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Rural Equitable Economic Growth

91 Avenida Norte #707 Col Escalon San Salvador Tel (503) 263 2539 e mail crecer@es com sv

Review of the Prospects for Cashew Production Processing and Marketing in Cooperativa de Reforma Agraria La Marañonera de RL (CORALAMA) San Miguel, El Salvador

Ian Duncan
National Cooperative Business Association (NCBA)

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Contract No 519-0397-C-00-4154-00

Through

Chemonics International, Inc
Instituto Interamericano de Cooperacion para la Agricultura (IICA)
National Cooperative Business Association (NCBA)
World Council of Credit Unions (WOCCU)

Agency for International Development (USAID)
El Salvador

January 1997

A

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EL SALVADOR
RURAL EQUITABLE ECONOMIC GROWTH PROJECT
REVIEW CASHEW PRODUCTION CORALAMA

A Background To CORALAMA Project

A1 Historical Background

CORALAMA (Cooperativa de la Reforma Agraria La Marañonera de RL) is an agrarian cooperative located in the Province of San Miguel, in El Salvador, that was instituted after the land reforms of 1976 CORALAMA is part of UCRAPROBEX - which itself is the parent body for agrarian reform cooperatives (containing about 60 cooperatives)

In 1980 CORALAMA took over some 1,500 hectares (2,238 manzanas) of land that was previously owned by a large private land owner This land was planted with cashew during the 1960's The private landowner continued to own a cashew processing factory (constructed in 1975) that was located adjacent to the CORALAMA land

In the 1980 to 1987 period CORALAMA harvested the crop and sold raw nuts to India for prices that ranged US$ 400 to US$ 725 per MT In 1988 the processing factory and site of 20 hectares was purchased by CORALAMA at 2 1 million colones (US$250,000 approx) However, the factory was in poor condition as much of the processing machinery had been removed by the previous owner prior to the sale (including the Cashew Nut Shell Liquid - CNSL - Cashew Nut and cashew apple processing equipment)

After 1988 CORALAMA commenced operations in the factory but they rarely managed to process more than 25 % of their crop Due to a lack of management experience and the effects of the war during the 1980's, CORALAMA was not successful in its new cashew business During this period the effective area actually managed was reduced to some 1,000 hectares - the remaining areas were effectively abandoned

From 1993 major changes were made in operations At this time the plantation was organised to function on an "organic" basis and actions were taken to remedy problems occurring in the plantation

The move to organic farming has allowed CORALAMA to be certified by Organic Crop Improvement Association (OCIA) CORALAMA's organic crop now finds a ready Canadian market at about a 40 % price premium over the wholesale trade

In October 1996 CORALAMA commenced new business arrangements with the neighbouring cooperatives and UCRAPROBEX (Union de Cooperativas de la Reforma Agraria Productoras, Beneficiadoras y Exportadoras) - an umbrella organisation of association of about 60 agrarian cooperatives This new arrangement involved CORALAMA joining five (5) neighbouring cooperatives in establishing the Sociedad Cooperativa Productos de Marañon (SCPM)

These five neighbouring cooperatives (Chilinguera, San Ramon, Naquigua, El Plantar, Gualuca) are smaller cashew growers and as members of SCPM they will jointly own the processing factory with CORALAMA UCRAPROBEX will undertake the marketing of final product on behalf of SCPM

The total area planted to cashew by SCPM members is 1,331 hectares of which CORALAMA is the dominant grower with 800 hectares as follows

The Canadian Government (via its aid agency) has offered a C$ 1 0 million grant to SCPM for the further development of its cashew operations on the condition that it continues the organic production of cashew

A2 Objective of Report

- In view of the recent developments (establishment of SCPM and the offer of the Canadian grant) it was considered appropriate to fully consider the future development of the cashew operations at this time This involves a comprehensive examination of all aspects of the business - production, processing and marketing

- The consultant was requested to undertake this assignment and his terms of reference are attached in Annex B It is the Consultants objective to outline recommendations that are appropriate for next five years

B Horticultural Aspects of Cashew

B1 Introduction

Cashew (*anacardium occidentale*) is a tree native to northeast Brazil that was transplanted by the Portuguese in their other colonies (mainly Goa and Mozambique) during the 16th century The tree was later widely distributed to many tropical countries although to day there are only a few major producers

The cashew is an evergreen perennial tree that may grow as high as 15 meters in favourable conditions There is also a sub species found in Brazil - the 'dwarf cashew' that grows only to three meters

The cashew tree produces a nut (raw nut) with the kernel found inside the hard shell Attached to the raw nut is a false fruit or cashew apple The main product is the kernel which is obtained by removing the shell (processing) of the raw nut The normal yield of the kernel is 20% to 30% of the raw nut

The cashew apple which weights some five to ten times the weight of the raw nut contains a high level of Vitamin C and is utilised as juice and other products mainly in India and Brazil Cashew nut shell liquid (CNSL) is contained within the shell of the raw nut and this product can be harvested by certain processing methods CNSL is a natural phenol with heat resistant properties and has a market mainly in the motor industry in the manufacture of brakes and clutch linings The normal level of CNSL recoverable is 8% to 10 % of the weight of the raw nut

The cashew is a deep rooting tree that has developed a reputation for being both hardy and drought resistant and the ability to survive in poor conditions It is a heterogeneous open pollinated tree whose seed normally has a wide genetic variation - genetic integrity can be maintained only by vegetative propagation

Cashew is overwhelmingly cultivated by small farmers in developing countries as seedling trees and they give it a low priority in terms of soil selection and little care and maintenance Where its cultivation has been sponsored by government it is frequently as part of re-forestation or soil stability projects

As a consequence of the contemporary conditions of its development the cashew usually gives a low yield However, research elsewhere has demonstrated that yields up to ten times the current average can be achieved if consideration is given to genetic improvement and it is given the necessary care and maintenance

B2 Brief Review of Characteristics and Requirements

The following are the major characteristics

B2a Morphology

The cashew (*anacardium occidentale L*) belongs to a genus that comprises 400 species of trees and shrubs - including mango and pistachio There is a wide variation within the cashew species in terms of growth habit and production The

simplest classification would separate the common cashew growing to 15 meters and the 'dwarf' cashew which is early bearing and grows only to three meters

It is a fast growing evergreen tree and its development is very much effected by the growing conditions

- Tree Life-Span There is little reliable data on the productive life of cashew Some authorities show evidence where the tree is still producing well after 50 years It is also maintained by others that the best productive life may be shorter- perhaps 25 to 30 years After this time the tree may go into a slow declining phase It is clear, however, that the growing conditions will have an important bearing on life span and development of the tree

- Tree Canopy A healthy tree not suffering severe disease or pest attack should demonstrate a thick canopy even at the end of the dry season A tree with a sparse canopy usually indicates some unfavourable condition

- Root System In favourable conditions (well drained sandy soils) the tree can develop extensive lateral root system and a deep tap root In Tanzania it was found that lateral roots in six year old trees could spread 7 3 meters Elsewhere (Madagascar) it was found that five-year-old trees could have a tap root descending to below five meters

- Flowering The age at which a tree commences flowering and fruiting depends on genetic factors and growing conditions Normally this occurs in 2 - 3 years but in exceptional conditions this could be within the first year of growth Usually flowering occurs after the growth flush at the end of the rainy season and may extend over four months - however the peak flowering is usually about four weeks after commencement of flowering Cashew produces both male and perfect (by sexual) flowers - the ratio between the two has been found to vary from 1 28 to 3 7 (research papers various countries)

- Pollination and Fruiting Insects are the main pollination agent - the agent can vary between countries (India - ants, elsewhere the native bee and other insects have been important) Pollination is usually achieved by cross pollination although self pollination can occur There is some evidence to suggest some trees are self incompatible After pollination the proportion of fruit set can vary significantly (3 % to 38 %) while there is a similar scale variation between the number of mature nuts achieved as a proportion of fruit set Research (Pillar) did show in one experiment that

85 % of perfect flowers were fertilised, however, of these only 5 % achieved fruit maturity Of these 20 % were destroyed by insects and the remaining 60 % shed for other reasons Growth regulators have been used in some countries to attempt an improved ratio of fruit maturity

- Nut and Fruit Development The nut usually becomes visible about one week after pollination and reaches its maximum size 5 - 7 weeks after pollination Thereafter the nut shrinks, the shell hardens and the green colour turns to grey The mature nut is 75 % of it's maximum size (when green) and this loss in size is mainly moisture - the kernel does not change size The apple makes little development but grows rapidly 20 days after fruit set In general fruit maturity is considered to occur 60 to 70 days after fruit set

- Nut Characteristics Nut size can vary between about 1 5 gm to 30 gm The ratio of shell kernel and testa can vary significantly Research data shows that the kernel size is usually - but not always -not necessarily negatively correlated with nut size The recovery rate - the most important ratio of kernel (minus testa) to shell can vary from about 18 % to 40 % The proportion of testa to whole nut has been found (by Ohler) to vary between 1 3 % to 3 6 % Cashew nut shell liquid (CNSL) is contained in the mesocarp of the shell and it's proportion by weight of the whole nut can vary from virtually nil to about 22%

- Apple Characteristics The apple can vary significantly in size and shape It can vary in ratio from 1 1 to as large as 1 15 to the nut It contains 85% juice of which 10% is invert sugars Apples are either red or yellow in colour - research in Mozambique found little difference in colour as significant characteristic

B2b Climatic Factors

The cashew as a tropical plant thrives at higher temperatures An ideal range could be deemed to be a maximum of 38 to minimum of about 20 degrees C It can tolerate low temperatures (i e approaching 0 degrees C for short periods)

- Rainfall (water requirement) There is as yet no firm data on the water requirement of cashew Cashew can grow under a wide rainfall regime depending on the length of the dry season and the soil conditions which will effect root growth In favourable soil conditions where the root system is well developed it will perform well under lower total rainfall

than in less favourable soil conditions Under rain fed conditions in a 4 - 5 month dry season situation, a total rainfall of 1,000 to 2,000 mm is usually considered to be preferred Cashew responds well to supplementary irrigation during the dry season The volume of water applied is a factor of soil type as well as method of application Research in Australia has shown that the use of irrigation up to maximum rates of about 300 litres/tree/week via drip system in a well drained soil conditions is capable of providing maximum yields

- Relative Humidity Cashew can withstand long periods of low humidity (i e 25 %) provided the tree has access to sufficient water (irrigation) However, high humidity (i e over 80 %) is conducive to the growth of fungus especially *anthracnose* and to the excessive presence of insect pests

B2c Soils

The best soils for cashew are deep well drained sandy or sandy loam soils Ideally soil depth should be three meters Cashew cannot withstand badly drained soils either with a high clay content or compacted soils with a hardpan The correct soil structure is most important - soil fertility is less important as cashew will thrive in these conditions provided nutrients are applied Cashew also prefers acid to neutral soils - a pH of around 6 0

B2d Genetic Selection

The vast majority of the cashew trees planted in the world are by seed As the cashew is an open pollinated tree, the planting by seed leads to a wide variation in performance To maintain complete genetic integrity other forms of multiplication are required In vitro propagation has not yet proved successful and propagation by cuttings is notoriously difficult The current effective method for vegetative propagation is by grafting (or budding) Grafting maintains the major benefits of vegetative propagation but the rootstock interaction factor must still be encountered

The variation in performance between grafted trees and trees planted from seed is demonstrated in the table below

Location	No of trees	Age	Yields
Brazil - seedlings (Pernambuco)	30	25 years +	1 5 to 34 kg/ tree
Brazil - seedlings (Pucujus)	80	3 - 14 years	0 1 to 35 kg/tree
Tanzania - seedlings (Nachingwea)	128	3 years	0 4 to 6 8 kg/tree
Australia-grafted trees	18	5 years	13 6 to 20 0 kg/tree

Note Trees in Australia were receiving a high standard of management
Source for data from Brazil and Tanzania Dr J C Ascenso

B2e Yields

Yields achieved are a function of genetic stock, environmental conditions (soil, climate), spacing and management inputs In practice contemporary practice involves seedling trees with a low level of inputs (nutrition and pest control) In this situation commercial yields vary from about 250 kg per hectare where conditions are unfavourable to about 1,000 kg per hectare where conditions are good

Research in Australia has demonstrated that when all the factors are favourable (soil, climate, superior grafted trees, nutrition, irrigation and pest control) then extremely high yields with good quality crop can be achieved In these circumstances yields of 4,000 kgs per hectare at 5 to 6 years can be achieved and the estimate that even higher yields will be achieved in the future

Spacing plays a significant role in the yield picture As the cashew tree bears only on the canopy surface their growth is greatly effected if the canopies are allowed to inter-grow Higher density plantings (i e 7m by 7m) may be used initially to gain early crop provided appropriate thinning is carried out subsequently If no later, thinning is to be practised The current procedure (in Brazil with seedling trees) is to plant on a spacing of 12m by 12m to 15m by 15m

The key to spacing is the tree shape If clonal types of a compact and upright tree shape are selected then a higher density can be achieved satisfactorily Research in Australia demonstrates that a density of 8m by 7m can be satisfactory

B2f Nutritional Requirements

Cashew responds well to applied nutrients as it is usually grown in nutrient deficient soils Applied nutrients are particularly important when higher production levels are expected There have been many fertilizer trials conducted in many countries, however, the results must be seen in the background conditions to the trials In general cashew responds well to N, P, K - lower responses were achieved in absence of P and least response to N application only

There have been a number of fertilizer trials carried out in various countries - these have concentrated on responses to N,P,K, only These studies have shown responses in the range of 50 % to 100 % depending on the circumstances of the trial

Micro nutrients are also important to cashew growth - especially boron, and zinc There are now (reasonably well agreed) nutritional standards for cashew However, any nutrition program is undertaken it is advisable to do an initial soil analysis to establish the background situation followed by regular leaf analysis to determine nutrient requirements

B2g Supplementary Irrigation

Cashew grows well in the dry tropics where there is a well defined wet and dry season However, in research in Australia has shown that supplementary irrigation during the dry season especially when the tree is commencing flowering allows significant improvements in yield Irrigation also has the benefit of allowing the regular application of nutrients through the irrigation system An accurate determination of the water requirement of cashew has not yet been completed Even when this is done, irrigation levels will require appreciation of soil profile structures and application methods A rule of thumb of requirements in deep sandy conditions in low humidity environments suggests a maximum application of about 400 litres per tree per week via a drip system

B2h Pests

In 1979, Pillar (in India) reported that 179 species of pests attacked cashew and of these 84 were known to occur in India Later research added a further 26

pest species For the purposes of simplicity we may make approximate classifications by their method of feeding as follows

- moth caterpillars of various types that cause damage mainly by eating the vegetative flush
- flying insects that suck the sap from leaves, vegetative flush and the fruit and may inject toxins into the tissue The damage is mainly caused by the injection of toxins (i e *Helopeltis*) however some types cause damage by massive loss of sap alone (*Thrips*)
- borers that mainly attach the woody parts of the tree especially the tree trunk

A summary of the most economically important pests are in the table below as follows

Pest	Main locations	Location and type of damage
1 Shoot and nut eaters ***Helopeltis sp***	**India, Africa Australia**	**When insect feeds it injects toxins causing necrosis to flush and fruit When feeding on immature nut it causes (economic) damage as processed kernel has black spot damage**
2 Leaf and shoot eaters		
Thrips sp	**India, Brazil, Africa**	**Extremely small insect (1 to 2mm nymphs and adults suck sap on underside of (especially semimature) leaves Has capacity to build up to extremely large numbers and damage is caused by general dehydration of tree**
Crimissa sp	**Brazil**	**Beetle that destroys young shoots**
Monoleptra	**India**	**Beetle in large numbers destroys leaves and shoots and can almost defoliate the tree**

Pest	Main locations	Location and type of damage
3 Flower eaters		
Aphis gosspii	Brazil, Australia	In large numbers lives in colonies in flowers and causes damage by sucking sap and dehydrting flowers
4 Apple and nut eaters		
Pseudotheraptus sp	Africa	Pest from coconut that suck the developing nuts causing both destruction and later economic damage to processed kernel
5 Stem and root borers		
Placaederus ferrugineus	India, Sri Lanka	Beetle lays eggs on tree trunk, developing grub bores through trunk and exits via roots In sufficient numbers the tree is destroyed
Mastotermes	Australia	Lives in colonies underground, burrows into root system causing damage/loss of tree

In addition there can be higher animals that become pests - in particular flying foxes (India, Australia) can feed on the cashew apple and rodents and wild pigs can feed on crop left on the ground

Beneficial Species

Research in Australia has indicated the most useful beneficial species are as follows

1 Spiders (*Araneae*) - have been shown to feed on beetles fladid bugs, and moth pests

2 Ants (*Foricidae*) - *Oecophylla smaragdina* is very important in Australia as a beneficial preditor and *Oecopphylla longinoda* may be useful in East Africa

3 Heteropteran bugs -	- In Australia *Platynopus turneri*, *Oechalia schellenbergi*, and the *lygaeids Geocoris* and *Germalus* are useful predators of caterpillar pests
4 Wasps (*Hymenoptera*)	- various species (especially vespid) wasps feed on caterpillars
5 Lacewings (*Neuroptera*)	- 5 species of lacewings identified as predators of aphids scale insects, and mites

B2i Diseases

On balance in nearly all producing countries disease is a much smaller problem for cashew than insect pests The exception would be *Powdery Mildew* which appears to have mutated from its original form and is now a major problem in Mozambique and Tanzania

The most important diseases are as follows

1 *Anthracnose*

The fungus *Colletotrichum gloeosporioides* is the causal agent for this disease and it is common to many tropical fruits This fungus spreads easily in conditions of high humidity, a temperature below 30 degrees C and when cashew trees are putting on new growth Damage can be caused to leaves, shoots, flowers and nuts

