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MAHAWELI ENTERPRISE DEVELOPMENT

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THE CASHEW PRODUCTION DEVELOPMENT PROGRAMME

by

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Report 4/1994

INTERNATIONAL SCIENCE AND TECHNOLOGY INSTITUTE, INC.

WITH

ERNST & YOUNG CONSULTANTS (Sri Lanka)
DEVELOPMENT ALTERNATIVES, INC.
HIGH VALUE HORTICULTURE, PLC.
SPARKS COMMODITIES, INC.
AGROSKILLS, LTD

CONSULTANTS TO THE MAHAWELI AUTHORITY OF SRI LANKA

Mahaweli Enterprise Development (MED)

The development of the natural and human resources of the Mahaweli river basin is a high priority of the Government of Sri Lanka. The construction of physical infrastructure, the settlement of the land and the formation of the agricultural production base are largely completed. The challenge now is to build a diverse, dynamic economy capable of steadily raising Mahaweli family incomes. In meeting this challenge, the private sector - farmers, entrepreneurs, companies, community groups, non-governmental organizations - has an important role to play.

MED is a project of the Mahaweli Authority of Sri Lanka and the United States Agency for International Development. MED promotes investment and employment generation by the private sector in non-farm economic activities and contract outgrower programs producing diversified crops. MED does this by: (i) developing technical, marketing, financial and other services which assist self-employed individuals, microenterprises and companies to start and improve their businesses; (ii) developing entrepreneur associations and other participatory groups; and (iii) carrying out studies and analyses to improve the frameworks for development in the Mahaweli areas.

The Employment, Investment and Enterprise Development (EIED) Division of the Mahaweli Authority is the MED implementing agency. Technical consultancy is provided by a consortium led by the International Science and Technology Institute, Inc. (ISTI), and including Agroskills, Development Alternatives, Ernst and Young, High Value Horticulture and Sparks Commodities.

PREFACE

Mr Ian Duncan, a Cashew Specialist, visited Mahaweli from March 5 - 19, 1994 to evaluate the progress made by Informatics and advise them on the development of their cashew project in System C. Mr Duncan's consultancy was provided by MED through ISTI's subcontract with High Value Horticulture.

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1. BACKGROUND TO REPORT

The consultant visited the Mahaweli System C in Sri Lanka from 20th February to 12th March 1993 to advise Informatics on the development of their cashew plantation. The consultant's report was published by MED in June 1993 (report 7/93)

The consultant made a return visit 5th to 19th March 1994 for a reassessment of the plantation with a brief review of cashew processing and marketing. The terms of reference for this assignment are given in Annex 10.

2. BRIEF SUMMARY OF 1993 REPORT AND RECOMMENDATIONS

2.1 Summary of Report

The Informatics Agrotect plantation known as Kuda Sigiriya was commenced in 1987 and by 1993 about 589 acres (26,000 cashew seedling trees) had been planted. An inspection by the consultant revealed the following problems

- the plantation site was clearly not ideal in terms of topography for any significant mechanical farming or allowing installation of a proper sprinkler or drip irrigation system.

- there was also little information on the soil types on site and on a visual inspection the consultant was concerned about the suitability of atleast some of the soils present.

- temperature regimes are ideal but no rainfall figures for the site were available, data from the nearest alternative suggested a non optimal distribution pattern with possible reduced yield in some years when significant showers occurred during flowering.

- the planting of all seedling trees from unknown genetic origin would limit the scope for good yields. There was no in house capacity to graft trees and no source of good planting material.

- insect pests especially helopeltis were a major problem causing significant damage. There was only very limited capacity and knowledge about controlling pests.

- illuk grass (Imperata cylindrica) was widespread on site and a major impediment to proper management of the plantation.

- as no nutritional analysis (soil or leaf) had been undertaken no worthwhile nutritional program could be undertaken

2.2 Summary Of Recommendations

The consultant recommended an action plan concentrating on the following points

- detailed soil profile analysis on site to confirm suitability to grow cashew in addition soil and leaf nutritional analysis to allow application of worthwhile nutritional program..
- installation of rain gauge to determine suitability of rainfall pattern
- selection of superior mother trees at Puttalam and training of staff in grafting techniques to allow production of grafted trees. Only grafted trees from known superior mother trees to be used for future plantings.
- commencement of an entomology program utilizing students (under supervision) from the University of Peradeniya
- approach research organizations in Sri Lanka and overseas to enquire alternative methods to control Illuk grass.
- investigate water shed development potential on site.

3. DEVELOPMENTS ON SITE SINCE 1993 REPORT

The departure of the previous General Manager and the arrival of the replacement in October 1993 clearly disrupted farm operations and delayed progress on the important issues raised in the 1993 Report.

Regarding normal farm operations during 1993 the following should be noted,

(a) Nutrition - no fertilizer has been applied since March 1991

(b) Entomology - no insect pest control measures (spraying) have been undertaken since March 1993. Significant helopeltis infestation was evident in 1993 and again in 1994.

(c) Illuk grass - efforts to control illuk have continue to mainly rely on hand cutting with a little spot spraying. This is time consuming and expensive. It costs about Rs. 720/- per acre (US$ 498) and places huge demands on available labour. In the period 24th December 93 to 11th March 1994 some 80 % of all labour was used on illuk cutting.

(d) The 1993 harvest - undertaken during May/June when some 1,500 trees (4 - 5 years old) were harvested. The estimated total yield was about 850 kg - some 748 kg was counted and about 100 kg (uncounted was used for planting). No individual tree data was collected, average tree yields were 0.5 kg with an estimated 2 kg being the highest individual yield.

Work relating to the recommendations from the 1993 Report was as follows:

- a rain gauge was installed on site in April 93

- An initial selection of 73 trees at Puttalam was made on the basis of a yield analysis of the 1993 harvest. These were later culled to 23 superior mother trees and these were used as a source of scionwood for the Agrotech 1993/94 grafting program.

- Three grafters from Department of Agriculture at Gannoruwa (Kandy) were hired to both graft trees for future plantings and to train Agrotech staff in grafting techniques.

- Department of Entomology at Peradeniya was approached both to supply students and to provide periodic supervision for insect monitoring to allow a start to the insect control program.

- Progress was made on the installation of the elephant proof fence on the Kuda Sigiriya boundary with Maduru Oya National Park.

4. ASSESSMENT OF CURRENT SITUATION ON SITE

4.1 Planting and Tree Status

A bush fire in July 1993 originated from the Cashew Corporation land next door and spread easily through the plantation due to a lack of boundary firebreaks and the stand of Illuk grass in the plantation. Before it could be controlled some 7,787 trees mainly two year old were destroyed. To replace these losses some 1,048 seedlings were planted later in the year.

The farm tree survey in September 1993 indicated the following tree status. All plantings are by seedling trees.

Date Planted	Surviving Trees	Spacing
1987/88	260	45' * 45'
1988/89	1,299	40' * 40'
1989/90	2,494	35' * 35'
1990/91	980	30' * 30'
1991/92}		
1992/93}	15,798	30' * 30'
replants 93	1,048	30' * 30'

	21,879 total	

(b) Climate

Some rainfall data is available since measuring equipment was installed on site from April 1993. This shows the following pattern compared to the approximate average for 1984 - 91 from Aralaganwila Research Station.

Month	Kuda Sigiriya (mm rainfall, for 1993)	Aralaganwila (mm rainfall, av. 1984 -91)
April 93	98.0	100.0
May	72.1	60.0
June	16.6	10.0
July	138.5	75.0
August	25.2	73.0
September	32.0	125.0
October	198.3	158.0
November	596.5	220.0
December	596.4	325.0
January 94	480.4	260.0
February	364.5	150.0

It has been pointed out that the wet season of 1993/94 was an exceptional period of heavy rainfall - no accurate monthly figures for this period were available from Aralaganwila apart from the advice that rainfall between 15th September 93 and 11th march 94 was 2,018.2mm. The corresponding figure for Kuda Sigiriya was slightly higher at 2,205.5mm.

The preliminary conclusion is that the rainfall pattern at Kuda Sigiriya is probably similar to Aralaganwila and that it is not ideal for cashew. There is no clear consistent dry season and it is apparent that significant showers may be possible during the March/April flowering period. In the years that this occurs it is possible that yields may be reduced. This rain pattern is also likely to increase the potential for insect pest problems especially in a monoculture plantation.

There is no concern about temperature as annual average maximum and minimum from Aralaganwila ranges from 36 - 21 degrees celsius. This shows a warm and even regime which is very suitable for cashew.

4.2 Soils

No soil profile or nutritional analysis has been undertaken since the 1993 report. A further site inspection by the consultant and others suggested that the following soil types may be present on Kuda Sigiriya However it must be emphasized that the extent of the illuk grass currently over the plantation impedes making a good visual inspection.

- reddish brown, pH of 6.0 to 6.5 and an estimated composition of 40% clay, 40 silt and 20% sand.

- low humic clay, pH of 6.0 to 6.5, and estimated composition of 25% clay, 35% silt and 40% sand.

- non calcic brown, similar pH to above with estimated composition of 16% clay, 14% silt and 70 % sand.

