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MAHAWELI ENTERPRISE DEVELOPMENT

MED/EIED PROJECT

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CASHEW DEVELOPMENT

A short-term consultancy report
by
Mr Ian Duncan

June, 1993 Report 7/1993

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

The Mahaweli Enterprise Development Project

The development of the natural and human resources of the Mahaweli river basin has been a high priority of the Government of Sri Lanka and international agencies since the late 1970's. Largely completed are the construction of dams, irrigation and power systems, roads and other physical infrastructure, the settlement of the land and the formation of the agricultural production base. The challenge for the 1990's is to build a diverse, dynamic economy generating higher incomes for Mahaweli families. In meeting this challenge, the private sector has a leading role to play.

The Mahaweli Enterprise Development Project (MED) is a special initative of the Mahaweli Authority of Sri Lanka, with the support of the United States Agency for International Development. MED promotes private investment and job creation in agribusiness, manufacturing, tourism, minerals and services by directly assisting entrepreneurs and companies with technical expertise, marketing support, training, business advisory services and credit. MED also provides policy analysis support to improve official frameworks for sustainable enterprise development in the Mahaweli areas.

The Employment, Investment and Enterprise Development Division of the Mahaweli Authority is responsible for MED implementation. Technical consultancy is provided by a consortium led by the International Science and Technology Institute, Inc., a private consulting firm with head offices in Washington, D.C. Also in the consortium are Agroskills, Development Alternatives, Ernst and Young, High Value Horticulture and Sparks Commodities. Marketing services are provided by SRD Research and Development Group, Inc.

PREFACE

Mr Ian Duncan, a cashew specialist, visited the Mahaweli during February 20, to March 12, 1993 to advise Informatics on the development of their cashew project in System C. Mr Duncan's consultancy was provided by MED through ISTI's sub-contract with High Value Horticulture.

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1. SUMMARY AND RECOMMENDATIONS

1.1 Summary of Project

Development

Informatics Agrotech commenced a cashew plantation in 1987 in Mahaweli Zone 6 System C, some 12 km from Dehiattakandiya. As the company specializes in computer technology it did not have any previous experience in agriculture.

To date the company has planted 589 acres with cashew (26,000 cashew trees). They propose to plant the balance of this land (411 acres) over the next one to two years. This new area is covered with some heavy forest and scrub and initial clearing costs may be significant. Future plans include purchasing crop from nearby small holders, the installation of a processing factory and marketing of cashew kernels and by products. The company is also planting some cash crops on site to assist with early cash flow prior to earning income from cashew.

Site

The project farm site is clearly not ideal. The land is undulating and even after the forest clearing it remains largely covered by illuk grass ('imperata cylindrica') which must be controlled for effective plantation management. However the methods currently proposed for the control of illuk are expensive. Soil conditions on site are unknown as no analysis was undertaken. A visual inspection indicated that the soil structure may not be ideal for cashew. An examination of the trees showed no obvious restrictions to growth so far, however, the oldest trees are still only 5 1/2 years of age. A poor nutrient soil status is less important for cashew as nutrients can be added.

Climate

No climatic data is available from the site, information from Aralaganwila Research Station (10 km away) suggested that the rainfall pattern may be unfavourable for cashew and this could affect the crop in some years while high humidity levels could lead to increased insect pest activity. Agrotech staff indicate that weather conditions on site may be different to Aralaganwila.

Agronomy

All plantings to date have been by seed, initial efforts at nursery propagation and transplanting proved a failure and in the past year direct seedling has proved more successful.

Fertiliser is applied only at planting, there is some watering of newly planted seedlings for the first few months. Helopeltis is a major pest and has caused significant damage to the plantation since November 1992. Inspection by the consultant indicated additional infestation by a foliage eating caterpillar (likely to be leafroller) and no doubt other insect pests will become important as trees mature and canopies grow. Stem borer, while significant in other

plantations, does not appear prevalent on site. Elephants are also a problem as the site is adjacent to a wildlife park.

In 1992, some 1200 of the oldest trees were harvested (4-5 years) and 464 kg of raw nuts collected (Av. 0.39 kg/tree).

Future yields from the mature trees (10 years) are very likely to be not more than 500 kg - 750 kg per hectare (200-300kg/acre) with present agricultural practices. This is much lower than indicated in the company's Project Proposal (3000 kg/ha). The likelihood of increasing future yields to even approach the proposed level (300 kg) will only be known after climate soil and irrigation potential is investigated thoroughly.

Staff

The Farm Manager and his deputy are keen and qualified in agriculture. However, they as yet have very limited experience in cashew, have no technical literature to consult and have virtually no effective research back up for the project.

1.2 Recommendations

Overall Strategy - the company should concentrate it's immediate efforts (9-12 months) to overcoming both the production and cost control problems on the farm. Following a consideration of this report it is suggested the company re-work the financial data on production. Then there can be a re-examination of the processing options and marketing of product.

The following specific recommendations are made:-

Points 1 - 7 refer to production issues of the nucleus farm.

Point 10 refers to processing, Point 11 to the Outgrower-Scheme, and Point 12 to Marketing.

1. Improve the genepool and change policy to planting grafted trees propagated from superior mother trees

   As cashew is an open pollinated seedling, trees are highly variable in performance. Evidence from Brazil and elsewhere indicates that while there may be a few outstanding examples in any seedling population the majority will be poor performers. Agrotech will be able to achieve very significant increases in yield from superior clonal trees.

   Cashew is sensitive to climatic and soil changes and any selected clones will have to be tested on site in a progeny trial before extensive multiplication. In the short term superior mother trees must be selected from the existing seedling populations in Sri Lanka. Because of logistical difficulties and as no yield data is available it is suggested that in 1993 Agrotech limit their selection pool to the easily manageable plantations near Puttalam. 50 selections from the Premadasa, Pandura and Cashew Corporation plantations should be made. They should employ their own staff to

reside at Puttalam and ensure correct collection of data. In 1994, the area of search for superior mother trees could be extended.

For the longer term imports of scion wood and especially seeds from selected sources overseas are essential for clonal selections. These arrangements can be made by the consultant during 1993. Importation of vegetative material may be quarantined at the proposed screen house at Aralanganwila.

2. Ensure Agrotech has access to skilled grafting techniques in cashew

The ability to successfully graft is an essential requirement in the plan to plant clonal trees. Agrotech staff have no experience of grafting. There is evidence that there are people with the ability to graft cashew at both the MARD System B nursery and at Department of Agriculture research station in Gannoruwa, Kandy. It will be necessary for Agrotech to make arrangements with these organisations to:-

- hire staff to undertake the propagation of the clonal trees to be produced at the end of 1993.

- teach Agrotech staff the technique so that the company has this skill in-house.

There are a number of techniques used, but wedge or cleft grafting appears to be most satisfactory in the consultant's experience. A reasonable level of performance could be considered to be at least 70% success rate and plant trees in the field in 3-4 months after planting rootstock seed.

3. Undertake analyses of soil structure and nutrient status. Leaf analysis would also be useful to determine nutrient status for later fertilizer applications

While the site selection decision was taken some years ago, it is still important to determine the soil structure conditions on site. Cashews prefer a deep free draining soil without compaction or hardpan. A visual inspection on site gave concern that the soils are not ideal for cashew. If the soils analysis indicates unsuitable soils Agrotech must accept that there will be limitations on expected future tree growth and yields.

The preferred procedure would be for a qualified soil scientist to visit the site and take samples for analysis. The number of samples taken should reflect the degree of soil type variability. Proportions of clay, silt and sand need to be determined to a minimum of 2 metres depth. In particular the existence of any soil compaction or hardpans must be examined.

A soil nutrient and leaf analysis should also be done to determine the nutrient status of the soil and the trees.

The application of fertilizer has proved to be most productive in cashew, especially if the soils are low in nutrients. In the absence of irrigation fertilizers can only be practically applied in the wet season - say October-January. However, with irrigation they can be applied during the year.

It is proposed that soil and leaf analysis details be sent to the consultant for advice on nutrient applications. Once the nutrient requirements are determined Agrotech should make plans to apply fertilizers by October 1993.

A minimum of the following is requested from the analysis.

Soil nutrient	Leaf (Nutrient %)	
-pH	-N	- Manganese
-organic matter	-phosphorus	- Iron
-M.E.	-potassium	- Boron
-N	-sulphur	
-phosphates	-calcium	
-calcium	-magnesium	
-magnesium	-copper - (ppm)	
-potassium	-zinc - (ppm)	
-sodium		

4. Initiate an Entomology Programme on site

There is no data available about the likely insect pests on site or any predator/parasite species. The current evidence is that insect pests have already had a major impact on tree performance - this situation can only get more difficult as the number of trees mature.

There is little information about effective control measures. The initial objectives of the entomology program must be:

(a) compiling biodata on insect species on site to allow correct identification and future understanding of impact of pests and predator/pest relationships.

(b) insect monitoring system to give early warning of insect pest attack.

This allows quick response to pest hot spots thus avoiding spraying whole plantation as much as possible.

Agrotech has no entomology capability therefore it will be essential to organize this assistance to the project from the appropriate organization. The compiling of biodata on insects is a time consuming task that will require extended periods on site. This task could be well done by final year entomology students working under supervision. Negotiations with the Entomology Department, University of Peradeniya indicated that these arrangements could be made.

The design of an insect monitoring system and spraying programme is best undertaken by an entomologist experienced with commercial plantations.

5. Programme to improve training for Agrotech staff

The company has commenced a cashew project, initially in production but its future plans involve processing and marketing. However, it has no experience in this business. The Farm staff have very limited experience of cashew, no technical literature and no back up research support from institutions in Sri Lanka.

The improvement in knowledge and skills should be tackled on three levels.

- Organize to acquire immediately the available technical literature on cashew. This will include the standard text books cashew and the literature published mainly in India, mainly by the Central Plantation Crops Research Institution.

- At farm level visiting experts to site to give training seminars to staff. The immediate high priority areas are nursery propagation/young tree maintenance and entomology. The Consultant can arrange the necessary experts from overseas if they are not available in Sri Lanka.

- Management need to become better informed on research activities and commercial performance in production and processing elsewhere in the cashew world. A quick study tour to India, Brazil, Europe and possibly Australia would be an advantage and can be arranged by the Consultant.

India has six research stations involved with cashew and they have done work in selection, vegetative propagation, nutrition and pest control. Arrangements should be made to visit at least two stations. In addition Agrotech to visit processing factories using different systems (hot oil bath, steam, drum roasting) under guidance of local experts and CFTRI Mysore for information on cashew by products.

Brazil is the only country that has large commercial cashew plantations operated on a systematic basis. It is the origin of the genepool and has also done some research at the Pacajus Research Station. The opportunity exists to examine production and processing issues (both kernels and by products).

Australia is the only place where research has been conducted at a high level.

6. Agrotech to initiate system to record data required for efficient management of plantation

Currently apart from the normal wages and stores and staff information, limited operational data is collected. It is recommended that the following be implemented:-

(a) **A Farm Plan**, in essence a system that numbers every tree on the plantation for later easy identification. This can be achieved by dividing the plantation into blocks, each with Row and Tree numbers. It is only necessary to mark sufficient rows with markers to allow identification of other row and tree numbers.

(b) **Weather data**, purchase and installation of rainfall, humidity and temperature data (including absolute max and min). This data must be recorded on a daily basis.

(c) **Yield data**, commencing with 1993 collect crop from any outstanding trees. Once identified yield data must be collected on annual basis together with raw nut size and recovery %. In 1993 the crop from the 1987 plantings (260 trees) and 1988 plantings (852 trees) should be recorded. This will allow some estimates of future yields from this seedling populated. Once clonal trees are introduced it is essential that they be planted in variety groups for ease of later evaluation in the progeny trials.