Control can be assisted by providing unfavourable conditions in the field for the survival and spread of the spores - i e thinning and pruning of trees to allow penetration of sunlight

2 *Powdery Mildew*

A fungus disease caused by *Oidium sp fungus* Its conditions of spread are similar to *Anthracnose,* but the spores give a whitish appearance Damage symptoms and control methods are similar to *Anthracnose* - however, *Powdery Mildew* is now a much larger problem due to the apparent mutation of the fungus that has occurred in East Africa

3 *Die Back*

Several diseases that have a number of causal agents and perhaps initiated by mechanical damage (wind) It can result in the dying of twigs, floral shoots and occasionally larger branches Incidence of this is usually low

C Review of World Cashew Market

C1 Production of Cashew

The current major producers are India and Brazil Up to the mid 1970s Mozambique and Tanzania were with India the largest producers but subsequent political and other problems in East Africa saw a major decline in their crop by the early 1980s This caused a fall in world supplies and a resulting escalation of kernel prices These higher prices stimulated increased production from India, Brazil and 'new entrants' especially Vietnam and other countries in South Asia

World Production (000 MT Raw Nuts)					
	90/91	91/92	92/93	93/94	94/95
India	290	305	349	340	321
Brazil	110	190	120	170	210
Mozambique	31	54	24	29	33
Tanzania	20	40	39	47	30
Vietnam	25	30	40	60	90
Kenya	25	18	24	20	20
Guinea Bissau	18	10	18	15	31
Nigeria	10	15	13	10	12
Indonesia	18	20	22	25	35
Others	50	50	55	60	100
Total	597	732	704	776	782

Note

1 Others include Sri Lanka, Thailand, Madagascar, Togo, Ivory Coast Benin, El Salvador Venezuela, Guatemala Philippines etc

2 There is no accurate published data on world production - the above table are estimates based on trade sources This is because most of the world's production comes from small holdings who grow cashew with few, if any inputs and have low productivity Only in Brazil have large plantations been established by the major processing companies to provide an in-house source of crop These plantations provide about 50% of the Brazilian crop but they also use few inputs and have a low productivity

Of the total world crop perhaps only about 60% enters the world trade Some part of the crop is consumed in the villages while another part is processed locally and sold as product in the local retail trade There is a very large domestic market in India and in some SE Asian countries where there is a national preference for cashew in the diet

C 2 Development of Cashew Processing and Raw Nut Exports Trade to India

Up to the 1960's virtually the whole world's crop was processed in India where very cost efficient hand processing methods had been perfected During this time the Indians controlled the international trade in processing and marketing of cashew Apart from their own crop they imported increasing volummes of crop that was becoming available from Mozambique and Tanzania By 1960 India processed and marketed 95 % of all traded product

The dominance of the world trade by India was sustained by the scale of the raw nut import program, especially from Mozambique and Tanzania which peaked at about 200,000 mt in 1972 At this time the total world crop was less than 400,000 mt

The installation of mechanical processing factories in East Africa together with the reduction of crop in those countries during the 1970's and 1980's encouraged the Indians to expand their local production, as well as diversify their sources of raw nut imports In recent years Vietnam, especially, and Indonesia and West Africa have become more important sources of raw crop However, this trend is now changing as Vietnam is encouraging local processing by the recent introduction of an export tax on raw nut exports - currently 20% of fob and expected to rise to 30% next year (The use of export taxes on raw nut exports has been used by a number of counties from time to time)

Indian Raw Nut Imports (000 MT Raw Nuts)				
	1992	1993	1994	1995
Country of Origin				
Tanzania	17 147	38,368	55 658	49 858
Mozambique	14,777	19,908	na	7 665
Vietnam	44 427	26 516	43,898	12 267
Indonesia	11,829	13,517	25,821	13,966
Guinea Bissau	nil	9,058	31 410	28,236
Ivory Coast	nil	5 621	19 128	24 059
Others	73 403	27,511	80,546	na
Total	117,166	135,544	276 369	193,125

Raw Nut Import Prices (US$ c & f)					
Country of Origin	1990	1991	1992	1993	1994
Guinea Bissau	903	1 040	1 060	1 133	1,004
Indonesia	968	766	984	902	905
Ivory Coast	785	951	1 039	944	983
Mozambique	-	-	787	796	822
Nigeria	1,030	904	919	709	793
Tanzania	885	931	1 090	777	832
Vietnam	763	833	1 020	832	1 069

The processing industry in India employs about 300,000 people (mainly women) and is estimated to have a capacity to process 500,000 mt raw nuts p a As domestic production and imports have not reached this level, the industry has previously operated well below capacity However, this spare capacity is being reduced as Indian local production expands

In Brazil the processing industry has developed to process the whole crop mainly using mechanical methods This development was aided until very recently by a ban on raw nut exports In the last few years there have been some very limited raw nut exports allowed to India from Brazil (3,895 mt in 1992)

In Africa and SE Asia the producing countries have a mixture of local processing and raw nut exports to India While these producing countries would no doubt prefer to process all their crop and sell kernel, they face very strong price competition from the Indian raw nut trade, who probably have an advantage of about US$ 150 to US$ 200/mt that reflects cost efficiency in processing

The prices paid by the Indians for raw nut imports could be reduced in the future as their local production increases to meet local processing requirements - however, this point is probably 10 years or more away

C3 Development of Mechanical Processing

By the 1960's there had been a significant growth in cashew production in Mozambique and Tanzania to the extent that they were producing 70 % of the world crop This led to a desire for greater control over their crop for both economic and national reasons These reasons included a need to gain a greater share of the value added and to create employment

In the 1960's to early 1970's the Oltremare (Italian) and Sturtevant (UK) processing systems were developed to meet this need for processing to be undertaken by the African producing countries

These new mechanical systems essentially involved the mechanisation of the roasting and shelling process (these were difficult and dirty tasks), while mainly hand labour was used where it could be most effective i e peeling and grading Later the manufacturers introduced machines for other processing functions such as peeling and grading but these were not necessarily more cost efficient than the alternative hand methods

Later on, The Cashew Company of Japan and Buhler Miag (Switzerland) also designed similar processing systems (These companies were not particularly successful - Buhler is now no longer in business and the Japanese also appear to be 'non-operational')

In the past few years a couple of other manufacturers (NRI and MDR) have also made new systems available for the market

There have been probably about 50 mechanical processing factories installed mainly in Africa, but some also in Asia The majority of these plants were built during the 1970's and some are no longer operational to day for a variety of reasons

These new factories gave opportunities for African countries to process their own crop, nevertheless the Indian industry has maintained its cost advantages over the traditional Oltremare/Sturtevant mechanical systems This advantage has been estimated by some sources as being equivalent to about US$ 150 to US$ 200 per mt of raw nuts and this is obtained by a combination of the following factors

1 Low capital cost of factory

2 Higher revenue (perhaps 20 %) because of higher quality final product (processing efficiency) as follows

- say 22 0 % more whole grades	= 8 7 % higher revenue
- say 1 5 % higher shelling %	= 7 5 % " "
- higher % white kernel and reputation of processor	=3 8 % " "
	20 0 %

Indian labour use is at a higher rate per mt processed but this is not a significant factor due to low cost of labour in that country

The cost/efficiency of the Indians was previously demonstrated in Tanzania where the local processing industry has been competing for the local crop with Indian purchasers

in a free market In the late 1980's various World Bank reports concluded that in many cases the returns to local processing were negative compared to the export of raw nuts The Tanzania factories were not helped by the fact that some of them were not able to be maintained in good condition and this affected the quality of their final product

Previous efforts in African countries to emulate Indian processing methods have not been particularly successful because African workers have not been able to match the Indian standards of work

The competition from the Indian processors to purchase crop in Africa is expressed in what they are willing to pay for the crop These prices reflect their cost/efficiencies (as indicated above), as well as the following

- As the Indian factories have traditionally been working well below capacity the processing of African raw nuts could be treated as a 'marginal cost'
- Exchange control concessions - importers of inputs to processing have got concessions in relation to amount of rupees exchanged for dollars as compared to the official rates

The currency factor is less important now with the recent liberalisation of the exchange controls In addition, in the future the Indian domestic production is expected to keep increasing - some sources believe it could be close to meeting the demands of their processing industry perhaps in ten years or so It is therefore reasonable to conclude that at some point in the future the Indian industry may have less incentives to maintain their current purchase habits

C4 Supply of Kernel

India has been the dominant supplier of kernel, but Brazil is also important especially to the US market Tanzania and Mozambique were previously important suppliers but are now relatively small Vietnam and to some extent Indonesia are small but growing sources of kernel

Exports of Kernel (mt)

	1991	1992	1993	1994	1995
India	47 686	52 109	62 817	78 266	68 058
Brazil	23 434	37 142	29 914	22 709	36 297
Mozambique	3 334	4 015	2 654	892	453
Tanzania	1 088	1 043	45	nil	113
Others	4 627	3 334	2 858	4 996	2 336
Total exports	80 127	98 185	97 890	106873	107259

Source Mann Production Rotterdam

Note Total kernel exports in other categories are probably underestimated by 2 000 to 3 000 mt as some minor exporters may be missed

C5 Kernel Consumption

The total annual world trade in kernels is now above 100,000 mt The USA is the dominant market and takes about 50% of world trade The other important markets are UK, Netherlands, Canada, Japan and Australia

Kernel Imports (MT)					
	1990	1991	1992	1993	1994
USA	54 469	49 464	61 087	59 954	61 632
Netherlands	3 870	4 102	5 721	8 593	13 354
Germany	3 732	4 011	5,519	6,892	8 412
Canada	4 472	4,749	4,952	5,537	4 781
UK	5 107	4 857	5 758	6 510	6 019
Japan	4 299	5 531	4 893	5 622	6 193
Australia	2,807	3 300	2 949	3 771	4 488
Others	14 568	7,681	8 355	10,606	12 477
Total	93 324	83 695	99 234	107 485	117 356
Re-exports	3 501	3,239	3 047	6 265	10 154
Net imports	89,823	80 456	96,187	101 220	107 202

Source Mann Production Rotterdam

Note re-exports occur mainly from Rotterdam (Netherlands) and also from Hamburg (Germany) and London (UK)

In addition to the major traded markets (above) there is also a very large consumption of cashew at the retail level in India supplied from domestic production There is no accurate data on this market, but it is estimated by trade sources to be about 25,000 mt kernel and growing strongly There is also significant consumption of cashew from domestic production in Thailand, Indonesia, and an emerging market in China

C6 Kernel Prices

As the US is the world's largest importer, it is the New York market that effectively sets the world prices in US dollars per lb The W320 grade (300 to 320 whole white kernel per lb) is used as the benchmark for all price quotes - larger white whole grades are sold at a premium while scorched, dessert, smaller wholes and broken grades are sold at a discount

The following table of a recent quote from a major trader demonstrates the relative prices for some of the most frequently traded grades as follows

Grade	Description	Price (US$/lb)
210	white whole	2 90
240	white whole	2 60
320	white whole	2 35
450	white whole	2 14
SW	scorched whole	2 12
FB	fancy buts	1 80
FS	fancy splits	1 75
LWP	large white pieces	1 60
DW	dessert wholes	1 60
SWP	small white pieces	0 70

The benchmark price usually reflects Indian product - kernel from other sources may be discounted depending on previous quality and reputation

Prices are mainly set by supply and demand factors However, future crop expectations can cause price fluctuations especially as there is frequently a background of limited accurate data

In the period 1975 to 1980 kernel prices more than doubled reflecting the shortage of crop brought about by the fall in production in Mozambique and Tanzania, apart from a few temporary reversals prices remained at higher levels until early 1989 In the past 6 to 7 years prices have remained at more moderate levels and this has encouraged a very significant expansion in consumption

Kernel Prices (US$ per lb W320 Grade)	
1985	2 40
1986	3 17
1987	3 18
1988	2 98
1989	2 46
1990	2 39
1991	2 75
1992	2 47
1993	2 38
1994	2 40
1995	2 56
1996	2 73 (January to June only)

Current (January 1997) cashew prices for W 320 grade are as follows

ex India US$ 2 40 fob ex Vietnam US$ 2 42 fob

C7 Outlook for World Market

World production has expanded very significantly in the past 10 - 15 years encouraged by the period of high prices during the early to mid 1980's However, in the past few years affordable kernel prices have lead to a large expansion in the market (The trade considers wholesale prices of W320 grade above US$ 3 00/lb as being regressive on retail demand)

It is expected that in the immediate future world production will continue to increase at perhaps 5% to 10% p a This is because India is continuing to expand to try and meet its domestic processing requirements while producers in other countries (Brazil, Vietnam, etc) have land available and find it profitable In Tanzania and Mozambique the industry is now recovering

On the demand side apart from further growth in the mature markets (USA Europe), etc , there is significant potential for market growth in India, S E Asia and China

The estimate is that apart from occasional temporary reversals due to climatic factors - demand and supply factors should remain approximately in the current balance, and current prices should be maintained for the immediate future

C8 The Market for Organic Cashew Kernels

The marketing of organic cashews is a very recent phenomena and there is little accurate data available on the parameters of this market The total world market currently is very small - probably no more than 500 MT p a (200 MT Europe, 200 MT N America and 50 MT elsewhere) This is about 0 3 % of total world consumption However, according to one European importer the market is growing at 10 % to 15 % p a The market appears very much concentrated in western countries and the current demand is mainly from particular health conscious customers There is little information on the market position in Japan - which is the largest Asian importer of cashew

There appear to be three issues that are relevant to consider

- What is the inherent demand for the organic product?
- What premium above regular market prices will clients pay for organic product? Will OCIA approved product command a higher price premium above other organic product?

- What is the difference in relative market position of organic product that is approved by OCIA or other regulating body or organic product that is not carrying such approvals?

Currently there appear to be only a few producers who are growing organic cashew Apart from CORALAMA the known organic projects include two growers in Sri Lanka, one in India and one in Brazil The certification status of these other projects is not known

Demand To date Ports West International of Victoria Canada (Nick Orton, General Manager) has been the pioneer in developing the organic cashew market for CORALAMA in North America His total purchases to date are 16MT, but he has expressed an immediate need for 35 MT p a and increasing in the future The National Cooperative Business Association (NCBA) has indicated a potential buyer in the USA (once again Nut Butter Nunda) who have expressed a requirement of 45 MT p a The consultant has also identified potential clients in Australia and Europe who have a requirement of about 10 MT each

The import of organic cashew into Europe appears to be dominated by three organisations (Horozon Natuurvoeding Holland, Rapunzel, and Care in Germany) who apparently import 75 % of the European consumption (200 MT)

Demand for organic product is estimated to increase significantly in the next few years but this will be influenced by price

A summary of the current and future markets is presented as follows

	Current market (MT)	Market in 3 years (MT)
North America *	250	1,000
Europe **	200	300
Australia/New Zealand ***	10	50
Japan	unknown 460	unknown 1,350

Estimates by Ports West Int for North America * Horizon Natuurvoeding Europe ** and Jorgenson Waring Australia ***

The prices currently offered for organic cashew approved by OCIA appear to be about 50% to 100% above levels of the conventional trade These prices are sustained because world supplies are still very small - it is likely in the longer term that prices could fall to a much smaller premium once supplies build up

looking at 10% to 20% above world prices In Australia the premium offered would be about 50% as the market there is still very new It can be expected that price premiums will probably settle no more than 20% above conventional world prices once some stability in demand and supply is established

The issue of the Organic Approval Process is also very relevant OCIA is considered by many to be the most respected organisation world wide and its stamp of approval gives a major marketing edge In Europe, the market appears to accept approval on organic authenticity by any organisation that is acceptable to the European Union - and there are about ten organisations in this category There is no information available as to whether the OCIA certification gives the potential to charge higher prices to product approved by another recognised body

The importing and distribution of organic cashews appears to be in the hands of medium to smaller traders who are supplying large organic grocery stores in the USA while in Europe the retail sales are made smaller natural food shops

Future prospects for El Salvador organic cashews - the forecast by an experienced trader (Nick Orton of Ports West International) is that there is a window of opportunity for El Salvador product to capture a good share of the emerging market especially in North America

This opportunity may be two years at most as the potential exists for Brazilian producers to increase their supply of organic cashews very rapidly Attracted by good price premiums over the conventional market, large Brazilian plantations are in a position to become certified in one year if they use some (other than OCIA) approved agencies In the opinion of the Ports West International, if the CORALAMA processing factory fails to process its total production within two years, it may lose its market to the competition

C9 Market for CNSL

CNSL is a natural phenol (90% *anacardic acid*) contained within the shell and is a by-product associated with processing The volume of CNSL contained in the shell may vary, but in practice some 8% to 10% can be recovered depending on raw nut quality and processing method

90% of the CNSL collected is processed into resins for use as fillers in auto brake linings and clutch facings Other minor uses include marine paints and varnish There are competitor products to CNSL in the auto industry, some of which - the synthetic phenols out perform CNSL However, the manufacturers prefer to use CNSL as long as the price is competitive

The major markets for CNSL are USA, UK, Japan and South Korea The major suppliers are as follows

CNSL Exports and Prices					
	Brazil (mt)	US$/mt	India (mt)	US$/mt	Mozambique (mt)
1988	-	-	2,591	560	593
1989	20 504	295	2,559	518	538
1990	26 304	299	4,422	411	408
1991	17 045	292	4 990	330	923
1992	na		3 757	344	437
1993	na		3 868	275	77
1994	na		4 245	215	72
1995	na		na	na	306

Sources
- The Cashew (Indian Journal)
- The World Cashew Economy (Nonisma)
- Secretaria de Estado do Caju Mozambique

