassavica, Asclepidaceae, which is present on the coasts of Central America, the West Indies and South America as far as Brazil. This typical weed houses the protozoan flagellate Phytomonas elmassiani in the latex vessels and hosts insects of various species of Oncopeltus, an animal host to the flagellate. These 3 organisms are produced in the coconut agroecosystem in all countries where the disease has been found: Mexico, Ecuador, Guyana, Venezuela, Trinidad and Tobago, St. Vincent and Surinam, Brazil and Columbia.

SYMPTOMATOLOGICAL COMPARISON BETWEEN

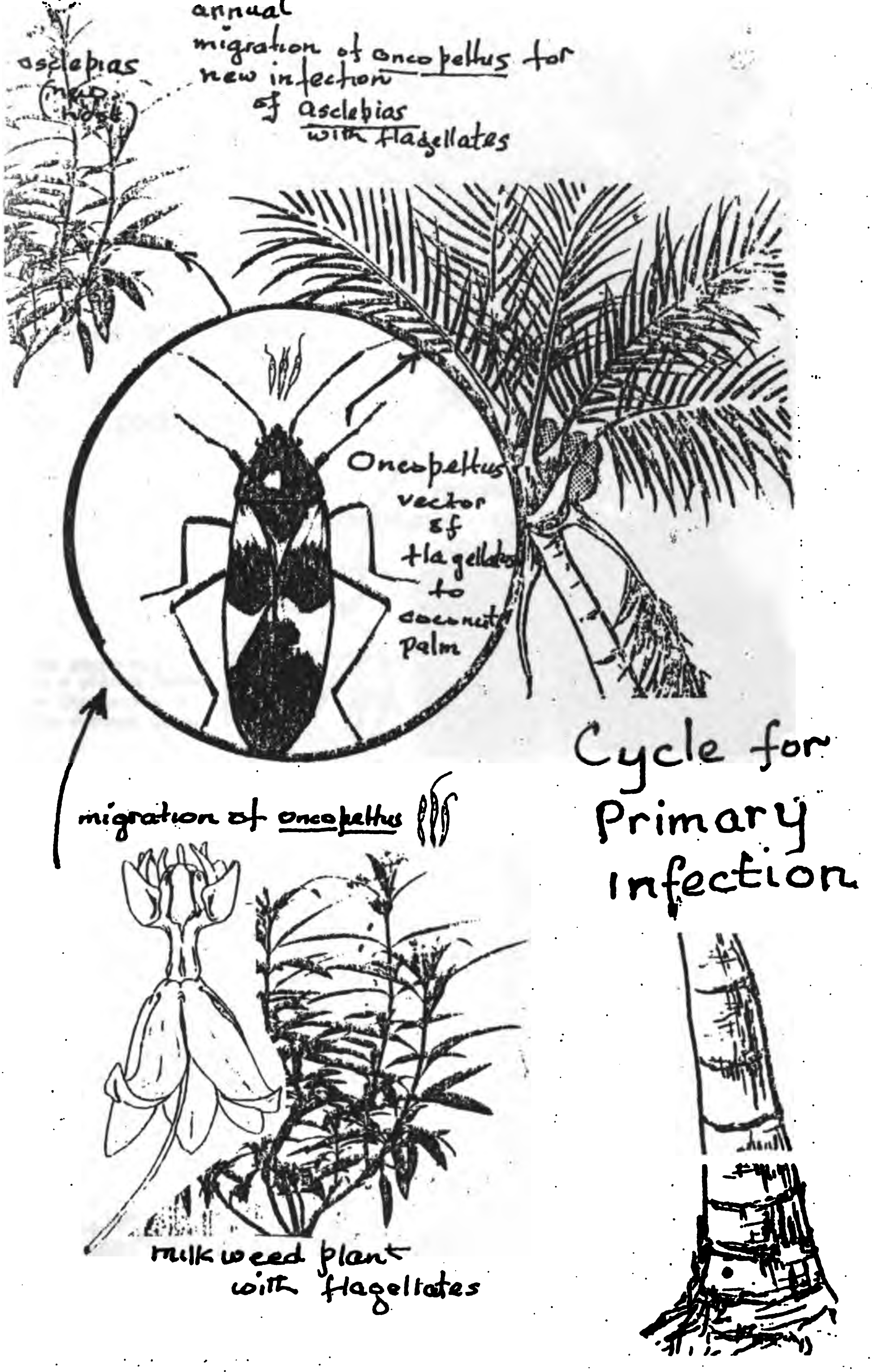
BRONZE LEAF WILT, CEDROS WILT AND RED RING DISEASE

	Bronze Leaf Wilt	Cedros Wilt	Red Ring Disease
Prognosis:	Non-fatal or rarely fatal.	Fatal - within 30 days of definite symptoms; independent of age of tree.	Fatal - 6 weeks to 3-6 months after symptoms or longer in old trees.
Nature of Disease:	Non-infectious physiological disease - Blocks of trees with same stage of ill-health	Infectious different stages of infection in the field; rapid wilting.	Infectious different stages of infection in the field; gradual wilting.
Symptomatology:			
Apex;	No death of bud normally. If death, no putrefaction.	Death of bud and strong odour of decaying cabbage or rotting sardines.	Death of bud, but no putrefaction
Leaves:	Sudden bronzing of all leaves.	Gradual yellowing in order of age beginning with lowest; rarely reaching crown leaves before death.	Gradual yellowing in order of age of all leaves starting from lowest leaf.
Nuts:	All nuts fall prematurely.	Nuts fall prematurely leaving calyx; necrosis of inflorescence.	Premature nut fall generally; nuts retain calyx.
Stem:	No discoloration in section.	No discoloration in section.	Red ring (or cylinder) of necrotic tissue (characteristic)