The above analysis is very approximate and there is so far no real appreciation as to how much of a particular soil type is present in the plantation. In addition in parts of the plantation there are rocky areas where bed rock may be present some little depth below the surface.

Cashew prefers deep well drained sandy/sandy loams with a rooting depth of 3 - 4 metres with no hardpan or soil compaction. A pH of neutral to acid is preferred. The soil profile is critical for cashew, a low soil nutrient status is less important as nutrients can be added.

It is clear that of the three soil types apparently present on site only the non calcic brown could be considered really suitable for cashew. The reddish brown would be considered quite unsuitable

It is imperative that an adequate soil profile analysis of the site (atleast in all areas that there is an intention to plant cashew. We need to know the extent of each soil type in the form of a farm soil map. This will allow the planning of future plantings to the most suitable soil areas.

4.3 Genepool Selections

Following the recommendations from the 1993 report a selection program was commenced on the Pandora Plantation at Puttalam. There was no useful data on individual trees so some 75 trees were selected on anecdotal evidence from the staff based on previous results. The 1993 harvest was carefully monitored and an analysis made of their crop. The criteria used was maximum yield and maximum nut size.

From the original 75 trees some 23 were selected as mother trees to provide scions for Agrotech. The complete results are given in detail in Annex 1 but the top 10 are shown below. All trees selected are believed to be about 8 years old.

Tree No	Yield (kg)	No. of Nuts	Av Nut Weight (gm)
2	25.4	2,255	11.3
1	23.5	2,584	9.1
52	19.8	1,810	10.9
51	18.5	1,864	9.9
35	17.1	1,315	13.0
65	15.8	1,464	9.5
53	15.3	1,148	13.4
56	14.1	1,486	9.5
3	13.3	1,841	7.3
19	12.8	1,353	9.5

The criteria used for selection included yield and large nut size. These priorities are only partially correct and need to be adjusted for the future. While total yield is important the critical factors are recovery rates and total yield of kernel. Very large nuts as currently selected often have low recovery rates and therefore their yield of kernel may be below other trees with smaller but adequate sized nuts.

It is not suggested that any of the 23 trees currently selected should be discarded, however it is recommended that

a) the selection criteria be adjusted to emphasize other priorities

b) the search area be expanded in 1994 to include a wider genepool.

The details of these recommendations are given in Recommended Future Work Plan - Genepool.

4.4 Nursery and Grafting

Following the selection of trees at Puttalam three grafters were hired from the Department of Agriculture at Gannoruwa at Kandy to initiate the Agrotect grafting program. this work was undertaken between August 93 and January 94.

The grafting details are as follows

- July/August 93, 2,000 grafts from 18 selected trees. Destroyed by elephants in nursery.
- September/October 93, (a) 1,000 grafts from 9 trees, 30% success rate (b) 3,000 grafts from 23 trees, nil success due to poor after care.
- November/January 94, up to 4,500 grafts from 23 trees, success rate not yet finalized but could reach 50%.

The early grafting in July/August was undertaken solely by the people from Gannoruwa while Agrotech staff were trained and joined in from september onwards. Two or three of the Agrotech staff are now considered to have atleast a little grafting experience.

The methods used for propagation involve using the float test to determine rootstock seed viability and topsoil as potting mix. The wedge graft is used and the union is tied with grafting tape. A plastic cap is put over the graft and removed when the graft 'takes'. The plants are housed a thatched roof shed for protection.

A number of ad hoc experiments were tried including puncturing the plastic caps and raising the pots. The consultant believes that the procedure will improve with more practice but some guidelines for future consideration are included in Section Recommended Future Work Plan - Nursery.

As at 10th March 1994 some 1149 grafts from 19 selected mother trees were observed to be successful. This rate should increase as some 1,100 grafts are still 'work in progress' with their take still to be determined (Annex 2).

4.5 Entomology

In March 1993 the consultant observed a significant helopeltis (Helopeltis cyclonocus) infestation on site and in addition there was evidence of caterpillar pests especially leaf roller - Anigraea ochrobasis.

In March 1994 the impact of helopeltis observed was even worse with up to 50% of the trees effected in parts of the plantation. The helopeltis was first evident in November/December and as no control spraying has been undertaken the problem has increased with time. The flowering flush on many trees was well eaten and a number of trees were so badly damaged as to probably eliminate the chance of a crop this year.

Leaf roller and leaf minor was also evident in trees that had flush not effected by helopeltis, however the importance of these other pests may be masked by the initial severe helopeltis damage.

There is no worthwhile information on the abundance of potential beneficial insects - predators or parasites such as lacewings, parasitic wasps or ant species.

Following the recommendations of the 1993 Report Agrotech management had discussions with Dr Bandara and others at the University of Peradeniya regarding the allocation of students for insect monitoring. This approach culminated in the arrival in 22 nd February 1994 of three students at Kuda Sigiriya for a two year program - one of which is specifically allocated for entomology work

4.6 Illuk Grass (Imperata cylindrica)

The majority of Kuda Sigiriya is covered by illuk which is a ryzhome grass that is persistent and difficult to eradicate. The importance of illuk is that it complicates the management of the plantation in the following ways,

- competes for light nutrients and moisture with cashew
- allows the easy spread of fires (in July 1993 a bushfire destroyed 7,700 cashew trees or 25 % of the plantation)
- makes it near impossible to undertake any meaningful entomology program as it is very difficult to monitor the trees properly. It also probably increases the insect pest problems by providing an alternative host for the insects.

The only sure longer term solution is to control the growth of illuk through shading but in a plantation situation this will take years before the cashew will grow sufficiently to shade the illuk.

In the past Agrotech has tried both chemical sprays (roundup) and hand cutting. Both are only temporary and very expensive. The estimated costs are

- roundup spray say 2 metres wide along the row of cashew trees would cost about Rupees 1,200 per acre (US $25).
- hand cutting requires 12 man days per acre + other costs giving a total cost of about Rupees 900 per acre. (US $ 19)

Both methods are prohibitively expensive as they would have to be repeated annually for perhaps 5 - 6 years until the cashew grows sufficiently to exert some control by providing shade.

Expert opinion advises that illuk is an opportunistic invader of low nutrient soils but there is no known research information on biological control methods. It is imperative that a more cost efficient short term control method is used as the current situation is very unsatisfactory.

5. RECOMMENDED FUTURE WORK PLAN

5.1 Future Strategy

There are a number of problems that require resolution at Kuda Sigiriya and some of them will require the input of technology to fix. Currently the new manager is experienced in administration and management and the other staff would have little technical expertise. The relatively isolated location of the site eliminates the use of professional staff from a relevant research institution. This would not be practical for a number of reasons. The nearest institution,

Aralaganwila Research Station appears not to have the right type (or willingness) of staff to fulfill this role. The only practical institution to assist is the University of Peradeniya and this (at Kandy) is to far away to expect to get a regular input from staff at Kuda Sigiriya.

The solution lies in Agrotech acquiring it's own in - house technological expertise with occasional back up supervision by the university. The arrival of three Peradeniya agricultural science graduates in February 93 and the intended hiring of a fourth in April provides on opportunity to develop a plan along the proposed lines.

5.2 Overall Plan

(a) Manpower

Agrotech should use the three agricultural science graduates that arrived on 22 nd February and a fourth that will be hired in April as the major 'agents of change' in the plantation. Prior to the consultants visit they had no defined role - it had been proposed that the consultant would define their job in the overall context of future farm plans.

The graduates are as follows:

- Dispala Medageadara BSc major entomology
- Sudath Kumarasinghe BSc major soil science
- Hewa Arachchige Samantha BSc major animal science
- Miss Wijenayake

The consultant (with the agreement of Agrotect) has organized the work plan of the farm along the following lines,

1. The first three graduates are to be enrolled at Peradeniya as part time M Phil students a three year course commencing. October 94. This would involve them in about 50 % of their time on campus during term time - three days per week and four days on site.

2. Each of the three students will work in a defined role - they will cover the critical areas that need attention in the plantation and their area of work will be accepted by the university as the basis for their M Phil course work

   The jobs are as follows:

   a) **Dispala Medageadara**

   - Bioecology of Insect Species at Kuda Sigiriya (identification and study of behaviour of pest and beneficial species)

- Insect Pest Monitoring System (monitor pest numbers and damage levels)

b) **Sudath Kumarasinghe**

- Soil Map of Kuda Sigiriya (soil profile analysis and mapping)

- Nutrition Program (soil and leaf nutrition analysis)

- Soil Fertility, Nitrogen Fixation Plants and Illuk Control (research available information)

c) **Hewa Arachchige Samantha**

- Grafting and Nursery Propagation of Cashew (in conjunction with Gannoruwa and others)

- Screening and Selection of Mother Trees (at Puttalam and elsewhere according to set performance criteria)

- Management Of Progeny Trials At Kuda Sigiriya

- Selection Of Commercial Varieties

- Cashew Phenology Study

3. Miss Wijenayake will be responsible for the reference collection and the operation of the small field laboratory that will be set up at Kuda Sigiriya later this year. In addition she will act as a back up to all three other graduates in the unlikely event that one leaves

(a) **Improved Facilities**

The following items should be acquired for the improved operation of the plantation as per the new plan.