Total world supply of CNSL is estimated at about 45,000 mt Brazil is the major supplier where CNSL is automatically extracted in their mechanical factories where the hot oil bath roasting method is used almost universally

In India only a small fraction of the potential CNSL is collected This is because the traditional processing methods (drum roasting) burn off the CNSL, and because the steam cooking method is in many cases replacing hot oil bath systems In steam cooking factories, CNSL is not automatically extracted, as occurs in the hot oil bath If the price of CNSL rises sufficiently, the operators of steam factories have the option to acquire equipment (expellers, etc) which would allow them to recover the CNSL from the expended shells

The capacity of the Indian factories to increase CNSL production would act as a self regulating brake on future significant price rises

C10 Market for Cashew Apple Products

The production of cashew apples is 5 to 10 times the volume of the nuts produced, however, in most producing countries little economic use is made of the apple The most likely outcome is the consumption of the apple as fresh fruit Only in India and Brazil is any significant commercial use made of the apple and even here only a small fraction of the potential crop is utilised

The cashew apple is a highly perishable fruit which is about 85% moisture The apple is of value also because it is higher in vitamin C and B than most other fruits

Vitamin Contents per 100 g					
	Cashew	**Pineapple**	**Orange**	**Lime**	**Grapefruit**
vitamin C (mg)	186 - 249	80	49	45	40
riboflavin (ug)	100 - 124	20	30	trace	20

Source Cashew J G Ohler

In trials undertaken in India 17 different varieties with different apple types were analysed and the following results were achieved

	Apple weight (g)	**Juice recovery (%)**	**pH of juice**	**Total sugars (%)**	**Vitamin C (mg/100g)**
maximum	87 3	74 3	4 8	15 1	314 3
minimum	11 7	64 2	3 9	6 6	na

Source Physio - Chemical Properties of Cashew Apples of Some Promising Clones, D K Sena and others
Physico - Chemical Properties of Cashew Apples of Different Cultivars J S Hallad and others

In India and Brazil significant commercial use has been made of the cashew apple

The Central Food Technological Research Institute in India has identified the potential products that can be made from cashew apples as follows

1 Cashew apple juice, sweetened, spiced or carbonated
2 Cashew apple juice blends (i e with pineapple)
3 Cordial
4 Concentrate
5 Cashew apple syrup
6 Wine
7 Vinegar
8 Cashew candy
9 Cashew jam and mixed jams
10 Cashew chutney
11 Cashew pickles
12 Cashew whisky

In Brazil the following cashew apple products have been identified in the literature

1 Cashew apple juice with pulp in suspension
2 Clear cashew juice
3 Cashew nectar
4 Cashew apple in syrup
5 Cashew apple plum
6 Cashew apple jelly
7 Cashew apple flour
8 Cashew apple liqueur/brandy/cognac

In Brazil the industry is dominated by the larger plantation companies that have cashew apple processing facilities within their normal nut processing operations These producers manufacture juices (the most common product) which are marketed on the domestic market at the retail level in competition with other juices There is no information on the volummes of cashew apple product produced - the estimate is that perhaps 30,000 MT of juice is consumed in Brazil

In India, the processing of the apple is much more a smaller cottage industry with a few exceptions In Goa, the state government operates a factory that produces Fenni - a local whisky which sold widely in India

All cashew apple products are sold on domestic markets - there is no record of any exports of product

A major problem with the commercial use of the apple is that it is a highly perishable product and it requires virtual daily harvesting, and in the absence of refrigeration, it also requires immediate use for processing Research in Brazil (Soares 1975) showed that if cashew apples are kept at between 0 and 1 degrees C at 85% to 90% humidity, and subsequently subjected to three washings in chlorinated water in concentrations of 100,20, 2 ppm, then the product will keep satisfactorily for three weeks

Other research in India concentrated on the non - refrigerated methods of extending cashew apple storage life This trial (Extension of Storage Life of Cashew Apple by N Chattopadhyay) used different chemical and other treatments to test the retardation in the rate of decay The best results were obtained when the apples were dipped in solutions of *potassium metabisulphite* 1 0%, *Sodium benzoate* 1 0%, and *Citric acid* 0 1% With this application there was 75% decay after four days and 100% after six days

A further problem with the commercial use of the apple is astringent and acidic properties which are contained in the apples Various methods have been used to remove these properties, and three which have been found to be satisfactory are as follows

1 Steaming of apples five minutes under steam pressure of 5 psi and subsequent washing in cold water

2 Cooking apples for five minutes in solution of 2 % common salt

3 Addition of required quantities of gelatin solution to the expressed juice Trials with this method showed that the *tannins* that caused the problems were reduced from 0 32% to 0 03% (*Pectin* can also be used in place of gelatin)

The most common form of product especially in Brazil is cashew apple juice - especially the clear juice The standard processing flow chart for this product would be as follows

Daily harvesting of crop - separation of nut and apple

weighing washing pulping juice extraction sieving pre-heating to deactivate enzymes dis-aeration homogenisation	
concentration cooling freezing storage -18 degrees C *Concentrated frozen juice*	pasteurisation packing cooling storage - ambient temperature *Pasteurised juice*

In the above process, if refrigerated facilities for raw product are not available, daily processing of the apple is carried out

D Review of Plantation Operations - SCPM

(Sociedad Cooperativa Productos de Marañon)

D1 Background

CORALAMA is located at Tierra Blanca, some 40 km south east of San Miguel The other five cooperatives are located within 30 km of CORALAMA The cooperative has 107 members and a total population of about 560 It owns some 1,673 hectares of

land Cashew occupies 50% of the total land, the balance is used as follows 32% natural forest, 12% cultivation of maize and beans, and the remainder for living areas and for installations

While the other cooperatives have a much smaller involvement in cashew, they also operate significant areas of land and are in other agrarian pursuits The table below indicates the following

Cooperative	Total land (hectares)	Cashew land (hectares)	Other Business
CORALAMA	1 673	800	maize, beans
San Ramon	3,057	231	sisal
Chilanguera	3 720	167	sisal
Maquigua	946	60	--
El Plantar	1 391	40	sisal
Gualuca	596	33	--

Note the 800 hectares at CORALAMA refers to the managed area only Approximately 300 hectares of cashew is no longer managed and is now considered natural forest

Topography and Soil type The land at CORALAMA occupied by cashew consists of the following types

- 268 hectares flat/semi flat land Soil type generally classed as *Latozol Pardo Raizo* It is estimated as 20% sandy, 40% clay and 40% mixed pH of the soil ranges from 4 4 to 5 6 (5 0 av)

- 534 hectares hilly land Soil type estimated as 70% clay, 10% sandy, 10% mixed

The topography/soil type of land at the other cooperatives is broadly estimated by the consultant as follows

San Ramon - mainly flat/semi flat land Heavier soil type than flat/semi flat land at CORALAMA

Chilanguera - hilly land with variable slopes Heavier soil type than CORALAMA with numerous rocks

Maquigua - slight slope Soil types similar to CORALAMA

El Platanar - hilly land with variable slopes Heavier soil type than CORALAMA

Gaulaca - hill top with variable slopes Heavier soil types than CORALAMA

Comment the soil types appear to have too high a clay content to be considered very suitable for cashew Observation of tree growth at CORALAMA would confirm this estimation

altitude - variable CORALAMA ranges from 200 meters at the processing factory to 400 meters on higher slopes Some cashew is planted at altitudes of 400 - 600 meters, but these areas are no longer managed Some other cooperatives are at lower altitude - San Ramon and Maquigua are at about 50 to 100 meters

temperature - no information on absolute maximums and minimums was available The average temperatures at CORALAMA ranged from max 34 4 C to min 23 1 C The temperature regime could be considered ideal for cashew

rainfall - the estimated annual average rainfall at CORALAMA is 800 mm per annum Only estimates are available as CORALAMA does not monitor weather data The only data available to the consultant was from Chilanguera for 1995 and 1996, which apparently were exceptional years for heavy rain

Month	1995	1996	% of annual total (av of two years)
- January	12 5	na	na
- February	50 0	na	na
- March	na	na	na
- April	155 0	31 0	2 15
- May	1152 2	113 0	14 66
- June	515 0	375 0	10 31
- July	975 0	273 0	14 46
- August	587 7	1030 0	18 74
- September	717 5	1179 0	21 98
- October	583 0	642 0	14 20
- November	195 0	42 0	2 74
- December	nil	nil	nil
	4,941	3,685	

The consultant is highly dubious the above statistics are accurate - based on advice from reliable sources it is estimated that the rainfall at Chilanguera is about 1,500 - 2,000 mm pa El Platanar is estimated at up to 2,400 mm p a , while San Ramon is similar to CORALAMA

The lack of any reliable data is an impediment to the analysis of production improvement

crop phenology - as the tree stock is seedling trees, there is quite a wide variation in phenology and it varies slightly between the cooperatives The flowering period is generally November to March The harvest period is as follows

CORALAMA/San Ramon	February - June
Chilanguera/Maiquigua	March - May
El Platanar/Gauluca	No significant crop yet

Significant rain during the flowering period can impede flowering, while heavy rain before the harvest is completed can make proper post harvest treatment (cleaning drying storage) more difficult

The issue is what proportion of the crop is affected by the start of the rains?

The lack of reliable data makes the task difficult to access Based on advice to the consultant the best estimate is that 20% of the CORALAMA and San Ramon crop is affected by rain Maquigua will probably be the same but Chilanguera and El Platanar could be more based on the very limited data available

There is a need for a proper weather monitoring especially rainfall at the major cashew sites

D2 Production

All cooperative plantations are of seedling trees based on seed apparently imported from Martinique, Trinidad and Jamaica during the 1960s The original seed was planted at CORALAMA and subsequent seed from CORALAMA was used for the plantings at the other cooperatives

All the plantings at the cooperatives were at similar high density spacings, but in the past some thinning has been undertaken as follows

Cooperative	Spacing Trees/hectareas	Thinning done	Current Spacing
CORALAMA **	- 6m by 6m 275 - 7m by 7m 200 - 8m by 8m 156	almost 100 % of area but some 20 % of cut trees show re-growth	12m by 12m (335 ha) 14m by 7m (200 ha) 18m by 18m (265ha)
San Ramón	- 6m by 6m	40 hectares heavy pruning considered inappropriate and now terminated	
Chilanguera	- 6m by 6m - 8m by 8m	nil	same
Maquigua	- 6m by 6m	nil	same
El Plantar	- 6m by 6m	nil	same
Gauluca	- 6m by 6m	nil	same

** Note In addition there are some 100 grafted trees of two varieties (origin Jamaica and Martinique) planted in 1981 These two varieties were selected on basis of resistance to anthracnose (red apples trees apparently more resistant) There is no yield data from these trees Only information is on nut size (116/kg) or 8 6gm nuts - compared to average of plantation of (143/kg) or 6 99gm

The heavy pruning at San Ramon involved the removal of the lower branches to allow sunlight penetration Heavy pruning of semi mature trees is not appropriate and does not give a permanent solution to overcrowding This practice has been terminated

and will be replaced by conventional thinning to 12m by 12 m with the alternative tree from the mid row being left (90 trees/hectare approx)

At CORALAMA thinning to the different spacings was undertaken in 1993 However, there is now sign of re-growth from some 20 % of trees that were cut down In some places this re-growth is beginning to cause overcrowding that will require further attention

Further information on the profile of the plantings is as follows

Cooperative	Area planted (hectares)	Age of trees (years)	Suitability soil/terrain	Production in 1996 (metric tons raw nuts)
CORALAMA	800	25 - 32	40 % flat / semi 60 % hilly	541
San Ramon	231	5 - 8	100 % flat / semi	38 **
Chilanguera	167	4 - 6	100 % hilly	5
El Plantar	40	6	100 % hilly	nil
Maquigua	60	4	90 % flat 10 % slight slope	nil
Gualuca	33	12	100 % hilly	nil
				584

** Note Because of labour shortage only 157 hectares were harvested in 1996

Because of the age of the trees only CORALAMA has been producing commercial quantity of crop for a number of years The available data on production is given below

CORALAMA Production - Period 1989 to 1996				
Year	Area harvested (hectares)	Total harvest (MT raw nuts)	Average yield (Kg/hectares)	% of crop undamaged
1989	800	545	681	54 %
1990	800	681	852	53 %
1991	800	590	738	65 %
1992	800	500	625	73 %
1993	400	363	909	87 %
1994	800	400	501	
1995	800	438	548	
1996	800	542	677	

Source 1989 to 1993 data from Techno Serve report August 1993 Data 1994 to 1996 from Crecer It is indicated in the report that the smaller area was harvested in 1993 because of a lack of funds to manage the whole plantation

The volume of crop damaged in the period 1989 to 1993 appears to be very high The Techno Serve report indicates that this damage was caused by *anthracnose*

Note The CRECER's agricultural advisor to the project advised me that the total yield data for the period 1989 to 1993 could be inaccurate He could only be confident of data for 1994 to 1996 - the time during which he was directly involved with the project

D3 Production Methods

Prior to 1993, CORALAMA was using conventional production techniques Available information from CRECER indicates that the following chemicals were used in the period up to 1993 for the three main management activities

application of fertiliser	- mature trees	2 lbs / tree *sulphate of ammonia* 2 lbs / tree 16 20 0
	- young trees	29 oz / tree *sulphate of ammonia* 10 oz / 16 20 0
pest control	- chemicals used included	*malathion, manzate, dithane, bavistivi*

In 1993 a decision was made to change to organic production methods as approved by OCIA The OCIA system involves the adherence to approved practises for a minimum of three years before certification is approved Approved practices prohibit the use of artificial fertilisers and chemical insecticides CORALAMA achieved its OCIA status in 1996 for the entire plantation (265 hectares was considered organic in 1994 because it had not previously been managed) The other five cooperatives are in the transition stage to OCIA and will achieve this status as follows

Maquigua / El Platanar / Gauluca	1998
San Ramon / Chilanguera	1999

The following table indicates some of the major approved and prohibited substances by OCIA for each horticultural practice

OCIA Approved Practices		
	Approved	**Prohibited**
Fertilisers	composted manure uncomposted if turned for 6 months	artificial fertilisers green manure crop residue waste residue
	natural limestone and *phosphate*	highly *soluble nitrate and phosphates ammonia and urea*
	some minerals *(borax, sodium molybate potassium sulfate)*	
Pest and weed control	*bacillus thuringenses* organic insecticides (*neem natural pyrethrums*)	all synthetic pesticides
other		growth regulators

The current practice at CORALAMA is to use the following

1 *Nutrition*

At CORALAMA nutrition is applied in the form of composted manure - 25 lbs per tree is applied in May, June (after harvest) The formula for the compost is apparently from Mexico where it was used for production of organic coffee The compost has not previously been examined as suitable for cashew

A list of ingredients used is given below In addition, an analysis of the compost by Laboratorio de Suelos y Plantas on 1 August 1995 is also given

Compost Contents		Compost Analysis	
green material	17 %	pH	8 0 %
cattle manure	24 %	organic matter	26 2 %
fibre (sisal)	24 %	nitrogen	0 8 %
coffee skin pulp	17 %	phosphorus	0 7 %
burnt rice hulls	9 %	potash	0 7 %
soil	9 %	calcium	3 0 %
calcium	trace	magnesium	0 7 %
		boron	98 2 ppm
		copper	20 3 ppm
		iron	3 437 5 ppm
		manganese	407 0 ppm

The consultant understands that there is reasonable scope of changing the ingredients of the compost in response to the requirements of cashew

The other cooperatives are in the transition stage and will start using the similar compost this year

2 Pest Control

At CORALAMA and at most of the other sites the major pest species are insects that are not positively identified but assumed to be *Leptoglossus sp* (*Coreidae*) This is a large insect in the adult form that is not a recorded pest of cashew in other producing countries Preliminary evidence suggests that in El Salvador this insect has made an opportunistic cross to cashew from another crop - possibly from maize and/or sorghum This insect appears to have a preference to attack the developing nut and it causes damage when it injects toxins into the nut when feeding This damage is evident either by the destruction of the nut developing on the tree or especially later in the processing factory

The estimate is that perhaps 10% of the crop is being destroyed on the tree, but a significantly greater level of damage is being incurred in the factory Data from the factory indicated that 35% of processed kernels was being discarded because of damage - the vast majority of which was caused by *leptoglossus* type insect attack The total combined loss from this source can only be described as a disaster

The control method used is the application of neem oil (Nim CE 80) processed in Nicaragua by Cooperativa de Produccion de Insecticidas via aerial application At CORALAMA the application is made via aerial application three times per year, December, January and February At San Ramon there are two sprays p a , once p a. at Chilanguera while El Platanar and Gualuca do not spray at all

The neem (concentrate) is applied at the rate of 1 5 kg per hectare and may be applied at the same time as the *copper hydroxide* which is used for *anthracnose* control

At the time of the consultants inspection *Leptoglossus* type insects appeared to be in evidence in significant numbers at CORALAMA especially - his companions had no trouble catching them by hand while the insects were feeding on the early crop that was developing This was 15 days after an aerial application of neem had been made While neem generally has a slower kill rate than chemical insecticides - 15 days should be sufficient time to expect the maximum kill rate

Thrips (not identified but presumed to be *Selenothrips rubrocinctus*) was found in plague proportions in Chilanguera The potential loss of crop could be to be considerable (30 % or 40%) *Thrips* is apparently present at all sites but Chilanguera is particularly bad Chilanguera are currently not normally conducting any measures in pest control - however, an aerial application of neem was used during the consultants visit

It would appear that there are a number of issues that need resolution in order to adopt effective pest management These are as follows

1 Overall effectiveness of Neem against major insect pests (*leptoglossus, Selenothrips Sp*) Optimum concentrations to be used