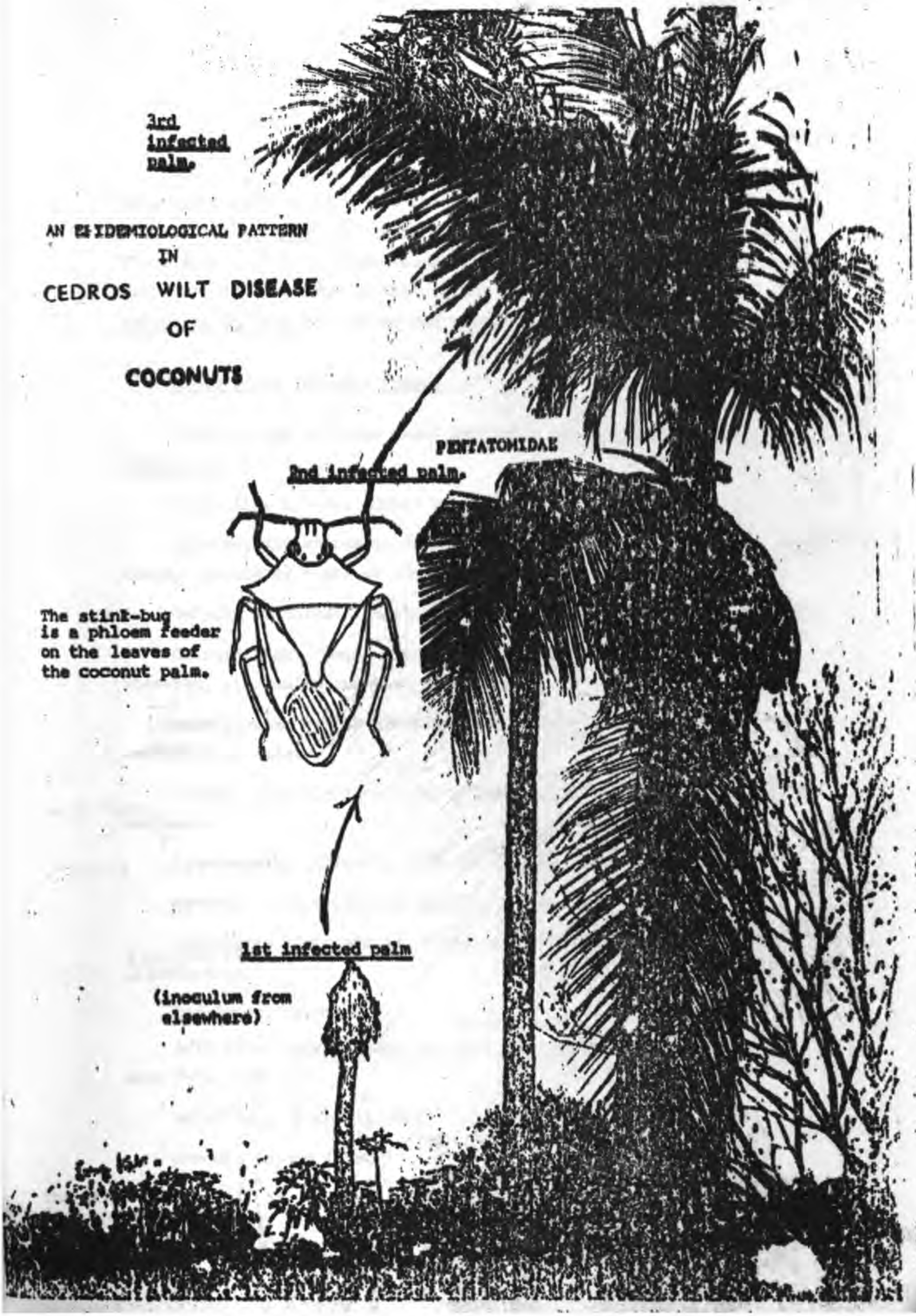
SYMPTOMATOLOGICAL COMPARISON BETWEEN

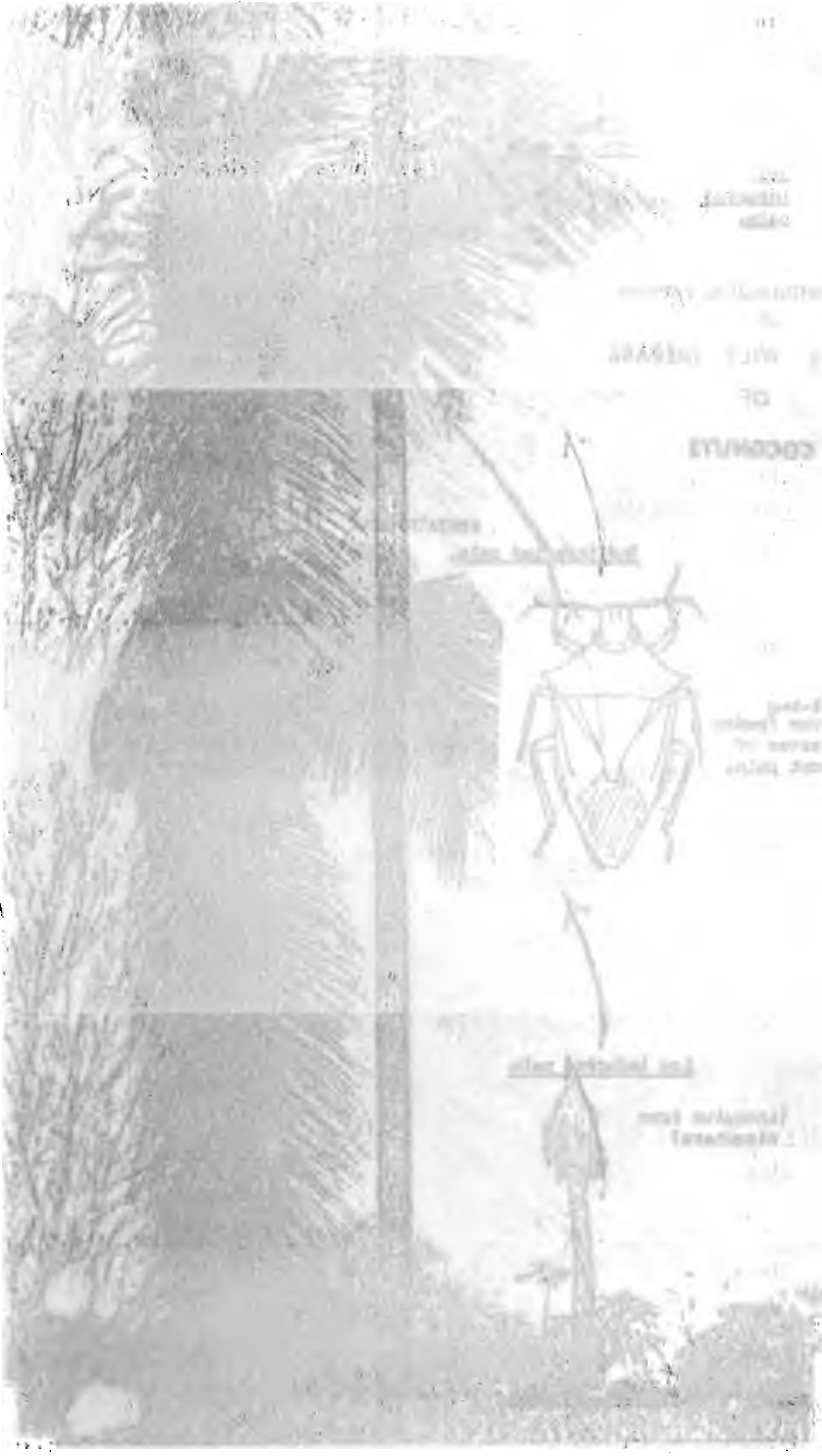
BRONZE LEAF WILT, CEDROS WILT AND RED RING DISEASE (Cont'd)

	Bronze Leaf Wilt	Cedros Wilt	Red Ring Disease
Symptomatology:			
Roots:	Some drying out.	Drying out of all roots; necrosis of tissue	Necrosis of tissue and death - reddened tissue.
Inflorescence:	Drying from tip.	Necrosis both in unopened and opened inflorescence.	Drying up of inflorescence but no necrosis.
Susceptible Age of Tree:	Throughout life; most pronounced in mature trees.	Palms in the upper storey at any age.	Palms: 3-10 years most susceptible; older trees die more slowly


annual migration of oncopeltus for new infection of asclepias with flagellates
asclepias
Oncopeltus vector of flagellates to coconut palm
migration of oncopeltus
milkweed plant with flagellates
Cycle for Primary Infection

AN EPIDEMIOLOGICAL PATTERN IN CEDROS WILT DISEASE OF COCONUTS





ASSOCIATED MICRO ORGANISMS

Two species of micro organisms have been found in diseased palms internally associated in the phloem elements. These are the protozoan flagellate, Phytomonas, and a bacterium, Micrococcus (agilis) roseus. The flagellates were first found by Waters (1976)[3] and the bacterium by Griffith (1977)[2]. The initial vector to pathogen in Trinidad is Oncopeltus cingulifer and the second vector is Mecistorrhinus sp.

Micrococcus (agilis) roseus

Found in the milkweed plant Asclepias curassavica and Oncopeltus cingulifer.

a'gi. lis. L. adj. agilis agile.

Spheres, 1.0 micron in diameter, occurring singly, in pairs and in fours. Motile by means of one or two flagella. Gram-variable.

Gelatin colonies: Small, gray, becoming distinctly rose-colored.

Gelatin stab: Thin, whitish growth in stab. On surface think, rose-red, glistening growth. Generally slow liquefaction.

Agar slant: Growth glistening, dard rose-red, lobed with much variation in color.

Broth: Slightly turbid, with slight, rose-colored ring and pink sediment.

Litmus milk: Slightly acid, pink sediment.

Potato: Slow growth as small, rose-colored colonies.

Loeffler's blood serum: Pink, spreading, shiny, abundant. Slow liquefaction.

Indole not produced.

Acid from glucose, sucrose, insulin, glycerol and mannitol. No acid from raffinose.

Nitrites produced (trace)

Ammonia formed (trace)

The Frequency of occurrence of Micrococcus and flagellates together in various Parts of diseased coconut palms with Cedros Wilt

Plant Part	Frequency of Bacteria and Flagellate together	Frequency of Flagellate (With/without Bacteria)	Frequency of Bacteria (With/without Flagellate)
Inflorescence	25.0%	25.0%	70.0%
Crown	28.57%	42.86%	71.43%
Petiole and Leaflets	80.0 %	80.0 %	100.0 % *
Spear	50.0 %	62.5 %	75.0 %
Roots	48.0 %	53.2 %	80.0 %

* site of infection

THE PROTOZOAN FLAGELLATE AND ITS ASSOCIATION WITH DISEASED PALMS

The organisms are invariably restricted to the mature sieve elements. They are not present in other phloem cells, the xylem or the contiguous ground tissue. The flagellates are oriented with their longitudinal axes parallel to the longitudinal axis of the sieve element. The organism varies in their numbers per infected cell but often they are densely packed.

Flagellates isolated from tissues by squeezing with a pair of pliers have a promastigote morphology. The body is finely tapered posteriorly and blunter anteriorly where a single robust flagellum is inserted within a flagellar reservoir. Organisms are 1-1.5 um across at the widest point and approximately 27 um long, including the flagellum which is approximately 7 um long. Many of the flagellates expressed from fresh or fixed tissues are twisted; in preparations made of living flagellates the twisted forms are as active as the non-twisted forms. Swimming activity is rarely observed in flagellates from the coconut, the organisms remaining more or less stationary, flexing the body so that the anterior is brought round towards the posterior.

Table 1

Numbers of sieve elements containing Phytomonas in healthy and diseased inflorescence samples (Waters, 1978)[4]

	Healthy Palms A	Healthy Palms B	Diseased Palms A	Diseased Palms B
Mature sieve elements containing Phytomonas	0	0	1955	1076
Mature sieve elements without Phytomonas	615	1295	256	137
% affected sieve elements	0	0	88.4	88.7

The trypanosomatid flagellate

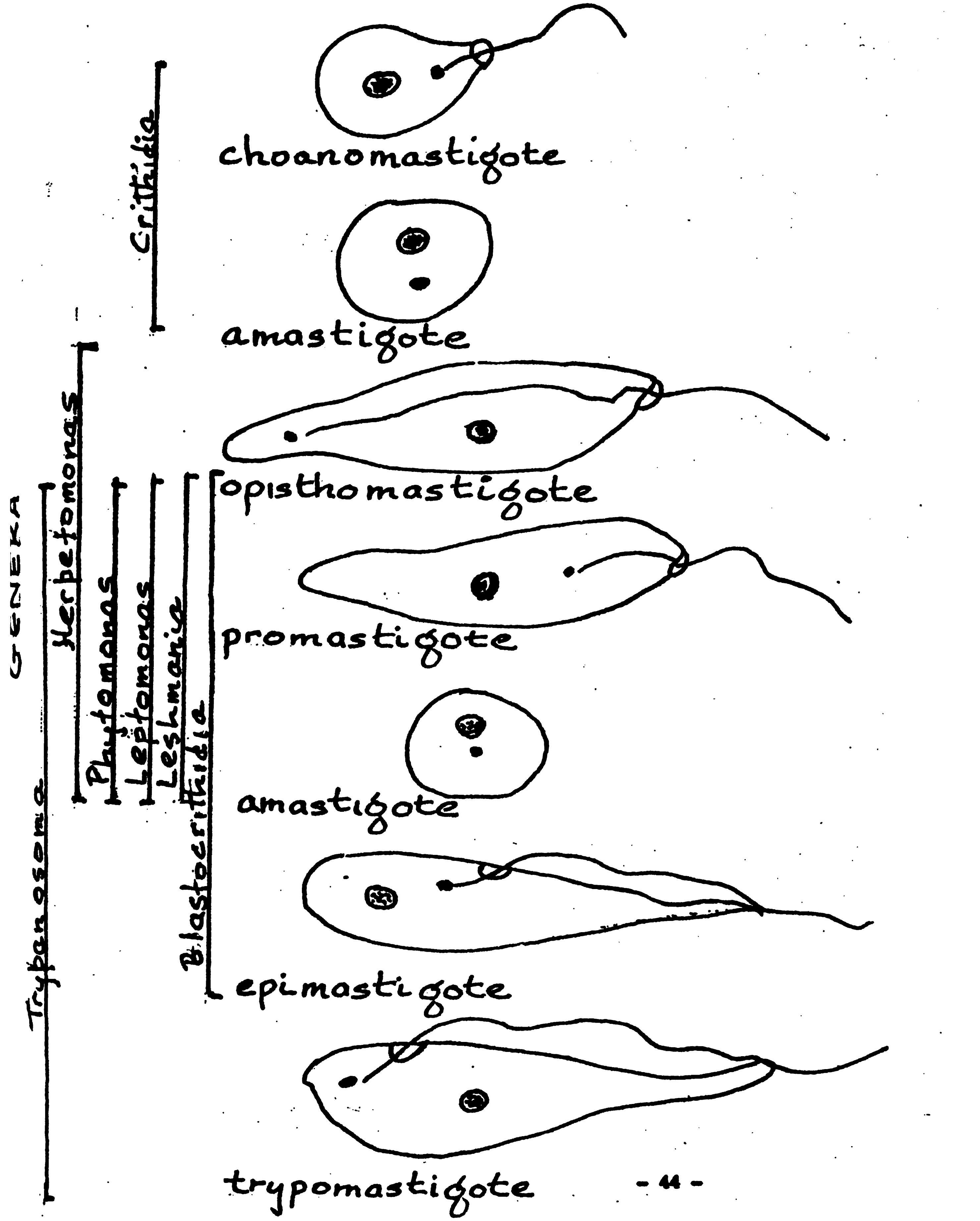
The term "trypanosomatid flagellate" will be taken to include all members of the family Trypanosomatidae. The family constitutes a natural group of entozoic organisms which are characterised by the presence of a single flagellum (except in the leishmanial or amastigote stage), arising from a basal granule situated close to a disc-shaped, Feulgen-positive structure known as the kinetoplast. The position of the kinetoplast relative to the nucleus and the point at which the flagellum emerges from the cell vary considerably in different developmental stages of these organisms and these features have been used to provide a basis for the subdivision of the family into a number of genera. Recent taxonomic studies based on both light and electron microscopy have led to a revised classification of the Trypanosomatidae and to the introduction of new terms to denote different developmental stages of the organisms (11-16). The classification based on the views of Hoare is summarised in Figure 1 and will be adopted throughout this review.

Subdivision of the genus Leptomonas

Since their discovery by LaFont, trypanosomatid flagellates which infect plants have been reported and described from various lactiferous plants throughout the world. Although the generic name *Phytomonas* appears to be generally accepted, the criteria for establishing species for this group remain a problem. Considerable emphasis has been placed on the size of the protozoa and host plants as determinants of species despite the fact that the size of certain trypanosomatids is dependent on the culture medium in which they exist. In fact, many of the described species might actually be synonymous.