(d) **Entomology data**, record results of regular insect surveys i.e., trees inspected, number/type insects found, control measures undertaken, post control inspection results. Data on damage by other pests, i.e., elephants, etc., also to be recorded.

7. Investigate the potential to provide supplementary irrigation

Irrigation in cashew when used is always supplied in conjunction with added nutrients. However, experiments in Australia have showed that even in the absence of any fertilizer the application of irrigation alone increased total yield by at least 20%. This increased yield was obtained largely by increases in the recovery rate of the nuts (i.e., higher kernel to raw nut ratio).

Agrotech are not allowed to pump water from the two major tanks adjoining the farm. Their only capacity to provide water for irrigation is to either sink tube wells and/or construct small scale tanks on the farm.

An effective mode of water application to the trees is complicated by the undulating nature of the land. In some areas of the farm, depending on topography, gravity fed irrigation systems may be possible, where this is not possible, water may have to be applied by bowser.

The optimum volume of water required per tree is not yet known, but experiments in Australia indicate that for a mature tree this may be 15-18 kl per irrigation season. The relevant figure for the nucleus farm will depend on their conditions, (soil, climate etc.) and this is unknown. However, using the Australian figure as a guide this would give a total volume water requirement of 720 ML net p.a.

It is recommended that Agrotech commission Dr. Bassnayake an agricultural engineer, Department of Agricultural Engineering, University of Peradeniya to undertake a study with the following objectives:-

- Obtain previous groundwater study data (if any)

- Examine most cost efficient method to provide for supply of approximately 720 ML of water p.a..

- Advise on design of gravity irrigation system where possible

- In absence of gravity system to advise on system to minimise cost of transport of water for irrigation.

The feasibility report of Agrotech makes some allowance for construction costs (bulldozer for earth moving).

8. Initiate search overseas for more information on more cost efficient methods to control illuk grass ('Imperata Cylindrica')

Illuk grass is a major impediment to efficient plantation management. It competes with young cashew trees for sunlight, moisture and nutrition and is a physical and (physiological) barrier to workers on the plantation operations.

The only suggested control methods known in Sri Lanka involve either repeated discing using a bulldozer or repeated spraying with Roundup over 3 - 4 years. Both methods may be effective but are considered to be very expensive. The current mentod used - spraying a corridor for the young trees will cost Rs. 8000 per hectare over 3 years (US$ 174). This would be equivalent to the total returns from the cashew trees for up to the first 6 years.

Illuk is known as a problem grass in rubber plantations in Malaysia. It is recommended that approaches be made to Sime Darby and other major plantation operators in Malaysia and to the CSIR4O Division of Tropical Pastures in Australia.

9. Agrotech to investigate methods to reduce cost of clearing the 411 acre second stage

The new extension - 411 acres is currently covered with forest timber and heavy scrub, land clearing will involve pushing the timber over, collecting it in piles for disposal by burning and rootraking the soils.

The company owns an old D4 bulldozer which is now not in reasonable working order. It cannot expect to clear the land without access to better equipment either by purchasing or by hiring. Both options are expensive. The company has budgeted for the purchase of a D6 machine. This investment would also have useful future utility on the farm re road, dam construction and this would be the preferred option. The alternative of hiring a contractor to undertake the clearing is also expensive as follows:-

Purchase option

	Rs. (million)
Capital cost D6	5.35
fuel/labour	0.65

	6.00

Contractor option

	Rs. (million)
Pushing timber (5 acres/day) at Rs. 2500/hr	1.644
Collecting timber (10 acres/day) ~	0.822
Root raking 10 acres/day ~	0.822
Total clearing cost	3.3

The total budget plantation costs for the first five years of the new area (411 acres) without bulldozer/clearing costs are as follows:-

	Rs. (million)
Capital	6.4
Operating	7.6
	14.6

The budgeted costs of clearing the new area (Rs. 6.00 million) represent a 43% increase in expenditure, even the option of hiring a contractor for clearing at Rs. 3.3 million is also a large increase in total project costs (24%).

10. Agrotech to re-evaluate the processing options at the appropriate time

There are a number of options for the processing of cashew and the company's plans to purchase a Peabody Sturtevant MK600 plant (capacity 1000 MT raw nuts) may not be the most cost efficient method.

Much of the quoted processing efficiency figures i.e., % whole kernels, is incorrect and rarely (if ever) achieved in practice. (The '75% - 85% wholes achieved' by Peabody systems as indicated in the proposal is highly inflated). A proper evaluation of processing options is only possible with the input of expert advice that has intimate operational knowledge of the different systems. There are two basic options for processing:-

1. A turnkey 'mechanised' factory as designed by Peabody Sturtevant or Oltremare. (The NRI in the UK now make a miniature version of the Peabody system). Buhler (previously Widmer & Ernst) are out of business and Cashco (Japan) have not sold a plant in nearly 20 years.

2. Use a manual or semi-manual system based on Indian or S.E. Asian methods. Within this group there are options for raw nut treatment (hot oil bath, steam cooking, drum roasting etc.,) and decortication (manual, semi-manual machine).

The mechanised turnkey factories by Peabody and Oltremare are high capital cost systems originally designed for African conditions where labour was more expensive and less productive than in India. Their efficiency in processing is usually well below that achieved by the Indian manual methods. The Indian manual or semi-manual factories are much lower in capital cost and are highly competitive due to the high productivity of the workers.

It should be noted that while the consultant was working for the World Bank in Tasmania in 1989 he was able to verify that it became more economic to sell the raw nuts to India - rather than process them in the existing mechanical (Oltremare, Cashco) factories and sell the kernels.

The correct choice for processing in Sri Lanka depends on an analysis of capital, and labour costs, labour productivity and operational efficiency of the equipment used.

11. Agrotech to pursue the plans for the Outgrowers Scheme

The company's plans to manage an outgrower scheme on both the ex Cashew Corporation Weheragal Plantation and with 6400 small holders each growing 1/2 acre of cashew. These sources of crop are sensible options for Agrotech to increase their supply in the future.

Both sources are located in close proximity to the Agrotech site and their location relative to other cashew production and trading infrastructure in Sri Lanka should mean that the company should not face excessive price competition for the crop

12. Agrotech to examine marketing options in detail at the appropriate time

The company's future plans include:-

Selling
- kernels at the retail level in export markets (perhaps supplying and contract packing for major retailers).
- sales of CNL
- utilisation of cashew apple. The company plans to co-operate with Smak, a Sri Lanka fruit juice manufacturer, to market juice products.

The retailing of kernels on the export market by a small producer/processor is currently unheard of. While this may appear to be a desirable objective, to the consultants knowledge it has only been achieved in a small way by the Zambia Cashew Company. There are significant obstacles to overcome, including existing market structures and difficulties in an unknown small producer achieving market credibility. At the very least Agrotech would have to sell at a significant discount at the initial stages to gain market entry.

ACTION PLANS

1. GENEPOOL

DATE	ACTIVITY	ACTION BY
March 13	Initial selection of mother trees at Puttalam based on anecdotal evidence of plantation managers	Agrotech/MED/ consultant
April 1	Recruitment of staff for Puttalam	Agrotech
April 12	Second stage selection based on inspection of trees (at near fruit maturity stage).	Earl Guise/ Dr. Pethiyagoda
May	Periodic visits to Puttalam to check on progress of data collection.	Dr. Pethiyagoda
June	Completion of harvest. Evaluation of results of mother trees. Selections made.	MED/Agrotech/ Consultant
August	Application for import of scions and seed.	Agrotech

Earl Guise to be responsible for coordination of genepool data. Consultant to plan importation of overseas planting market for delivery end of 1993.

2. GRAFTING

DATE	ACTIVITY	ACTION BY
May	Identify grafters	Agrotech
June	Negotiate arrangements to use System B nursery for propagation of clonal trees.	Agrotech/MED
August 1	Propagate 1500 + rootstock seedlings	Earl Guise/ System B Nursery/Agrotech

September 1	Propagate 1500 + rootstock seedlings	Earl Guise/ System B Nursery/Agrotech
October 1	Propagate 1500 + rootstock seedlings	Earl Guise/ System B Nursery
	Grafting of scions on rootstock	Earl Guise/ System B Nursery
November	Grafting of scions on rootstock	Earl Guise/ System B Nursery

Clonal trees planted on site December and January 1994.

3. ENTOMOLOGY

DATE	ACTIVITY	ACTION BY
May	Negotiate assistance with Department of Entomology, University of Peradeniya re provision of students for collection of insect biodata on site.	Agrotech
June	Students take up residence on site for collection of insect data.	Agrotech
August	Consultant entomologist to design insect monitoring programme plan control measures.	Local Entomologist or as arranged by Consultant

4. TRAINING

DATE	ACTIVITY	ACTION BY
April	Collection of technical data for Agrotech	Consultant
April/May	Organization of Agrotech Study tour (Brazil, India, Australia).	Consultant

July	Agrotech study tour.	
August	Training seminars to be arranged for Agrotech staff especially for entomology, propagation and nursery.	Consultant

5. OTHER

DATE	ACTIVITY	ACTION BY
March	Installation of weather recording equipment.	Agrotech
April	Arrange analysis of soil structure by Dr. Lathif at Aralaganwila.	Agrotech/ Consultant
	Arrange nutrient analysis of soil structure by Dr. Lathif at Aralaganwila.	Agrotech/ Consultant
May/June	Results of soil/leaf analysis. Consultant to draw up nutrition plan for 1993/1994.	Consultant
	Approach to Malaysian plantation owners and CSIRO Division of Tropical Pastures re Illuk grass.	Consultant
	Approach Mahaweli Authority re-extension of Elephant Fence	Agrotech
August	Water storage and irrigation potential study by Dr Ben Bassnayake	Agrotech

2. THE CASHEW INDUSTRY IN SRI LANKA

2.1 Production

Production was introduced from Goa (India) in the early 1900's and became established as a minor crop in the 1950's/60's. The eating of cashew during April - the Singapore New Year - is considered a part of Sri Lanka culture.

Initial steps in the organised planting of cashew were undertaken by the State Plantations Corporation, who commenced planting in the Mannon District in 1965. In May 1973 the Sri Lanka Cashew Corporation was incorporated with the objectives of promoting the development of the cashew industry including production processing and the provision of extension services and subsidies to small growers.

The production initiatives of the Corporation involved the identification of suitable land and the planting of the following plantations:-

PLANTATION	HECTARES PLANTED	MATURE TREES (HECTARE)
Kandachchi	2586	1759
Puttalam	387	N/A
Komandaluwa	202	N/A
Hardy	86	N/A
Mirigjawila	100	N/A
Madhu Road	120	100

	3481	

In the Kandachchi Plantation some 200 hectares were planted in 1965-69 and the balance during the 1970-83 period.

In addition the Weheragal plantation (near Dehiattakandiya) was recently transferred from Cashew Corporation to the Mahaweli Authority and will shortly be allocated to small holders. This plantation was estimated to have up to 30,000 trees (20,000 7 years, remainder younger) which is effectively 250 hectares (685 acres).

It should be noted that the red tree numbers on the Cashew Corporation plantations will be lower than the official figures as losses will have occurred. In addition the plantations at Kandachchi and at Batticaloa are no longer operational as they are in terrorist affected areas. (See Appendix 6 for details on plantations).

The major private sector cashew plantings are as follows:-

	Hectares
Panadura Plantation Puttalam	160
Kind Mudalali Estate Puttalam	53
Agrotech (to date)	232

There are an estimated 50 - 100 small growers with an estimated 10 - 15 hectares of cashew and numerous small holders in the following districts:-

Mannar, Puttalam in the north, Kurunegala in the central area, Batticaloa in the east and Hombantota in the south.