- small field laboratory to support the work of the four graduates. The lab to be equipped with basic equipment for entomology soil/nutrition work as well nut quality analysis.

- reference collection (borrowed books, photocopied articles etc)

- more plantation equipment to handle necessary tasks on an improved basis ie power sprayers to allow timely insect pest spraying (see Entomology Recommendations) and mechanical cutters for illuk control (see Illuk Control Recommendations).

b) Work Plans For 1994

The following are the 1994 work plans for both research and normal farm operations which take in to account the recommendations in this report

FARM OPERATION ACTION PLAN

Date	Activity
April	- commence cutting illuk with cutting machines (to finish by July) followed by spot spraying with roundup as required.
	- contractor to make firebreak around plantation
May	- clearing of 411 acres new extension by contractor. - nursery program - plant 2,500 rootstock seedlings - commence harvest at kuda Sigiriya
June	- nursery program - plant 2,500 rootstock seedlings - harvest at Kuda Sigiriya
July	- nursery program - plant 2,500 rootstock seedlings - commence grafting 2,300 seedlings (assume 70 % success rate)
August	- nursery program - grafting 2,300 seedlings - water shed study
September	- nursery program - grafting 2,300 seedlings - planting 1,650 grafted trees in 50 acre new block - monthly nutrition program can commence depending on rainfall pattern and based on nutrition analysis
October	- planting 1,650 grafted trees in 50 acre new block
November	- planting 1,650 trees in 50 acre new block

RESEARCH ACTION PLAN

Date	Activity
April	- entomology, commence insect monitoring including identification of species and weekly reports of numbers and damage assessment This activity to continue indefinitely.

	-	genepool, identification of target mother trees for 1994 yield analysis at Puttalam, Cashew Corporation plantations and Kuda Sigiriya
	-	soil map, commence soil profile analysis and identification of soil types
	-	staff, arrival of fourth graduate
May	-	genepool, commence crop collection from target mother trees
	-	research facilities, commence collection reference materials and equipment (to be housed in field laboratory when complete)
June	-	genepool, complete crop collection, commence nut quality analysis (recovery rates,kernel weight).
July	-	soil/leaf nutrition, organize soil and especially leaf nutrition analysis to establish nutrition status. This will need to be repeated in February 95 to give data on annual variation on status.
August		-
September	-	preliminary report - entomology, report on insect monitoring, types of insects,seasonal abundance.
	-	preliminary report - diseases,report on type and scale of diseases
	-	preliminary report - soils, location, types and characteristics of soils at Kuda Sigiriya.
	-	preliminary report - nutrition status soils/cashew trees.
	-	preliminary report - genepool, results of 1994 harvest (yields,recovery rates and qualitative assessments of selected mother trees)
October	-	graduates enroll at Peradeniya and continue with set programs
	-	commissioning of new field laboratory at Kuda Sigiriya

5.3 Recommendations For Nursery

Agrotech now have two to three staff who have atleast some grafting experience having trained with the grafters from the Department of Agriculture at Gannoruwa. It is suggested that Agrotech follow the following guidelines,

1. Grafters from Gannoruwa to be hired again for atleast one more year to continue to train and supervise Agrotech staff.

2. Get a reasonable number of people trained adequately in the art of scion identification and transport as well as in grafting techniques. All four graduates especially Mr Samantha should be in this training group.

3. Be aware that although grafting of cashew is not inherently difficult but some people appear to develop the 'touch' more easily than others.

4. There are no universal rules for grafting - techniques may be basically the same between countries but there are differences that local grafters use to accommodate differences in local conditions for maximum performance. Do not be afraid to experiment a little to find your own best combinations.

The consultant suggests that Agrotech be mindful of the following guidelines to successful nursery practice and grafting but also be prepared to adapt them to suit their experiences.

1. <u>Rootstock</u>

   a) screen the plantation for rootstock source trees. Select healthy trees especially with apparently good root systems. To reduce performance variability in grafted trees it is preferred to select and standardize on rootstock used. Undertake float test to determine seed viability.

   b) only use fresh seed, if seed has to be stored, store in cool dry location. Be aware that seed viability will be reduced after about 12 months even with good storage.

   c) choice of potting mix may vary, common mixes are mixture of soil 60%, sand 30% and woodchips 10%. Agrotech are apparently having good results with 100% top soil - in this case continue with it.

2. <u>Grafting</u>

   a) for scions selection can be either

      - cut immediately if semi mature wood and bud is about to burst

      - prepare on tree, remove leaves on scion and leave for about 14 days for terminal to almost burst before cutting.

   b) to transport for up to 24 hours scions can be packed in damp paper

   c) scions and rootstock must be matched for size (width of stem) for grafting

d) continue using wedge graft technique but also try side graft as a variation

e) try holding graft union with 3 - 4 clothes pegs, it is much faster.

f) use plastic cap on graft and try using a sweat tent - a igloo shaped tent covered with thick plastic to hold humidity.

g) remove plastic cap when graft takes (after 7 - 14 days when a leaf develops) but leave in sweat tent another 7 days or so until second leaf develops.

h) place under shade for about four weeks,cloth 80% shade if hot sun, 50% shade in more cloudy weather.

i) place outside in direct sunlight for hardening off for about 3 - 4 weeks before planting.

5.4 Recommendations For Genepool Development

1. The Mother Tree Selection Program

The selection program in 1993 involved the initial selection of 75 trees at Pandora Plantation Puttalam and these were later culled to 23 trees which provided the scions for the grafted trees The criteria used for selection were high yield and large nut size.

The consultant proposes some changes to the selection criteria and that the selection process continues to concentrate on the Pandora plantation but in a limited way it could be extended to include the Cashew Corporation plantations (especially at Puttalam) as well as some of the other smaller plantations at Puttalam.

a) Selection Criteria

In 1993 the criteria used was high yield and large nut size. While some good trees have been selected the consultant believes that too much emphasis has been placed one criteria (nut size) and other criteria have been ignored.

Trees that have extra large nuts, say 9 gm and larger do not necessarily have the most appropriate kennels. They frequently have lower recovery rates and in addition their total yield of kernel may be lower that trees with smaller but adequately sized nuts.

The consultant suggests that the following criteria be used for future selections - and current selections be reconsidered. (see Annex 3).

- maximum yield of kernel (raw nuts are processed and kernel weighed). The minimum sized kernel is grade W 320, or 320 kernels per lb.

- tree age, any yield must be related to age. Trees will not mature before ten years or so.

- tree shape. make a qualitative assessment. Upright growth habit with maximum lateral branches would allow highest yield potential in minimum space.

- assessment of resistance to insect pest (especially helopeltis) attack.

Items 1 -2 could be done in the initial selection phase, items 3 - 4 can be done in the later screening down process.

b) Pandora Plantation

The 23 trees selected should be re-assessed according to the new criteria and others included if warranted

c) Cashew Corporation and others

At a meeting with the consultant the new chairman of the Cashew Corporation Mr Ransi Gunasekara showed a lot of support and indicated his willingness to help the Agrotech genepool program.

The plan involves Agrotech contacting Mr Surendran the research officer for the corporation and using his assistance to monitor any outstanding trees on the corporation land in 1994. In addition Mr Surendran apparently has contacts in other private plantations around Puttalam where this process may be repeated.

d) Kuda Sigiriya

Agrotech should not forget that some superior mother trees may well be found among their seedling population planted on site. From 1994 onwards any outstanding trees should be noted and included in the selection program.

A reasonable target is to select a total of 50 superior mother trees for evaluation in progeny trials.

2. Progeny Trials and Varietal Selection

Selected mother trees will need testing on site at Kuda Sigiriya as we need to confirm that the superior genes are transferred to grafted plants and need to determine environmental suitability as cashew may be site specific to some degree.

Selected trees should be grafted out in sufficient numbers to allow both proper progeny testing and as a source of scion wood if it proves to be superior and a decision is made to plant it commercially. The minimum number is 20, 10 for progeny trial and 10 for budwood.

The progeny trials may need to be monitored for a minimum of five years (and compared to the mother tree's performance) before there is sufficient information to decide which varieties are the best and worth large scale multiplication.

A reasonable target is to select perhaps the best five varieties for commercial exploitation. Genetic selection is a continuous and long term process with a significant lead time, however Agrotech could use the 411 acres which it intends to plant up over the next few years as a large scale progeny trial. While the final selections may be a few years away, on average the performance of the trees in this trial will be very much superior to the seedlings that were originally planted.

The consultant recommends that Mr Hewa Arachchige Samantha is made responsible for the operation of the genepool development program at Kuda Sigiriya including mother tree selection,progeny trials and variety selection. This work would form the basis of his M Phil course at Peradeniya.

5.5 Recommendations for Entomology and Diseases Program

1. Entomology

It is evident that Kuda Sigiriya could face a potential future insect pest problem because of the local rainfall pattern and humid climate. This is already evident as in the past two years helopeltis has significantly attacked the cashew trees - and other pests such as leaf roller and leaf minor have also been observed. Experience elsewhere shows us that the scale of insect pest problems can only increase in a monoculture as both tree numbers and canopy sizes increase. In addition to future potential problems it should be noted that no previous work on entomology has been undertaken at Kuda Sigiriya and that Agrotech also currently lack sufficient equipment on site to carry out a proper control program. It is for these reasons that Agrotech should give some priority to entomology.