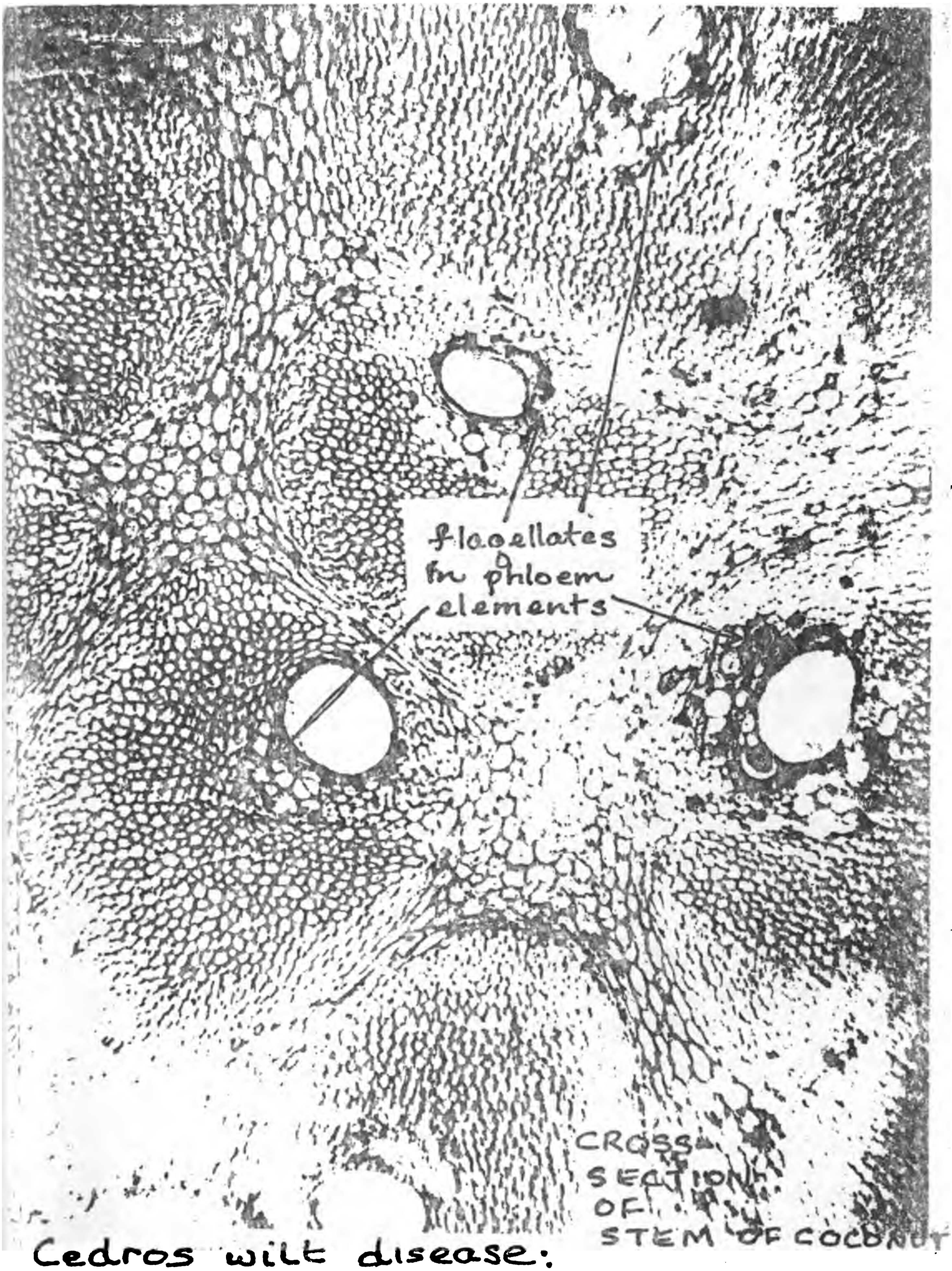
The ability of *Phytomonas elmassiani* to reproduce in the latex of several different species of latex plants from geographically widely separated areas of the world raises certain questions about the naming of species of phytomonads on the basis of host plants.

Trypanosomatidae-
Stages of development



The host specificity of these protozoa is obviously not very marked and considerable caution should be exercised in utilizing this criterion in species determination in this group of flagellates.

The changes observed in length of the flagellates cast serious doubt on the validity of the criterion of size in the description of new species.



Cedros wilt disease:

Ultrastructure of the protozoan flagellate

The individual organisms are surrounded by a continuous pellicular membrane which lines the reservoir and covers the flagellum. A single row of subpellicular microtubules lie immediately below this membrane. These microtubules lie obliquely to the longitudinal axis of the organisms. The largest number (30-40) of microtubules is at the widest point of the body; the numbers fall off both anteriorly and posteriorly to as few as 12.

The anterior flagellar reservoir is asymmetrical, the lip being longer on one side than the other. No subpellicular microtubules line the reservoir except for a discrete group of four short microtubules which is opposite microtubule doublets 3 and 4 of the flagellar axoneme. Distally they appear to be unequal in length.

The single flagellum arises from the floor of the reservoir and for much of its length carried a paraxial rod. This flagellar appendage is composed of an amorphoid weakly electron dense material and it is always opposite the shorter side of the flagellar reservoir and coincides with microtubule doublets 5 and 6 of the exoneme, approximately 0.5 um above the floor of the flagellum. The flagellum measured 250x175mm in diameter.

Within the cytoplasm of the organism, the root of the flagellum is associated with a kinetoplast which is composed of a reticulate network of electron dense DNA like material. The ribosome-rich cytoplasm also contains a single nucleus as well as diffuse membrane-bound structures.

The promastigote morphology, its presence within plant sieve tubes, and the ultrastructural features of the flagellate allow it to be classified as a trypanosomatid of the genus Phytomonas.

ASCLEPIAS CURASSAVICA L.

A. curassavica L.   Matac: Wild Ipecacuanha (Griseb. F. 419: Urb. Symb. Ant. 4, 497: 8,550; Britt. F. Berm, 296: Britt & Millsp. Bah, F. 341: Brit & Wils. Sci. Surv. Puerto Rico 6. 95).

Herb. 20–80 cm high, erect, sparsely branched; lvs. oblong-lanceolate, thin, 5-12 cm long, up to 4 cm wide, the upper ones narrower than the lower, acute at both ends; petioles 0.5-1.5 cm. long, connected at the node by a distinct interpetiolar ridge; cymes usually several in the upper axils, few-several flowered; peduncles about 4 cm long; pedicels 1-2cm; cal. lobes linear-lanceolate, acute, 4mm long; corolla lobes orange-red to scarlet, ovate, 7 mm long; strongly reflexed; staminal column distinct; corona golden yellow, the hoods erect, 3-4 mm long, each bearing within an awl-shaped incurved horn, longer than the hood and arching over the stigma head; follocles 5-10 cm long, fusiform, smooth, relatively thin walled.

A common weed of pastures, roadsides, and wastelands, Trinidad and Tobago, South-eastern United States of America, West Indies and continental tropical America.

A SIMPLE KEY FOR THE CLASSIFICATION OF DISEASES WITH SYMPTOMS OF WILT

Some commom diseases of the coconut palm in Tropical America with symptoms of wilt are:-

1. Red Ring disease
2. Bronze Wilt
3. Lethal Yellowing disease
4. Budrot disease
5. Acute wilt
6. Cedros wilt.

Easy classification for the identification in the field with typica variety (tall palms).

1. (a) Leaves with bright yellowing beginning anywhere on the leaf from near the rachis or at the tip of the leaflets .... 2.

   (b) Wilt symptoms present but leaves are still green and show no yellow discoloration .... 6.

2. (a) Yellowing and death of the young leaves at the crown only; the centre leaves of the crown can be pulled out easily. There is putrefaction of the bud; limited nut fall. (BUDROT).

   (b) Yellowing of the leaves in order of age round the tree, progressing at any rate and beginning with the lowest leaves .... 3.

3. (a) Rapid yellowing; bronze discoloration rather than just yellowing; the trees do not die; general nut fall. Many trees are affected simultaneously in one block, (BRONZE LEAF WILT)

(b) All the leaves turn yellow more or less chronologically; discoloration, however, is always progressive. complete nut fall .... 4.

4. (a) Discoloration normally present in all the leaves present on the tree. These persist and turn brown before dying. Younger trees often have a broken neck (RED RING).

(b) The yellow discoloration is completed in all lower leaves, but the crown leaves remain green for a long time. Nuts fall leaving their calyces attached to inflorescence............... 5.

5. (a) Identification in any isolated palm or pairs of palms, or small groups of palms located among healthy trees. Unopened inflorescences show necrosis (CEDROS WILT).

(b) Affected trees die in 5 months on the average. Symptoms very similar to 5 (a), but the yellow discoloration more orange than yellow and crown leaves always turn yellow before death. Diseased trees at similar stage of pathogenesis close by (LETHAL YELLOWING).

6. (a) Very rapid wilting of the leaves which sometimes break at the centre. Later, the brownish leaves can be pulled out easily; some isolated trees (CEDROS WILT).

(b) Slow or rapid wilting of the young plants, principally in the dwarfs when conditions are dry, not fatal. Coloration depends on variety either yellowish or greenish. (ACUTE WILT).

CEDROS WILT AND ITS EPIDEMIOLOGY

The disease called Cedros Wilt in Trinidad and Guyana, and 'La Marchitez de Cedros' in Ecuador, Venezuela and Colombia, is also recognised in Surinam as Hartrot disease. The symptoms are overtly not unlike Lethal Yellowing disease when they are expressed in the tall variety of coconuts but different from those of Red Ring disease where there is no putrefaction of the bud, necrosis of the inflorescence and blackening of the unopened spathes. It is different from Bronze Leaf Wilt in that this disease is physiological and rarely fatal. Nevertheless, it is often confused with Red Ring disease since it has so far been found only in countries where Red Ring disease occurs. This was so in Trinidad until 1976. Internal symptoms are quite different in both diseases since in Red Ring there is a band of red tissue forming the ring which is characteristic of the disease. In Cedros Wilt the stem is without discolouration.

The epidemiology of both diseases however shows differences and Red Ring disease is normally associated with adolescent trees whereas Cedros Wilt is associated with trees of any age. With Red Ring disease spread is confined to nearby young trees in any direction from a disease tree; however, clusters of old diseased trees that are nearly contiguous are formed with Cedros Wilt. Pathogenesis is shorter in Cedros Wilt. Diseased trees die within one month to six weeks from the time definite leaf symptoms are seen. In Red Ring disease death occurs between six weeks to three months on the average. In Trinidad, Venezuela, Ecuador, Columbia, Guyana and Suriname the flagellate protozan is also associated with a bacterium Micrococcus (agilis) roseus, which occasionally gives a red tinge to the diseased stem or inflorescence internally or also the coconut meat. This bacterium causes the rotting of the bud after the tissue has died from starvation/and or toxins due to the rapidly growing population of flagellate in the phloem. The physical dimensions of the phloem apparently restricts the growth numbers as the plant dies from starvation. Micrococcus roseus is also present in the insects vector and Asclepias.

The stink bug, Mecistorhinus sp. Palisot de Beauvois which is sometimes present on coconut palms take the flagellate around from tree to tree when the palms are contiguous and crawling juveniles infected from one free pass the flagellates over to the phloem of the healthy neigbouring contiguous palm of the same age or size. The eggs of Mecistorhinus are heavily parasitised by the egg parasite Phanuropsis semi-flaviventais Giralt (Hym. Scelionidae). A heavy influx of these parasites can sometimes cause a dramatic reduction in the disease clusters.