There are no official production statistics but the useable crop is estimated at 8,000 - 10,000 MT raw nuts. The export of raw nuts from Sri Lanka is banned.
The Cashew Corporation has operated a cashew subsidy scheme as part of its extension services to small growers in the industry. Via its 20 regional cashew development offices and its nurseries it had assisted only the small holders, i.e., those with less than 10 acres (3.9 ha). This assistance has involved distributing an (officially) estimated 80,000 seedlings each year together with a subsidy of 10 Rs./plant in the first year and 5 Rs. in the second. While a large number of seedlings may have been distributed the survival rate may have been low.

In addition some unknown proportion of the total crop on the land is behind terrorist lines and therefore not available for use.

All plantings of cashew in Sri Lanka are by seed, on plantations the spacing is usually about 40-50 per acre. Fertiliser use is rare but spraying is sometimes undertaken against insect pests especially helopeltis, stem borer is also a major problem. There is little information on yields, the only reliable data (Dr. Pethiyagoda Mahaweli Authority) indicated an average yield of about 500 kg raw nuts per hectare from mature trees at the Kandachchi Plantation. (Appendix 1). Evidence from Pandora Plantation Puttalam indicated an average yield of 950kg/hectare over the three years 1990-1992. These figures are in line with what is achieved elsewhere in the world in smaller circumstances, although the figures from Panadora would be better than most.

There is no evidence of any worthwhile research into cashew being undertaken in Sri Lanka. The main responsibility for research appears to have been with the Cashew Corporation, but the consultant was unable to find any reports or references.

2.2 Processing

There are five (known) significant processing factories in Sri Lanka, these are:-

Owner/ operator	Location	System	Capacity (raw nuts per day)	No of workers (approx)
Cashew Corp	Puttalam	Steam	0.5 MT	70
Cashew Corp	Makewita	Steam	0.5 MT	70
Colombo Import/Export	Puttalam	Steam	1.5 MT	150
Colombo Import/Export	Seeduwa	Steam	1.5 MT	150
La Cashew	FT2	Unknown	Unknown	Unknown

The consultant was unable to visit the La Cashew factory but was advised it had a labour force of about 250. The estimate is that the organised processing factories process up to 2000 MT p.a. raw nuts. There is a significant 'back-yard' processing industry with numerous small units especially in the Ja-ela area north of Colombo. This cottage industry processes perhaps 70% of the kernels produced in Sri Lanka.

The larger processing factories use steam cooking and Mangalore type pedal operated shelling machines. The cottage industry operators either pan frying to remove CNSL before manual shelling or sometimes manually shell without pre-treatment.

The processing factories usually purchase the raw nuts from traders who go round purchasing from the small holders. Factory gate prices at Puttalam for the 1992 crop ranged from 18 Rs./kg at harvest time to 35 Rs./kg at the end of the season, i.e., March - April (Range US$0.40 - 0.78 per kg).

Most of the factories do not grade their purchases. The prices paid to the small holders by the traders would only be slightly less than the 18 - 35 Rs. as they would be working on quick turnover basis.

Some informed sources indicated a view that processing had not been very successful in Sri Lanka for the following reasons.

- Sri Lanka wages were higher than similar workers in Kerala (India).
- Sri Lanka workers productivity was lower than in Kerala.

2.3 Marketing

Export of kernels from Sri Lanka became significant after 1980, and after a temporary decline in mid 1980's have remained about 1000 MT p.a. In 1992 exports surprisingly doubled - the reasons are unclear, an increase in crop and perhaps more crop became available from the terrorist controlled areas.

Cashew Exports from Sri Lanka

Year	MT (kernels)	Value (Rs. millions)
1980	399.4	32.6
1981	1106.9	73.5
1982	616.8	64.6
1983	899.0	83.7
1984	128.2	17.0
1985	284.5	1.2
1986	503.4	90.7
1987	1034.1	195.6
1988	1116.2	208.5
1989	1327.6	244.4
1990	1281.4	277.2
1991	1102.0	289.3
1992	2012.0	N/A

Source: Cashew Corporation 1980 - 1991, Expo Lanka 1992

The major markets for kernels are the Middle East, Far East, Japan and Hong Kong. There are 17 cashew exporters listed by the Sri Lanka Export Development Board, the major ones are:

Expolanka Ltd
Akbar Brothers Exporters (Put) Ltd
Jayes Trading Co

Expolanka admitted to be responsible for about 250 MT kernel exports.

The size of the domestic market is uncertain and even industry estimates vary. There is a tradition of eating cashew in the food, and at Pasyala there is a permanent sale of cashew to passing traffic via numerous stalls. The best estimate is that the domestic market is about 300-500 MT kernels p.a.

The strong demand for cashew has led to a situation where the domestic price is often higher than the export price. Retail prices of kernels at the Cashew Corporation shop in February 1993 were as follows:

	Price (Rs.)	Equivalent US$ price per lb
Whole grade 340gm pack	150	4.50
240gm pack	100	4.20

The Colombo retail prices are similar to prices in Australian retail outlets.

2.4 Other Issues

There is little production of CNSL in Sri Lanka and no commercial utilisation of the cashew apple as occurs in Brazil and some parts of India. However the apple is often consumed by the smallholders.

The Ceylon Institute of Scientific and Industrial Research (CISIR) in Colombo has undertaken some research in cashew products, usually as a result of requests of clients. Work has been done on different flavoured kernels - chilli, curry, batter and salter. The latter two are specific products for the Japanese market. Cashew apple juice and chutney has also been researched for private clients.

3. THE INFORMATICS CASHEW PROJECT

3.1 Background

Agrotech, a subsidiary of Informatics, commenced a cashew project in 1987 in the System C area of the Mahaweli Development Program.

System C is a 67,000 hectares economic development area in the central east of Sri Lanka, some 40km from the east coast at Batticaloa. The main town centre at Dehattakandiya has an estimated population of 30,000 and the surrounding area contains about 12,000 small growers. The major crops currently grown are gherkins, melons, mango, banana, rice and papaya. This area has only been developed in the past ten years, and while some infrastructure has been developed, i.e., roads, others like communications still require improvement.

Agrotech has a 33 year lease on 232 hectares of land (589 acres) some 12km from Dehattakandiya, it will also soon acquire a lease on the adjoining 162 hectares (411 acres).

3.2 The Site

The site is undulating country with some rocky outcrops and has some hills perhaps 200m high at one boundary. There is little information about the soil type, no soil analysis has been undertaken. It is generally classed as a non-calcic brown but is variable. It becomes very hard on the surface in the dry season. Apart from the rocky outcrops, there is a suggestion that there may be a layer of bedrock in parts of the site at an unknown but possibly shallow depth. The site adjoins a 2000 hectare Weheragal cashew plantation previously handed over from the Cashew Corporation to the Mahaweli Authority, and a canal which forms the boundary with the Madura Oya Wildlife Park. There are also two tanks (dams) on either side of the site.

3.3 Informatics Development Proposal

The Informatics cashew developments can be divided into a number of parts:

(a) The original nucleus farm of 232 hectares (589 acres) which was developed between 1987 - 1993;

(b) Further plantings of cashew on the additional land 162 hectares (411 acres).

(c) Provision of extension services and a crop purchase scheme for the 433 outgrowers who will each have 7 acres of the ex Cashew Corporation plantation land.

(d) The nearby Mahaweli Authority land where some 6,400 small growers will be given 3 acres of land (2.5 irrigated, .05 unirrigated) over the next five years Agrotech will provide extension services and have a crop buy back scheme for those outgrowers who will be persuaded to grow cashew on the 1/2 acre of unirrigated land.

(e) Construction of processing plant.

(f) Marketing of cashew kernels to export retail markets.

(g) Utilisation of cashew by-products, CNSL and especially the cashew apple for juice and other products on the domestic market.

3.4 The Nucleus Farm

Work commenced on site in 1987 with land clearing and the setting up of a nursery and some basic facilities.

Genepool

The original seed stock was purchased from Puttalam in 1987, the origin of the seed apparently come from Kandachchi Plantation Mannar. In subsequent years additional seed was purchased from the same area. By 1991 the domestic crop was being used for planting and by 1992 no imports were necessary as the crop was sufficient for all plantings.

The criteria that has been used for seed selection is size and a floating test for germination. As no information is available on the mother trees of the original seed, it can be assumed that all the project plantings have come from unknown sources.

Propagation and Planting

The efforts at propagation in the period 1987 - 1991 did not prove very successful with high losses. In this period propagation was by seed in poly bags which were later transplanted in the field during the wet season only. In this time it is estimated that 60,000 seedlings were propagated with over 50% losses. The reasons for these failures were:

- incorrect procedures, seedling's transplanted when too mature
- bushfires
- damage by animals, porcupines etc.

In 1992 a change was made to direct seeding. With this approach two seeds were planted in the same hole (to allow for losses) and subsequent watering and mulching. The procedure was to plant throughout the year with plants receiving watering once every two weeks for up to the first year. The volume of water applied is 1/3 approximately 1/3 - 1/2 litre/seedling/watering. This system has proved much more successful in terms of both losses and cost.

The current tree status is as follows:-

Date Planted	Surviving trees	Spacing Equivalent/hectare
1987	260	45'x45'
1988	854	40'x40'
1989	2725	35'x35'
1990	1003	30'x30'
1991	7386	30'x30'
1992	14580*	30'x30'
	26808	

* number of trees planted, no record yet of losses.

Around the boundary of the farm teak trees have been planted and castor trees have been planted on the boundary adjacent to the Wildlife park. The castor was chosen as it was expected to be a repellent to elephants.

Yields

A small harvest was collected in 1991 but no records are available. In 1992 some 464 kg of raw nuts (58,000 nuts) was harvested from 1200 of the oldest trees - the 1987/88 plantings. The average yield was 0.4 kg/tree with average nut size of 8 gm. No information is available on kernel quality or recovery rates. The majority of the crop was used for planting during 1992/93.

Nutrition and Irrigation

There is no supplementary irrigation apart from the hand watering of the seedlings once fortnightly from planting until the wet season. There is a small application of basal fertiliser (NPK 111) at time of planting, thereafter there are no further applications. An examination of trees by the consultant suggested that deficiencies are likely on site, as typical symptoms were observed. However, there is little information as no soil nutrition or leaf analysis has been done.

Pests, diseases and problems

The major pests were considered by the management to be as follows:-

- elephants
- porcupines
- insects

The site is adjacent to the Madura Oya Wildlife Park and incursions by elephants at night are frequent (Appendix 4) for list of elephant damage). The company employs six guards and one supervisor equipped with lights and firecrackers (and shotguns) to control entry. These efforts are only partly successful as over the period September 1992 - February 1993 an estimated 20 large cashew trees were destroyed by elephants with much greater damage to other crops on the farm such as rice, bananas etc.

Porcupines were previously responsible for the loss rate of up to 25% of young seedlings in some parts of the farm. In the past year young seedlings have been protected by installing a small (20cm high) fence of sticks which appears to be successful.

The major spraying activity is against helopeltis which had caused significant damage to perhaps 60% of all larger trees during the consultant's visit. The normal practice is to spray all the larger trees once an attack is noticed. Helopeltis was first noticed in early November 1992, however spraying with the chemical Sevin only commenced in late December due to 'frequent interruptions due to rain'.

The farm has one power backpack sprayer that in practice has the capacity to spray about 60 trees per day (3-5 year old trees).

Stem borer is also known as a pest, it is prevalent in the nearby ex Cashew Corporation Weheragal Plantation but to date there is only one recorded incidence on the nucleus farm.

There is no information on diseases on the farm although one or two trees have died of unknown causes. No pathology examination was done as the farm has no backup research facilities (it is doubtful if worthwhile facilities are available in the region).