The consultant proposes that the following programs be commenced. Mr Dispala Medageadara should be responsible for carrying out the work but he should be assisted by the other three graduates.

a) Bioecology Of Insect Pest Study

A study of insect pest and beneficial species. Identification, feeding habits behaviour patterns, seasonal abundance and life cycles. For important pest species i.e. helopeltis any predator/parasite relationships would be important.

This study would form the basis of Mr Medageadara's M Phil program in which he would receive supervision assistance from his supervisor at Peradeniya.

b) Weekly Insect Pest and Damage Assessment Program (See Annex 4)

The plantation requires a regular status report on the insect pest situation that is collected on a tree and panicle sampling basis.. This would include data on type of pest, stage of life cycle (nymph or adult) numbers found and details of damage.

The purpose of this work is to detect early signs of particular pest build up so as to be able to make timely control measures - in this case spray with the relevant chemical. The decision as to when to spray depends on the assessment as to what is the 'critical threshold'. This is a difficult decision that is best taken with some experience on site. As a general rule you avoid spraying without good reason as chemical controls also kill pollinators and other beneficial species such as predators and parasites.

Mr Medageadara would be responsible for carrying out this program and he would be assisted by the other three graduates.

2. **Diseases**

In parts of the world where cashew is grown in ideal climates ie well defined wet and dry seasons (with one or two exceptions) diseases are usually not a major issue. However in other parts with less suitable climates diseases can be a problem. No previous work has been done on diseases of cashew in Sri Lanka - at Kuda Sigiriya the rainfall pattern is not ideal and we could assume that diseases could be atleast an issue to consider.

To date very little time has been spent on identifying diseases at Kuda Sigiriya but there were some signs of possible anthracnose infection when the consultant inspected in March 94.

The consultant proposes that Mr Medageadara be responsible for a regular quick inspection of trees based on a sample method to detect diseases. He would be assisted by the other three graduates. Pathology sample could be taken to Aralaganwila Research Station for analysis where a plant pathologist is in residence.

For both the entomology and diseases work it would be beneficial if as many of the other (non graduate) farm staff be trained in identification as they would widen the net of observers.

5.6 Recommendations on Soils And Nutrition

During his 1993 visit the consultant expressed concerns about the suitability of at least some of the soils for growing cashew and he recommended then that the appropriate analysis be carried out.

Unfortunately this has not been done and the consultant now recommends that Mr Sudath Kumarasinghe be responsible for the work related to soils and nutrition and the greater part of this would be the basis of his M Phil course at Peradeniya.

1. Soils Map

It is necessary to produce a soils map of Kuda Sigiriya with the priority of starting on the 411 acre area still to be planted with cashew. This will allow planned planting so as to avoid the most unsuitable areas.

To produce the soils map Mr Kumarasinghe may initially try the available sources of data and supplement this by the necessary soil profile analysis. As cashew prefers deep soils for proper root development it would be best to take profiles to 3 metres, or at a minimum 2 metres.

The plantation also has areas where there are rocky outcrops - as far as possible the places where there is bedrock below the surface need to identified so as to avoid planting cashew.

In the past Agrotech was relying on Aralaganwila Research Station to assist in the soil analysis but it never eventuated. This time it may be more fruitful to use the university soils department.

2. Nutrition

No nutrition has been applied since March 1991 and nothing is known about the nutrition status of the soils. A casual inspection of the plantation suggests that there may be some deficiencies and anecdotal evidence from System C shows the soils in that area are deficient in zinc - a critical micro nutrient for cashew.

It is important that a nutrient analysis is carried out, (soils and especially leaf) - probably by the university soils department. There should be two sets of samples, one of which can be held in reserve in case of loss or spoilage. This analysis should be carried out atleast twice in the first year to establish some base data ie in August (after harvest) and March (flowering). Some guidelines on the taking of soil and leaf samples are given in Annex 5.

When the nutrition status is known a nutrition program can be planned although without irrigation nutrition can only be applied when there is sufficient rainfall. As far as possible monthly installments of fertilizer are preferred to large single doses.

There is some data on the nutrient requirements of cashew, the table below shows guidelines for cashew from a major laboratory. It is recommended that the nutrition program be based on the requirements indicated below.

SGS Quantum Guideline Levels For Cashew:

nitrogen	%	1.65 - 2.75
phosphorus	%	0.16 - 0.25
potassium	%	0.90 - 1.40
sulphur	%	above 0.08
calcium	%	above 0.11
magnesium	%	above 0.11
copper	ppm	above 7
zinc	ppm	20 - 50
manganese	ppm	60 - 500
iron	ppm	100 - 200
boron	ppm	40 - 100
sodium	%	less than 0.3
chloride	%	less than 0.5

5.7 Recommendations on Illuk Control

Agrotech will have to tackle this problem on two fronts, both short term and longer term solutions. For the short term there appears to be no alternative to finding the most cost/efficient mechanical control method together with changes in planting procedures of cashew. In the longer term while it would be worthwhile to examine the biological options.

The consultant recommends the following action :

1. **Short Term**

- investigate the modification and use of the Agrimec Jet 5 paddy rice cutter (made by Jinasena) or similar machine to cut illuk. Assuming the use of three machines and a machine write off over five years the cost per acre of controlling illuk would be rupees 265 per acre p.a. (US $ 5.50) - very much cheaper than either by spraying roundup (rupees 1,200 per acre) or by hand cutting. (Rupees 900 per acre) See Annex 9 for details on costs.

  The use of the cutting machines could be followed up with use of local spot spraying with roundup where necessary. The additional benefits of using the cutting machine include the following:

- much faster, 486 acres cut in less than 100 days even allowing for downtime compared to atleast 300 days for hand cutting.

- lower demand on labour, 7 workers compared to 12 for hand cutting which monopolises all available labour for long periods inhibits what other work can be done on the plantation.

- when not required at Kuda Sigiriya the cutting machines could earn revenue while being leased to farmers for paddy harvest.

- in addition the spacing of cashew tree planting could be changed to provide for the earliest shading of the illuk. Correct spacing is mainly a function of tree shape and normal spacing for common cashew seedlings in plantations is 10m by 10m (narrow) up to 15m by 15m (wide). Sometimes higher density plantings are made with later thinning when the canopies touch. The important issue is that a higher density planting must be such as to leave a viable spacing after thinning takes place.

The consultant believes that Agrotech should use a higher density planting for both earlier return and for greater illuk control. Based on the normal tree shape an initial planting of 20 ft by 20 ft (6.1m by 6.1m) may be appropriate. After 5-6 years this may then be thinned to 40 ft to 40 ft. Agrotech should not hesitate to alter initial planting spacing to perhaps 5m by 5m if they find a variety with a particularly upright growth habit. This would later be thinned to 10m by 10m.

2. **Long Term**

- We are aware that illuk grows well on low fertility soils and therefore as part of establishing longer term control measures it is recommended that Mr Kumarasinghe include an investigatory role into biological control methods for illuk. Such work would form part of his M Phil work at Peradeniya.

  It is likely that this work would start by enquiries elsewhere in the world where some work may have been done on illuk grass. this would include Malaysia and Australia (CSIRO Division of Tropical Pastures).

  If the situation supports the premise the university may be able to organize some research on the relationship between illuk, soil fertility and perhaps nitrogen fixation plants or other topics as warranted.

5.8 <u>Recommendations for Water Shed Development</u>

It is clear that the uneven topography at Kuda Sigiriya prohibits the use of a normal drip or sprinkler irrigation system. It could also be argued that even if it were possible to install a system it may not be cost effective in this case because

- the capital costs would be high.

- the rainfall pattern is such that there is no significant clearly defined season and the water deficient period is relatively short (especially in the higher clay content soils)

- the response by the seedlings trees would be likely to be less than if superior grafted trees had been planted.

However the use of a cheaper water delivery system to extend the period of providing moisture to the trees would be an advantage. The topography at Kuda Sigiriya lends itself to the installation of numerous smaller ponds to be build on the contour line. These ponds would fill up in the period up to February and in the following months would release moisture by seepage through the top soil to trees planted 'downhill'.

It is recommended that Agrotech approach International Irrigation Management Institute (I.I.M.I.) water resources engineer Nihal Fernando to under take a quick survey on site (2 - 3 days) to advise as to the size and locations of these ponds.

5.9 Recommendations on Work Study Tours

It would be beneficial if the manager at Kuda Sigiriya Mr H.B Tennakoon was give the opportunity to visit other cashew growing areas as appropriate to increase his knowledge where possible.

The factors to consider in arranging such a tour is cost and number and accessibility of places that are willing to receive visitors. in general government stations may be more willing to allow entry - private farms are only going to be accommodating if special contacts are available.

It is clear that a visit to India offers the best opportunity in terms of the criteria above in terms of production, processing and marketing of cashew . There are about seven major state research stations and numerous processing facilities in addition to the marketing trade.

A one week visit to India could be arranged via the consultant's contacts allowing Mr Tennakoon to visit some establishments at reasonable cost.