PROPOSALS FOR THE REHABILITATION OF THE COCONUT INDUSTRY IN GUYANA

Coconuts are generally accepted as being the third crop of importance in Guyana. At the end of 1970, the acreage was estimated at nearly 47,000 acres. An estimated 5,000 tons of copra was produced. Edible oil production was nearly 800,000 gallons; laundry soap was 5,000,000 lbs. and margarine and lard compounds 2,349,000 lbs. The year before, 1969, copra production was 7,400 tons. Comparatively, about that same time, with approximately 40,000 acres of coconuts Trinidad and Tobago produced 13,000 tons or virtually twice Guyana's production with a comparable acreage. By and large, since Coconuts in the West Indies are produced generally with the tall variety having a common origin and similar spacing, the production capacity would be similar except when agronomic or management conditions differ significantly. To a large extent, management conditions are best on large farms and worst in smaller units from two points of view; (1) agronomic and (2) processing.

On the average, coconut palms are just left to bear fruit in semi-abandonment in small acreages except the farms are also involved in mixed cropping where the land is utilized further for greater profit. On large farms, commercialization is accentuated and conditions are more economic from the point of view of diminishing returns with the quality of labour and available technology. There is always some voiced justification for a lower level of investment when the over-all economy of the country does not allow for sufficient entrepreneurial diversification of capital. This can occur despite the fact that a market is available for the products.

A major feature of large scale monocropping systems which deal with a processed crop and utilize small and large owners, is the organizational structure. To a large measure, this accounts for the level of efficiency of the production. In coconuts, the organization for processing stems from the factory and the method of linkage with the co-operating estates or farms. It is easiest for larger owners to be linked with a particular factory than for the smaller farmers who may want to subsist on local

market sales for the unprocessed fruit, fresh or dried. Nevertheless, the organizational structure must be such that these too, may be able to enter and contribute to the growth of the industry.

At another level, the organization of the farm comes into focus. As a business structure, a manager who has experience in the crop and capable of working with overseers and adjusting to the changes of the country's economy, is essential. Copra is a raw material for industry and as such its production must be cheap. This often requires high capital investments and expansion to maximise the activity of the capital invested. At the small farm level, the organization is more related to the system of production and cropping in order to utilize the land more thoroughly, thus spreading the cost of labour per acre on coconuts. In other words, mixed-cropping programmes are required om smaller farms to make the production of copra effectively cheaper.

Proposals for rehabilitation will be based, therefore, on the features which would tend to make copra production cheaper and more efficient with regard to the existing circumstances of farm-size, distribution, labour, lack of fuel resources and a pausity of capital for investment in an environment where market diversity does not stimulate sufficient intensive activity of capital. The following have been noted:-

1. Absence of adequate copra-driers for consistently good grades of copra.

2. Absence of power aids to collect and transport crops.

3. Absence of machines for facilitating cracking, etc.

4. A need for mixed-farming and mixed-cropping in farms of different sizes.

5. Organization of farms and improved factory relations.

6. Product diversification for new market development.

COPRA DRYING

This project was first described by P. C. Catanoan from the Philippines, in consideration of the number of small farms available and the diversity of their location. Copra-drying stations were proposed for several small growers in various Regions. On the other hand, larger growers may use their own.

Description of the Programme

Several copra drying stations are strategically located within the coconut-producing Regions 1 - 6, suitably and feasibly designed to be able to process all nuts produced in the area at maximum utilization. The proposed model, which shall have a nominal capacity of 6,000 nuts per load scheduled for 3 loadings per week, shall be located in a coconut area where at least 3,000 nuts can be harvested per day within a 5-mile radius. Preferably, the site should be near the main road for transportation to the oil factory or shipping point, and should be connected by access roads to the farms.

The station consists of a copra dryer, work shed, a small office, and a protecting fence. A buffalo or a tractor with a nut-trailer will be provided to haul nuts from the farms (road-side) to the drying station.

The proposed dryer is a twin-model of an induced-draft dryer designed by Catanean. The dryer will work well with coconut husk as fuel but can use coconut shells, wood, or leaves, whichever is preferred and available. The first unit was built and successfully tested at ICA EL Mira Research Station in Tumaco, Colombia. Each section of the dryer can be operated independently. If operated correctly and continuously, the copra can be dried in 16 hours, and the drying-cycle from loading to unloading can be finished within 24 hours. To provide for operational delays, it is assumed that copra-making, from dehusking to bagging, can be finished in two days or 3 loadings can be done in one week.

The dryer shed will serve to provide roof for the dryer and to provide a shedded area for husking, deshelling, bagging, and temporary space for copra. The building will have open sides, galvanized iron roof, wood structures and concrete floor. The office building will provide space for business transactions and storage for documents, and small equipment and tools. The yard will be fenced with low cyclone-wire mesh to prevent trespassing.

A trailer with one or two buffaloes and a capacity of 5 tons should be provided (or a 72 h.p. wheel tractor).

Each drying station shall be manned by a station foreman who shall be responsible for the maintenance of the station and supervision of copra making operations; and a collector, who shall maintain and drive the transport service and assist the foreman in the maintenance and repair of other equipment in the station.

Number of Dryers

Quite likely, each of the 6 regions would be accommodated initially by 2 dryers. If large farms are available, as in Region 4, further arrangements might be made between large farm-holders, small farm-holders, and factory management.

Schemes of Operation

The Central Drying Scheme (CDS) can be operated privately, co-operatively, or by government agents. It provides facilities for drying whereas the farmer pays rental for the use of the dryer and also hauling charges.

Two alternative methods of operation are suggested.

Scheme A.

The farmer supplies all labour for hauling, husking, cracking drying, deshelling, chopping and bagging. The farmer owns the copra, shells belong to CDS.

Scheme B

CDS buys the husked nuts and makes the copra. The owner of the nuts brings them to road side, loads them into the trailer, unloads them at the Station, dehusks the nuts and sells them to the CDS. The CDS hires extra workers to make the copra.

Sources of Income

For the cost of operation and maintenance of the CDS, the following sources of incomes are proposed:

Scheme A:

1. Rental for the use of the dryer. A rental per ton of copra produced to be collected from the copra owner.

2. Premium on quality of copra. A premium to be collected from the copra processor or buyer.

3. Hauling Charges. A hauling charge per ton of copra to be collected from the nut owner.

4. Sale of coconut shells. The shells may be sold for fuel.

Scheme B:

1. Profit from copra making. The prices of copra and nuts shall be adjusted to provide for profit in making copra.

2. Premium on sales of quality copra. (per ton).

3. Sale of Coconut shells. (per ton).

Operational Costs

The following will constitute the operational costs of the CDS.

Scheme A:

1. Salary of the CDS foreman
2. Salary of the tractor operator
3. Feed, medication for animal
4. Fuel and lubricants for tractor
5. Miscellaneous costs
6. Overhead expenses
7. Reserves for depreciation.

Scheme B:

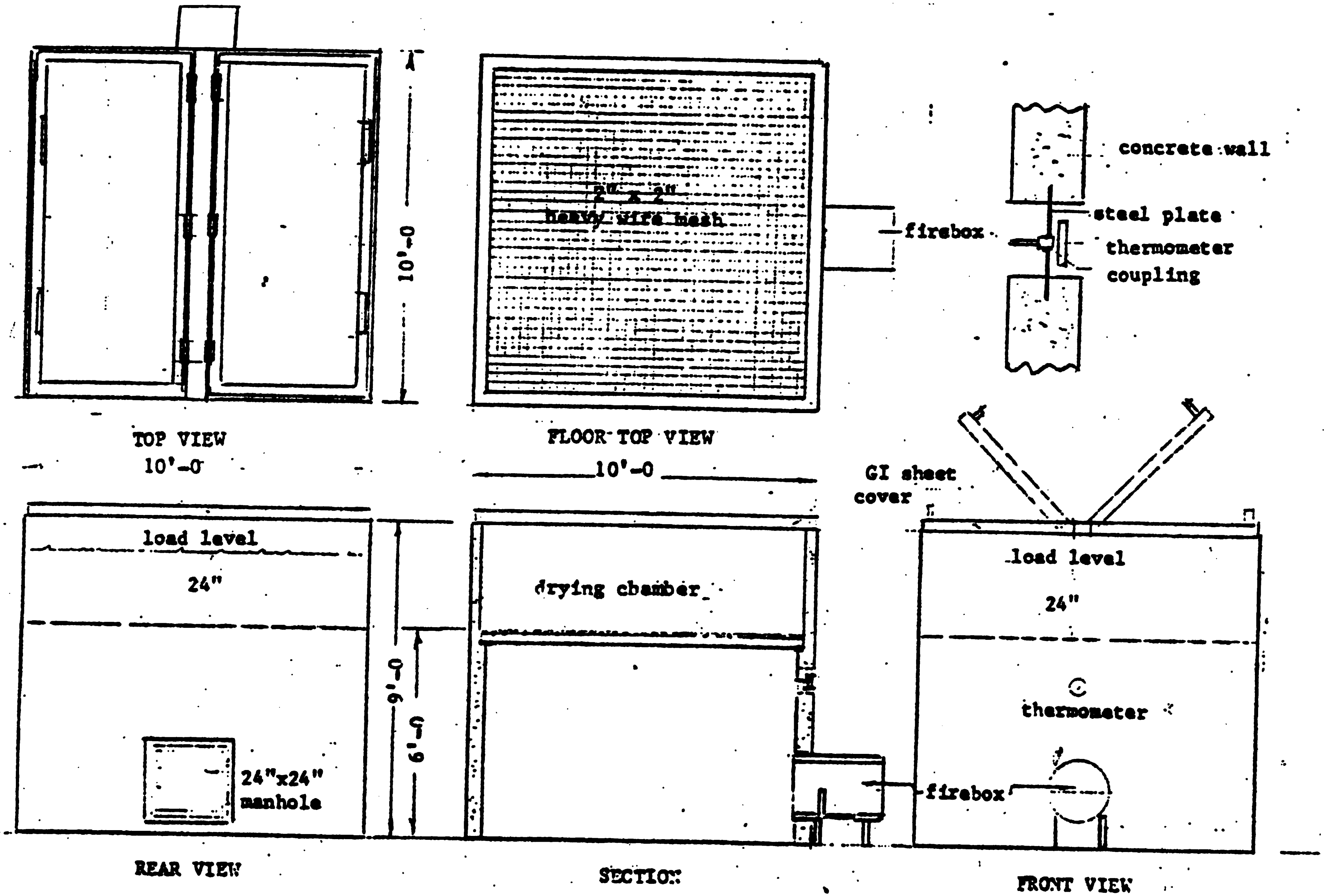
1. All of the costs in Scheme A.
2. Labour cost for copra making.

Estimate of Project Cost

The capital investment for one drying station is estimated at G.$56,000. detailed as follows:

Fixed Capital Investment:

Dryer	G.$ 3,000.
Dryer Shed	10,000.
Office building	5,000.
Tractor (or 2 imported water buffaloes)	14,500.
Nut trailer	4,500.
Miscellaneous tools & equipment	1,000.
Fencing and roadwork	6,000.
Installation	3,500.
Contingency	5,000.
Working Capital	3,500
Total Project	$56,000.