Illuk grass ('Imperata Cylindrica') is a perennial rhizomatous grass that covers the majority of the nucleus farm area. It has apparently becomes dominant after the clearing of the natural forest cover. At the end of the rainy season (Dec/Jan) it attains a height of 1.5 m. For the first few years the grass was cut manually about 4-5 times p.a. (the undulating terrain prohibits mechanical slashing). However this practice was terminated in 1991 due to excessive cost. Discing and ripping operations were considered and rejected as too expensive and as an alternative a two metre wide corridor is sprayed with Roundup once a year in December along the tree line. This is effective in giving some (not optimal) access to the young trees. It is estimated that these corridors may have to be sprayed for 3-4 years before the tree canopy can assist in reducing the grass. The cost of spraying in labour and materials is a prohibitive 2670 Rs./ha p.a. (US$60/ha).

The management considers the Illuk grass as a major farm problem both in terms of cost and because of the extra difficulties imposed in farm management.

Staff

The overall management of the project is by the General Manager who is based in Colombo but usually makes twice monthly visits to the site.

The operational staff are:

Farm Manager:	Agricultural science graduate, 20 years experience in sugar. No previous experience in cashew, he started with Agrotech in June, 1992.
Assistant Manager:	Agricultural science diploma, has worked on the project for the past 2-3 years.
Supervisors:	3
Caretakers:	25 Each responsible for about 23 acres.
Office staff:	3
Driver/mechanics:	2/3
Watchmen:	6
Miscellaneous:	2

In addition casual labour is taken on at peak times like harvesting, planting, etc.

Labour costs are 72 Rs. per day (60 Rs. wages + 12 Rs. provident fund and other costs). This is well above the minimum wage level of about 45 Rs./day. Agrotech feel this is an appropriate wage considering that labour is scarce in the Mahaweli region.

Research backup and information

The farm management has no published technical information on cashew to consult. There is no relevant government extension service and little interaction to date with the nearest agricultural research centres at Aralagonwila and Girandurukotte some 10-15km away. Very little research has been conducted into cashew by either the Cashew Corporation or by any research institution in Sri Lanka.

The farm does keep some basic records, it has no site weather data and few operational records.

4. EVALUATION OF NUCLEUS FARM

4.1 Soil

Cashew is planted on 589 acres of undulating ground. The general soil types are classified as Non Calcic Brown (NCB) and Red Brown soils (RB).

No detailed information was available on the nucleus farm soils. No soil analysis has been done and no reports were available on soil types as being positively identified as similar to the nucleus farm soils. It was not possible to meet Dr. Lathif the soil scientist at Aralaganwila, however, an approximate appreciation was constructed on the basis of general comments by several parties and a personal site inspection.

The main characteristics are: Sandy loam (unknown % clay silt), free draining soil, low organic matter, low nutrient status. Ph 5.5-6.0 possible soil compaction at 1-5.5 metres. Water table may vary from 5 metres in February to an unknown depth in the dry seasons.

In addition there is evidence of layers of rock in places in the subsoil. There is little information on the depth and extent of this rock throughout the plantation.

The soils of the nucleus farm appear not to be ideal for cashew. Cashew prefers the following characteristics: Deep well drained sandy/sandy loam soils with a rooting depth of 3-4 metres with no hardpan or soil compaction. A pH of neutral to slightly acid is preferred. A low nutrient status in the soil is not a limiting factor provided added nutrients are applied (apart from NPK, zinc, boron and manganese have been found to be important to cashew).

The major concern at the nucleus farm is the possible existence of significant soil compaction or a hardpan as this would restrict root development and hence eventual nature tree performance. In addition if the rock is shallow and extensive in nature, there would be restrictions on tree growth. Visual inspections of larger trees by the consultant showed no obvious restriction at this stage. However, the oldest trees are only five years of age.

4.2 Temperature

No temperature data is available from the nucleus farm so information was taken from Aralaganwila Research Station (10 km from the nucleus farm). Note: See Appendix 2 for all available weather data from Aralaganwila.

Cashew prefers a warm and even temperature regime. They can withstand low temperatures for brief periods (i.e., 7°c) and extreme high temperatures (40°c) may also be undesirable especially at flowering time.

Information from Aralaganwila suggests that the expected temperature regimes on site will be ideal for cashew. At Aralaganwila 1984-90 maximums were 37°c, mere minimums 21°c. In 1992 absolute maximum was 38.4°c absolute minimum 13.1°c.

4.3 Rainfall and Humidity

Cashew prefers an annual rainfall of 800 - 1800 mm p.a. with a well defined wet and dry season. The dry season should extend for at least four months. Cashew will continue to flower and fruit when rainfall is evenly distributed throughout the year, however, this situation is unfavourable for good performance. Light showers during flowering will do no harm, however heavy rains will adversely affect yields. In addition, rain (and associated high humidity) during flowering and fruiting time will encourage higher insect pest and possibly disease problems.

Cashew is a drought resistant tree if growing in soil conditions that allow deep rooting. There is a strong relationship between performance and water availability in the soil. In deep friable soil the roots can grow deep and spread to cover a large area.

In shallow soils, heavy clay etc., the rooting system is restricted and cashew will suffer drought stress during the dry season.

As no data is available from the nucleus farm site rainfall information was taken from Aralaganwila Research Station (10 km from site).

The mean monthly and weekly rainfall figures for 1984-90 do not show a well defined dry season of any significant length. Over the critical flowering to harvest season (February - June) there appears to be a higher than desirable rainfall. For comparison purposes data from Aralaganwila is shown with data from a site in Northern Australia that is considered ideal for cashew.

Mean Monthly Rainfall and Relative Humidity

	Aralaganwila		Northern Australia	
	Rainfall (mm)	Humidity % (at 8.30am)	Rainfall (mm)	Humidity % (at 9.00am)
February	150	85	3	66
March	138	73	nil	61
April	105	84	3	67
May	70	67	11	65
June	10	63	57	69

Based on this evidence one might conclude that the rainfall pattern on site is not ideal. Heavy showers especially at peak flowering (March/April) could depress yields. In addition it would be likely that nucleus farm would face increased insect pest problems - this problem can be corrected if a high standard of insect monitoring and control is practiced.

There is an opinion from Informatics staff that the actual rainfall pattern at the site is different to that at Aralaganwila. They advise that it is drier during February- June and point to the evidence of only one days rain during February 1993. This evidence is based on only one years experience with no hard data. It is imperative that the nucleus farm starts recording all relevant data on site.

4.4 Genepool

The initial plantings at the nucleus farm were from seed purchased from the Mannar District. Later plantings were from seed obtained from Puttalam and by 1991/1992 seed from the harvest was being used for propagation.

The original seed source is unidentified and there is no information on the mother trees used. The only selection criteria used was seed size and the germination float test.

Cashew is an heterogeneous open pollinated tree and as such there is enormous genetic variation in the seed. Seed from a group of selected superior mother trees in a controlled clonal garden would give reduced variation at a higher level. The only method of obtaining strict trueness to type is by in-vitro propagation. This technique has not been perfected in cashew and the only current practical method is to use vegetative propagation. Depending on genotype the inherent characteristics will be passed to the progeny within a certain range - this range will be determined by rootstock interaction with the scion.

The most practical method of vegetative propagation is by grafting. Budding would be more effective but has been mastered by very few individuals. Propagation by cuttings has been tried many times without any significant success.

Virtually all cashew plantings are currently by seed and subsequently there is a very wide variation in the performance of individual trees. The normal pattern in a given population is for a few outstanding trees but with the majority of specimens being at a low level.

The following are examples from plantings in different countries where reliable data is available.

Brazil

1. Pernambuco Research Station
   30 adult trees — Average yield 10.3kg
   Range 1.5 kg - 24.0 kg

2. Pacajus Research Station
   80 trees (3-14 years) Range 0.1 kg - 35 kg

3. Survey of commercial plantings in Brazil 1974-86 by EMBRAPA

0 - 2 kg	41% of trees
2 - 4 kg	22% of trees
4 - 6 kg	14% of trees
6 - 8 kg	10% of trees
8 kg >	13% of trees

Tanzania (Nachingwea)

128	3 Year old trees	Average yield 2.6 kg Range 0.4 kg - 6.8 kg
60	mature trees	Average yield 9.5 kg Range 75% less than 9 kg, 3 trees above 36 kg.

Nigeria

Plot 1	Unknown number of trees	Average yield 4.2 kg Range 0.8 kg - 13.3 kg
Plot 2	Unknown number of trees	Average yield 7.8 kg Range 0.1 kg - 36.1 kg

India

A survey of mature trees in India showed a range from 0.5 kg - 200 kg per tree.

By contrast data from Australia (below) shows that variations in yield and nut size in clonal trees is much more limited even allowing for unknown rootstock interaction. The objective is to obtain performance at a higher level with much reduced variation.

Clone X Tree Number	Yield (kg raw nuts)	Nut Size (gm)
1	16.0	5.58
2	17.6	5.56
3	20.0	6.06
4	14.4	5.60
5	15.2	5.92
6	13.6	5.40
7	13.6	5.58
8	20.0	5.36
9	15.2	5.72
10	24.0	5.80
11	13.6	5.42
12	12.0	6.28
13	13.6	6.36
14	12.0	6.42
15	17.6	5.84
16	20.0	6.12
17	15.2	6.02
18	16.0	5.20
Average	16.09	5.80

4.5 Yields

The normal commercial plantings elsewhere in the world are of seedling stock with no irrigation, sometimes a little fertiliser and usually some efforts at pest control. In this situation the expected average yields are about 300 - 750 kg/hectare raw nuts at maturity. In especially favourable situations where soil and climate conditions are suitable higher yields of about 1000 kg/hectare or more will be achieved.

Apart from the normal low yields, there can also be significant variability of yields from year to year depending on climatic conditions or pest populations etc.

In Sri Lanka there is evidence from Dr. Pethiyagoda (Mahaweli Authority) of average yields of about 500 kg/hectare from mature trees at the Kandachchi Plantation, Mannar (Appendix 1). This area is generally regarded as being among the most suitable for cashew in Sri Lanka. Evidence from the Manager of Randora Plantation in Puttalam indicated an average yield of 900 kg/hectare from mature trees over the 1990 - 1992 period. This is a reasonable result but it should be noted that soil conditions at Puttalam appear quite suitable for cashew.

In making estimates of future yields from the nucleus farm (under existing circumstances) it would be necessary to consider that the soil conditions appear to be less favourable for cashew than in the Mannar or Puttalam areas of Sri Lanka.

From research work in Brazil it is possible to estimate the yield curve of seedling trees in a plantation situation assuming correct spacing.

Cashew Yields Curve

Year	% of Total Yield
1	0
2	2
3	3
4	7
5	13
6	20
7	46
8	66
9	95
10	100

In 1992 the company achieved a harvest of 464 kg off about 1200 trees (300 5 years, 900 4 years), giving an average of 0.4 kg/tree. At the spacing of 120 tress/hectare this would indicate yields of about 560 kg/hectare in the 10th year. Of course, the yield in any one year might be distorted due to climatic, pest factors etc. However, it is the consultant's estimate that under existing circumstances average yields will not exceed 500 - 750 kg/hectare at maturity.

4.6 Nutrition

Currently no added nutrients are used on the cashew trees at the nucleus farm. Previous experience has shown that cashew responds well to fertilizers especially if grown on low nutrient status soils.

There have been a number of studies on fertilizing cashew, however, many are of little value as (1) data on local conditions i.e., soils, climate, spacing, tree age etc., were not given and (2) methods used in experiments to determine type, level, time and mode of application is not given. Some worthwhile trials were conducted by Lefebre in 1970 in the Malagasy Republic. These involved with fertilizing in the planting hole and broadcasting.