Australia is another option however despite having more advanced research it does not offer the same opportunity for the following reasons

- it would be more costly
- the research has mainly be done by one private organization, partly in conjunction with CSIRO. These organizations by policy are protecting their research results very stringently.

6. BRIEF COMMENTS ON THE PROCESSING OF CASHEW

6.1 Background

Up to the mid 1960's the majority of the world's cashew crop was processed in India. The Indians not only processed their own crop but also purchased raw nuts from other producers for processing in their factories. At this time they controlled the major portion of the world's kernel supply. The exception was Brazil which for political reasons banned the export of raw nuts. However at that time Brazil was a relatively minor producer.

Exports of Kernel - India

	1950	1960	1970	1980	1990
Estimated % of world's exports	99	95	85	65	55

Cashew is somewhat difficult to process because the kernel is an odd shape and it is brittle. The indian success in processing is due to both the methods used and to the low cost of labour. The method used after roasting (preparation) basically involves manual processing (shelling,peeling grading) of raw nuts individually. The labour force is nearly always women and over the years these people have built up great work skills which are handed down from generation to generation.

More recently in some parts of India simple mechanical pedal operated cutting machines (Mangalore type) have introduced to improve productivity. However in the major processing area of Kerala completely manual methods continue as required by legislation - this being done for political reasons to increase the number of jobs.

In the 1960's some efforts were made in the major African producing countries to set up 'Indian style' processing units as they wished to retain their crop to add value rather than sell raw nuts. however these efforts were generally unsuccessful because the Africans could not duplicate the skills of the Indians. As a result a demand arose (mainly from Mozambique and Tanzania far an alternative to the processing methods.

To meet this demand two organizations (mainly) Sturtevant (UK) and Oltremare (Italy) designed mechanical processing equipment that could be installed as complete turnkey factories. Oltremare installed it's first factory in Tanzania in 1965 while Sturtevant's first plant was in Mozambique in 1971.

Oltremare installed 16 factories between 1965 and 1981 (total capacity 122,000 mt) of these nine were in Tanzania and three in Mozambique. None were built in the period 1982 - 1987 but a few more were added subsequently (Vietnam, Madagascar and Nigeria).

There were two other minor manufacturers of mechanical processing systems - Cashco (the Cashew Co of Japan) built three factories in Tanzania (capacity 30,000 mt) while Buhler of Switzerland built one in Indonesia. Cashco appear to have gone out of the cashew business while Buhler sold it's processing business to Oltremare in 1992.

To day the scene in the mechanical processing industry is one of major disruption and of working under capacity. Of the 14 plants in Mozambique (capacity 147,000 mt) some were destroyed by civil war while others have been allowed to decay through neglect. It is understood that only two factories are currently operating - this has ben mainly due to the dramatic drop in the availability of the crop.

In Brazil the development of the mechanical processing industry has been more successful. Due to the ban on raw nut exports (apart from some very minor recent exports) the industry has had a captive market. currently in Brazil there are about 14 significant factories with a reported capacity of about 140,000 mt.

The processors in Brazil have mainly designed their own equipment however it is apparent that in some cases they followed some design features from Oltermare and Sturtevant.

6.2 The Economics of Processing

There are four key factors that determine the economic viability of the method of processing They are :-

- cost and quality of raw material (raw nuts)
- capital cost of factory
- operating costs (mainly labour)
- quality of output

Ignoring the price of kernels the amount a processor will pay for raw nuts will depend on the perceived quality of the crop.

a) The quality of raw nuts is defined as -

- size of nuts and recovery rate
- condition of nuts, ie good or diseased, immature etc
- % moisture a high moisture content is not only a waste of money it also increase the chance of spoilage.

The price for raw nuts could vary by US $ 150 - 200/mt depending on quality.

b) The capital cost of a factory may also vary

In India a factory using manual or semi-manual methods and processing say 2,000 mt raw nuts p.a. could be constructed for say US $ 100,000 - 150,000. In comparison mechanical factories (Oltremare, Sturtevant) are much more expensive (Sturtevant MK 300 processing 1,250 mt costs US $ 1.2 million, Oltremare 800 mt plant costs US $ 0.5 million)

c) Operating costs are mainly labour

The labour requirement, it's productivity and cost can vary depending on the processed used and country of operation. An Oltremare plant for one shift processing 400 mt requires 70 workers not including management and support staff. An Indian factory to process a similar amount would require about 100 workers.

The cost of labour can vary from less than US $ 1.00 per day in some parts of Indonesia and China to US $ 5.00 in Papua New Guinea. The cost of labour in a processing factory in Sri Lanka (Puttalam) was 80 rupees/day + provident fund (12%). This is about US $1.90 per day and is a bit above Indian rates especially of the processing stages outside Kerala.

Labour productivity can also vary between countries although no good data is available on these differences. In Sri Lanka the consultant was advised by processors that they considered Sri lankan labour to be less productive than their Indian counterparts.

d) The quality of output can vary and this has a significant impact on the economics of processing. The market pays higher prices for larger kernels without blemishes while broken,desert (spoiled) and scorched grades fetch lower prices. The margins between these grades is not constant but may vary due mainly to spot demand and supply factors.

The standard of raw crop plays some part in determining the quality of output, but the standard of processing is also very important.

The Indian system (if done properly) achieves a much higher percentage of whole grades (85%), and (depending on preparation method ie drum,steam or oil bath, and skills) usually a lower level of scorched kernels (8 %- 10 %).

In contrast in mechanical factories the usual operating % wholes is significantly lower ie 55 % - 65 %. in factories that are not well run and maintained the % wholes could be 50 % or less. The % scorched may vary from 10 % - 12 %.

There is no doubt that Indian processing factories enjoy cost/ efficiency advantages over mechanical systems. This is best illustrated by the situation in Brazil which has a large mechanical processing industry and protects this industry by a ban on the exports of raw nuts.

The average 'buy in' price for raw nuts in Brazil for the three seasons 1989/90, 90/91,91/92 was US $470/mt. In comparison the average for crop purchased for processing in India is as follows,

	US per MT c and f
1989	951
1990	972
1991	841
1992	970
1993 (Jan - March)	930

6.3 The Options in Sri Lanka

The options are

- sell raw nuts to an existing processor in Sri Lanka (the 200 % tax on raw nut exports makes selling to India uneconomic)

- build a factory, process and sell kernel

To justify the factory option the net return after factory investment costs would have to be greater than selling raw nuts.The following simplified analysis helps to illustrate the point.

Analysis of Processing Factory

This analysis assumes

- the operation of a reasonably well run mechanical processing factory.

- price for Indian W 320 grade kernel is Us $ 2.30 per il c and f, estimated returns from 1 mt of raw nuts is as follows:

	%	Price/lb	Value (cents)
Wholes - 210	1	2.90	3.9
- 240	2	2.50	5.0
- 320	38	2.30	85.1
- 450	11	2.12	23.3
Brokens	35	1.50	52.5
Scorched wholes	8	2.15	17.5
Scorched brokens	3	1.20	6.0

		US $ 1.95/ per lb average	

Assuming a recovery rate of 23 %, the theoretical return from processing 1 mt of raw nuts and selling the kernel is US $ 988. If we add the CNSL (cashew nut shell liquid) this would add an additional US $ 28 giving a total return of US $ 1,016. (CNSL - 10 % recovery at US $ 300/mt less freight and commissions)

However there are a number of other factors that need to be considered. They are as follows,

a) Agent's selling commission In order to sell effectively in to a recognized export market i.e. USA Europe etc the factory would have to use a local selling agent. The usual commissions are about 2%.

(b) Freight from factory to market, say 5 cents/lb

(c) For a small new factory in Sri Lanka price discounts from standard Indian prices would occur. This would be because

- the factory would have no previous track record and buyers would be very cautious on perceived quality.

- the volumes of each grade turned out by the factory would be too small to interest many main stream buyers. buyers like to purchase grades by the container on a regular basis. The factory would take many months to accumulate enough of one grade to fill a container.

It is quite possible that this factory could see discounts of 10 cents per lb.

An alternative is to sell in to the domestic market in Sri Lanka. An analysis of the urban retail market by the consultant in March 94 indicated that retail prices for consumer packs from the Cashew Corporation's shop in Colombo were as follows

Grades	R/kg	US $/kg	% of sales
wholes	440	9.20	20
splits	370	7.70	60
pieces	300	6.30	20

It is not easy to compare prices internationally as quality varies but it appears that retail prices in Sri Lanka may be about the same as in some other countries. In Australia moderate grade wholes (Woolworths brand) were about A$13.00/kg or US $ 9.10.

There are no statistics on the size of the urban retail market in Sri Lanka but this is estimated at about 500 mt of kernels p.a..

7. THE CASHEW APPLE

7.1 Technical

The cashew apple is a by product of cashew production which is usually 6 - 10 times the size of the nut. the apple has a thin skin, bruises easily and deteriorates quickly once it is ripe and has fallen to the ground. The apple has received attention because of it's high content of vitamin C.