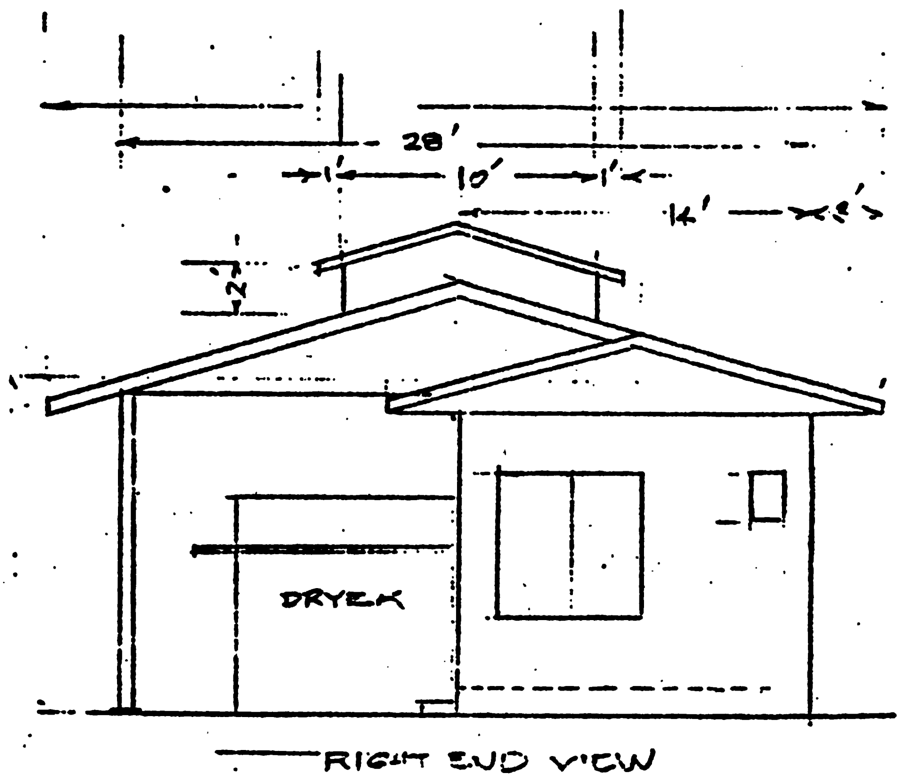
PCC COPRA DRYER

Capacity- 3,000 nuts

Scale: 1/4"=1'-0

Designed by: P. C. Catanaoan
UNIDO Consultant

Figure III



Copra Dryer

By

P. C. Catanoan

Benefits of the Project

This project is of essential importance since most of the copra in Guyana is sun-dried and serious problems occur with obtaining the correct degree of dryness required for copra. As a rule, an oil mill buys copra dried to a moisture content of 3 to 6%. The long wet-season in Guyana and the normal high humidity, in areas like the Pomeroon, act against a year-long availability of grade 1 copra or even copra just free from moulds. Because of this, oil production is reduced considerably even though coconut production figures might be higher. This applies to both small and large farms. Small farm owners, however, often suffer also from lack of enthusiasm to dry copra properly with the result that, in many cases, more than 60% of their product contain mould, stones, dirt and foreign matter generally, apart from the fact that their copra is characteristically rubbery. Thus, in the first instance, the organised copra drying scheme which will provide Grade 1 copra consistently, even from fallen nuts which would otherwise be left ungathered, would increase significantly the country's yield from existing nuts and afford a stimulus for improved agronomy.

Since artificial drying of copra is a general and major limiting factor in Guyana, an organized drying scheme is more suitable than supplying individual dryers, or expecting small farmers to use chulas as in the Philippines or Sri Lanka where coconut husbandry is a national tradition. Individual dryers would require a period of education and extension and affording of loans to individual small farmers who are the least able to pay interest or repay the loans. At present, there are two main oil factories in Georgetown, both of these may decide to organize their own systems using loans in Guyana dollars to build the equipment since everything can be had locally.

TABLE 5

REHABILITATION PROGRAMME - MULTIPLE FARMING

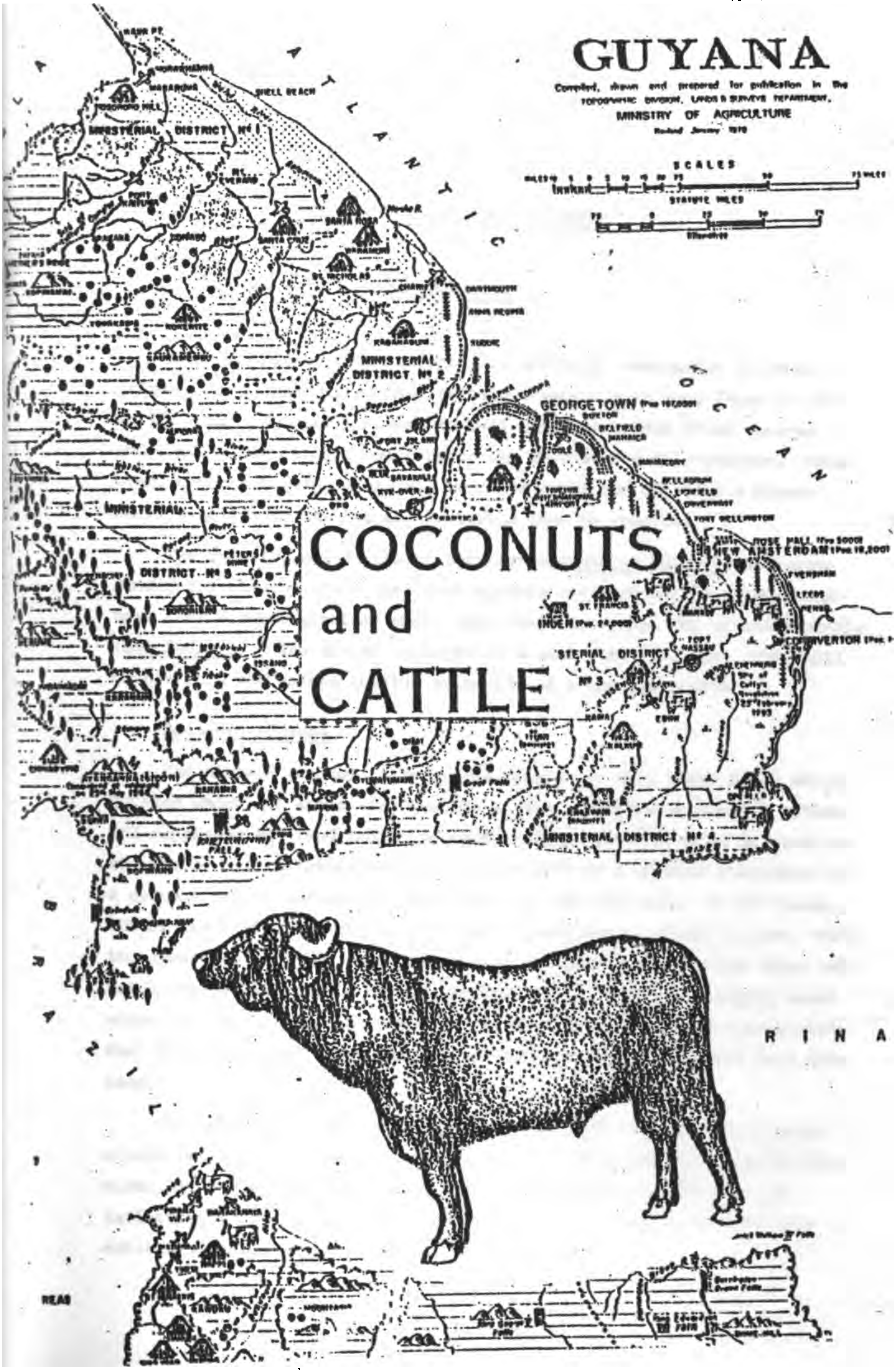
NUMBER OF FARMS ACCORDING TO ACREAGE OF COCONUTS PLANTED IN PURE STANDS BY REGION AND SUBREGION

REGION AND SUBREGION	Total Farms with Coconuts in Pure Stands	ACREAGE OF COCONUTS PLANTED							
		Less Than 2.0	2.0 To 4.9	5.0 To 9.9	10.0 To 14.9	15.0 To 19.9	20.0 To 29.9	30.0 To 49.9	50.0 And Over
Guyana	2,861	1,500	854	223	128	63	32	37	26
Northwest and Pomeroon	382	90	149	40	71	13	—	13	8
Northwest	135	49	70	—	17	—	—	—	—
Pomeroon	247	41	79	40	54	13	—	13	8
Essequibo Coast & Islands	551	203	241	74	—	11	11	11	—
Essequibo Coast	165	142	—	23	—	—	—	—	—
Essequibo Islands	385	60	241	51	—	11	11	11	—
West Demerara	13	11	—	—	2	—	—	—	—
East Demerara	671	273	227	74	31	23	20	12	11
East Bank Demerara	9	1	1	—	—	—	7	—	—
Lower East Coast Demerara	355	151	142	35	—	23	—	—	4
East Coast Demerara-Mahaica	168	77	53	15	15	—	—	4	4
East Coast Demerara-Mahaicony	139	43	32	25	16	—	13	8	3
West Berbice	526	411	72	24	11	—	1	1	6
East Berbice	718	512	165	11	13	16	—	—	1
East Bank Berbice	32	10	22	—	—	—	—	—	—
Lower East Coast Berbice	78	57	22	—	—	—	—	—	—
Middle East Coast Berbice	364	303	35	11	13	1	—	—	1
Upper East Coast Berbice	244	142	87	—	—	15	—	—	—
Status of Farming for Rehabilitation	—	Mixed Cropping: Bananas, Plantain, cassava, etc.			Mixed Farming with Sheep & Geese			Mixed Farming with Buffalo.	

PRODUCTION SYSTEMS FOR LARGE FARMERS

Table 5 shows the distribution of farms according to size and related to this are recommendations for either mixed-cropping or mixed-farming. Economically, farms over 30 acres may be grazed with buffaloes, *Bubalis bubalis*, which may be sold as meat or may be utilized as draught animals since petrol may not always be available, and the terrain not always solid enough for a tractor. Farms of smaller acreage may be mixed with sheep and geese. The smallest farms as shown may be involved with mixed-cropping, using bananas, plantains, cassava or those smallest still, where labour is not a problem may go in for vegetables of the appropriate kind. The programme for mixed-farming with buffalo will be discussed as a beef production system.

COCONUTS and CATTLE



BEEF PRODUCTION UNDER COCONUTS

Introduction

Beef production under coconuts is a viable combination of enterprises. It is being practised quite successfully in many farms in the wprld. There is need to increase beef production from local sources and land available in coconut farms can be used for this purpose. Moreover, coconut growing areas all over the world are adopting a mixed-farming policy to utilize all available land on estates.

The buffalo, hog-cattle or buffalypso (Bubalis bubalis) is recommended for this system since these animals are more easily managed and have less disease problems under such conditions than the ordinary cattle (Bos indicus). The system employed is a semi-extensive one. This will ensure that the estate trmains primarily as a coconut estate

Economic Acreage

The minimum economic size of the estate for this sytem is 30 acres. Estates under 100 acres will require a more intensive management system and supplementary feed including coconut meal, would have to be given to the stock. In an intensive system there will be a greater likelihood of a coconut estate becoming a cattle farm in the leng run. In old farms, 10% of these 30 acres should be rehabilitated over a 5-year period, while the remainder is being used for grazing 10 adult animals. The acres set aside for grazing should be divided into 2 or 3 fields of roughly equal size. 3-4 acres of grass are expected to support one adult animal fully for the entire year. The addition of supplementary feed would make this less.