Experiment 1

20 gN, 40 gm P2O5, 36 gm K20 in the planting hole, repeated annually up to fourth year after planting. Results were:

Treatment	Height	Stem Circumference	Yield (kg/ha)
Control	20	23	82
N.P.K.	35	42	901

Yields measured cumulative up to four years after planting, height at 39 months, circumference at 43 months after planting.

Experiment 2

Fertiliser broadcast at following rates:

Year 1	200 gm, NPK (11:22:16) in planting hole
Year 2	400 gm, 600 gm, 800 gm, (11:22:16) broadcast

Results were:

Treatment	Yield Increase % Yield 3 to Year 4	Yield per ha Year 4 (kg/ha)
Control	8	450
N	70	611
P	31	515
K	44	624
NP	39	559
NK	95	710
PK	8	482
NPK	59	655
NPK + trace	64	652

Source: Lefebre (1970)

Other nutrition trials conducted in Australia indicated good response to nutrition. Best yields were obtained at the highest NPK rates, lower responses were achieved in the absence of P and least response in N only applications.

In the Australian trial the level of NPK applications was varied with tree age. All plots consisted of trees of a single clone of the same age.

At four years of age the following fertilizer rates were used for the following treatments. For simplicity data on only some of the treatments is given below.

Treatment No		Fertilizer (gm element/ha)	Average Yield per tree (kg) raw nuts
1.	N_3	780	5.6
	P_3	450	
	K_3	140	
3.	N_1	140	
	P_1	50	3.4
	K_1	80	
9.	N_2	270	2.3

Treatment 9 is used as control (Nitrogen only) as no fertilizer use is not a practical option in Australia. The above results show a very significant response over control - of course these trees were all receiving supplementary irrigation at the standard rate. Further work in Australia shows that different genetypes also have different response levels to added nutrition. This work also shows the importance of some elements such as zinc, manganese and boron.

The results from Australia cannot be directly extrapolated to Sri Lanka because of the difference in the parameters i.e., clonal trees, irrigation etc. However, the principle that cashew gives an economic response to fertilizer especially if grown on low nutrient status soils is established.

4.7 Irrigation

There are virtually no irrigated commercial cashew plantings in the world and to the consultants knowledge the only serious research of irrigation in cashew has been undertaken in Australia. Of course, the irrigation is undertaken in connection with a nutrient program. The early trial work in Australia established (as expected) a response to irrigation and later work is now using new technology to establish the actual water requirement of the tree to avoid drought stress.

The water requirement is complicated and the results are not yet available. However, the following data could be used.

Experiment: Irrigation without nutrition, plot of four clonal trees used in each trial

	Irrigated	Non-irrigated
No of nuts/tree	961	1133
Yield/tree (kg)	4.29	4.24
Nut weight/tree (gm)	4.46	3.73
Recovery %	32.3	27.4
Kernel weight	1.48	1.04
Total Kernel weight/ tree (kg)	1422.3	1178.3

The above research shows that the major function of irrigation is to increase nut size and recovery rates and hence the size of the kernel. As a result the kernel yield per tree increased by 20% despite a small drop in the number of nuts set compared to the non-irrigated plot.

Of course, these results are specific to the conditions on site i.e., soil type, clonal tree etc. However, the principles could be extrapolated elsewhere.

The nucleus farm currently only irrigates seedling trees for a period from planting up to next wet season. The volume/frequency is about 1/3 to maybe 1/2 litre once every two weeks.

The optimum level of irrigation is dependent on tree size, rainfall patterns, the soil structure and water holding capacity. Larger cashew trees (4 metres high) growing in sandy soils may require up to 600 litres/tree/week in the peak period in Australia. (say 2ML{Megalitres}/hectare p.a.).

Because of the lack of information on soil conditions at the nucleus farm no conclusions can be made on irrigation rates. However, if these figures were extrapolated to the Agrotech site some 720ML of water would be required for an irrigation season (for 1000 acres).

The Agrotech site is located close to two tanks but, they are not officially allowed to pump from these. The only current source of water is a well. The possible construction of dams has been discussed - assuming dimensions of 3m x 140 m square for each dam, some 13 would be required (if there was no loss to evaporation). Alternative water sources of constructing tube wells were also discussed but no costs were available.

In Australia both micro-sprinkle and drip irrigation systems are in use. The undulating nature of the terrain on site puts severe limitations on practical application methods Sprinkler and drip systems are probably impractical. Some small scale gravity irrigation may be possible depending on the location of the dam. 'Pitcher' irrigation methods were also examined.

Given the physical constraints on site it is not clear that irrigation will be economically feasible but the idea needs to be explored.

4.8 Insect Pests

Little is known about the potential insect pests of cashew in Sri Lanka. The only available research information is an unpublished communication by Dr. Baptiste (1940's) which gives a list of insect species on cashew (Appendix 3).

On the nucleus farm 'helopeltis cyclonous' is known. In his visits the consultant saw helopeltis damage on perhaps 70% of the larger trees. Some trees were very severely damaged and may not give much crop in 1993. A further examination of trees on the farm also revealed a significant presence of a caterpillar pest most likely 'Anigraea' (cashew leaf roller).

It appears that the presence of helopeltis on site was noticed in November, 1992. However, effective spraying operations were not commenced until January due to numerous interruptions by rain. During the November-January period the helopeltis were unchecked and populations increased to cause significant damage.

The presence of leaf roller was first noticed during the consultant's visit and it is highly likely that other insect pests will become significant in time. Experience elsewhere shows that individual pest problems may vary from year to year due to climatic factors. However, the full potential impact may not be seen until there is a sufficient number of trees, with adequate canopy size to create a "monoculture".

In the opinion of the consultant the following insect pests (and others) may in time be of importance on the nucleus farm -helopeltis, leaf curler, tip borer, leaf roller.

Helopeltis is the major pest of cashew in India and it is likely to also be significant in Sri Lanka. There has been no research on insect pests in Sri Lanka, however the following information is based on research elsewhere.

a. 'Helopeltis cyclonicus': different species of helopeltis are found in other cashew growing areas. (India 'helopeltis antonii'). Overall life cycle estimated 17-20 days Adult insect is small, 3-4 mm in size. Population of helopeltis may increase during wet season, but greatest damage usually done during dry season as insect has ability to damage shoots, flowers and nuts (while maturing). Damage is caused by helopeltis injecting phytotoxins while feeding. Typical evidence of damage is a blackening around the affected area. In severe attacks on foliar or floral shoots, necrotic lesions occur in effect ring barking the stem resulting in die back of the shoot.

b. Leafroller ('Anigraea ochrolasis') has been recorded in cashew in SE Asia. A caterpillar pest that causes damage by eating new flush leaves. In situations of high density they have the capacity to defoliate a tree. Larvae chew tender emerging leaves, early instal larvae typically web together opposing margins of the leaf to form a tent like structure. Life cycle is estimated at 26-29 days.

c. Tip Borer ('Penicillaria jocosatrix') has been recorded as a pest of cashew in India. It is a caterpillar pest that is also commonly found on mango. The preferred food of the larvae are the tender leaves of newly emerging foliar flush. Larvae initially eat the leaf margins, later large portions of the leaf may be removed leaving only the mid ribs. Under conditions of high density larvae can remove entire flushes and damage immature nuts. Overall life cycle is estimated at 21-30 days depending on location.

d. Pink wax scale ('Ceroplastes rubens') identified by Dr. Baptiste in the 1940's as being in Sri Lanka, scale may be found on mature leaves and flowers taccines. The main effect of scale is thought to be on tree rigor and consequent reduction in flowering.

e. Stem Borers Dr. Baptiste identified 'Ctenomeristis ebriola' in Sri Lanka, while Gerini (1976) reported 'Placaederus ferrugineous' as being the major stem borer pest in the country.

Stem Borer was reported as being of very minor importance at the nucleus farm (one affected tree). However, the consultant saw significant evidence of stem borer at an inspection of the next door Cashew Corporation Weheragal Plantation. The plantation manager reported a significant number of trees attacked by stem borer and up to 30 trees killed.

The mode of attack is as follows. The beetle prefers to lay its eggs in crevices of loose bark or damage on the stem frequently where there is branching. This activity is usually up to one metre above ground level. The young white grubs feed into the tree stem, for pupation it descends to the root system, and exists via the soil as a beetle to attack the next tree. The length of the life cycle is unknown, but may be a few months.

Control methods used on the plantation involve identification of grubs entry points and digging them out with a knife. Chemicals like CNSL have also been used on the affected areas to kill the grubs and eggs.

Unlike helopeltis which can increase population rapidly, stem borer is more a slowly progressive attack and can be a significant problem in plantations where management standards have been allowed to fall.

It would be important for the borers at Weheragal Plantation to be positively identified.

4.9 Other Pests

Elephants. The nucleus farm is adjacent to the Maduru Oya national park and there is a reasonable population of elephants in the vicinity. The small holders in the district have to take constant precautions to protect their crops from elephant damage.

The farm also has had a significant number of incursions by elephants - farm records show 30 incidents between April 1992 - March 1993 (Appendix 4). There may have been more elephant incursions that were not recorded. The farm records show that in the 30 recorded incursions some 70 cashew trees, mainly young seedlings, were destroyed. Greater damage was done to the other crops grown on site such as paddy rice and coconuts. While the elephant damage on cashew is relatively small, the management time/cost of keeping an all night surveillance system is not inconsiderable.

There is currently a plan by the Mahaweli Authority to extend an elephant proof electric fence along the canal between the Wildlife Park and land adjacent the nucleus farm (see map Appendix 5). It is estimated that the extension of this fence as planned will very likely increase the elephant problem, as it will channel them through the Agrotech land in their nightly migration looking for food.

It is estimated that the fence would have to be extended a further 11 km to give Agrotech complete protection from elephants, and a 7 km extension only along the canal would give reasonable protection. It is understood that the Mahaweli Authority have been informed of the situation.

Fruit Bats Fruit bats are a known pest of cashew in some countries. In Australia the main problem is with the black fruit bat. They can live in large colonies and can travel great distances (up to 50 km) in search of food. They may attack cashew only if the normal food source is in short supply. The bats find the cashew apple a worthwhile meal. They may carry the apple with nut attached to the nearby branch of the tree consuming the apple and dropping the nut.

When the bats are in large numbers they may seek a quiet spot to consume the apple. In these circumstances they will try to fly to a tree away from the plantation to consume the apple in peace. Experience in Australia has shown that the favourite eating place for fruit bats is the nearest tall trees in the forest. If this occurs it is an economic loss as the nuts which fall to the ground can be difficult to harvest.

The preferred control method is to provide a ring of tall dummy roost trees around the plantation. This will encourage the fruit bats to feed on the apple and drop the nut in an area that can be easily harvested.

4.10 Diseases

Cashew was originally considered to be free of serious diseases. However, the problems have increased in the past few years as the monoculture of the crop has spread especially in the presence of declining standards of management.

'Oidium anacardii' (Powdery mildew) is a whitish/greyish fungal growth disease that is caused by the oidium sp. It is known in many cashew growing countries and affects inflorescence and the nuts. It has become very prevalent in Tanzania in the past few years because of previous declining standards of management. The severity of Oidium in Tanzania was personally verified by the consultant in 1989. Oidium is apparently unknown in Sri Lanka.

Other significant diseases of cashew in other countries are anthracnosis, die back, gymosis, and various leaf diseases. There is no information available on diseases of cashew in Sri Lanka. Evidence from Dr. Pethiyagoda indicated that there had previously been pathogenic problems at the graft unions of oranges in Sri Lanka. However, there is no evidence that this problem would be an issue for cashew. The consultant observed various symptoms especially on leaves but without extensive analysis it would be impossible to determine whether they were nutritional or pathogenic in nature.

On the nucleus farm and elsewhere the consultants attention was drawn to a few trees which had died for no obvious reason. In this case the possible cause could have been pathogenic, and probably die back, which could be caused by a number of agents, and has been observed in India.