Analysis of Apple

Moisture	85 -90	(gm/100gm)
carbohydrates	8 - 13	"
proteins	0.2 - 0.9	"
fat	0.01 - 0.2	"
fibre	0.6	"
ash	0.2 - 0.3	"
Ca	0.2 - 10.0	"
P	6.0 - 19.0	(mg/100gm)
Fe	0.2 - 0.7	"
B1	0.02 - 0.2	"
B2	0.02 - 0.2	"
C	140 - 600	(iu/100gm)
A	450	"

Note: carbohydrates are mainly invert sugars.
Source: Ohler

7.2 Commercial Use

In both Brazil and India there has been some commercialization of the apple. In Brazil major use is made of the apple as fruit juice - it is estimated that the current production is about 40,000 mt of juice p.a. (1mt of cashew apple makes about 720 litres of juice).

The astringent properties of the cashew apple can now be overcome by various processes, including treating with gelatine,ascorbic acid, bentonite or polygonal pyro.

In Brazil a number of raw nut processors also have juicing facilities in their factories. They utilize apples from their own plantations as well as purchasing from small growers.

Farmgate Prices of Cashew Apple in Brazil

Year	US$ per/kg
1979	0.85
1980	1.17
1981	0.85
1982	0.51
1983	0.41
1984	0.98
1985	1.75
1986	1.35
1987	0.84
1988	0.61
1989	0.25

Source: Embrapa Documentos 93 - (note values in US$ are converted from local currency which has a very high rate of inflation).

The potential supply of cashew apples is enormous and only a fraction of the crop is utilized.

Because of the high perishability of the cashew apple the farmgate price is a reflection of the extra costs of harvesting and delivery.

In india a significant effort has been made to find alternative uses for apples the main uses are as follows:

- ethanol
- Bharath Fruit Distilling in Goa manufactures alcohol from apples for both domestic and export markets
- wine, alcoholic beverages, cashew wine
- jam, candy, chutney, pickles, vinegar etc

In most cashew growing countries the cashew apple is usually eaten as fresh fruit in the villages as well as fermented for alcohol. Apart from a limited export of Feni from Goa (the local version of whisky from cashew apple) the consultant has no knowledge of any significant export market of cashew apple products.

8. THE MARKET FOR CASHEW APPLE IN SRI LANKA

8.1 Background

In the 1990/92 period CSIR developed a method for processing cashew apple juice and removing the astringency present to make it a potential consumer product. CSIR then set up a small pilot plant to produce cashew apple juice at the rate of 10,000 litres per day.

In 1992 CSIR in conjunction with the Cashew Corporation undertook a simple test market of cashew apple juice in Colombo. In this test 1,000 bottles of juice were given to people who were passing the Cashew Corporation office and they were asked for their comments. The apparent reaction was quite positive from most respondents and while this market trial was not conducted on a scientific basis the promoters concluded that cashew apple juice had potential in Sri Lanka.

No effort was made to try blending cashew apple with other juices to test the 'blended' juice market.

CSIR is now apparently trying to sell it's cashew apple processing technology to private industry. Dr (Mrs) Ediriweera advised that although there had been some negotiation between CSIR and other parties (including foreign companies) no agreement on a sale had yet been reached.

The terms that CSIR is looking for is reported to be 25,000 rupees for non - exclusive rights, exclusive rights may also be available at a higher price.

8.2 Market Potential In Sri Lanka

The non alcoholic drink market in Sri Lanka is about 50.8 million litres of drink p.a., of this 80 % is carbonated drinks and the other 20 % is fruit juices (both blended and straight juices). The market is currently expanding rapidly at about 10 % p.a.
Any market potential for cashew apple lies in the fruit juice sector either blended or straight juice. The parameters of this market sector are as follows,

- straight juices, 5.0 million litres p.a.,The most popular product lines are mango, woodapple, pineapple, passion fruit and lime

- blended juices 2.2 million litres p.a. The usual ingredients are mango (say 35%), pineapple (say 35%), papaya (say 20 %) and lime (say 10 %).

Cashew apple could make an immediate entry in to blended juice market without any significant marketing (advertising) costs if it could satisfy the three following conditions,

1. Blend satisfactorily with other juices in the mix. For example if cashew apple is substituted for mango it must react atleast as well with the others in the mix.

2. It must be price competitive - mango or pineapple juice is currently available at 7.2 rupees per litre for inclusion in the blend. Cashew apple would probably have to be less to encourage the drink companies to change.

3. Provide a secure and reliable supply guaranteed throughout the year.

The maximum (theoretical) market for cashew apple juice would be 770,000 litres p.a. if it was used in all blended juice products to replace one of the major ingredients - either mango or pineapple. This amount of juice could be produced from about 1,000 mt of apples - equivalent to the harvest of 150 mt of raw nuts (+ apples).

The market potential for cashew apple in the straight fruit juice market may be much higher as it would be in a much larger market segment - just 10 % of the market would be 500,000 litres of cashew apple juice. However the barriers to entry to this market include promotional expenses as well as being price competitive and providing a reliable supply throughout the year.

ANNEX 1

REVIEW OF AGROTECH CASHEW PLANTATION

AT KUDA SIGIRIYA SRI LANKA

Visit to Sri Lanka March 5 to 19, 1994

Ian Duncan

May 1994

DETAILS OF GENETIC SELECTIONS FROM PANDORA PLANTATION PUTTALAM 1993

Agrotech Selection

Tree No.		Yield (kg)	No of Nuts	Av. Nut Weight (gm)
1	*	23.50	2,504	9.1
2	*	25.47	2,250	11.3
3	*	13.36	1,841	7.3
4		3.05	258	11.6
5		8.01	807	9.9
6				
7		6.00	586	10.2
8	*	11.10	1,010	11.0
9	*	10.05	916	10.9
10	*	10.62	1,226	8.7
11		9.42	689	13.7
12		6.00	614	9.8
13		7.46	719	10.4
14		6.20	544	11.4
15		5.05	865	5.8
16		7.35	553	13.3
17		4.58	396	11.6
18		4.90	382	12.8
19	*	12.82	1,353	9.5
20		6.33	478	13.2
21		3.74	282	13.3
22		3.01	292	10.3
23				
24		6.45	542	11.9
25		6.15	516	11.9
26	*	11.10	864	12.8
27		7.44	732	10.2
28		6.15	520	11.8
29		4.75	309	15.4
30		6.90	677	9.0
31		6.65	680	9.8
32		6.00	580	10.3
33	*	10.95	986	11.1
34		6.15	47	11.2
35	*	17.10	1,315	13.0
36		7.70	716	10.8
37		7.52	812	9.3

Tree No		Yield (kg)	No of Nuts	Av Nut Weight (gm)
38	*	10.65	980	10.9
39		6.49	589	11.0
40	*	11.00	1,050	10.5
41	*	9.65	976	9.9
42		6.63	681	9.7
43		5.60	683	8.2
44		no data		
45	*	8.18	837	9.8
46		7.90	652	12.1
47	*	11.35	1,050	10.8
48		no data		
49		no data		
50	*	9.80	786	12.5
51	*	18.53	1,864	9.9
52	*	19.85	1,810	10.9
53	*	15.35	1,148	9.5
54		6.30	542	11.6
55	*	9.21	822	11.2
56	*	14.15	1,486	9.5
57		6.68	695	9.6
58		7.22	703	10.3
59		4.73	456	10.4
60	*	9.25	1,075	8.6
61		6.35	649	9.8
62		4.95	470	10.5
63		4.45	489	9.1
64		5.62	502	11.2
65	*	15.85	1,464	10.8
66		6.70	765	8.8
67		5.25	464	11.3
68		5.42	586	9.2
69		4.98	557	8.9
70		4.63	409	11.3
71		no data		
72		no data		
73		no data		

Note:

1. All trees harvested for trials at Pandora Plantation are believed to be about 8 years old.
2. The 23 trees originally selected for grafting and progeny trials at Kuda Sigiriya marked thus *.

ANNEX 2

STATUS OF GRAFTING AT KUDA SIGIRIYA NURSERY AS AT 10 MARCH 1994

Agrotech Selection Tree No	Total Grafts made	No successfully grafted
1	192	67
2	110	6 *
3	378	291
8	160	40
9	168	
10	168	
19	168	
26	168	
33	189	73
35	138	75
38	238	17 *
40	203	44 *
41	132	64
45	107	8 *
47	182	44
50	78	45
51	258	110
52	335	119
53	80	7 *
55	120	53
56	168	23 *
60	270	42 *
65	210	21 *
	---	---
	4220	1149

Note:

1. Trees marked thus * have grafts still in the immature stage in the nursery and find success rates still unknown.

ANNEX 3

TREE SELECTION CRITERIA AND RAW NUT ANALYSIS

a) Yield and Nut Quality

1. Selected trees to be individually harvested to obtain total yields.
2. Sample of 100 nuts are weighed to get average raw nut weight.
3. Sample is roasted and shelled and testa is removed.
4. Kernel weighed to get (a) recovery rate and (b) average kernel weight.
5. Calculate weight of kernel produced by tree.
6. Calculate value of kernel produced by tree (weight of kernel x price of grade).

Use following table for kernel grades

Grade	Price US$ per lb.
W 320	2.30
W 240	2.50
W 210	2.70
W 180	3.00

Note: grade W 320 refers to kernels per lb or individual kernels of 1.45 gm, a W 240 kernel is about 1.9 gm.