2 Effectiveness of application method (effective penetration of canopy)

3 Role of alternative host plants

4 Effectiveness of alternative organic compounds against major pests (*pyrethrum,* etc)

The consultant has no information on the effectiveness of Neem on *Leptoglossus* type insects There is literature evidence to suggest that neem has been used with effect in other crops (tea, vegetables) against other species of *thrips* (*Thrips tabaci, Scinothrips dorsalis*) One can presume that it should be effective against *Slenothrips rubrocinctus*

The 'quality' of neem does depend on the method of processing the neem seed to achieve the oil It is apparently quite difficult to produce the active ingredient of neem (*azadirachtin - A*) in crystalline form The consultant has no technical information about the Neem being used by CORALAMA

The method of application has a major role in determining effectiveness It has been previously established that aerial application can give poor penetration in situations where there are thick tree canopies and especially where planting has been carried out on dense spacing with inadequate subsequent tree thinning This can occur because aerial applications use very fine droplets of spray

In addition, the size and positioning of the insects on the tree also play a role - in this case the *Leptoglossus* types as a very large insect (apparently) feeding (in a more exposed position) on maturing nuts while *thrips* are extremely small and are located in more protected positions on the underside of the leaf

Given the extent of the area and hilly topography, aerial application would appear to be the only practical method of application The only other method would be to undertake insect monitoring and to undertake hand spraying of the hot spots when insect numbers reach threshold levels This system works well when the available skills are available and when the insect problem is reasonably under control

It is apparent that the *Leptoglossus* types are normally present in alternative host crops (especially maize, sorghum and rice) then the move to cashew is quite easy when these crops are grown in the vicinity It is clear appears that at CORALAMA and other

sites these alternative host crops are grown in close proximity to the cashew The issue of whether the control program could be extended to cover these alternative host crops within a proscribed area could be one possible solution

Apart from Neem there are other organic compounds that could be alternative control measures against *leptoglossus* and *thrips* and are acceptable to maintain OCIA status The alternatives include *pyrethrum* and other compounds

Termites (type not identified) are in evidence at CORALAMA and other cooperatives These *termites* live in nests in the tree and they build galleries on the tree trunk to move between the nest and the ground The damage caused by these *termites* appears to consist the sap they suck from the tree bark Control is achieved manually by physically removing the nests from the trees This is not classified as a significant pest

No other pest problems were indicated to the consultant during his visit This does not mean that they do not exist as no detailed Bio-Ecology Study has been undertaken of the insect population It is possible that the severe extent of the *Leptoglossus* could be masking other potential pests which could flourish in the absence of *Leptoglossus* In addition, there is no information on potential beneficial species - without the information available from a Bio- Ecology Study

3 Disease Control

Control of *anthracnose* is achieved by aerial spray of Kocide 100 (*copper hydroxide* 77%) at the rate of 1 5 kg per hectare The copper is usually sprayed at the same time as the neem

The consultant was informed by Señor Leopoldo Serrano (Department of Plant Protection National University) that the *Leptoglossus* type insects could also be responsible for the distribution of the *anthracnose spores* - thus becoming a contributing factor to *anthracnose* control

D4 Future Yield Estimates

MT of Raw Nuts Organic Crop					
	1997	1998	1999	2000	2001
CORALAMA	589	635	645	680	680
San Ramon	59	81	100	135	155
Chilanguera	5	22	45	68	115
Maiquigua	14	18	25	32	42

MT of Raw Nuts Organic Crop					
	1997	1998	1999	2000	2001
El Platanar	5	11	15	18	20
Gualuca	6	10	15	20	24
Total	678	777	845	953	1 036

The above crop figures are considered to be very conservative A less conservative estimate may be a total up to 1,500 MT The consultant would use the average of the two estimates - about 1,200 MT

In addition, if the CORALAMA factory can demonstrate that is has sufficient processing capacity, then it is estimated that a further 200 MT could be purchased from nearby small farmers already identified by CRECER and who also grow cashew It is understood that these farmers have not previously used chemicals and this should not be in conflict with CORALAMA's organic cashew trade However, before anything is finalised the matter must be checked with OCIA

D5 Costs of Production (Plantation Maintenance)

Based on average yields of 600 kg to 700 kg per hectarea

	Assumption	Cost colones/kg raw nut Yield	
		600 kg/ha	700 kg/ha
harvest	30 colones/quintal	0 66	0 66
spray (3 times /p a)	265 colones/manzana (materials and plane)	1 98	1 70
compost (manufacture)	0 55 colones/quintal application 25lbs/tree	0 14	0 14
compost application	25 trees p a at 25 colones per day	0 20	0 20
plantation cleaning	8 men/manzana/25 colones/man/day	0 40 3 38	0 40 3 10

On data given to the consultant, he estimates the cost of production to range between 3 10 and 3 38 colones (US$ 0 35 6 to US$ 0 38 8) per kg of raw nut produced depending on yield levels achieved The consultant did not include administration costs as these were unknown

The consultant was advised that the studies undertaken by CORALAMA on the total cost of production in the plantation gave a figure of 133 colones per quintal (100 lbs)

of raw nuts produced These figures apparently include all costs including fuel, administration, etc

The CORALAMA figures, if converted to the consultants' method of calculation (colones/kg raw nut), would be 2 93 colones/kg

E Review of Processing Factory

E1 Current Processing System

The processing factory is located in a compound within the CORALAMA cooperative land It consists of a processing factory housed in a building and other smaller storage buildings The processing system used is similar to that of many other processing factories elsewhere in the world It combines a semi-manual shelling system with a steam cooking pre-conditioning system

The current processing system involves the following work flow

1 Raw nut receival process

Raw nut brought from the field in sacks Nuts are dried in the sun (on sacks on the ground) for up to three days to reduce moisture to levels suitable for long term storage (8% moisture) At time of drying an initial inspection and hand grading is undertaken to remove defective (blanks and heavily damaged) nuts The consultant was advised that about 7% of the crop was rejected at this stage

Comment

A problem exists in the event of wet weather during harvest period - which effects 20 % of the crop according to anecdotal evidence and the limited data available A suitable investment could be to construct a simple shed with a concrete floor and a clear perspex roof to allow a permanent drying facility The clear perspex protects from rain showers but allows sun heat to continue the drying process

2 Storage

Raw nuts are stored loose in heaps on floor in storage sheds There are three storage sheds which have a capacity to store 90 MT (2,000 quintals) Raw nuts can also be stored in vacant areas of the factory especially in the area currently occupied with redundant cashew apple processing equipment The raw nuts are bagged for movement from the storage sheds to the steam cooker

Comment

Storage facilities are completely inadequate relative to the intended processing capacity of the factory Their needs for storage space for 12 months of production is currently up to 600 mt

The method of storage, i e in heaps on the ground, is not recommended This method could lead to overheating of nuts at the bottom of the pile if stored for any length of time The recommended method is storage in hessian bags as this allows efficient air flow to keep nuts in good condition If raw nuts must be stored loose on the ground then they should not be stored more than 10 cm deep

3 Raw Nut Grading

Grading of crop by size prior to processing is not undertaken

Comment

Grading of all crop into a (say) four grades (by size) at the start of the processing work flow is normally standard practice but is not being carried out in this factory Apparently in the past raw nuts used to be graded but, this practice was abandoned because of pressure from workers Efficient grading allows more effective pre - conditioning of raw nuts (hot oil bath, steam or dry roasting) and shelling This is because the parameters of the process can be made to more accurately meet the requirements of the raw nut

The factory has a mechanical grader that can grade into three sizes

4 Steam Cooking

When required for processing the raw nuts are moved to the steam autoclave for pre-conditioning treatment 1,800 kg (40 quintals) of crop is the operational capacity that can be loaded for treatment in single operation A hopper and conveyor is used to load the raw nuts in to the steam autoclave They are then steam cooked for 13 to 15 minutes The purpose of the steam cooking is to make the shells more brittle and conducive the shelling process

The factory has no laboratory or moisture measuring equipment and so the current timing for nuts in the steam has been developed by trial and error by the current management This trial and error has involved making visual assessments of the condition of the crop and the level of external humidity

The management believe that the current procedures are the best compromise between the proportions of under-cooked and over-cooked nuts The factors that make a good compromise difficult between over cooking and under cooking are

- possible design of autoclave (space between hot air pipes) The steam is utilised in the autoclave by a series of internal hot air pipes that are circular in design The objective is to give an even flow of steam over the crop

- variable seed grades (grades) and especially a high proportion of partially damaged raw nuts all combined together in one steaming process

Comment

The consultant agrees that lack of nut grading and generally poor quality (damaged nuts) makes a good cooking result difficult, and can make no comment on the internal design of the steam cooker as no internal inspection was possible

The consultant notes that in another steam autoclave of similar size he saw in Goa India, the raw nuts were graded and then treated to 10 minutes of low steam before being given 25 minutes of full steam followed by cool down period The suggestion is that CORALAMA might benefit by trying a short low period before the normal full steam - this may assist in helping to reduce the proportion of scorched kernels

5 Cooling

The steamed nuts are removed from the bottom of the autoclave by means of an opening valve The nuts are then placed on wooden floors to depth of about 10 cm to cool for three days

6 Shelling

When required the nuts are moved to the shelling machines for shelling The machines used are standard semi - manual (twin blade) shelling machines operated by foot pedal One operator places the nut in the cutting position and operates the foot pedal which causes the blades to cut the nut The other operator separates the kernel from the shells The task is dirty because steam cooking causes CNSL to adhere to the external surface of the nut As CNSL is a caustic substance the workers put vegetable oil on their hands to protect themselves from the CNSL The danger of injury to the sheller arises because of any miscalculation that may occur while the operators hands are close to the cutting blades

The average production per shelling machine (2 workers) per eight hour shift is 85 kg of raw nuts processed The proportion of kernel produced will depend on the quality of the crop and also the skill of the operators In practice this is about 23 8 kg kernel (28% recovery) and with 70% to 80% wholes at this stage

Comment

The productivity of the CORALAMA shelling workers are as good as elsewhere in the world where the same machines are used There is not much more that can be done to make this task cleaner or less dangerous other than as follows

- keep machines in good order
- operators to wear full uniforms and eye protection (which I understand they dislike)

The shelling process would be made more efficient if the nuts were graded and the cutting blades were adjusted to fit the particular grade, then the operators would not have to constantly have to adjust their cutting Processing trial number 2 (this report) demonstrated this increase in productivity (85% wholes for large grade and 63% for small grades) Apparently the workers do not like the idea of nut grading as the workers with the smallest grade would have the hardest job - this could be resolved by giving graduated piece work rates

In addition, a task rotation scheme could be used - between sheller and separator and between the grade of raw nut being shelled This would help alleviate job boredom - but would only work with the approval of the workers

7 Drying

The purpose of drying the kernel is to shrink the kernel and stretch the testa as an aid to later peeling In this factory, the kernels are placed in trays in a batch drier and heated 80 degrees C for 4 to 6 hours (Factory manager decides on drying time depending on current weather/humidity) The usual objective is to reduce the moisture content of the kernel to about 4% to 4 5% to achieve maximum benefit towards peeling If the kernel become too dry they will break during peeling - if they are too wet they will be difficult to peel, and may get broken in the extra peeling effort However, the factory has no laboratory or any measuring equipment so they have no way of measuring the moisture content In effect the drying process adopted has been arrived by a combination of experience of trial and error

Comment - Without the proper moisture measuring equipment it is not possible to operate the drying process most efficiently Trial and error, however skillful, is not a substitute for accuracy

8 Peeling

Manual peeling methods are used on whole grades - splits and pieces may be put through a conventional agitator peeling machine The drying process is supposed to loosen the testa and allow it to be removed by hand However, it is normal for a proportion of kernels to have hard to remove tests especially on the inside slope of the kernel In this case a small blade may be used to scrape away the testa

9 Recovery

This is where the problem kernels (especially damage by *Leptoglossus* type insects) are sent where attempts are made by hand to cut away the damage parts using a blade Currently a significant proportion of CORALAMA crop is so badly damaged that the kernel is discarded and used for stockfeed

Comment

Currently 43% of the kernel is sent to recovery, and of this 81% is discarded as animal feed When the insect damage problem is brought under acceptable levels of control no more, say 10% of the crop, should need to go to recovery and only a fraction should need to be discarded

10 Grading

Grading into six grades is undertaken by hand The grades are as follows

white wholes	(all sizes)
scorched wholes	
white splits	
scorched splits	
white pieces	
scorched pieces	

11 Final Product Packing

Product is vacuum packed in aluminium lined 25 lb packs which are put in separate cardboard boxes

12 Marketing

In 1996 some 100 MT of raw nuts were processed between October and December and this produced 16,388 kg of kernel sale Of this total the following sales were made

white grades	14,390 kg	Ports West International
scorched grades	1,998 kg	Costa Rica market

In addition, the discarded kernel (9,029 kg) was sold as animal food at 68 32 colones per quintal (US$ 0 17) per kg In addition, the testa was sold as animal food for 10 colones per quintal (US$ 0 02 per kg)

The prices paid by Ports West International were as follows

white wholes	US$ 3 75
white splits	US$ 3 40
white pieces	US$ 2 70

The white grades are sold to Ports West in Canada at the following prices

wholes	US$ 3 75 per lb
splits	US$ 3 40 per lb
pieces	US$ 2 70 per lb

The scorched grades were sold on the Costa Rican market at lower prices (no details available)

E2 Factory Processing Capacity, Costs And Efficiency

E2a Factory Equipment and Resources

A list of the current processing resources at the factory site are as follows

factory building	area 2,058 sm (42m by 49m)
other buildings	for raw nut storage, etc , capacity for 90 MT (2,000 quintals)
boiler	provide steam for steam cooker and hot air for drier Requires about 2,000 litres water per day of operation
raw nut grader	capacity 500 kg raw nuts per hour

steam cooker	capacity 3,600 kg raw nuts per day {1,800 kg raw nuts per operation - i e 3 hours to allow for loading, cooking (15 minus) cooling and removal Two operations per day are comfortably possible}	
shelling machines (40)	capacity	3,400 kg raw nuts per day
drying ovens (12)	capacity	545 kg kernel per shift of 4 hours (Maximum capacity per day 1,100 kg kernel)
peeling machine (pieces)	capacity	10 kg kernel per hour

Processing capacity of factory - with the existing equipment the (theoretical) processing capacity is 3,400 kg of raw nut per eight hour working day The factory works 11 days per forthnight (37 4mt) or about 860 mt raw nuts in a 46 week working year

The practical capacity is however significantly lower The limiting factor is the ability to attract sufficient labour (women) to undertake the semi - manual shelling work The factory records show that while there are 40 shelling machines, the average number in daily use is 18 and the maximum recorded was 20 The reason is that shelling is a dirty job with some risk of injury because of the use of fingers in close proximity to the cutting blades during operation As a result, it is not the most popular job and the cooperative has previously had difficulty (and will probably continue) to have difficulty attracting sufficient labour for this task It must be mentioned that shelling is a task that requires some skill for successful operation

The factory also has the remnants of old equipment that was used for the processing of the cashew apple All the machines are in some state of disrepair A few items are still positioned in the factory building and other bits have been taken to pieces and thrown away outside the factory It would be fair to assume that none of it has any further practical value

The factory has no capacity to collect CNSL It is not collected automatically as in a hot oil bath processing system With a steam system it would be necessary to put the spent shells through an expeller to collect CNSL However, this system uses the spent shells as fuel in the boiler which provides steam to the autoclave and hot air to the driers

E2b Labour Usage and Cost

The following are the estimates for labour requirement and costs of processing under current operating condition

Task	Labour Nos	Total labour cost (Colones per kg of raw nut processed)
Raw nut drying/ Initial grading Boiler operation	 7 8 1 0	 0 05 0 01
Steam cooker also Other tasks including weighing of nuts before shelling, removal of spent shells to boiler etc	2 0 (for 40 % of time) (60 % of time)	0 01 0 02
Shelling	38 0	0 86
Kernel drying	1 0	0 02
Peeling	38 0	0 61
Recovery Grading Final product, also Other duties	44 0 7 4 0 02 (50 % of time) (50 % of time)	0 74 0 19 0 02 0 02
Factory repairs & maintenance Total labour Total factory labour cost	2 0 143	0 42 2 97
Materials - packing materials - repairs and other materials (15,000 C p a) - electricity (9,000 C/ month)		0 30 0 03 0 25
Total cost (excluding management rent taxes etc)		3 55 Colones

Assumptions used in above calculations These assumptions as far as possible reflect current practice at the factory - where information is not available the consultant has used his own estimates

1 Daily production run of 1,600 kg of raw nuts
2 A 28% recovery after shelling, of which 80% wholes and 20% brokens 25% recovery rate after drying

3 A 55% of kernel of sufficient quality after peeling to go for grading, 45% to go to recovery Of proportion sent to recovery, 81% is classified as unsuitable and discarded to be used as animal feed

4 Work rates as follows

shelling-	95 lbs raw nuts/worker, 1 70 C / lb kernels wholes, 0 20 C / lb brokens
peeling-	12 7 lbs kernel/worker, 1 60 C / lb kernel wholes, 0 60 C / lb brokens
recovery-	9 0 lbs kernel/worker, 3 0 c / lb kernel wholes and brokens
grading-	117 lbs whole kernel/worker at 0 25C / lb - 55 lbs brokens (splits)/worker 0 45C / lb - 55lbs brokens (pieces)/worker 0 48C / lb

E2c Processing Efficiency

The following analysis of the data of the period 11 October to 30 December 1996 when the factory processed 100 MT of raw nuts from the CORALAMA crop is as follows -