4.11 Staff Training

Informatics is a company specializing in computer technology and had no experience of cashew prior to embarking on this project in 1987.

The Informatics project director, who has been involved for the past two years, has been able to pick up a little information on cashew within Sri Lanka.

The Farm Manager joined the project in June, 1992. He is an agricultural science graduate with 20 years experience in sugar. The Deputy Farm Manager, a diploma holder has worked on the farm for about two years. There are also three supervisors. There is already a great desire to learn and improve the project staff but this has been hampered by the almost complete absence of technical literature or research information in Sri Lanka.

The Sri Lanka Cashew Corporation was incorporated in 1977. The stated objectives of this organisation include undertaking research, preparation and publication of technical and marketing information and providing facilities for training. There is evidence that in the earlier years some research and other work was undertaken by the Corporation, but the consultant was unable to find any published material.

As the Cashew Corporation had the responsibility of managing the cashew industry there was little work done in other institutions (Universities etc.,) as regards cashew.

The project cannot hope to operate at reasonable efficiency without a big improvement in knowledge and training.

APPENDIX

APPENDIX I

Chart of yields achieved at Kandachchi Plantation Mannar 1976-1989

Results of mid 1980's onwards is concluded to be of mature or mainly mature trees.

Data compiled by Dr Pethiyagoda of Mahaweli Authority.

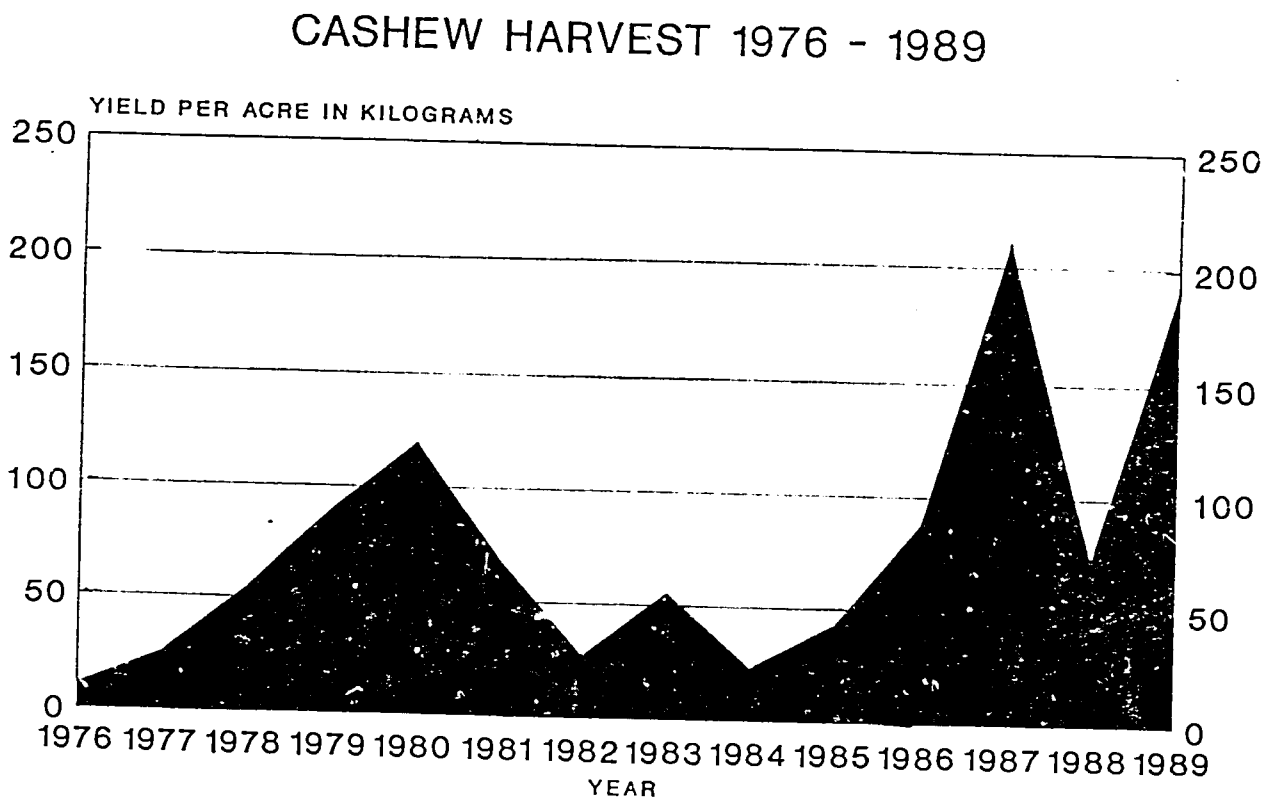


FIGURE 1

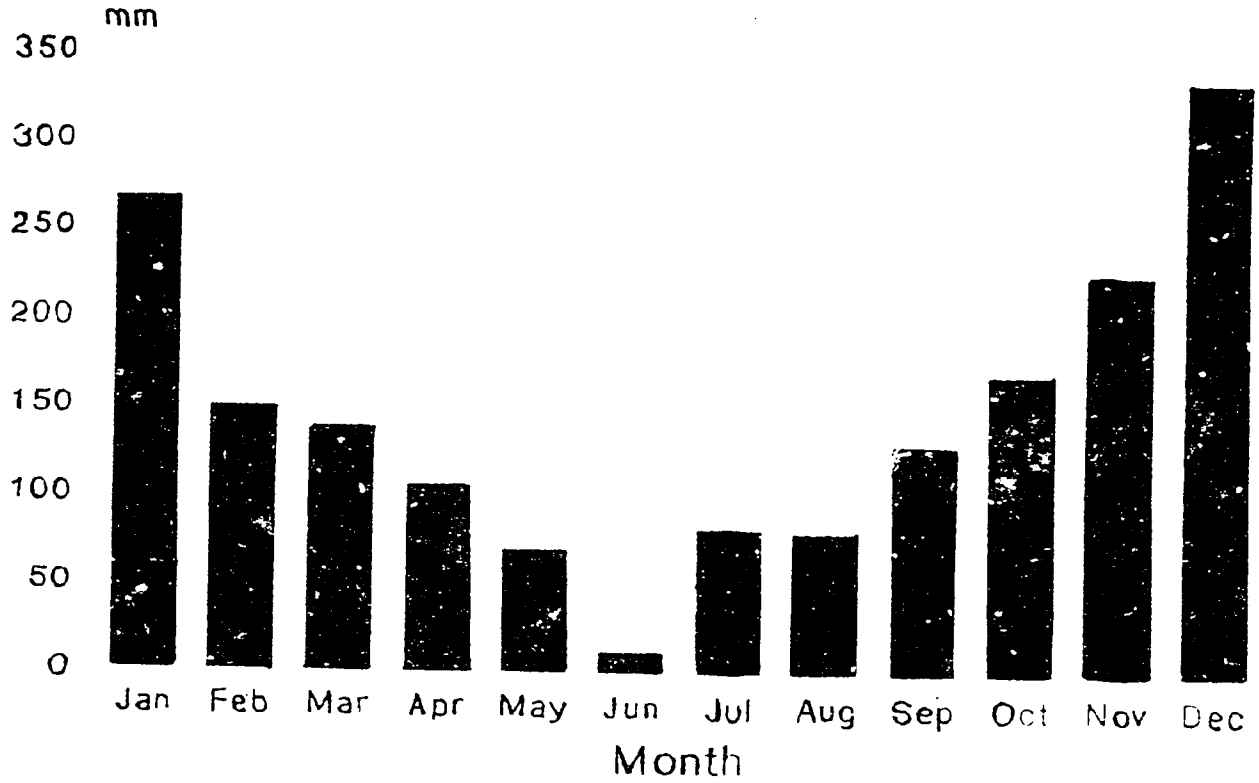
Series 1

APPENDIX 2

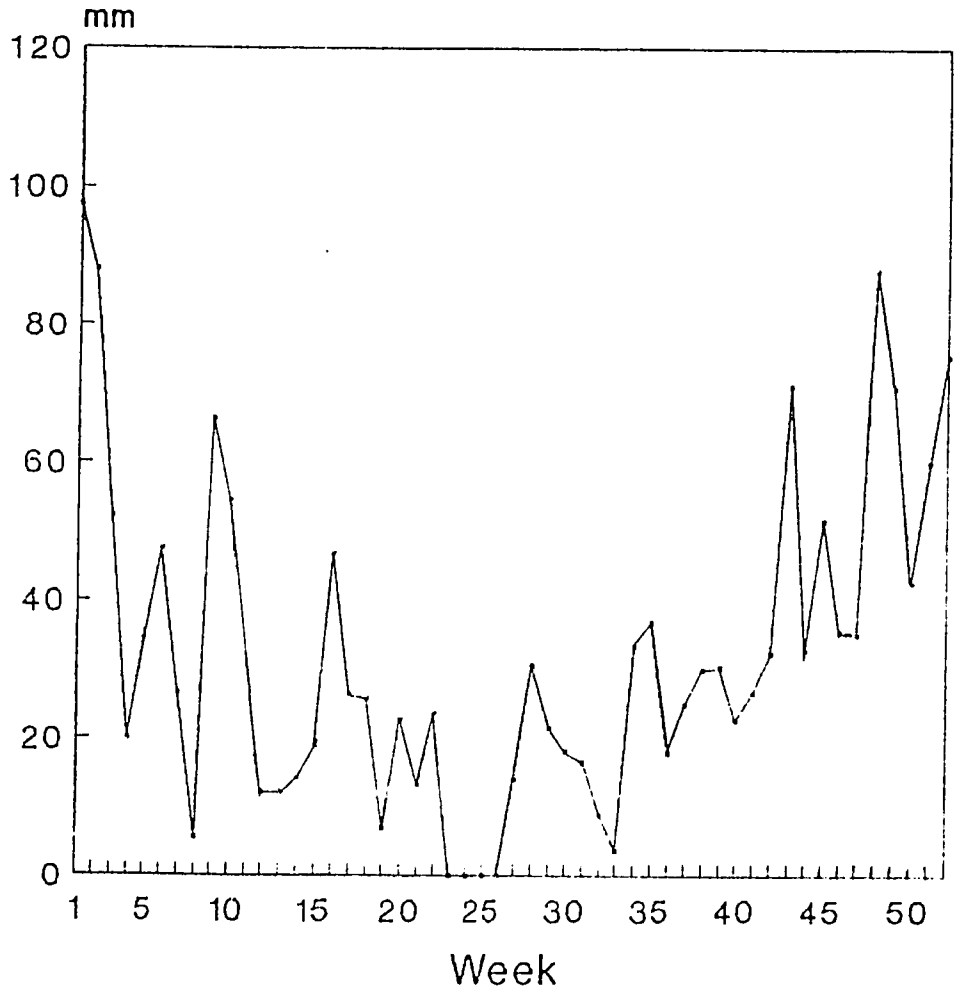
Weather Data 1984 - 1991 from Aralaganwila Research Station

Data includes temperature, relative humidity, mean evaporation and rainfall.