Original selection of seedling mother tress can be done on yield and nut quality aspects as above. If selected for progeny trials additional criteria can be added in selection process.

These additional criteria are

b) Tree Shape

An upright growth habit allows a higher density of planting's and therefore a potentially a higher yield per hectare.

Trees that attain a greater height have the capacity to growth more canopy with a potential for greater yield.

c) Resistance to Insect Pest Attack

Some trees appear to (tolerate) resist attack by insect pests more than other trees - for unknown reasons. As helopeltis in particular is expected to be a continuing problem any clonal trees that appear to escape significant damage should be noted.

d) Resistance to Wind Damage

Cashew, especially when young, are susceptible to wind (storm) damage. Any clonal trees that appear to suffer significantly from wind damage should be excluded.

ANNEX 4

SUGGESTED WEEKLY INSECT MONITORING FORMAT

Preparation

1. Divide farm into segments for insect monitoring.
2. Train monitoring team to identify insect pests at different life cycle stages and damage caused.
3. Monitoring program once a week, preferably on same day.
4. Trees to be picked on sampling basis but preference for trees showing growing flush (if available).
5. Examine 10 panicles each from 10 trees if of sufficient size (otherwise 5 panicles from 20 trees).
6. Record insects numbers and damage rated to a scale.
7. Monitoring is a qualitative skill - in overall result adjust for any bias by any individual in monitoring team.
8. Total monitoring effect is dependent on resources available, but at Kuda Sigiriya suggested that 4 students should monitor for say 3 hours/weekly session.
9. Decision to spray depends on assessment of 'critical level' which is gained by experience. Objective is to anticipate any build ;up by detecting rising populations of pests still at immature stage.
10. Follow any spray with monitoring to gauge effectiveness of control measures.

Forms for Insect Monitoring

a) Pest Numbers (sample)

Location	Panicles Examined	Leaf Roller			Helopeltis		
		S	M	L	S	M	L
Segment 1	100	20	10	-	50	100	120
Segment 2	100	5	16	10	20	32	96

S, M, L refers to small, medium or large sizes in relation to life cycle of insect pest.

b) Damage Rating

Location	Panicles Examined	Leaf Roller					Helopeltis				
		1	2	3	4	5	1	2	3	4	5
Segment 1	100	21	2	6	10	8	-	10	20	15	10

1, 2, 3, 4, 5 refers to scale of damage seen, 5 being total destruction.

ANNEX 5

SOIL AND LEAF COLLECTION PROCEDURES

A) Instructions for soil sample analysis

1. Choose your area to be sampled carefully:-

   - Divide into obviously different areas such as hillside, valley, etc., and make one composite sample for each area

   - the area sampled should be uniform, i.e., all look the same, with the same crop, same slope, same colour etc

   - the area sampled should not be more than (1) hectare

   - avoid abnormal areas, such as piles of ash, barrets, tracks.

2. Make a Composite sample (Composite means made up of several small samples):-

   - take several (10 - 20) small samples from different places in each area

   - collect soil from the average cultivation or rooting depths of the crops to be grown

   - do not mix topsoil with subsoil, make a different composite sample of each

3. Mix all the small samples from one area together to make the composite sample, we will need about 1 kg of soil for the analysis:

4. Put the soil sample in strong bags (preferably plastic):

   - Use two (2) bags one inside the other and put a label between the two bags with the location of soil and/or an identifying number written on it.

   - Mark the outside of the bags clearly with the same name and number.

   - Tie up the bag carefully.

   - Send off for analysis.

It is good policy to do two sets of samples and hold one set on site in the event of a loss in transit of the sample being sent for analysis.

B) Instructions for Leaf Analysis

- Take sample leaves from sample of trees from different areas in the plantation (in particular samples should reflect any differences in soil type, tree type/age, and topography types in the plantation).

- Leaves should be in semi mature state.

- Wash any dust off leaves with distilled water.

- Pack in paper wrapping (not plastic) for transport to laboratory for analysis.

ANNEX 6

COSTS OF CONTROLLING ILLUK GRASS

Hand Cutting

Current control methods involve hand cutting using a gang of 12 men which takes virtually the whole year to clear the 486 acre farm.

The disadvantages of this method are:

- uses up all available labour for whole year which can put pressure on other farm operations
- expensive, estimated cost Rs. 394,000 or Rs. 810/acre.
- slow, and illuk grass while it remains uncut is both a fire hazard and an alternative host plant for insect pests especially helopeltis

Machine Cutting

The proposed control method is to use modified Agrimec Jet 5 or similar machines with spot spraying with Roundup for illuk control.

The advantages of this method are:

- is faster, using 3 machines control could be achieved in an estimated 100 days
- cheaper, assuming the machines are written off over 3 years, the annual cost would be about R 160,000
- removes problem of labour shortage as only 7 men are required for about 100 days
- faster control time reduces fire hazard risks and reduces insect pest problems
- gives opportunity to earn revenue by renting machines for contract paddy harvesting.

Details on Costs

1. Hand Cutting Rs.

- labour for cutting 12 man days/acre (12 x 486 acres x Rs. 60)	349,920
- labour for stacking 1 man day/acre (486 acres x Rs. 60) =	29,160
- materials, 50 sickles x Rs. 47	2,350
- worker transport	12,000
- medical	500

	393,930

2. Machine Cutting

- machine purchase and modification (3 x Rs. 75,000 [purchase] 3 x Rs. 10,000 for modification) = Rs. 255,000 Assume write off over 3 years	85,000
- annual maintenance on machines	15,000
- labour (7 men x 100 days x Rs. 60)	42,000
- fuel (5 l x 3 machines x 100 days x Rs. 12/l)	18,000

	160,000

Each machine is operated by 2 men with a work rate of 1.6 acres per day (compared to work rate of 4.0 to 4.5 acres/day in paddy).

ANNEX 7

VOLUMES AND VALUE OF KERNEL EXPORTS FROM SRI LANKA

	Volume (MT)	Value (Rs million)
1981	1,105	73.6
1982	616	64.7
1983	899	83.7
1984	128	17.0
1985	284	41.2
1986	503	90.7
1987	1,034	195.6
1988	1,116	208.5
1989	1,327	244.4
1990	1,281	277.0
1991	1,102	290.0
1992	1,062	236.5
1993	1,123	268.2 (Jan - Sept)

The major markets are as follows (1990)

	(MT)
Israel	371
United Arab Emirates	435
Saudi Arabia	242
Lebanon	66
Cyprus	44
Others	123

	1,281

ANNEX 8

MAJOR CASHEW EXPORTERS IN SRI LANKA

1. **Jayes Trading Co**
   111 1st Floor Bankshall Street
   Colombo 11
   Tel.: 436366
   Fax 449514

2. **Hemas (Drugs) Ltd**
   Hemas Building
   36 Bristol Street
   Colombo 1
   Tel.: 422 307-8
   Fax 574560, 445910

3. **Expolanka Ltd**
   10 Milepost Avenue
   Colombo 03
   Tel.: 575169-71
   Fax 574213, 574046

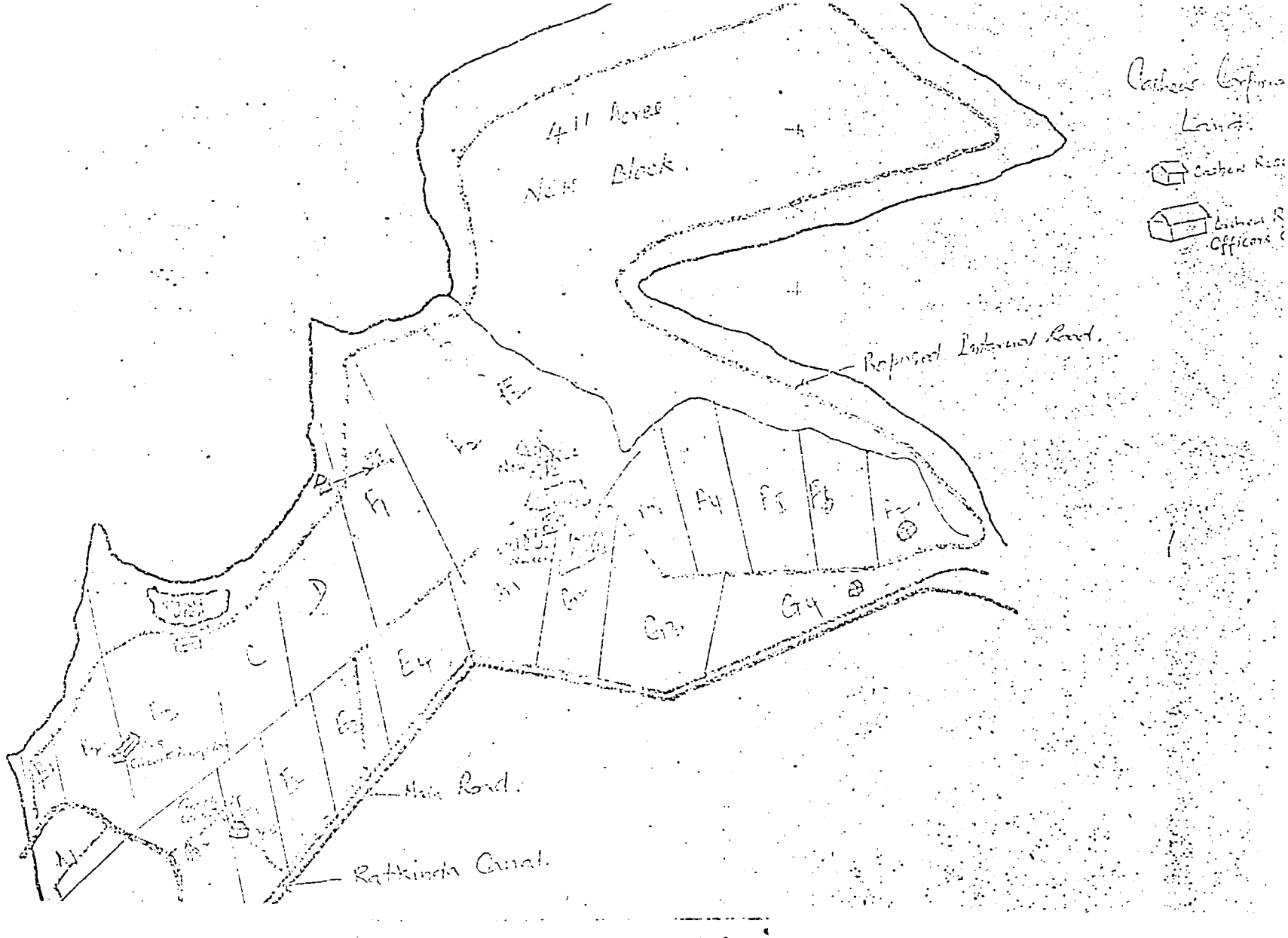
4. **Swarna Enterprises**
   29 2/9A Gaffoor Building
   Colombo 01
   Tel.: 440 666
   Fax 449820