The acreage of land available to the animals for any period would always be the remaining portion which is not being rehabilitated at the time. At the present time, most estates in Guyana require some rehabilitation since over 35% of the trees in the majority of the large estates are older than 60 years.

Beef Production Systems

Cattle farmers operating on this system of management may sell their animals at different stages as follows:-

1. Those selling feeder-calves at 8 to 9 months of age;
2. Those selling feeder-yearlings at about 18 months of age;
3. Those marketing both feeder-calves and feeder-yearlings;
4. Production of slaughter animals (older adults).

Smaller farms tend to make more money from selling mainly feeder-calves, 8-9 months of age; whereas larger farms produce yearlings and slaughter animals.

Starting Beef Cattle Production

It is not difficult to begin beef cattle production with the buffalo. There is always some native grass in coconut estates. One may start with animals feeding on these grassy areas. It is important to know the acreage of these grassy regions since the number of animals with which one may start depends on this. After having done this, one must now decide in what areas of the coconuts the establishment of new grass will begin. One should begin planting pastures under the oldest coconuts and the rehabilitated section. These areas must be fenced off.

A corral is a necessary part of the farm. It should be located in the centre of the ranch operations to reduce the distance in moving stock to and from it. Since it will be a common area for all the stock, a well drained part of the estate should be chosen as a site. One must provide other equipment, water-troughts, etc., for the animals. An important consideration from the very beginning should be simple labour-saving devices which are lasting.

There is a weed, Asclepias curassavica, which is very poisonous to water It is present very often in many estates. It is considered unpalatable to the animals and they generally leave it alone. However, under conditions of feed shortage some animals may eat it and die. It will be wise to uproot this weed wherever it is seen on the estate.

Nerum oleader is also of some toxicity.

Pasture Management

The recommended pasture grass is Digitaria decumbens or Brachiaria sp. which is common. When well established it is deep rooting and reasonably drought resistant. However, before establishment, guinea grass or molasses grass, or any native grass present may be utilized.

At least two large grazing fields are necessary in this system. The size of the fields must be related to the number of animals in the herd. The herd may graze for a maximum of 6 weeks in one field before it is removed to another field. The animals should be moved by the herdsmen over the entire field to take full advantage of the grass and to avoid over-grazing in any one section. Proper records should be taken for the time of adequate regrowth in the dry season. This will help determine when a field is ready for new grazing.

Each field should be grazed until the grass growth slows. The grazed field should then he allowed to rest for 6 to 8 weeks before grazing again. During the rest period the fields should be brushcut and may also be fertilized with 75-150 lbs/acre of sulphate of ammonia broad-cast over the grass.

Fencing

It is important to have a programme of progressive fencing-off of areas to be supplied with young coconut palms. The programme would involve:

1. Fencing off areas to be supplied for 5 years. After 5 years these trees would be too large to be browsed by the animals. Areas where grass is being planted should normally be fenced.

2. Dividing acres to be grazed into fields which would be grazed in succession for 5 years until areas under rehabilitation are ready for grazing. Portions of the areas being grazed may then be rehabilitated next and fenced off for 5 years.

3. After several years the entire estate may have been fenced off by this method.

Fencing helps in the following ways:

a) It prevents supplies of seedling palms in areas of rehabilitation from being eaten by the animals.

b) It allows fields to be grazed and rested alternatively, allowing regrowth of grass and adequate weed control on the farm.

c) It keeps other animals out of the farm area.

Fencing should be done with 4-strands of barbed wire on posts set 16 feet apart. Live Gliricidia sticks may be set between the posts. As these grow they keep the wire tight, and this saves labour costs to tighten fence wires. Sub-divisions with the fields can also be made with these Gliricidia sticks. Gliricidia leaves may be used as fodder.

Corral

A corral for rounding up animals for feeding supplements, deworming, branding, weighing and other necessary attention is recommended. Allow 20 sq. ft. per mature animal. Drinking water should be made available. Corrals should be strongly built and painted to preserve the material.

A loading chute becomes important for loading stock on or off a vehicle. This must be located such that trucks and trailers can reach it easily. After this is established, the rest of the corral can be built around it.

Fences should be 5½ to 6 feet high. Wooden posts are set 6 feet apart and at least 2½ feet in the ground. Set corner and gate posts 3 or 4 feet deep. Posts set in concrete rot easily and are difficult to replace. Good strong gates are essential. Whereever possible the gates should open in the direction in which the cattle are being driven. Gates should be made of the same material as the corral - wooden boards.

A cattle branding chute will come in handy. It should be so conducted that both small and large cattle can be worked through the chute at the same time without having the larger ones lodged in it.

Pasture Equipment

Each pasture should have a permanent water trough (or a wallow) made of concrete, or a "Copper". Allow 1 gallon of water/100 lb. live-weight in the season per adult animal per day (1/2 this quantity in the wet season). It is important to remember that if the animals cannot drink enough, they will not eat as much. This decreases weight gains. The number of troughs or coppers should hold enough water for the requirement of all the animals.

Four to six salt licks should be available free-choice on the pastures. Cut oil-drums can be successfully used for feeding molasses every day. When these drums become rusty they should be replaced.

STOCK MANAGEMENT

Stockmanship

Stockmen must be careful and observant. They must know the animals by name if necessary. They should seek new-born calves and tend to their navels immediately. The navel should be treated with an antibiotic powder such as Negasnr, or dipped in a clean cup containing tincture of iodine. The farm manager must be told of every birth and the sex of the calf so that it can be recorded.

Branding

Calves should be freeze-branded for identification and record-keeping. For branding some basic equipment is necessary:

a) Branding irons

b) Large bucket

c) "Dry-Ice" (frozen carbon dioxide)

d) Alcohol.

Make the freezing mixture by adding 1 gallon of alcohol to 50 lbs

"Dry-Ice". Place the branding-irons in the mixture for 5-10 minutes. They are then pressed into the right side of the animal for 45 seconds. The branded area turns white after 21 days.

Freeze-branding does not injure the hide and no infection is likely. Identification is permanent but may not be very distinct on the buffalo hide. Care must be taken to avoid the branding mixture from splashing into the eyes of the stockman and animals.

Ear tags may be used instead of branding. These have to be purchased along with the equipment for clipping on these tags to the animal's ears.

Deworming and other attention

Calves should be dewormed every 4-6 weeks until they are 6 months old. While the herd is gathered to take molasses, each animal should be inspected for bruises or any signs of illness. If any illness is observed, it is wise to call a veterinarian early.

The herd should be given a TUBERCULIN TEST every year by a veterinarian to ensure that no Tuberculosis is present in the herd.

Feeding and Grazing Management

Buffalo can be adequately maintained on improved pastures of Pangola or Guinea grass, where they should gain 1 pound more per day to double their weaning weight in 1 year.

The herd should be moved into a new part of the field every day so that they cover the whole field before being moved to the next field. The calves should be left to run with their mothers. Leave only the breeding bull with the herd. The other adult bulls, if kept on the estate as working animals, should be kept separate from the rest of the herd to avoid fighting. Each field should be rested for 6 weeks to 2 months to allow the grass to grow back. This may be longer during dry spells.

Supplementary feeding of molasses mixed with water should be given to the herd every day. 10 - 15 gallons of molasses mixed with an equal quantity of water per 100 animals is adequate.

The breeding and working bulls should be allowed 1 - 1½ lbs/ day of concentrate feed containing 14% - 20% Crude Protein in addition to pasture grass abd molasses. Wheat middlings, Brewer's dried grains or coconut meal can be used for this purpose.

Animals being fattened for slaughter should reach 900 lbs in 2 years and be slaughtered at a liveweight of 1,200 lbs to 1,400 lbs at 3 years old.

PASTURE ESTABLISHMENT

Organisation

A farmer should follow a definite pattern in planting new grass pastures under his coconuts. A possible plan is as follows:-

1. Establish pastures unddr older trees (above 40 years) and in rehabilitated area with supplies.

2. Under mature bearing trees 15 to 40 years old.

3. Under young bearing trees 5 to 15 years old.

In the area under rehabilitation,grass should be established over three wet seasons; so, at the and of 5 years, the area can then be grazed while another 10 acres of the area presently being grazed is rehabilitated. Over a period of years, following the method given above, the entire area might be established in pasture with the slightest practical damage to the roots of the young plants. Different grasses may be used for different conditions of soil water content.

Planting

New grass is planted at the start of the rainy season by hand planting of mature stem cuttings or root divisions. These may be placed in shallow furrows made with a cutlass or hoe and covered lightly with soil.

It is a good idea to develop a nursery on the farm. Set aside 5 - 6 acres for a nursery. Planting material for the nursery is available

from Agricultural Demonstration Stations inthe country. One tenth of an acre of grass will give 1 ton of planting material which is enough to plant 1 acreoof grass. Having a nursery on the estate saves transport and purchasing costs as planting material does not have to be brought in each time grass is to be established.

Weed Control

Weedicides such as 2,4-D or Shell Weedicide - D at the rate of 3 - 4 pints per acre of grass. Each pint should be mixed with 8 gallons of water.

Dung Spreading

Fresh dung can kill the grass underneath it. Dunggmust be spread over the pasture with a hoe or rake after each area is grazed. Dung which is properly spread is a good fertilizer and helps to condition the soil.

HERD IMPROVEMENT

A farmer must always strive to make his herd a better one over the years. Continual efforts are needed to better the herd. Mature cows should produce a calf 3 out of every 4 years. Cows which do not produce a calf regularly should be replaced. Cows should be kept as long as they are producing and weaning healthy, heavt calves. In selecting herd replacement, heifers from high producing cows in disease-free herds should be bought.

Breeding bulls should not be kept with the same herd for more than 6 years. This prevents them from mating with their own daughters and grand-daughters. When this happens the inbreeding level is high and weak calves are produced. The quality of a breeding bull is judged by the weaning weight of his calves. Bulls weaning small calves should be replaced. Calves should wean at about 300 - 350 lbs, grow fast at a rate of 1 lb or more per day and do not fall easily to disease.

A good time to start a herd improvement programme is when the majority of calves are 6 - 7 months old. This is the usual weaning age when the animals should weigh between 300 - 350 lbs. This is made easy by

the fact that generally 82% of all calvings occur between July and December.

Animals should be weighed at 1 year old and again at 2 years old. A weight for age guide for herd improvement is:

Birth Weight	-	71 lbs.
6 - 7 months	-	300 - 350 lbs.
12 months	-	450 - 500 lbs.
24 months	-	900 - 1,000 lbs.
36 months	-	1,200 lbs. or more.

Have each animal weighed at these ages and record the information. Animals not reaching these standards should be culled.

Good stock scales are an essential part of the improvement programme. These should be checked before the animals are weighed to make sure that they are in good working order.

When selecting a breeding bull, the farmer should look for certain characteristics. The animals must be heavy and compact with a thick neck, smooth shoulders and a straight top line. The hind-quarters must be thickly fleshed down to the hocks. The animal should have a deep covering of muscle over the entire body, but especially on the loin, round and rib regions. These regions provide the high-priced cuts of meat. A bull 15 - 24 months old, having these characteristics should be selected and kept as a future herd sire. This ensures continual improvement of the herd as these characteristics will be passed on from sire to offspring.

COSTS AND RETURNS

Grazing cattle under coconut needs to be well managed. The size of the herd must always be related to the acreage available for grazing. Most of the food, therefore, comes from the grass.

Costs per animal include supplementary feeds such as molasses, wheat middlings, citrus pulp and coconut meal. Also included are water facilities, storage sheds for feeds, veterinary supplies and miscellaneous items.