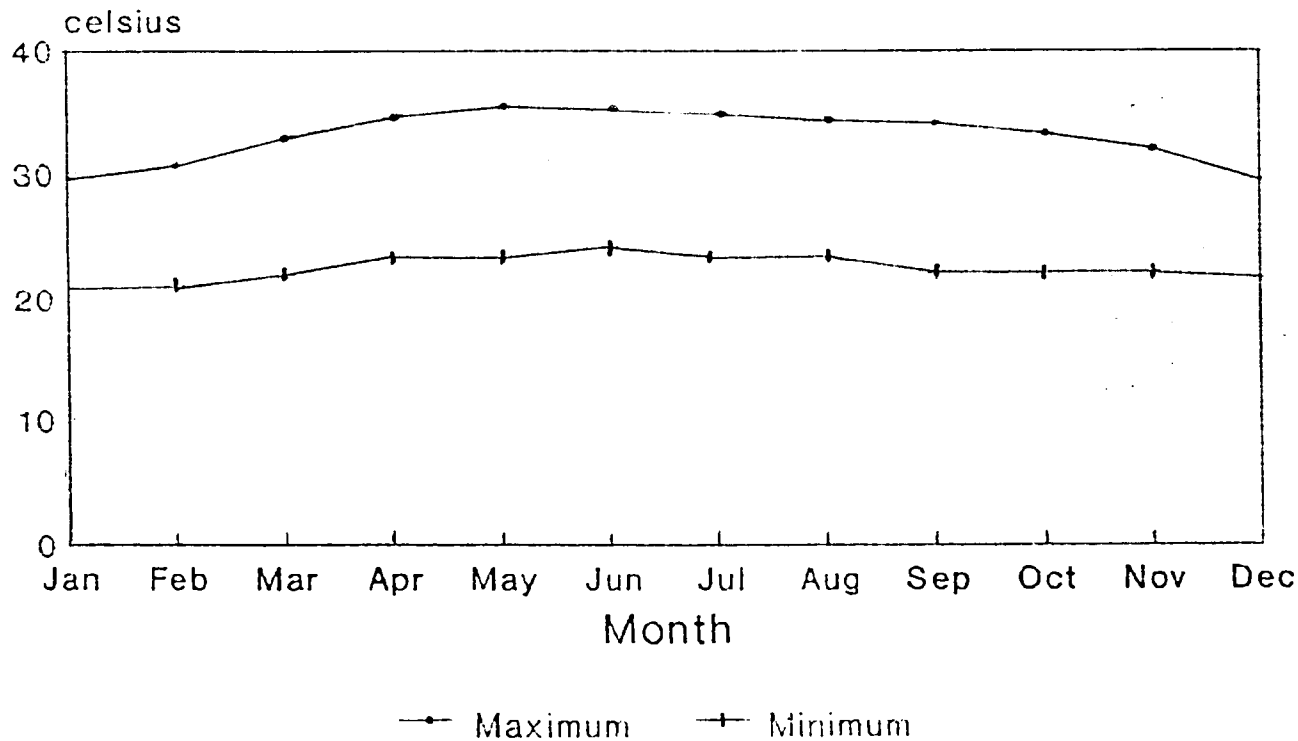
Mean monthly rainfall
(1984 - 1991)



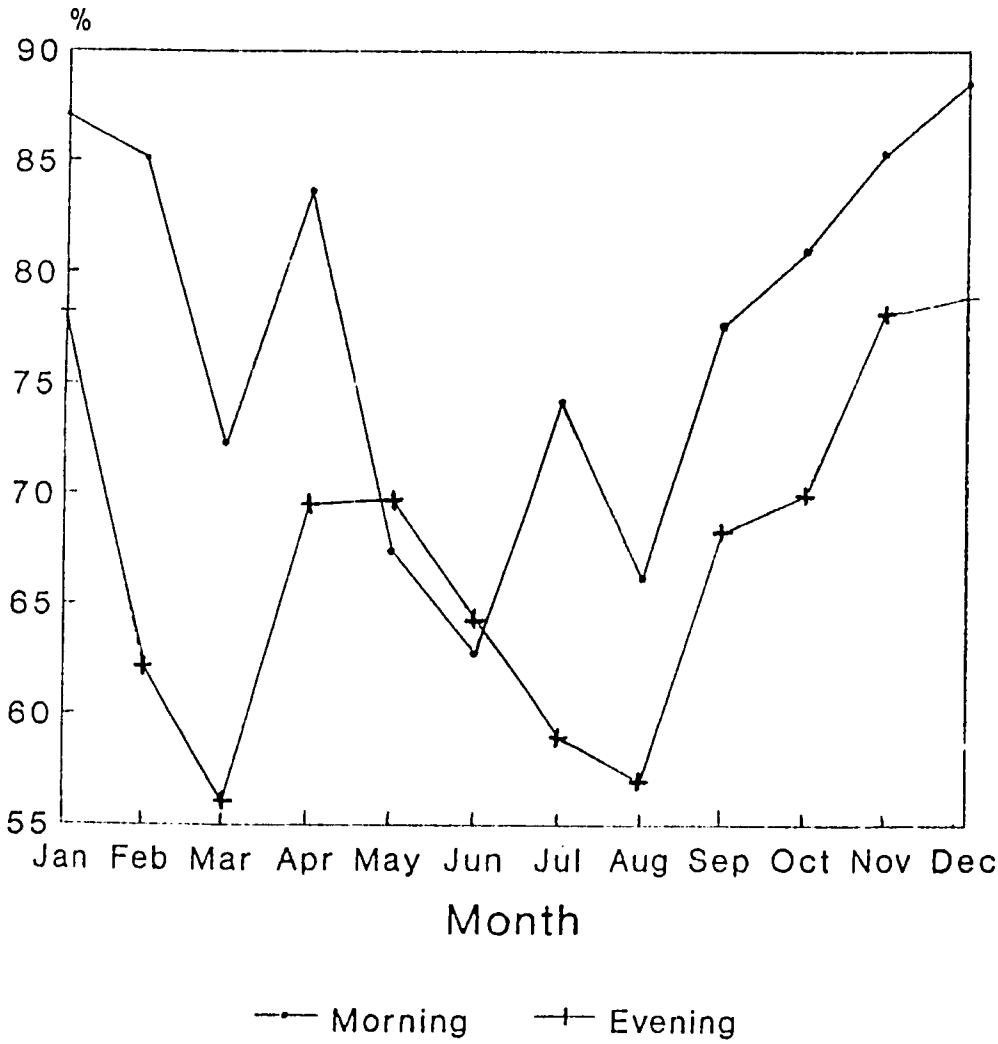
Weekly Total rainfall
RARC/Aralaganwila.
(1984 - 1990)



Mean monthly temperature
(1984 - 1991)



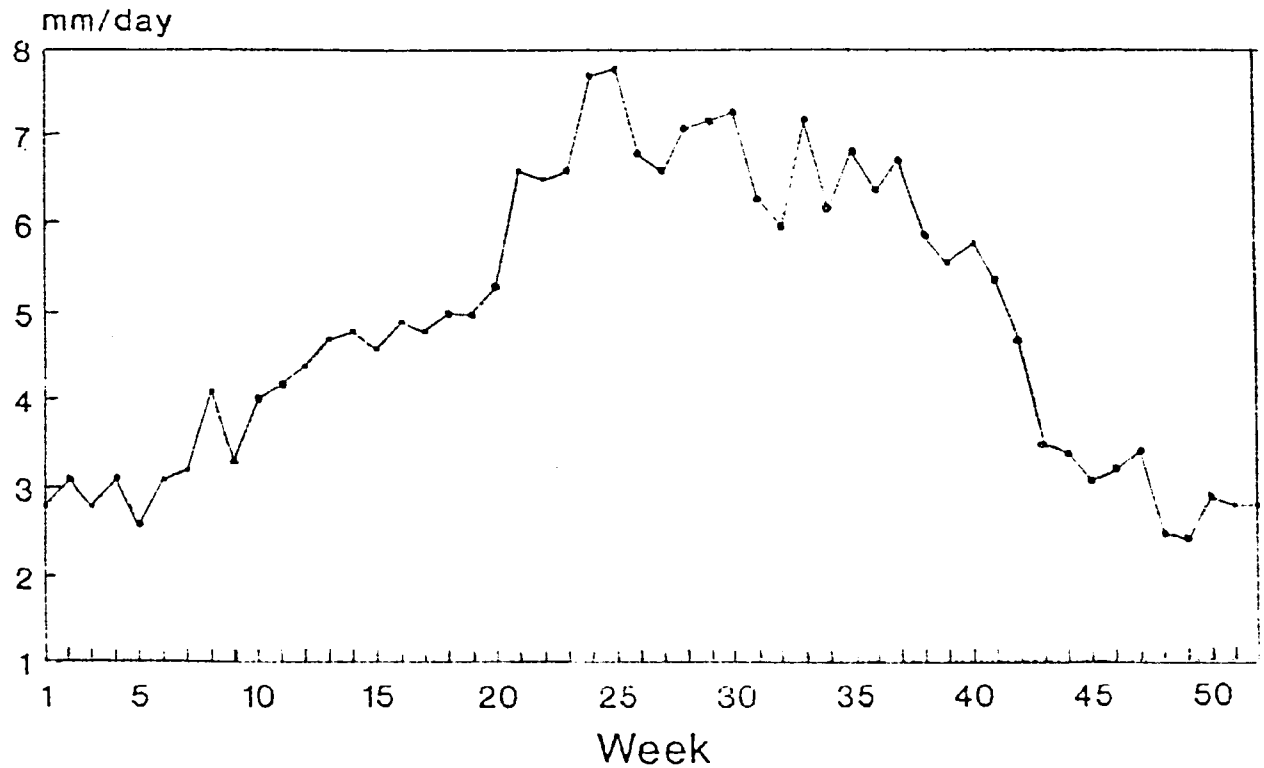
Mean Relative Humidity
RARC /Aralaganwila.
(1984 - 1990)



Mean Evaporation Rate

RARC / Aralaganwila.

(1984 - 1990)



APPENDIX 3

List of Insect Pests found on Cashew in Sri Lanka

An unpublished communication by Dr. Baptiste circa 1940's.

Leaf eating insects:

'Achaea janata L'
'Acrocercops privatana'
'Aetholix flavibasalis fuen'
'Penicillaria jocostarix Gn'
'Clania cramer Westw'
'Dasychira medosa Hubn'
'Anomis flava f'
'Thalassodes flavifusata'

Stem boring insects

'Ctenomeristis ebriola Meyr'

Fruit boring insects

'Myelois pectinicornella Hmpsn'
'Phycita leuconeurella Rag'

Plant sucking insects

'Aspidiotus destructor signoret'
'Ceroplastes rubens Maskell'
'Disphinotus politus Walter'
'Helopeltis cylonicus'

Termites

'Coptotermes ceylonicus Holmgr'
'Eutermes lacustris Bugn'
'Neutermes greeni Desu'

Others

'Selenthorips rubrocinctus Giard'