Processing of CORALAMA Crop 11 October to 30 December		
		Kgs
Raw nuts processed Raw Nuts		100,048
After shelling (29 % recovery) at estimated 9 - 10 % moisture Kernel		29,139
After drying (27 % recovery) at estimated 5 % moisture		27,973
After peeling (25 % recovery) at estimated 6 % moisture		25,417
Grading - initial quality satisfactory satisfactory after recovery unsatisfactory, discarded after recovery		14,378 2,010 (9,029)
Final product (16 3 % recovery)		16,388
Sales - exports - local sales	16,039 349	16,388

Standard of final product export sales as follows

	% of total	
- Wholes white	32 18	
- Scorched wholes	4 03	Total wholes 36 21 %
- White splits	23 12	
- Scorched splits	3 33	Total scorched 12 17 %
- White pieces	32 53	
- Scorched pieces	4 81	
	100 00	

The recovery rate (16 3%) at final product and a low % whole kernels (36 20%) was significantly influenced by the high volume of damaged kernels, mainly caused by the insect pest - *Leptoglossus sp* 35 5% of the kernel ex - peeling had to be discarded

If a good control of this pest can be achieved it would be reasonable to expect no more than say 5% of kernel to be discarded because of damage In the event this is achieved, we could expect final recovery rates to reach 24% and the proportion of whole kernel be 50%

Conclusions

1 The current cost of processing at CORALAMA (US$ 408/MT raw nuts) is quite high by international standards The reasons for this appear to be as follows

- high proportion of waste product

- labour costs for cashew processing in El Salvador (US$ 3 00 to 3 50) are in the medium/high range in relative terms in comparison to some other processing countries (Mozambique US$ 1 00/day, India, Indonesia, US$1 50 - US$2 00/day)

E3 Processing Trials

Trial No 1 - Processing of 110 lbs of Crop from Monte Cristo				
after shelling analysis	Shellwholes Brokens Defectives Error (loss)	lbs 70 50 26 10 6 25 5 45 1 70 110 00		
after drying and peeling	White wholes Scorched wholes Wholes (hard to peel) Wholes (after recovery)	10 60 1 50 1 30 1 12	14 52 lbs	56 6 % of total kernel
	White splits Scorched splits White pieces Scorched pieces	3 95 0 85 5 67 0 66 25 65		23 7 % recovery

Conclusions on Trial

1 The quality of the crop has a significant influence on the quality of the final product The Monte Cristo crop has significantly less insect damage than the CORALAMA crop The processed kernel shows much lower discarded kernel (4 9%) compared to 35 5% with CORALAMA crop, and as a result, there is significantly improved recovery rates (23 7% from 16 3%) and proportion of whole kernel (56 6% from 36 2%)

Trial No 2 from Monte Cristo with crop graded into 3 grades			
		lbs	
After shelling	Large size nuts wholes Brokens	2 00 0 35	85 1 %
	Medium wholes brokens	14 35 5 25	73 2 %
	Small wholes brokens total kernel	7 55 4 05 33 55	65 1 %
	Kernel Shells Defective raw nuts Total nuts processed	33 55 73 50 5 25 112 35	29 95 % recovery

after drying (moisture removal)	weight before drying (lbs)	weight after drying (lbs)	difference (lbs)
large grade	2 35	2 65	error
medium	19 60	18 35	minus 6 3 %
small	11 60	10 90	minus 6 3 %

Conclusions

1 The factory has no laboratory or any monitoring equipment This experiment has demonstrated that the drying process currently being carried out (4 hours at 80 degrees C) removes about 6% of moisture in the kernel

Trial No 3 with Crop from Monte Cristo		
Before steam process	**Weight of sample after steam process**	**3 days after steam (just prior to shelling)**
100 lbs	106 5 lbs	100 5 lbs
Control	+ 6 5% moisture	+0 5% moisture

This experiment was undertaken (in conjunction with No 2) to determine the moisture content at different stages of the process line This data together with the consultant's estimates are as follows

Raw nut from store	after steam	prior shelling	prior drying	after drying	final product
10%**	16 5%	10 5%	10 5%	4 5%	6 0%**

** denotes consultant's estimate

Conclusions

1 The data above appears to confirm that the factory is (more or less) achieving the correct moisture levels at the critical points of the processing function (in out of drying) by good use of trial and error techniques

F Processing Options

The available options of processing cashew can be broadly classified into the following

1 Manual or semi manual methods

2 Mechanical

F1 Manual and Semi - Manual Systems

The manual processing systems were first devised in India and consisted of a pre-conditioning process followed by hand shelling using the traditional wooden mallet for shelling Other countries following the manual processing approach have followed the Indian model but have used semi manual shellers in place of the Indian wooden hand tools

There are three approaches to the pre - conditioning process and each system has its adherents

(a) Drum roasting (unsophisticated, cheap, and can give good results but cannot collect CNSL by this method as roasting process burns off CNSL)

(b) Hot oil bath (suitable for larger scale operations, CNSL collected as part of process

(c) Steam cooking (growing in popularity as it can give higher percentage of white kernels, possible risk of CNSL contamination of kernel if insufficient care taken) CNSL can be collected if spent shells

The semi - manual shelling machines used are either hand or foot pedal operated and rely on the skill of the operator for good results Productivity in shelling (2 people per machine) is about standard in all countries at 90 to 100 Kg/machine per day raw nuts

Comment

Manual systems can give good results depending on the worker skills and quality of the crop In contrast, the mechanical systems are less dependent on individual worker skills and more dependent on the quality of crop processed i e including efficient grading, etc

F2 Mechanical Processing

Mechanical processing essentially is the mechanisation of the pre-conditioning, shelling and drying process For pre-conditioning the hot oil bath and dry roasting are used while shelling is achieved with either a centrifugal system or by use of cutting blades The peeling and grading can also be mechanised to some degree, however, most operators believe that manual methods at this stage are more cost efficient

All manufacturers can supply a fully integrated system including necessary laboratory and final product packing equipment and the emphasis is to improve worker comfort and safety by isolating the dirty and dangerous functions away from worker contact

The following mechanical processing systems are identified and examined

Oltremare

Sturtevant Lodge

Natural Resources Institute (NRI)

Modular Dry Roast (MDR)

F2a Background Information on Manufacturers

(a) Oltremare

Oltremare is a private Italian company based near Bologna, Italy, that specialises in engineering design Oltremare designed and constructed its first cashew processing factory in 1964 in Tanzania Since the 1960's the company has installed perhaps up to twenty factories around the world with the greatest concentration being during the 1970's when eight factories were installed in Tanzania Other factories were installed in Mozambique, Nigeria, Togo, Ivory Coast, Kenya, Madagascar and Venezuela The factories installed range in size (processing capacity of raw nuts) from 400 mt to about 15,000 mt p a

The company has installed very few factories in the past five to eight years in keeping with the slow down in the trade It is not known how many of the Oltremare factories are operational today, as political and other difficulties has effected cashew production and processing in a number of countries

The central core of the Oltremare system is their precision blade shelling machines Over the years they have developed this from a manual operated to an automatic system In good operating conditions (crop quality and mechanical), this system can give very good results

Oltremare can provide all equipment for a fully equipped factory, as well as establishment support

(b) Sturtevant Lodge

In 1969 the Tropical Products Institute (TPI) was a UK government research institute that designed a prototype processing plant In the late 1970s this design was taken over by the UK company Sturtevant Engineering - later to become Peabody Sturtevant In 1993 Peabody Sturtevant sold the design to another company, Lodge Sturtevant of Birmingham UK

The central core of this system was the centrifugal shelling technique which was designed to suit African conditions (simplicity of operation and low maintenance)

This design of factory was first installed in Kenya in 1971 and since that time has installed up to about twenty plants around the world, mainly during the 1970's (including Mozambique 8, Thailand 2, Indonesia 2, Thailand 2 Nigeria, China and Uganda) The Sturtevant system is designed in modules of 1,250 mt

(MK300), and larger capacity plants are multiples of the modules (The Angoche factory in Mozambique was installed with a capacity of 35,000 mt in 1972)

The Sturtevant centrifugal shelling design appears to have been copied (and probably modified) by the Brazilians in the construction of a number of their factories The company has installed few factories in the past few years (in keeping with the general slow down in the trade)

Mr John Vine - the General Manager for processing, with 20 years experience with the Sturtevant system- retired from the company in 1992 This left a large gap in Peabody Sturtevant's 's capability and combined with the world wide slow down in sales contributed to the sale of the business to Lodge Sturtevant Mr Graham Pye (of Lodge Sturtevant) advised the consultant in January 1997 that his company was "currently not actively pursuing sales at this time"

(c) N R I (Natural Resources Institute of UK)

Natural Resources Institute is the successor to the TPI - the organisation that developed the original Sturtevant centrifugal shelling system, government research institute that was previously associated with the UK Overseas Development Aid As from 1st May 1996, the ownership of NRI was transferred to the University of Greenwich The NRI system essentially involves using the original decorticator design developed by the Tropical Products Institute in 1969 (later Sturtevant), with a dry roasting pre-conditioning stage in place of the previous hot oil bath

The perceived advantages of dry roasting is to increase the potential for white kernel The disadvantage is that CNSL is not collected (it would be possible to substitute a hot oil bath for the dry roaster within the whole NRI factory if the customer required it)

NRI previously installed a (prototype) plant in Zambia about five years ago with a processing capacity of about 150 kg/hour raw nuts or 750 mt p a (2 shifts 300 days) Since the installation of the Zambia factory NRI have designed decorticators with capacity of 250 kg/raw nuts per hour The items of equipment for the factory are designed to fit into 20 ft containers for ease of transport

NRI claim they can supply a fully equipped factory together with establishment support under contract However, they have lost most of their key technical personnel over the past year or so as a result of their corporate changes, and the consultant believes this will affect their ability to service their clients

This current lack of technical background would affect NRI's capacity to provide a good service to clients

(d) Modular Dry Roast (MDR)

MDR is a private company in UK set up by (Mr B Nicholls) the engineer who was involved in the design of the original Sturtevant system commencing in 1967 and was Chief of Mechanical of Engineering at NRI from 1975 to 1990 In 1990, Mr Nicholls set up his own company (MDR) to further develop the NRI system which by then was out of patent

MDR follows the basic NRI dry roasting system, but has modified the centrifugal sheller with a variable speed system for improved performance In addition, a kernel conditioning system has been designed to follow the drying process to facilitate better peeling

The basic production line design is centred around a 250 kg per hour decorticator This is designed to operate up to a practical maximum of 20hours per day for 300 days p a , giving a maximum capacity of 1,500 MT pa of raw nuts Other tasks like peeling and grading can be run on single shifts as long as sufficient labour is applied

The MDR systems is also designed to fit into 20 ft containers for ease of transport

The factory in Zambia could be taken as a reliable guide as it can be considered as an earlier version of the current MDR model

(e) Other Systems

The Swiss company Buhler Miag installed two factories in Indonesia in the 1980's using their unique freezing and shelling technique This company had little success and recently sold their cashew processing business to Oltremare The Cashew Company of Japan has apparently done no business since the installation of their three factories in Tanzania in the mid 1980's

Both the Buhler and Japanese systems can be disregarded in this exercise

G Choice of Mechanical Processing System

The following is a comparative analysis of the four mechanical systems that are available to CORALAMA and the other cooperatives

Oltremare
Sturtevant Lodge
NRI
MDR

G1 Comparison of Work Stages

Of the four systems under comparison Oltremare and Sturtevant Lodge use hot oil bath but NRI and MDR use dry roasting Apart from the difference in pre-conditioning all systems have similar work stages

(a) Cleaning and Calibration

After receiving raw nuts in the warehouse all systems clean and grade nuts prior to humidification Oltremare grades into 3 grades, the others into 4 grades For Sturtevant Lodge, NRI and MDR each of the 4 grades is handled separately through the humidification, roasting and shelling process Oltremare uses 3 grades up to roasting but has a further calibration into 8 grades prior to shelling

(b) Humidification (To facilitate efficient roasting without damage)

This involves the gradual raising of humidity of the raw nuts from about 14% to 16% usually accomplished by regular spraying of water on raw nuts for periods up to 3 days

(c) Roasting (To condition raw nuts for shelling)

Oltremare and Sturtevant Lodge roast raw nuts in bath of CNSL at 185 to 190 degrees C for about 15 minutes This action conditions the raw nuts and also extracts CNSL, usually giving a yield of about 8% of raw nut weight NRI and MDR pass the raw nuts through a hot air chamber where the majority of the CNSL in the raw nuts is burned off The time in the chamber is brief (2 minutes of so) but the actual time /temperature regime is held as a confidential by the manufacturers

(d) Further Calibration (Only Oltremare)

Oltremare require a further calibration from 4 grades to 8 grades (sometimes more) to prepare for shelling process

(e) Shelling

Oltremare uses a method of mechanical cutting blades that attempt a precise fit on the nut using opposite curved blades to grip and cut the nut In this system the blades must be adjusted for each grade of nut being processed The earlier Oltremare shelling machines were either manual or semi manual which involved hand loading of the shellers Recently have introduced an automatic shelling where the shelling system is automatically fed by a hopper loaded with nuts

Sturtevant Lodge uses a centrifugal sheller that involves nuts in a revolving drum being thrown against a screen at a pre-determined speed The drum is estimated to revolve at 400 to 600 revolutions depending on grade of nut being processed NRI and MDR use a similar system to Sturtevant Lodge but they have made modifications which they hold as confidential MDR in particular stress that their variable speed gear/box allows very precise settings applicable for shelling

(f) Separation (To ensure separation of kernel and shell)

All systems use similar methods of cyclones, aspirators and vibrating tables to do main separation Some manual separation is used to back up mechanical system

(g) Drying

All systems use similar drying methods where kernels are dried usually at 80 degrees C for varying periods (6-18 hours) depending on conditions The objective is to reduce moisture levels to between 4% to 5% to assist stretching and breaking of testa to aid peeling Systems in use vary from batch dryers in trays to rotating drums

MDR use rotating drum for drying and this is followed by kernel conditioning unit where cooler air is passed over kernels to further assist testa removal

(h) Peeling

All manufacturers can supply mechanical peeling machines to peel whole kernel While these machines can reduce the requirement for labour by about 50% they also increase the proportion of broken grades by 5% Most factories believe that mechanical peeling is not cost effective and prefer hand peeling - and the industry standard for hand peeling is 1 4 kg/kernel per hour

(i) Grading

All manufacturers can use vibrating table sorters especially for broken grades however hand grading is still predominant for whole grades In larger factories especially

in Brazil electronic colour sorters are used to separate white, scorched and dessert grades The scale of the grading function depends on the number of grades being selected

(j) Packing

The traditional method of packing is 25 lb tins after gassing with carbon dioxide This is now being replaced with the vacuum packing in laminated aluminum or polyetene

G2 Advantages and Disadvantages of different systems

The comparison can be made in the following categories

operating efficiency
labour requirement
cost and complexity of operation
support services
purchase cost

G2a Operating efficiency

The main differences between the systems lies in the pre-conditioning and shelling tasks

Oltremare and Sturtevant Lodge use hot oil bath pre-conditioning while NRI and MDR use dry roasting The advantage of dry roasting is the automatic collection of CNSL(about 8% of nut weight) while the dry roasting burns off the CNSL While the collection of CNSL does give revenue, it is very small in relation to the kernel value (less that 1%) so its loss in the dry roasting is not a major disadvantage

The obvious advantage of dry roasting is that it gives a much smaller proportion scorched kernel of 4%-5% compared to the 8% -10% of the hot oil bath method The proponents of dry roasting also claim that it assists more efficient shelling

The main differences lie in the *shelling* method The Oltremare system operates on the principle of fine tolerances in being able to first grade and then shell individual nuts To achieve this, the system grades crop (8 grades minimum) by length of nut - each grade is then channeled to a cutting machine which has blades set at required limits to grip, cut and finally twist off the shell To achieve this, the nuts are moved individually on a continuous conveyor with necks to hold each nut and this moves parallel to the cutting blades

The Oltremare system can give good results in terms of whole kernel if the factors of nut size and grading exactly matches the pre-set tolerances of the cutting blades Here the only variable that cannot be predicted and allowed for is differences in the thickness of the shell of individual nuts However if any of the above factors are not well calculated then the results can be very variable

Oltremare has recently introduced an automatic shelling machine which would be offered to El Salvador The consultant is unaware where this machine is currently operating He visited a processing factory in Macata in Mozambique in July 1996 where the automatic system was supposed to be in operation However it appeared to have been removed before his arrival

Sturtevant Lodge, NRI and MDR use a centrifugal shelling system where nuts of similar grade (3-4 grades) are fed into a revolving drum (400-600 rpm) and then released at a screen with sufficient force to crack open the shell The grade of nut determines the forces used in the process The Sturtevant system is largely unchanged since the 1970's however NRI and especially MDR have continued to refine the centrifugal system MDR now use a variable speed gear/box to allow a more precise settings to suit small variations in impact

On balance, the conclusion is that Oltremare could achieve a higher % of whole kernel (5%) over the centrifugal systems if all the conditions of crop quality precise grading and if equipment is well calibrated and cuttings blades are in good working order However, in practice in the field all these conditions are not achieved very frequently

G2b Labour requirements

There is little difference between the systems in labour requirement assuming that Oltremare is using its automatic shelling system If the Oltremare semi auto or manual system is used then their requirement is much higher

The following is an estimate of labour requirement by function by 8 hour shift for a factory of 1,200 MT capacity The actual requirement may vary due to a number of factors including labour efficiency and the configuration of the factory

Task	Workers
nut grading and loading	3
roasting	1
shelling	2-3
peeling	35-40
grading	6-10
packing	2
other duties (including humidification, drying, etc)	4
	53-62

The big difference between the mechanical systems and the same mechanical system currently used by CORALAMA is the substitution of capital for labour in all processing up to peeling Overall it uses about 50% less labour than the semi mechanical system