Operational costs include labour, care of bulls, fences and taxes. Operating costs per acre increases with farm size from 30 acres to 150 acres. Above 150 acres the rate of increase in costs declines considerably. The smaller the farm the more one has to give supplementary feeds.

Indirect benefits of grazing cattle under coconuts are the efficient use of labour and the control of weeds. Fences and observation of the herd aid in controlling praedial larceny of coconuts and animals. Direct income from sale of beef increases the overall profitability of the estate.

It is suggested that pasture establishment and partial fencing off will be completed over a period of 5-10 years. Water should be available from public mains or lagoons if they are present near the estate as in the Pomeroon.

Cattle purchases take place in the first two or three years. Unlike copra, no beef will be produced until the third year of operation. Production will not reach full capacity until the fourth year.

Records

Records for the estimating of costs and for selection of animals for stock improvement are necessary. Record Sheets should be kept up to date and contain the following information. These records should be kept in a note-book, specially ruled and prepared in the manner shown.

Care must be taken to see that the animals are not allowed into areas where young trees might be eaten by the animals. This can be controlled by proper fencing of areas where supplies have been made.

Figure IV

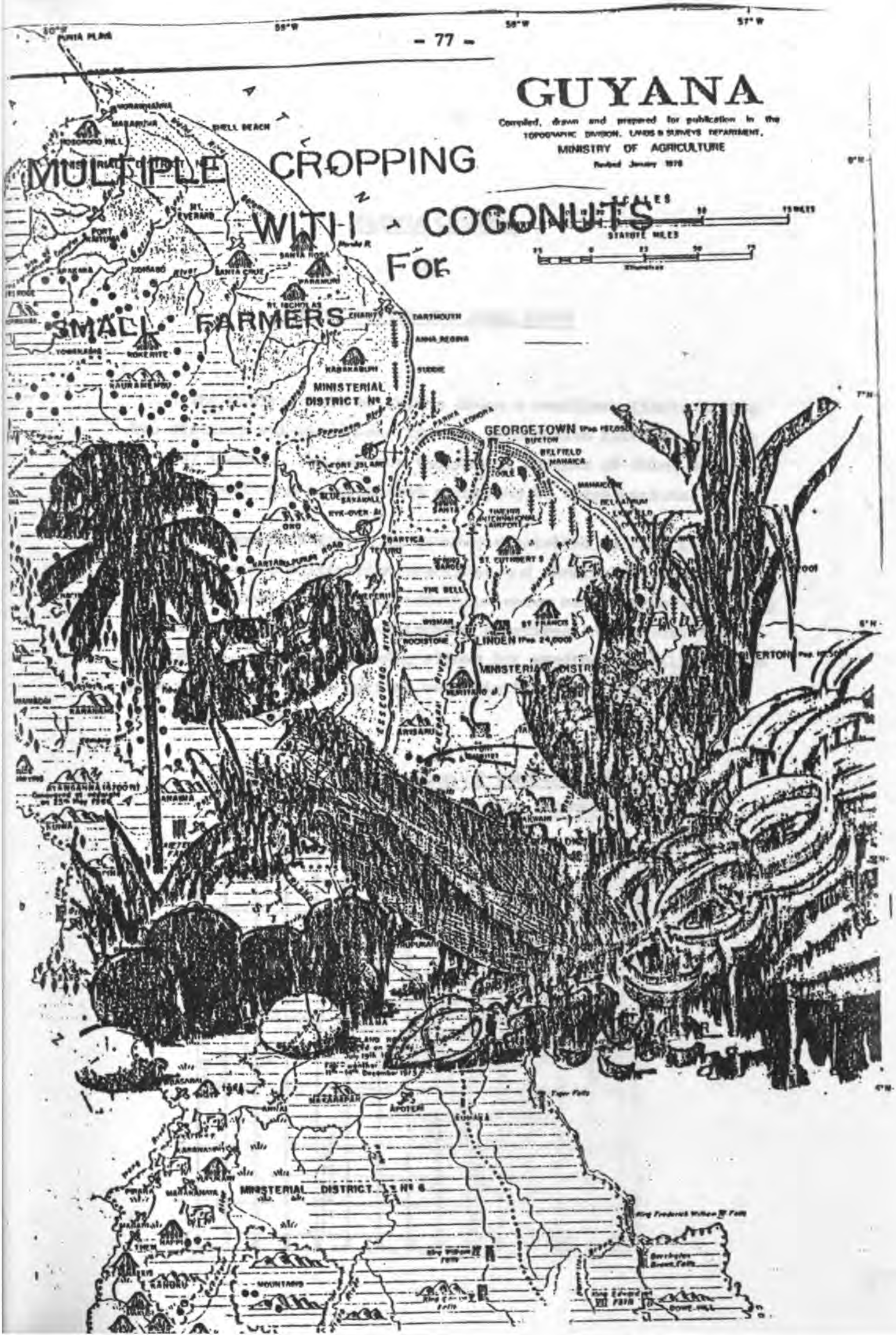
COW SHEET

COW			DATES			WEIGHT (lbs)			MARKET AGE (Years)	DATE SOLD
Name	No.	Age	Last Calf	Calved	Sex	Birth	Weaning	Market		

Trampling of the soil by the animals and compaction, especially in the dry season, is a serious problem in areas where there are clay soils. This may be solved by occasional shaking of the top soil with a rotary hoe when compaction is evident. In areas where the soil is sandy, Pangola grass may be easily uprooted by grazing cattle. The correct stocking density is important to avoid compaction and over-puddling.

Pangola grass, if allowed to grow too long, forms a mat which hides fallen coconuts. This makes collection difficult. Proper grazing management of the fields keeps the grass low enough from hiding the nuts.

MULTIPLE CROPPING WITH COCONUTS FOR SMALL FARMERS



MULTIPLE CROPPING

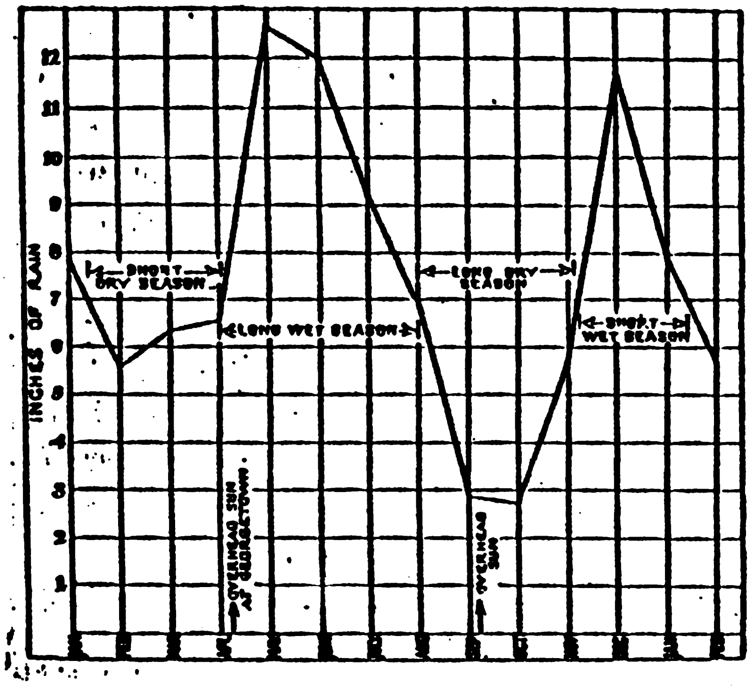
OR

MIXED CROPPING FOR SMALL FARMS

The Coastal belt of Guyana shows a maritime climate having two distinct wet seasons and two dry seasons with rainfall between 84 - 97 inches. The various vegetables capable of doing well in coconut lands can be organized according to these periods.

An important factor in growing vegetables is that they require intensive cultivation practices and usually give a high return. The cost of coconut production under mature estates is very greatly reduced. During replanting exercises and rehabilitation programmes, vegetable growing allows for weeding, fertilizing and pest management to be carried out jointly for both coconuts and the vegetable plots.

Figure 5. Distribution of seasons in Guyana for vegetable production



Recommended Crop Sequences

Three possible cropping sequences are suggested for mixed-cropping acreages up to 3 acres. These are conveniently divided into plots.

SEQUENCE 1

	PLOT 1 (1 acre)	PLOT 2 (1 acre)	PLOT 3 (1 acre)
YEAR 1:	Snap Beans, Lettuce and Patchoi, Cucumber, Tomato, Sorrel	Sweet Pepper, Corn Amaranthus	Cabbage Corn, Pumpkin
YEAR 2:	Sweet Potato Hot Peppers	Corn, Egg Plant Watermelon	Sweet Pepper, Corn, Pigeon Peas
YEAR 3:	Cucumber Cassava	Lettuce, Amaranthus, Corn Pumpkin	Sweet Potato, Corn Pigeon Peas, Sorrel

SEQUENCE 2

YEAR 1:	Lettuce & Patchoi Corn, Pigeon Peas	Amaranthus Cucumber Sweet Pepper	Tomato, Snap Beans Pumpkin
YEAR 2:	Amaranthus Cassava	Cabbage, Pumpkins, Bodie	Sweet Pepper Yams
YEAR 3:	Egg Plant, Lettuce Patchoi, Watermelon	Cucumber, Corn Beans, Watermelon	Corn, Cabbage Watermelon

SEQUENCE 3

	PLOT 1 (1 acre)	PLOT 2 (1 acre)	PLOT 3 (1 acre)
YEAR 1:	Hot Pepper Chive Celery	Sweet Potato Bodie Corn	Amaranthus Bodie Cabbage Tomato
YEAR 2:	Lettuce and Patchoi Corn Pumpkin	Hot Pepper Chive, Celery	Sweet Potato Beans, Corn Sweet Pepper
YEAR 3:	Beans Corn Egg Plant	Cassava Cucumber	Hot Pepper Chive Celery