5. **Colombo Exports**
   67, First Floor
   Keyzer Street
   Colombo 11
   Tel.: 432246

6. **La Cajou a Allied Products**
   Biyagama Export Processing Zone
   Biyagama
   Tel.: 571729-9
   Fax 571727

ANNEX 9

HAND DRAWN MAP OF KUDA SIGIRIYA PLANTATION



BEST AVAILABLE DOCUMENT

ANNEX 10

TERMS OF REFERENCE FOR CONSULTANT

Scope of Work for Ian Duncan during his visit to Sri Lanka
March 5 to 19, 1994

1. Evaluate the results of initial genepool development and suggest improvements on grafting techniques to increase the present rate of success which is about 50 percent.

2. Provide a long term production management plan based on progress made by Informatics in accordance with the previous recommendation. Specific recommendation for plant nutrition, irrigation and pest control to develop high quality cashew cultivars should be given so that increase in yield per acre and nut size may be achieved.

3. Comments should be made on the processing of nuts, apples and shell liquid in Sri Lanka for competing in the world market so that feasibility of establishing a processing plant may be considered.

4. Assistance should be given in arranging the educational trips for Informatics to Australia and India for observing production, processing and marketing techniques.

5. Prepare a report on the current status of the project and outline future course of action.

6. Give a briefing to USAID, EIED/MASL and Informatics on the progress of the project and future recommendations.

MED/EIED PUBLICATIONS AVAILABLE

Local Market for Pickled Products (December 1990)

Non Farm Small Scale Enterprise Credit on Selected Mahaweli Systems, Geoffrey Peters and M.W. Panditha (December 1990)

Crop Profiles - Spices, Herbs and Aromatics, L. Denzil Phillips (July 1991)

Study of the Tourism Development in the Uda Walawe (July 1991)

Potential for Silver Skin Onions in the Mahaweli, Walter Nueberg (August 1991)

Nursery Development of Papaya and Mango, Papaya Growers' Guide and Technical Notes for Business Plan for Mixed Fruit Cultivation Investment, Ben Hatfield (November 1991)

Dehydrated Fruit Processing Opportunities and Trends in Sri Lanka, Wanchai Somchit, (November 1991)

An Evaluation of the Entrepreneur Development Programmes, Dr. Susan Exo and Hina Shah, (December 1991)

Aromatics PIP Interim Report on Trials Establishment, Dr Thomas Davies (December 1991)

Agro-Business Financing Review, Dennis De Santis (December 1991)

Integrated Fruit Drying, juicing, Pulping project - Prep Feasibility Study, Michael Smedley, Ben Hatfield and Wanchai Somchit (December 1991)

Cold Chain Requirements for Uda Walawe, Fredrick E. Henry (March 1992)

Field Manual for Processing Tomatoes, Peter Florance (March 1992)

Processing Tomato Trials in Mahaweli System H, Peter Florance (March 1992)

Processing Tomato Trials in Mahaweli System C, Peter Florance (March 1992)

Dried Fruit Processing in the Mahaweli, Dr. Kamal Hyder (September 1992)

Feasibility Study on Commercial Potential of Snake Venoms in Mahaweli Systems. Anslem de Silva, (January 1993)

Census of Mahaweli Enterprises and Employment (January 1993)

Most publications are priced at Rs.100/-. The publications are available at the MED Office at 8th Floor, Unity Plaza, Colombo 4. (inquiries, Ph. 508682-4)

An EIED publication entitled - "Information Available for the Mahaweli Investor", is also available at the MED Office.

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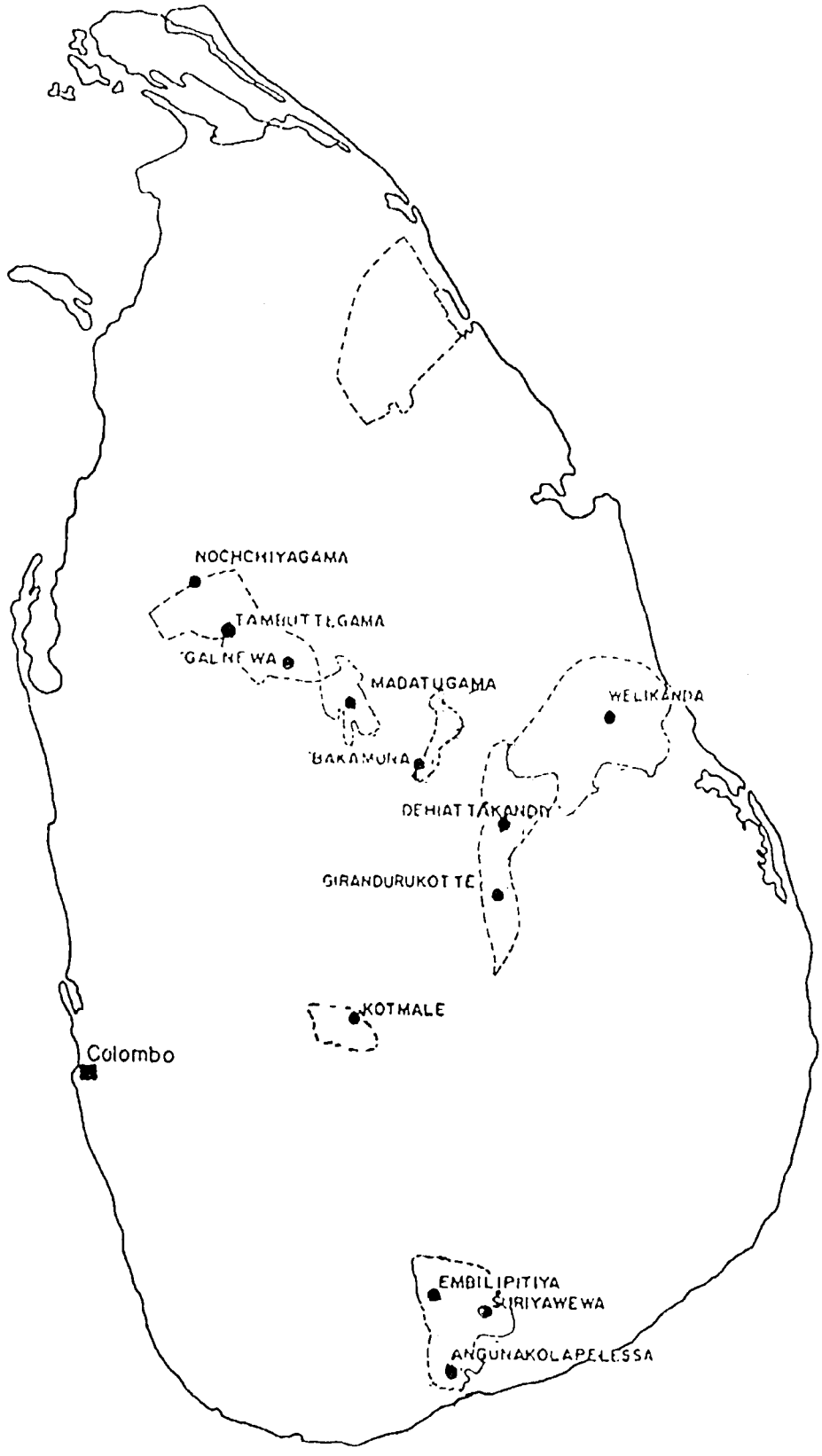

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--- MAHAWELI PROJECTS

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