G2c Cost and Complexity of Operation

The Oltremare system is the most complicated and expensive system in operation largely because of the nature of their shelling machine Advise to the consultant from engineers who have worked with these factories in Mozambique and elsewhere indicate that the repairs and maintenance may be double or more in comparison to the centrifugal systems The complexity of these machines in areas (especially in Africa) where the capacity to make timely maintenance of equipment has on a number of occasions led to these factories working well below their theoretical potential

In comparison, the Sturtevant Lodge shelling system in many countries is acknowledged as being simple and cheap to operate NRI and MDR have taken the simplicity factor one step further by designing the equipment to fit in a shipping container, the objective being to provide a processing service that can operate in a low technology environment in an African village

G2d Support Services

Sturtevant Lodge took over the cashew processing business from Peabody Sturtevant recently on the retirement of Mr John Vine - the previous MD of Peabody's cashew business Mr Graham Pye of Sturtevant Lodge advised the consultant that his company was not going to put much effort into the cashew processing business apart from servicing existing clients In this light one must question Sturtevant Lodge's capacity and interest

NRI lost the majority of their senior designers and technical staff when the organization was privatised in 1995 While NRI has expressed an interest in new business the consultant is doubious that the organisation has sufficient remaining expertise to give good after sales backup

MDR is run by Mr Bill Nichols, the previous chief designer of NRL While his track record in independent business is relatively short the consultant believes he has the necessary interest and capacity to give the required support

G2e Purchase Cost Estimates

For 1,200 MT capacity processing factory (capacity for two 8 hour shifts) estimate will include all equipment and required laboratory instruments but will not include simple furniture, i e tables, chair, etc

	Purchase cost	Shipping	Installation	Commissioning	Total
	(all costs in US$ quotes in pounds sterling converted at a rate of US$ 1 6)				
Oltremare	600 000+	30 000	15,000	10 000	655 000+
Sturtevant Lodge	800,000	30 000	10,000	10 000	850,000
NRI	704,000	26,000	10,000	10 000	750,000
MDR	430 000	26 000	10 000	10 000	476 000

The time period between order with manufacturer and installation and normal operation of factory will be up to 12 months as follows

Manufacture of plant to order	6 months
Shipping	2-3 months
Installation	1 month
Commissioning	1 month

H Conclusions And Recommendations

H1 Brief Background Summary

CORALAMA has 800 hectares (1,200 manzanas) of cashew trees, all mature trees in excess of 28 years old About 400 hectares of trees are planted on flat land adjacent to the processing factory and the other 400 hectares are located on hilly land which is more difficult to manage CORALAMA achieved organic crop status in 1996 and the crop was about 500 MT of raw nuts The other cooperatives will all achieve organic status by 1999

The other cooperatives have a total of 531 hectares of cashew trees ranging in age from 4 to 12 years old Half these trees grow on flat or semi-flat land and the rest of hilly land The current crop from these sites is only 43 MT The total crop from all sites will rise to 1,000 MT within five years Currently the application of compost is used to supply nutrition to the trees

The growing conditions for cashew are not ideal on any of the sites Cashew planted on flat or semi flat land are easy to manage, but those planted on hillsides are more expensive While temperature regimes are excellent, soil conditions are generally sub-optimal and there is a potential problem to the crop from early rains at all sites However despite these limitations the crop potential appears to be reasonable

All cashew trees planted at all sites are seedling trees As cashew is a hetrogenious tree seedlings will demonstrate a wide variation in performance The only method of ensuring a 'trueness to type' is to use vegetative propagation and plant (grafted trees) All trees were originally planted on dense spacing - in the mature plantations there is now overcrowding which has a deleterious impact on the crop

The major plantation problem is unidentified insect pests assumed to be Leptoglossus *sp* Elsewhere this insect is not normally regarded as a pest of cashew but in El Salvador it appears to have transferred to cashew from its normal host crop of maize and sorghum Leptoglossus feeds on developing nuts and causes a huge loss especially by the downgrading of the value of kernel during processing The current methods to control Leptoglossus and other pests involve the spraying of neem via aerial application

The processing factory uses a conventional steam pre-conditioning with semi manual shelling This system is similar to that used in a number of countries The

factory has the potential processing capacity of about 800 MT raw nuts p a , however there are two bottlenecks that severely reduce this capacity

The shortage of storage space for raw crop and a shortage of labour for shelling operations limited the volume processed in 1996 to only 100 MT raw nuts The balance of the 1996 crop (423 MT) was sold to an Indian trader for US$ 680 per MT The inability to process more of the 1996 crop was a significant loss of potential revenue

CORALAMA currently makes no commercial use of the cashew apple The apple processing machines still located in the factory appear to be non-operational There does not appear to be a demand for cashew apple juice (or other products) in El Salvador Ports West International have an interest in the potential for organic vitamin A, but at this time we have on information on the required technology to extract the vitamin A Assuming the apples are collected only from the cashew planted on flat land near the factory - then the potential crop is estimated to be up to 1,000 MT

Marketing - CORALAMA sold their total volume of processed organic white kernel (14 MT) to Ports West International - 14 MT kernel in 1996 Ports West are their only buyer of organic product and they currently pay a premium of 50 % above the conventional market The scorched grades (2 MT) were sold to markets in Costa Rica for lower prices

The premium prices for organic cashew are expected to fall to 20 % above conventional prices within two years or so

H2 Critical Issues

H2a Organic Cashew Market

CORALAMA has recently entered the organic cashew market and as virtually the first supplier to the North American market it is currently receiving a 50 % premium over world prices for product delivered to its only customer- Ports West International CORALAMA probably has only a window of opportunity of perhaps two years to establish a significant presence in the organic cashew market There is significant potential competition from Brazil emerging in response to the high prices being offered for organic product that has approved certification It is very likely that the price premiums for organic product will be reduced to perhaps 10 % to 20 % over world prices within a few years The major

European importers of organic product are already talking of price premiums of 20 %

H2b CORALAMA's Current Performance

CORALAMA's performance based on its handing of the 1996 crop was not good Its revenue was an estimated 9 84 colones per kg of raw nut (produced, processed and sold as final product) and this was 20 % more than its total cost of production at about 8 colones per kg raw nut processing cost 3 55 colones/kg, production 3 38 colones/kg and estimated administration 1 0 colones/kg

This apparent reasonable result was entirely dependent on the high prices (50 % premium) paid by Ports West International for the organic kernel In the event that the price for organic cashew falls to a premium of 20 % and if no operational improvements are made then CORALAMA's business will not be profitable as its cost of production will be virtually equal to the revenue (8 0 colones/kg raw nut)

H2c A Market Opportunity

The combined cashew crop of CORALAMA and the other five cooperatives will increase from the current level of about 500 MT raw nuts to about 1,200 MT in the next five years In addition, if adequate processing capacity and markets are organised a further 200 MT of organic crop can be purchased from surrounding producers The processing and sale of this total volume of crop on the organic market would give a gross revenue of about US$ 1 7 million (assuming a 20% premium for organic kernels)

H2d Plantation Productivity

The state of the plantations and the management exercised by the cooperatives are below levels that can be reasonably achieved Most of the cashew trees have not had adequate attention and the cooperatives lack the expertise to make the necessary technological improvements In the short term the potential exists to make productivity improvements to improve yields and especially crop quality by improved management, nutrition and pest control Pest control measures cost more than 50 % of production expenses and pest damage alone is responsible for a 35 % crop loss In addition, we have little, insuficient information about the pest and the effectiveness of current control measures

In the longer term significant productivity improvements (perhaps 100 %) can be obtained from a genetic renewal of the plantations by 'top working' with superior new varieties We should be able to identify these superior types from within the current plantation population

H2e Factors Inhibiting Factory Performance

The processing factory is operating well below its potential and the main factors inhibiting performance are

- Processing capacity of the factory The processing factory has a theoretical capacity to process about 800 MT of raw nuts p a based on current work practices at the cooperative (11 day fortnight) However, in 1996 the factory only managed to process 100 MT while a further 423 MT of raw nuts was sold to India
- Poor quality of the raw crop that is causing an enormous loss in final product Some 35 % of final product was discarded because of damage that occurred in the plantation By far the major cause of this damage is by unidentified insect pests currently assumed to be Leptoglossus sp or similar insect

H2f Processing Capacity of Factory

The factory in its current configuration has a theoretical (mechanical) capacity to process about 800 MT of raw nuts p a based on the accepted work timetables at the cooperative of 242 work days p a (one shift and 11 day fortnights) This capacity is sufficient to easily handle the current crop (500 MT)

However the real capacity is very much lower because of

- A shortage of labour willing to operate the shelling machines During 1996 there was sufficient labour to operate usually only 17 - 18 of the 40 installed shelling machines This bottleneck reduces the annual processing capacity to 370 MT p a Shelling with a semi- manual machine is a dirty and slightly dangerous job - and clearly at current wage rates there is a problem in getting sufficient labour There is no information as to how much wages would have to be increased in order to acquire a further 44 women to operate all the shelling machines The factory management believed that a significant wage increase might be required and if this was

done it would (probably) have to be passed on to the rest of the workforce and it would be an irrevocable action

- Shortage of storage space for raw crop The total storage capacity is only 90 MT Some raw crop could be stored in the factory but this may also impede normal factory operations (In 1996 only 100 MT of raw nuts was processed while 423 MT was exported to India as raw nuts The consultant was informed that this was because raw nuts were stored inside the factory and processing operations could not commence until the sale to India was completed)

Because of the two factors above, the actual factory processing capacity is probably less than 200 MT - less than the current crop and very far short of the potential 1,200 to 1,400 MT crop that could be available within five years

H2g Solutions to Processing Problem

The two problems requiring a solution are

1 The provision of sufficient storage space for raw crop

2 A cost efficient processing system that can meet both the short term (2 years) and long term (5 years +) requirements In the short term the cooperatives have perhaps only two years to firmly establish themselves in the organic market before competition increases

For the longer term (5 years +) it must have the capacity to handle the crop in year 2001 The total cashew crop is going to increase from 500 MT to perhaps 1,200 to 1,400 MT within five years The inability to process and market this volume to the organic market would be a huge loss of potential

(a) A Cost Efficient Processing System

There are two alternative approaches

(a) Modify Existing Factory

A total of 72 shelling machines and 144 operators would be required to give an annual processing capacity of 1,700 MT Currently the factory cannot find more than 36 shelling machine operators at current wage levels

(b) Purchase Integrated mechanical factory

The recommended type is the MDR dry roasting system that has a shelling capacity of 1,200 MT based on two shifts and 300 working days The mechanical factory effectively mechanises the pre-conditioning and shelling process which require minimal labour thus allowing easy two shift operation while the peeling and grading functions remain largely manual and can operate on one shift The lead time from ordering, manufacture, installation and full operation could be one year

The choice between the options can be examined according to the following criteria

- Unit cost of processing
- Unit value of final product
- Impact on worker safety and health
- Comparison of practicality of proposal

The following table shows comparisons of unit costs of processing and unit value of final product

Estimated Cost of Processing - Colones per Kg Raw Nut (based on data for 1996 crop processed by CORALAMA)			
			Colones/kg
1	Existing factory	- in current configuration	3 55
2	MDR factory	- 12 % interest charge purchase cost - operating at 50 % capacity (500 MT)	3 66
3	MDR factory	- 12 % interest charge purchase price - operating at 100 % capacity (1,000 MT)	3 16

Estimated Cost of Processing - Colones per Kg Raw Nut (based on data for 1996 crop processed by CORALAMA)			
4	Existing factory	- with 10 % wage increase - with 20 % wage increase	3 84 4 14
5	Existing factory	- with 5 % more whole kernel	3 03
6	Existing factory	- with 5 % more whole kernel - with 0 5 % higher recovery rate	 2 77
7	MDR factory	- no interest charge - operating at 100 % capacity	 2 67

Note The above calculations do not take into account the cost of improvements to the existing factory (i e more shelling machines laboratory etc) which would be relatively small The MDR is the recommended type - discussion on the available systems is in this report section G

The above scenarios look at following situations

1 Scenarios Nos 1 to 3 compare existing system with new factory at 12 % interest to reflect cost of purchase and installation

2 Scenario No 4 shows impact of having to increase wage rates to encourage more shelling labour

3 Scenario No 5 and 6 shows impact of existing factory obtaining better final product results than new mechanised factory If the semi-mechanical factory is well run it may get slightly better final product results than a mechanical factory with a standard quality of raw crop

4 Scenario No 7 shows potential of new factory without interest cost and working at full capacity

Comparisons on Worker Health and Safety Shelling using the semi - manual machines remains a dirty and dangerous job In the integrated factory 'dirty' operations like pre-conditioning (dry roasting) and shelling are undertaken mechanically without any worker contact with the crop

Comparisons of Practicality of Proposal to continue using the existing processing methods one must be certain that sufficient additional labour can be hired for shelling operations at acceptable wage rates Wages in cashew processing in El Salvador are already relatively high by world standards - further increases will only their reduce competitive position

H2h Quality of Raw Crop

The quality of the raw crop has an overwhelming influence on the quality (value) of the final product after processing The quality of the crop being processed by the factory is poor - 7 % of the crop is rejected during initial drying and a further 35 % is rejected during processing

The symptoms of crop damage are diseased nuts, nuts attacked by insects, blank or nuts with shrivelled kernel While there is a variety of reasons for this poor quality the damage caused by unidentified insect pests (assumed to Leptoglossus) is by far the most important These insects cause damage by injecting toxins into the developing nut while feeding and this becomes apparent later during processing as black spots which, if significant, are unacceptable to the trade The loss comes from extensively damaged kernel that is discarded or from the kernel that is broken while attempts are made for rehabilitation

The initial insect damage may also be a conduit for the spread of the disease anthracnose which also have an impact on crop quality

The current insect pest control measures do not appear successful for reasons that are not clear This could be because the material used (Neem) or the application method (aerial) is not effective or because the insects re-infest from alternative host plants (maize, sorghum etc)

H2i Marketing Plan

CORALAMA is too small a processor and its volumes too low to have any worthwhile prospects in the conventional market of exporting kernel to the major markets i e USA, etc In this market it would be necessary for a processor to sufficient capacity to supply a buyer on a regular basis with a significant volume - say one container per month with one or mixed grades To do this the processor needs to be processing a minimum of 2,500 MT raw nuts p a

In the organic market which is very new and still developing, CORALAMA's size is not a critical disadvantage However, they have only one marketing outlet for their organic product - Ports West International While the relationship appears good it still leaves CORALAMA in a very exposed position

in the (probably unlikely) event that Ports West ceases its purchasing for whatever reason

It would be marketing security for CORALAMA to diversify its customers over time - but it must have product to sell before it can do this It would be a major mistake to organise customers and then not be able to make delivery

H3 Recommendations

The recommendations are as follows

H3a Plantation

For Immediate Benefit

1 Tree spacing

Crecer has already started a program of tree thinning to eliminate overcrowding This program must be continued and expanded to the other sites as practical

2 Entomology

This work is of great importance because pest control measures are over 50 % of plantation production costs and insect damage is causing a 35 % loss of crop during processing

This is a major program of work and results will be achieved faster if two graduate students under supervision were engaged for a period up to two years The work should be split as follows First student concentrate on task (b), Bio-Ecology Study, while second student works on other tasks (c) ,(d) and (e) Task (a) identification should be undertaken by supervisor with aid of students for collection work

(a) positive identification of major pest species This may involve sending collected samples to world class authority for positive identification

(b) Bio-ecology study of insects (major pests and beneficials including major pollinators) Study of feeding habits and life cycles of the important species

(c) Determine efficacy of neem against identified major insect pest species Laboratory trials to be later confirmed in the field

(d) Determine effectiveness of aerial spraying techniques, canopy penetration, etc Trials using dyes can give visual demonstration of the cover achieved by the spray These trials will require cooperation of spray contractor to determine what variation can be given by the spray pattern (size of droplets, etc)

(e) Evaluate alternative organic compounds (pyrethrum etc) for efficacy against major pests The consultant will seek advice from relevant sources overseas and provide a list of potential compounds to be tried

If the insect damage cycle includes alternative host plants like maize sorghum, etc which are grown in close proximity to the cashew then they may need to be considered part of the study area

Task (b) is a major piece of work and to get worthwhile results may involve one student under supervision for one to two years This work requires significant time on site as well as laboratory facilities when required The second student could be continuing on with the other tasks at the same time

A program of work and budget needs to be worked out for the tasks outlined above The consultant suggests that Mr Leopoldo Serrano, entomology taxonomist at Department of Plant Protection at the National University (San Salvador) as supervisor, be engaged to undertake part (a) as soon as possible

The determination of the staffing of the rest of the program can be decided when an assessment is made of the available technical resources (domestic and foreign)

3 Nutrition

Nutrition program can be in two stages

- Initial complete screening Collect soil and leaf samples from CORALAMA and other major cashew sites (San Ramon, Chilanguera, Maquigua) and send to competent laboratory for nutritional analysis Analysis results to be examined by nutritional expert with experience of cashew for nutritional recommendations

In addition, a soil profile test (if possible to 3 meters) should be undertaken at CORALAMA on the preferred cashew areas This is to give an accurate reading of the soil structure

- Follow up analysis Leaf samples collected from major sites once a year (after harvest) and sent for analysis

The initial soil and leaf nutritional analysis is to determine if there are any significant deficiencies according to the accepted nutritional standards for cashew (see annex) This will allow adjustments to be made to the compost contents if necessary

If there are deficiencies in micro-nutrients then aerial application can be arranged (at same time as insect control measures) If these aerial applications are made, it will be necessary to check OCIA requirements before hand

The annual leaf analysis will allow a regular monitoring of the nutritional status If appropriate the consultant can organise on behalf of CRECER the instructions for the collections of the samples and both the analysis of the samples in Australia and the required nutritional expert opinion