Elephant Damage to Agrotech Nucleus Farm
April 1992 - March 1993

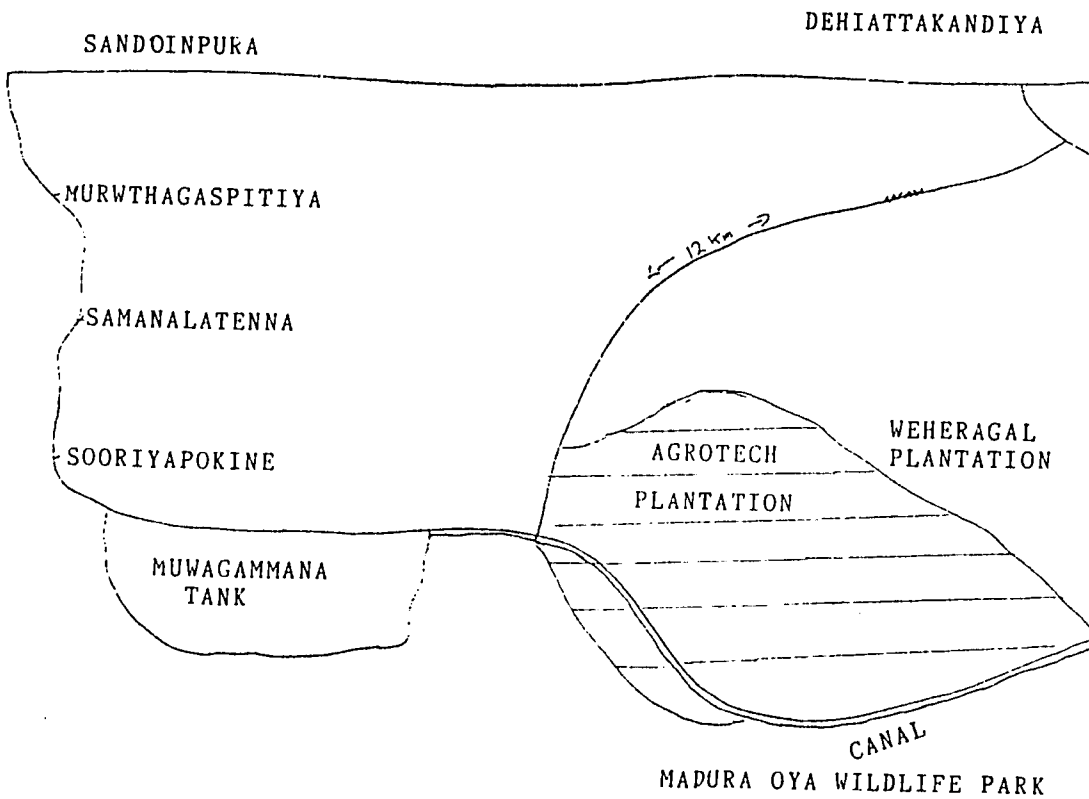
Source: Farm records

Date	Damage
1992	
24 April	38 3 year cashew trees 58 2 year coconut palms 1540 cashew seedlings in nursery
10 May	1 2 year cashew tree 1 house (worth Rs. 10,000)
11 May	50 1 year cashew trees
15 May	6 2 year coconut palms
7 June	10 1 year cashew trees
27 July	12 banana plants 3 2 year coconut palms
4 August	3 coconut palms 2 teak trees
5 August	4 banana plants 1 coconut palms
9 August	1 coconut palm
16 August	5 coconut palms
22 August	2 2 year cashew trees
31 August	1 coconut palm
7 October	5 2 year cashew trees
8 October	1 house (Rs. 1000 damage)
31 October	6 coconut palms

Date	Damage
1992	
5 November	5 coconut palms
15 November	5 coconut palms
18 November	3 coconut palms
21 November	3 coconut palms
25 November	3 banana plants
30 November	8 banana plants
1 December	2 1 year cashew trees
19 December	10 3 year cashew trees
22 December	3 coconut palms
23 December	5 cashew trees
1993	
29 January	Paddy rice, 75 sq ft.
30 January	6 banana plants
3 March	Paddy rice, 40 sq ft.
14 March	Paddy rice, 10,000 sq ft. 5 teak trees 15 banana plants 15 pineapples

APPENDIX 5

Hand drawn map of local area of Nucleus Farm



Details on Cashew Plantations

1. Cashew Corporation Plantations

No worthwhile information is available. The consultant was advised by the Chairman of the Cashew Corporation that a directive was required from the Minister before any information could be given.

2. Weheragal Plantation

Estimated at 2000 acres in size, the surviving number of cashew trees as follows:

	Age (years)
20,000	7
1,000	6
2,000	5
5,000	4
1,200	< 4
29,200	

The manager advised that the 1992 crop was 19 MT raw nuts - it was assumed that the actual crop was larger and that there were significant losses to theft.

The consultants inspection tour indicated that stem borer was a significant problem on the plantation. Over 30 trees inspected had been destroyed by borers, on the manager's advice quite a few trees had been attacked.

This plantation is currently being split up with 7 acres being distributed to each small holder family.

3. Panadora Plantation

Total planted are 160 hectares (400 acres), plantings commenced in 1981 and about 10 hectares p.a. were developed.

All plantings by seed with original seed stock from Cashew Corporation. Spacing at 120 trees/hectare giving total tree population of about 19200. Soil conditions on the plantation appear suitable for cashew and growth conditions of the trees has been quite good. However, climatic conditions may not be ideal - the manager reports that in four out of the past six years they have had unseasonal rains which have affected the crop. There is no fertiliser program but some spraying is undertaken against insect pests, especially helopeltis. The manager reports some 60 -70 trees per year at least are severely affected by stem borer.

The crop in the past three years had been estimated as follows:

	MT (raw nuts)
1992	123
1991	86
1990	98

The crop is sold to both the processing factories at Puttalam (Colombo Import/Export and Cashew Crop) as well as to cottage industry processors.

4. Kindi Mudalali Estate

Using seed obtained from the Cashew Corporation plantings commenced in 1976 (10 hectares). There were no plantings between 1977 - 1981, thereafter about 2-6 hectares were planted each year. Total area now planted is 53 hectares (135 acres).

This plantation is adjacent to Panadora Plantation and has similar soil and climatic conditions. Growth conditions of the trees on inspection appeared quite good. No fertiliser is used, and spraying is rarely undertaken even though helopeltis can be a major problem from time to time.

Harvest technique is for labour to hand harvest every three days during cropping period. The 1992 crop was 19 MT raw nuts - the crop is usually sold to the local processing factories. Prices required for raw nuts ranged from 28/29 Rs./Kg in 1992 to 42 Rs./kg in 1991.

List of Persons Contacted During Assignment in Sri Lanka

USAID

Mr Gary Alex

MED

Dr. Jim Finucane	- Chief of Party
Dr. Kamal Hyder	- Business Development Advisor
Mr. Earl Guise	- Agribusiness Advisor

Mahaweli Authority

Mr. A. Abeysinghe	- Director EIED
Mr K.H.S. Gunatilaka	- Director General
Dr. U. Pethiyagoda	- Consulting Agronomist, EIED

CISIR

Dr. (Mrs) Ediriweera

University of Peradeniya

Professor Gunasena	- Dean Faculty of Agriculture
Dr. Bandara	- Dept of Entomology
Mr. Gunasekera	- Dept of Entomology
Dr. Ahangama	- Dept of Entomology
Dr. Mapa	- Dept of Entomology
Dr. Handawela	- Faculty of Agriculture
Dr. Weerasuriga	- Institute of Fundamental Science

Department of Agriculture
(Seed Certification and Plant Protection)

Dr. M.H.J.P Fernando	- Deputy Director

Aralagonwila Research Centre

Dr. A. Lecamwasam	- Director
Dr. Lathif	- Soil Scientist
Mr. de Silva	- Research Officer

MARD System B

Martin West	- Consultant MARD

Cashew Corporation of Sri Lanka

Mr. Udalagama	- Chairman
Mr. Ramayake	- Manager Factory
Mr. Wickamarchchi	- Manager - Puttalam Plantation

Colombo Import/Export Co

Mr. Perera	- Manager Puttalam factory

Expolanka (PVT) Ltd

Mr Shafik Kassim	- Director

Santushi Basel Ceylon (PVT) Ltd

Mr. Rajakaruna	- Country Manager

Development Costs - 2nd Stage Plantation 162 Hectares (411 Acres)

Source: Agrotech Proposal

Capital Costs	YEAR 1	2	3	4	5	
			Rs. (000)			
Land development	557	470	-	-	-	
Nursery		49	47	-	-	-
Infrastructure	586	1249	28	-	-	
Equipment purchase	6040	2195	-	-	-	
Operating Costs						
Site maintenance	931	970	1046	1036	1037	
Plantation maintenance	75	660	862	571	352	
Harvesting & Storage				20	45	
		8238	5591	1936	1627	1434

In addition a further Rs. 0.4 m p.a. for minimum of three years will be required fr the chemical control of illuk grass.

Total expected expenditure over five years is Rs. 20 m or US$435,000.

Definitions:-

Land development	:	land clearing operating costs (fuel, labour repairs) Rs. 0.65 m.
Nursery	:	seed propagation costs
Infrastructure	:	Staff houses Rs. 0.67 m, equipment Rs. 0.4 m.
Equipment purchase	:	D6 bulldozer Rs. 5.35 m, 2 tractors Rs. 1.0 m.
Site maintenance	:	Wages Rs. 0.6 m p.a., fuel Rs. 0.14 m p.a.
Plantation maintenance	:	Watering young plants Rs. 1.5 m over 4 years, plant protection Rs. 0.1 m p.a., mulching Rs. 0.1 m p.a.

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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Galnewa

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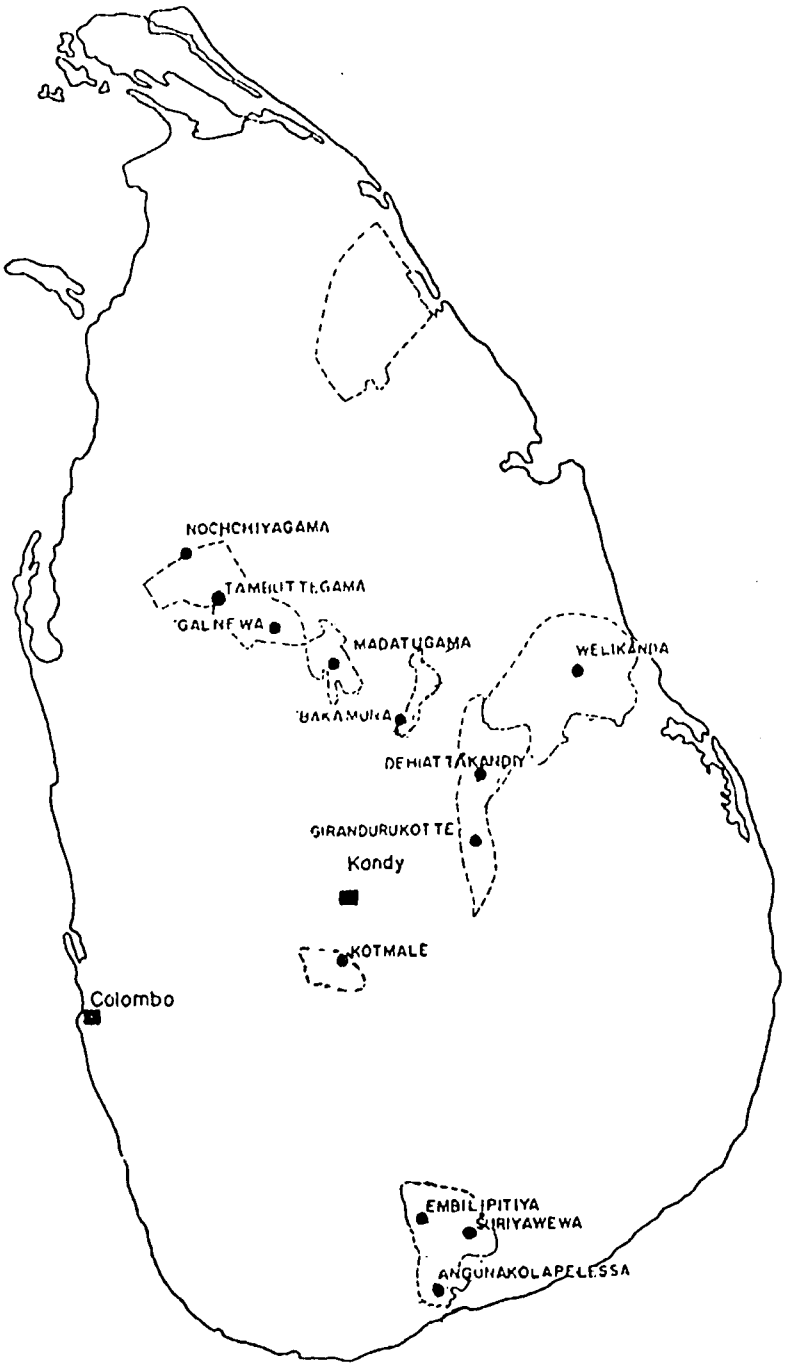

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