Figure 6

ODEL MECHANISATION OF COCONUT PRODUCTION

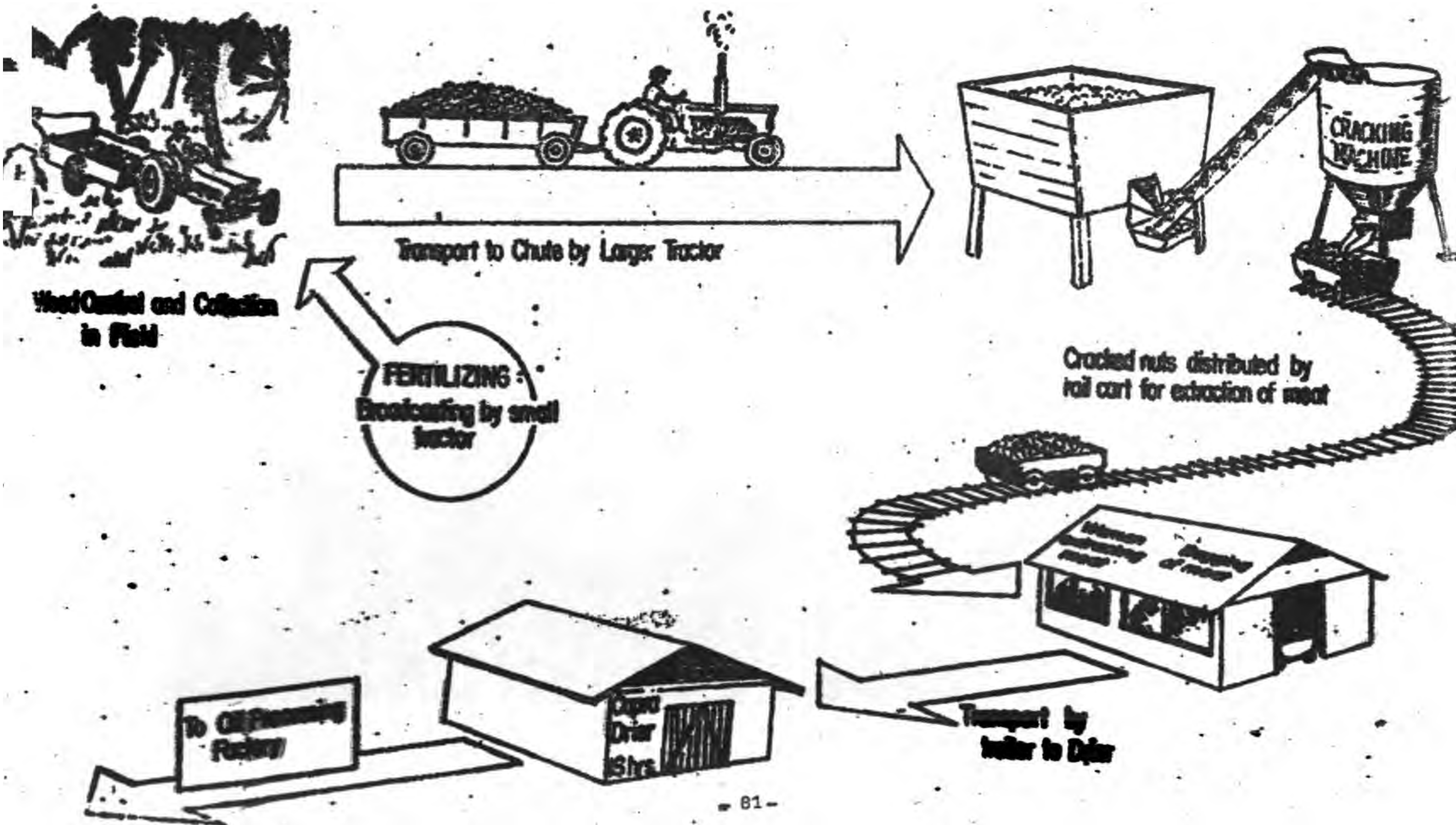


Figure 7. Mobile cracking machine for coconuts in Trinidad

COCONUT CRACKING MACHINES

Coconut cracking machines have been used in Trinidad and Tobago for the last 10 years. At first they were mobile machines (Fig. 7) attached to a tractor from which they got their power and were utilized on the spot in the fields. Their longevity was not more than 5 years and was directly related to the life of the tractor. Subsequently, permanent machines were installed in collecting sheds on the foconut farm. These were manned by an operator who placed the nuts in a trough from where they fell onto 3 revolving blades, and were cut in 3 sections. The 3 separate pieces fell onto a transporter belt which deposited them into carts on a railway line. The whole, dried coconuts which were brought in from the fields on trailers were placed on a conveyor belt which took the individual nuts to a cracking machine. Fig. 6 showing a mechanised production in Trinidad outlines the procedure.

Coconut farmers in Guyana should be allowed to see this system as it operates in Trinidad. The machines were all locally made and cost in the vicinity of $25,000 per unit. These installed units normally crack between 10,000 - 15,000 nuts daily on a 600 acre farm in Trinidad.

POLICIES AFFECTING THE COCONUT INDUSTRY AND DISEASE CONTROL MEASURES

The overall organization of the industry would allow for the unification of farmer effort and direction. An organised body of management can allow for specific planning and also continuity of action as it relates to the well-being of the farmers and their families and at least the two generations which the longevity of one coconut palm will span. In short, it is very natural for coconut production and development to require a legally stable and permanent authority for its management. In the case of Cedros Wilt, which is native and endemic, traditional responses must be developed to manage outbreaks, not only as written law but as traditional culture.

Apart from the management of diseases, several other concerns appear:

1. The coconut industry in Guyana has attained a magnitude that necessitates a more concerned effort at integrating the generally diffuse efforts being exerted at present towards its development.

2. The present stage of development of the industry, and its comparative history with other CARICOM countries, is generally characterised by relatively low yields and poor quality of product which can be substantially improved, given the necessary singular support from research, extension and marketing programmes (and associated credit institutions).

3. The Coconut industry in Guyana is ranked third in agricultural importance - volume of land occupied and related number of citizens - thus the improved viability of the industry will improve the well-being of the population.

4. The industry is a source of raw material which can be utilized to produce a diversity of products which may yield foreign exchange to the country. It, therefore, requires intensive and sustained trade promotion to obtain markets abroad. (Figure 8 shows the diversity of products obtainable).

5. A Coconut Authority which has as its objectives:

   a) the promoting of an accelerated development of the industry.

   b) the provision of general directions for a steady and orderly development

   c) the possibility of achieving vertical integration of the industry such that farmers become participants in and beneficiaries of the development and growth of the industry is very essential at this time.

6. The powers of such a Coconut Authority should relate to:

   1. Programme and Policy formulation.

   2. Regulate marketing and advising on pricing policies.

   3. Formulation and recommending of credit policies for coconut to Government.

   4. To receive and administer funds provided by law on behalf of members, etc.

   5. To enter into and make appropriate contracts.

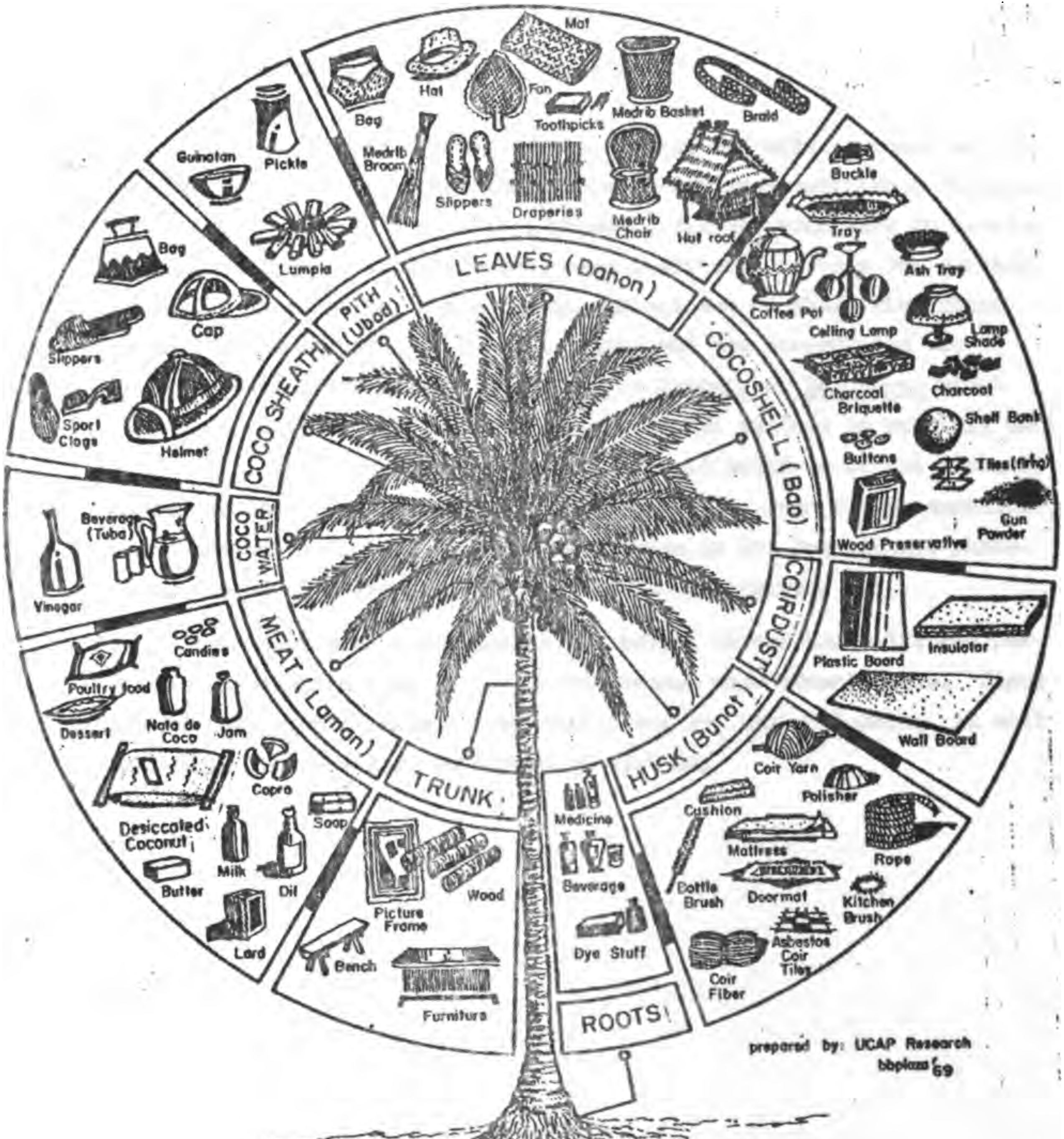


Figure 8

DIAGRAMATICAL CHART OF A COCONUT TREE
Showing the different end-products

The Coconut Authority and Cedros Wilt

At the subsistence level of the disease the effectiveness of the Plant Protection Act, proclaiming Cedros Wilt as a notifiable disease, comes into play. Interestingly, however, disease outbreaks do develop despite such water-tight clauses, especially when vectors can develop naturally on a healthy coconut palm and get out of phase with their parasites and predators. Not only this, but the unregulated use of several pesticides for say, Brassolis or Castnia or Eriophyes might create fortuitous conditions for the potential vectors to multiply until a source of inoculum appears to cause a rapid build-up of the disease. As can be seen now, individual control measures, even though sustained, might not be sufficient to curb the disease in its logarithmic phase. Region No. 4, for example, needs a 'Cordon sanitaire'.

It is with such functions as isolation, cordon sanitaire and pesticide utilization that an Authority becomes most advantageous. Since the Authority will be held responsible for its own well-being, it will move with the necessary swiftness or caution.

REVIEW OF PROGRAMME OF RESEARCH

The programme of research proposed initially for Cedros Wilt disease in Guyana cannot be executed in Guyana at the present time. Neither the staff capabilities nor the research facilities allow for the programme to be accomplished. On the other hand, the entire programme as formulated is not necessary either to determine the vector or to control the disease.

Essentially, the researchers in Guyana need to be given adequate directions on a project with clear-cut guidelines for collecting reliable information within the limits of their facilities and training. Through this, they would gain experience with the disease and develop their own line of expertise.

At present, their programme of research should relate to the following projects:

1. Efficacy of control measures related to tree removal; and the significance of timing of control and cluster development to control of the disease.

2. Transmission studies with the phloem feeding Pentatomidae associated with the early phases of pathogenesis.

3. Training on serological methods for protozoa, such as will be utilized for typing protozoan flagellates in the disease.

Serological methods are essential since the protozoans are otherwise only identified readily by electron microscopic work. Moreover, an

established method of typing is necessary in order to further classify Phytomonas elmassiani which is the original name given to the protozoan flagellate in the milkweed plant, Asclepias curassavica. All Phytopathologists who are researchers in the disease should understand these methods. Training facilities are available at Trinidad.

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FECHA DE DEVOLUCION

Fecha Devolución	Nombre del solicitant