4 Recording Relevant Data

A small weather station should be set up at CORALAMA for the recording of the following data rainfall, temperature (absolute maximum and minimum) humidity and pan evaporation At the other major sites (Chilanguera, San Ramon and Maquigua) only rainfall needs to be recorded (Following initiatives from CRECER, the cooperatives are organising to start keeping records)

For Longer Term Benefit

1 Genetic Improvement

Employment of appropriate qualified student for minimum period of two years to commence the genetic improvement work under supervision The objectives of this program are as follows

- To rehabilitate (using the top working technique) all the old trees in the plantation over a period of time - say ten years It will probably be sensible to limit this program to the trees currently growing on more accessible land
- To provide supplies of superior grafted trees to cooperatives (San Ramon) that have vacant land and may wish to make new plantings of cashew
- To provide training for cooperative staff to learn nursery operations and grafting techniques

The practical steps required in this work program are as follows

Period of work	Task
Prior to 1997 harvest	Screening of all apparently superior trees to identify perhaps 50 of best types according to historical information on performance Marking of trees for easy identification
	arrangements for complete security and collection of crop
1997 harvest	collect crop and tree analysis data [items 1, 5-7 see below**]
After 1997 harvest	samples of nuts analysed for nut quality [items 2-4 see below**]
Mid 1997	set up nursery and plant seed as rootstock for 1998 grafting program
Nov 1997/ Jan 1998	grafting of selected types in nursery
1998 harvest	collect data from same trees [items 1,7 see below**] and any new trees identified as superior

After 1998 harvest	repeat crop analysis [items 2-4 see below**]
	plant 5 replicates of selected mother trees in budwood area

** Crop and tree analysis data

1 *Total yield* (kgs raw nuts)

2 *Average nut size* (gms), weigh sample of 100 nuts

3 *Average kernel weight* (gms) without testa from 100 nut sample

4 *Recovery %* calculation proportion item 3 is of item 2

5 *Tree shape,* is either upright habit, spreading or medium

6 *Time of harvest*, early or late crop - month harvest matures

7 *Visual report* extent of pest or anthracnose damage

After two years of data it may be appropriate to plant more replicates in the budwood area to save time in building up supplies of potential scion wood The decision as to when to start using a new variety is a compromise between time and certainty On balance the consultant suggests that three years data should be a reasonable time to proceed with a new variety

H3b Processing Factory

In making recommendations for processing the consultant believes that the *actions should be appropriate to solve the problems for the next five years*

The key issues that dictate the scope of proposed plans are

- CORALAMA only has a couple of years to re-organise and increase its processing and production of organic cashew to the maximum potential or it may lose its place in the market to emerging competition
- Within five years CORALAMA must be able to handle the expected total crop of about 1,200 MT
- Consideration must be given to worker health and safety

The specific recommendations are as follows

1 Drying and Inspection of Crop

Construction of concrete floor area for drying of raw crop in the sun Concrete area should be of sufficient size to handle a minimum of three days harvesting

2 Facilities for Storage of Raw Crop

Construction of storage facilities of sufficient size to handle entire crop (about 500 MT) Current storage facilities (outside factory) only sufficient for 90 MT Storage facility must be weather proof building with concrete floor

3 Raw Crop Storage Methods

All crop to be stored in 50 kg hessian bags

4 Make order for MDR dry roasting factory with 250 kg per hour decorticator

The advantages for this selection are

- Factory will give adequate processing capacity for longer term Decorticator (shelling) and dry roasting system designed to operate up to 20 hours/day 300 days p a , with minimum labour giving capacity of 1 500 MT raw nuts p a Peeling and other functions can work one shift
- Factory comes fully equipped with all necessary equipment including laboratory
- Prototype factory of this type in Zambia gave good processing performance
- System was designed to be simple and cheap to operate, thus suitable for remote areas Factory is designed to fit in two shipping containers for easy transport
- Factory is safe and clean for workers

The lead time from ordering to installation and full operational status could be up to one year as factories are only build to order As part of the contractual arrangement, the factory designer, Mr W Nichols, must be asked to be present in El Salvador for the commissioning process

The total cost of purchase, shipping, and commissioning of the factory and staff training is likely to be about US$470,000, although a firm final quote is required from the manufacturer

5 Existing Factory Operation

The existing factory needs to continue operation to handle the 1997 crop Efforts should be made to allow it to process if possible the whole of the crop which is expected to be say 600 MT.

If there is adequate storage space for the raw crop outside the factory then there is no reason why the factory cannot operate all 12 months

To process an expected crop of 600 MT will require 52 shelling workers (using 26 machines) to work for 250 days

There are enough machines available (40), but an extra 16 workers are required The consultant cannot comment how difficult it will be to attach this number but perhaps a limited form of higher wages could be offered This would be unlikely to set a precedent for long as the shelling work would be eliminated within one year

There are a number of suggestions from the consultant to make the current factory work better (i e grade nuts, adjunct cutter blades on shellers, monitor moisture levels to assist drying, change steaming time, etc) However, it is doubtful if all these changes could be implemented in the short term due to worker resistance, and also one must question the spending of funds on a system that is to superseded

6 Factory Cleanliness and code of work

The consultant observed standards in the factory that would be below the best practise as used elsewhere These standards are consistent

regardless of the type of processing factory used The specific points of interest are

- All workers in peeling, grading, etc , who have any contact with the final product should be wearing appropriate clothes for workers who are involved in the food industry This would include head gear to keep hair under control The workers need to have adequate facilities for washing hands, etc
- Control of people and animals entering factory As a food factory there has to control on who and what goes in and out and what they do In many good factories there is restricted access on all exits so this can be monitored (The consultant was advised that a pig entered the factory unchallenged at one stage)
- General cleanliness including floors, walls, etc It has to be of a standard that potential customers (entering what is a food factory) are not discouraged by what they see In the cashew industry the buyers will want to see from where they are getting their product
- Final product security The theft or eating of kernel by workers is a world wide problem Many factories search the workers on exit from factory

It is recommended that the above points be considered in the new processing arrangements for the factory

7 Worker health and Safety

The major health and safety issue in the current factory concerns the shelling workers currently using the semi-manual shelling machines The nature of the task means that they are at some risk from injury from the cutting blades and from accidental contact with CNSL

These workers currently use vegetable oil on their hands and arms for protection against CNSL which is an accepted practice in other countries, (the use of gloves is resisted by many workers as they find them an encumberance) They do not wear any facial protection against CNSL which they would probably resist as being uncomfortable

The consultant is not aware of any simple mechanical modification that could be made on the existing shelling machines that can eliminate the risk of

injury from the cutting blades Any assistance on this matter could come more from a qualitative angle as follows

- Care in the selection and employment of workers Workers who are learning the required skills are especially at risk
- Job sharing between the two women on the one machine - they can take turns at shelling and separation to avoid fatigue This would not be a financial problem as the two workers share their combined output, (the consultant was advised that the workers were not enthusiastic about job sharing)

The grading of raw nuts would make their job easier - but there are other constraints on this alternative (worker resistance and the fact that the volumes of individual grades vary significantly)

In the proposed MDR factory there is no direct contact between workers and raw crop during the roasting and shelling tasks as these processes are totally enclosed The MDR factory also uses enclosed ducts and extractors to ensure that the workers are operating in a fume free and dust free environment, (the other mechanical processing systems indicated in this report also generally meet these criteria)

The consultant believes that the only way of ensuring that all factory workers operate in a cleaner and safer situation is to change the mode of processing as recommended in this report

H3c Marketing of Kernel

The cooperatives need to balance three objectives in marketing their organic crop

1 The initiatives by Ports West International have been responsible for the market opportunities for CORALAMA Ports West wishes to buy as much of the crop as possible in the future

2 There should be a balance of customers so as not to be totally reliant on one market

3 New markets can only be developed with an assured supply

Initiatives by the consultant during his visit identified two potential new customers - (Jorgenson Waring Foods and Michael Waring Trading) both of whom have expressed initial interest for about 10 to 15 MT p a Another potential customer identified by NCBA (Once Again Nut-Butter Nunda) has expressed an interest for 35 MT Together with Ports West the potential market could be about 100 MT of final product or about 500 MT of raw nuts processed

The following marketing policy is recommended

- No commitments to be given to three new markets until there are firm plans regarding the processing of the 1997 crop At this stage efforts could be restricted to sending of samples and exchange of information (The worst crime in marketing is to commit to the customer and then be unable to supply)
- There is probably no need to identify further potential customers as the three indicated above have more than enough potential to handle the supply in the next 2 to 3 years
- Efforts should be made to begin supplying these customers before their interest wanes It may require some decisions of rationing supply to Ports West if new markets are to be developed

H3d Cashew Apple

There appears to be little opportunity for developing cashew apple products at this stage There is little interest at this time from commercial juice manufacturers in El Salvador for supplies of cashew apple juice as a bulk product Ports West have expressed an interest in organic vitamin A Apparently there may be a significant market for this product, but at this stage there is no information as to the technology required to process the apples and isolate the vitamin A Ports West is continuing to pursue this option and for the moment it could be left to Nick Orton at Ports West to investigate further

H3e Management of Project

It is recommended that the consultant returns to El Salvador about November/December 1997 for the following purposes

(a) To assist in the development of the genetic improvement program including,

- Reviewing of data of selected trees
- Development of nursery and budwood area
- Commencement of grafting program
- Provide training programs as required

(b) Review entomology and nutrition programs

(c) Involvement in other programs as required, including further developments in cashew processing and cashew apples

The consultant is also strongly of the opinion that the cooperatives need a competent business manager to take charge of their developing cashew interests This business is rapidly increasing in complexity with a requirement of specialist knowledge in different areas, and there will also be need to have a system that can make decisions in a reasonably short time frame

ANNEX A

MDR PROCESSING FACTORY DETAILS

ANNEX A
MDR PROCESSING FACTORY DETAILS

1 Mdr Processing Factory Details

Based on the Zambia Cashew Company processing factory

This factory was installed by NRI in mid 1980's at Mongu in Zambia as a prototype factory to test processing systems Initially using a hot oil bath pre-conditioning it was found to be performing below expectations - when later changed to a dry roasting system results were considerably better

The factory design capacity was 125 kg of raw nuts per hour through the shelling system and the total volumes being processed was about 1,200 MI per annun

The following are details of a processing run of one day's production of 500 Kg of raw nuts

1 RAW CROP	500 0 KG raw nuts		
2 SHELLING	149 0 kg kernel	(29 8 % shelling)	
	comprising following grades		
	123 3 kg wholes	24 8 kg broken	0 9 kg diseased
	(82 8 %)	(16 6 %)	(0 6 %)
3 DRYING	148 0 kg kernel in to drier		
	136 1 kernel out of drier		
	(8 1 % moisture loss)		

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4 PEELING 136 1 kg of kernel for peeling

7 3 kg wholes	39 6 kg broken	11 6 kg peels	11 2 kg reject
(51 1%)	(29 0%)	(8 3%	(8 5 %)

Note - reject kernels include following -

- 3 5 kg unpeelable kernel
- 4 3 kg diseased kernel
- 3 4 kg crumbs/dust

Comments

The following are the key results in comparison with existing systems

Existing Systems	Zambia	CORALAMA crop	Montecristo crop
Shelling percentage of final marketable product	22 6%	16 3%	23 7%
Percentage whole kernel of final product	59 1%	36 2%	56 6%
Percentage white wholes	38 6%	32 1%	41 3%
Percentage scorched kernel	7 0%	12 1%	11 7%

Points to consider

1 The above simple analysis compares data from the Zambia factory with the CORALAMA factory processing both it's own crop and crop from Monte Cristo Some caution must be used in making comparisons between the factories in Zambia and El Salvador because of a number of difference in such matters as crop factors and handling and classification of final product (i e CORALAMA factory makes a great effort in trying to rehabilitate insect damaged kernel at the cost of damage in the factory In contrast, the Zambia factory would sell these kernels as dessert grade)

2 The CORALAMA crop results are poor for crop quality reasons which are well defined in this report The data from Monte Cristo may give a better indication of what is possible from the existing factory with reasonable crop quality

3 The Zambia factory details are indicative only as they are dated and it must be noted that further improvements have since been made to that system by MDR The new MDR factory can be expected to give better results

Conclusions

1 Assuming a standard crop quality (say Monte Cristo type) it should be possible to achieve results from a new MDR factory at a minimum similar to that currently achievable with the current semi-mechanical system

2 The benefits of the new mechanical system include

- Potentially lower unit cost processing
- Adequate processing capacity for longer term
- Safe and clean working environment

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ANNEX B

CONSULTANT TERMS OF REFERENCE

ANNEX B

CONSULTANT TERMS OF REFERENCE

ORGANIC CASHEW PROCESSING CONSULTANCY, CORALAMA COOPERATIVE, SAN MIGUEL, EL SALVADOR

DUTIES

1 Evaluate current processing factory, equipment and systems in terms of both cost/efficiency and worker sanitation Give details on alternative processing systems for processing of kernel and CNSL in terms of

- Advantages/disadvantages of alternative systems
- Costs of installation and costs and returns of operation
- Likely processing efficiency to be achieved
- Implications for worker sanitation

If alternative processing system to be recommended give justification of choice in terms of plant design, capacity, costs, worker sanitation and overall contribution to profitability

2 Examine current cashew production methods in the field, including post harvest treatment of crop from the field to the factory Where practical make recommendations on improved practices so as to facilitate

- increased crop productivity
- better processing efficiency

3 Make a business plan for the Cooperative's processing business that incorporates the following points

(a) a brief report on the world cashew market outlining demand, supply factors and expected prices so as to give the background for the future conduct of the business

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(b) a recommended plan for following

- Production improvements and post harvest treatment of crop
- System for processing of kernel and CNSL commercial use of cashew apple
- Marketing of kernel and CNSL

(c) A financial analysis of the recommended plan giving overall costs and returns

4 Evaluate options regarding commercial utilization of cashew apple This includes the following

- Identifying potential products and markets
- Costs and returns of production and marketing of identified selected product

5 Examine the cooperative's current marketing arrangements for kernel and CNSL If applicable make recommendations for improved practices and/or returns

REPORT

The consultant shall submit a completed report and corresponding annexes in English and Spanish prior to leaving El Salvador He is permitted to make minor edits and to submit a final version within two weeks of returning to Australia

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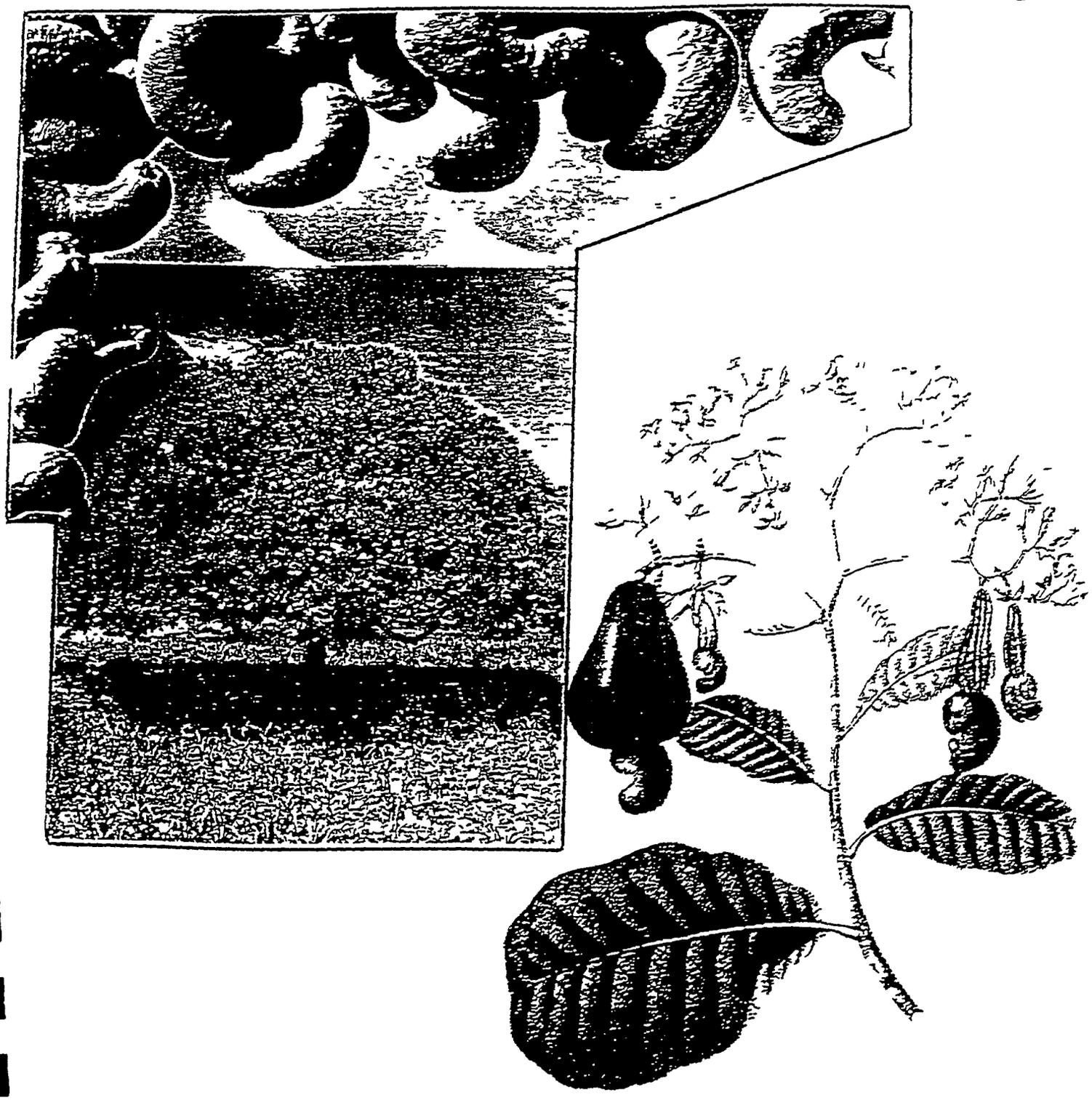
mechanical system for cashew nut processing



SPECIFICATION
OF
250kgs PER HOUR CASHEW PROCESSING PLANT

Introduction

The process system employed is en-masse decortication using a centrifugal cracker, this concept is well tried and proven in some sixty installations worldwide The major advantage of this method is the ability to process all sizes of nuts including small grades which cutters cannot accommodate

Dry roasting of nuts before cracking further enhances the performance of the plant by providing pretreated nuts in a condition which allows impact opening to be achieved at maximum efficiency

Kernel recovery, wholes in can and CNSL contamination are on a par with all existing systems Whilst cost levels equipment items cannot be equaled in the market at the current time

Overall the proposal offers significant advantages in three major areas costs, and the level of service inputs and operator skills required

Plant Capacity

Rated capacity is 250kgs per hour raw cashew nuts

2 tones per day on a single shift basis (500 tonnes per year)

4 tonnes per day on a double shift basis (1000 tonnes per year)

The module design features employed allows installations to be provided in multiples of 1000 tonnes

Equipment layout is shown on Drawing No NE01 The following item descriptions should be read in conjunction with this drawing

Raw Nut Cleaning and Void Removal

Cleaning table provided to allow initial cleaning of nuts and the removal of stones and other foreign matter Void nuts are also extracted at this stage

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Size Grading

Three section grading drum together with feed hopper and conveyor is provided to sort nuts into four size grades Graded nuts are held in storage hoppers built into the grading facility, this allows direct loading into the humidification bins

Humidification Facility

This provides the treatment essential to elevate the kernel moisture content to the correct level to allow the nut roasting stage to be carried out without scorching the kernel The system uses unit load bins and a water spray gantry with controlled water delivery system The loading station with hoist and conveyor allows direct feed to the roaster

Dry Roasting Facility

Fully automatic hot air roasting chamber incorporating nut feed and fuel hoppers with high performance variable speed drives to feed augers to give essential control for feed rates The rotating hot air chamber incorporates special design features which ensure that all surfaces of the nuts are uniformly treated The speed of rotation is set and controlled precisely to achieve consistent results for all size grades Low levels of scorched nuts in the output stream confirm the efficiency of this treatment method

All roaster parts subjected to elevated temperatures are fabricated from the appropriate grade of stainless steel Temperature monitoring and controls systems are provided to allow operatives to maintain treatment parameters at the correct levels with ease for all nut grades

The outlet from the roaster is via a water quench station which is self-contained, requiring supply of cold water Pipework and tank arrangements ensure that consumption of water is kept to a minimum The unit is complete with all duct work and hoods ensuring that the environment in the process area is fume free This system of nut treatment before decortication does not extract CNSL

Air Conveyor

A self-contained air flow system carries roasted nuts from the roaster to the decorticator The system is designed to deliver nuts at a constant rate via ducts and exhaust/delivery cowls

Centrifugal Decorticator

The sectioned impeller with multiple target plates is designed to optimise impact forces The main mounting for the impeller is a low profile anti-friction bearing This gives a low headroom arrangement which reduces product travel and minimises building height Drive is provided by a variable speed gearbox to allow settings within narrow tolerances to suit the small variations of impacts needed for graded nuts The decortication chamber is totally enclosed, this enclosure incorporates manifolds for char-dust extraction ensuring that kernels are dust free when exiting decorticator

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Dust and Detritus Extract System

A positive pressure close circuit extract system is provided to remove the char-dust and light fraction shell produced during decortication This system also removes the bottom screenings from the classification deck so that waste materials do not encroach on the process area

Product Classification Screens

The three deck reciprocating unit is mounted directly beneath the decorticator outlet This separates the product into the essential streams for processing Decks are powered by an eccentric drive system imparting the necessary action for effective classification of product flow and delivering fractions to the appropriate exit point Decks are attached to the main frame rubber by insert suspension units The overall design provides a low noise, durable facility for continuous shift working

Re-circulation air conveyor

A close circuit air conveyor is provided to route stream of un-decorticated nuts back to cracker This allows rapid transit of the product in a closed environment

Shell/Kernel Air Separators

The kernel/shell mixture from the classification screens is delivered to twin air separators, these are calibrated to achieve almost total recovery of the kernel fraction present

The design and operation of this type of unit is well known and proven throughout the cashew industry The controls, setup facilities and access for servicing are such that all aspects can be addressed without difficulty Kernel fraction is discharged on to short flat belt conveyors to allow removal of occasional unshelled nuts and shell debris The main kernel stream is fed to the drier via a spiroflight conveyor

Kernel Drier

This consists of a stainless steel flighted rotating drum, indirectly heated via shell a fired furnace and heat exchanger The air stream is applied to kernels by a central tube The gentle rotating action together with the warm air Stream combine to allow release of testa during the drying cycle Precise control of drying time and temperature is provided by facilities built into the unit

Kernel Conditioner

Testa release is further enhanced by passing warm kernels from the drier through a low temperature conditioning tunnel, reducing the amount of hand peeling required

Final Peeling, Grading and Sorting of Kernel

Main conveyor with necessary sections and bins provided Tables, chairs, containers, tools etc , to be provided by client

Laboratory Equipment

Equipment for quality control and assessment of feed stock and final product parameters is provided under this contract

Outline Kernel Recovery Figures (Based on average quality nuts FAQ)

Kernel weight recovered as a percentage of whole nut weight	24% - 32%
Whole kernels recovered as a percentage of kernel recovery figure given above	74% - 85%
NB This figure is taken at the exit of the air separators before hand peeling is carried out	
Expected percentage of whole kernels peeled and packed	63% - 75%

Typical Labour Requirements (on a per shift basis)

FACTORY MANAGER	- 1 -	Overall responsibility for factory operations
PLANT SUPERVISOR	- 2 -	Control of kernel extraction process through to the kernel peeling stage Some equipment service experience essential
NUT GRADING & LOADING	- 3 -	Grade feed stock and load roaster throughout shift
ROAST OPERATOR	- 1 -	Controls roasting operations throughout shift
GENERAL PLANT OPERATIVES	- 4 -	One trained to assist roaster operator others deployed on plant duties in the processing area
TOTAL	- 11 -	For the decortication stage
KERNEL PEELING & GRADING	30	Number depends on skill levels developed and method finally adopted for peeling
PACKING & FINISHING	8	
TOTAL	49	

Does not include drivers and loaders for raw material and final product handling and distribution

Services

ELECTRIC POWER	20 Kw (Process plant only)
WATER	3000 Litres per day

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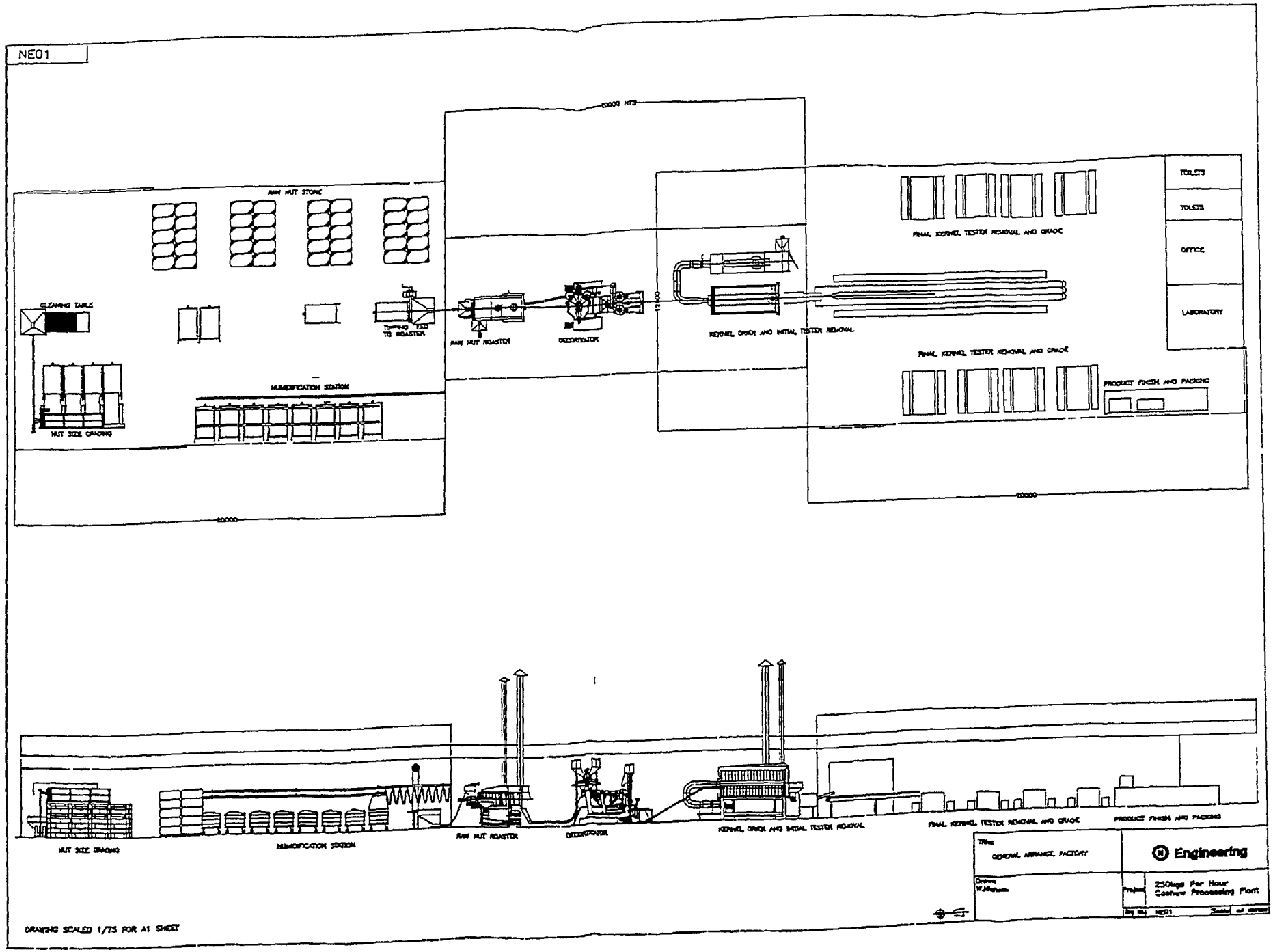

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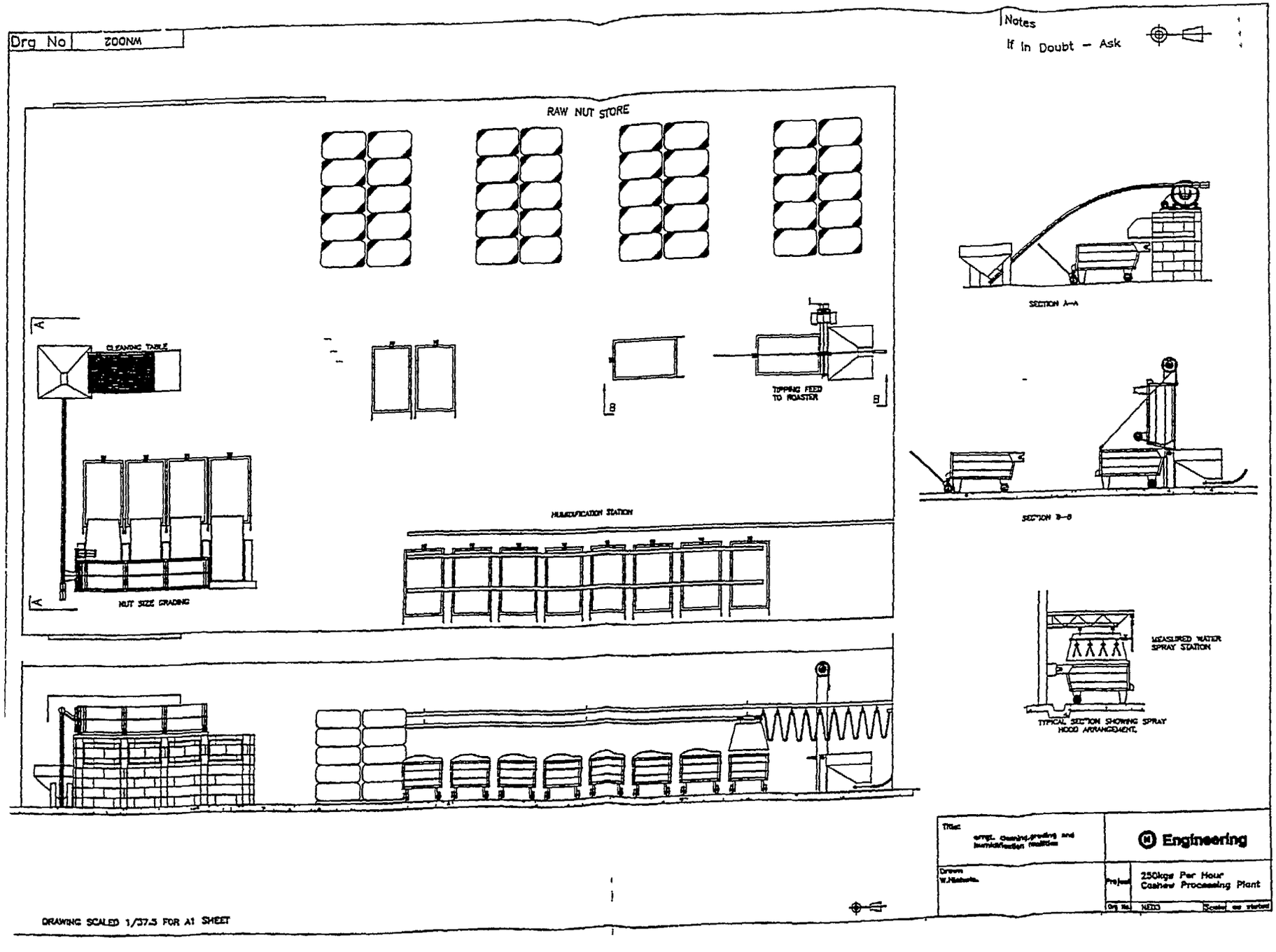

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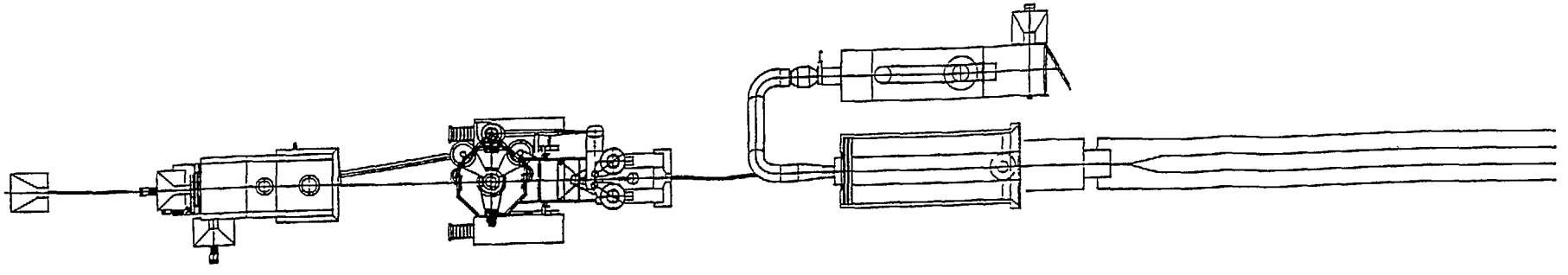
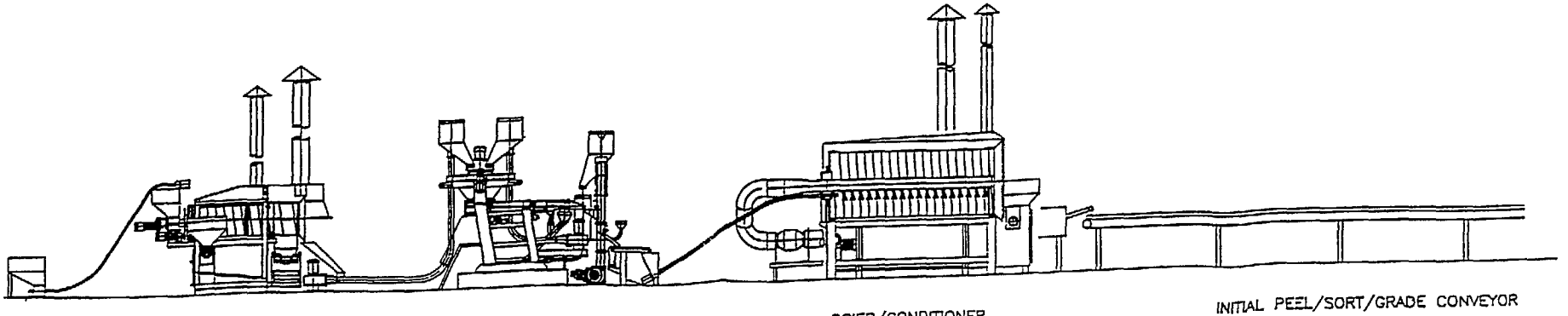
Drg No | NE02

Notes

If In Doubt – Ask

DWG. SCALED 1/27.3 FOR 1 SHEET





Title: arrgt. decortication and drying facilities	Engineering
Drawn: W.Mitchell.	Project: 250kgs Per Hour Cashew Processing Plant
	Drg. No: NE02 Scale: as stated