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D02307

United Nations Industrial Development Organization

Distr. LIMITED

ID/WG.88/4
10 February 1971

ORIGINAL: ENGLISH

Expert group meeting on processing
selected tropical fruits and vegetables
for export to premium markets

Salvador, Bahia, Brazil, 25 - 29 October 1971

CASHEW NUT GROWING, PROCESSING AND MARKETING WITH PARTICULAR REFERENCE TO BRAZIL [1]

by

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id.71-787

Distr. LIMITED
ID/WG.88/4/Corr.1
4 May 1971
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Corrigendum

Page 13, section (c):

Change heading to read: "Cashew Co. Ltd., Tokio, Japan"

Page 13, section (c), line 4:

Insert after: "The machinery is supplied from Japan"

the phrase: "by the Cashew Co. Ltd. of Tokio"

id.71-2615

C O N T E N T S

CULTIVATION OF CASHEW NUTS

1. The development of large scale plantations in Brasil

In North-Eastern Brazil, above all in the States of Ceará, Pernambuco, Piaui, Maranhao, Paraiba, Bahia, the cashew nut tree grows wild on a coastal belt of 80/100 kms and mostly on a sandy soil at the surface (0.80/1m.) and clayey in depth. The rainy season in that region usually lasts from January to July and when the rains are over the cashew nut tree starts to blossom and then bears fruit beginning from the month of October. Therefore the harvesting period is the driest period of the year and this gives a great advantage to the nuts which tend to be of very high quality owing to the very low moisture content as they fall on the soil which for its nature, being near the sea-side (and then getting the breeze from the sea), and without any rainfall for over three months, is absolutely dry.

The Federal Government - conscious of the increasing importance of the cashew nut tree - grants loans and fiscal facilities to the growers of cashew nuts in the North-East of Brazil through the SUDENE, a governmental body which coordinates and plans public and private investments. All this has encouraged the development of some large scale plantations to which mostly is due the increase of the production in the last few years.

The development of large scale plantations is, however, still limited so that sometimes the processing centres are not able to get all the raw material they need. It is therefore of utmost importance to favour the establishment of large scale plantations, as they represent an indispensable condition for the creation of processing factories. In fact, it is not possible to create new processing factories without one's own production as the lack of raw material would cause serious economic disadvantages. Besides, if one wants to get a high production of good quality, only with commercially organised large scale plantations it is possible to face the agronomic problems of the cultivation of the cashew.
As stated by Lefebvre, the fact that the cashew nut tree adapts itself rather well to various places and needs little human care, has been too often exaggerated. The cashew tree, for example, may also grow in unfavourable conditions, but its growth is extremely slow so that its bearing - if nothing happens to the growing - may even take place only at its 20th year. The cashew nut tree endures fire better than other trees. However, the cashew burns and when it happens it does not produce, and even for the following years the production still is lower than what it should be. On the other hand it is absolutely untrue that the cashew does not need any human care. Young trees must be kept free of grass and weeds by regular weeding to prevent potential damages due to fire. In the initial growth stages - the first two-three years - the practice of inter-cropping the cashew with soya beans, groundnuts, peas or even maize should be encouraged. Equally, an accurate prospection of the soil conditions

should be done. Also there is evidence that, in spite of an extensive root system, the cashew tree may suffer considerably from lack of water. The young trees need water (approximately 10 liters) once every two days in the first months, and then once every four days in the following months. Other necessary practices are: spacing, disinfestation against attack by insect pest, and diseases; seed selection; foliar analysis, etc.

No small-holdings of trees in individual ownership is able to face the technical problems of the cultivation, nor to sustain the economic risks of a tree which begins to produce after three years and gives economic results only in the fifth year.

Finally, in Brazil the establishment of rational large scale plantations is more necessary than in other countries because in this country the cashew apple - which detached from the tree lasts only 24 hours - is used on a large scale in making jams, juices and alcoholic drinks.

The cashew cultivation must therefore be carried out just as if it were a real orchard. Only in this way a high production with good quality may be obtained.

2. <u>Orientation lines to promote the development of cashew plantations in the North East of Brazil</u>

<u>Land</u>
Although cashew has been reported to thrive well even in waste lands it is considered that soil type is the more important limiting factor for production. In fact, in severe cases death may occur if the tree is planted on extremely poor soil. Generally, cashew thrives well where the soils are sandy loam or red soils which are sufficiently fertile and which are well drained. Heavy loams and clays are unsuitable.

When buying land for the planting of cashew, care should be taken not of buying land with a high percentage of shallow soils. Particularly in a region of low rainfall, the limiting factor in the production of cashew nuts may be water holding capacity of the soil and consequently also the totally available soil volume for each tree.

<u>Water requirements</u>
A continuous supply of water is required during the first stages of plantation and in order to face severe drought periods. Therefore, when establishing a plantation, the following possibilities for water supply must be investigated:

a) the possibilities of using sub-soil water;
b) to establish the plantation as close as possible to a river.

Spacing

A spacing of roughly 10 metres (100 trees per ha.) is recommended in Brazil. Using this space - even if the trees have reached maturity - the branches do not touch each other which enables every tree to breath, to absorb dampness and to blossom in perfect conditions. Besides, it is easily possibile to maintain free the ground amid the trees using tractors and agricultural machines, and, at the harvesting period, the trucks can follow the workers which pick the cashew apples and carry them immediately to the juice-factory.

At the initial stage of the cultivation a close spacing of 6 m.x 6 m. amid the tree may also be done on condition that later on this spacing is gradually converted to 10 m. or 12m. by thinning out the population from 320 to 100/80 trees.
Of course, the planting of more trees per ha. and the later removal of these trees involve extra costs which should be compensated by the increases in yield and factory output. At present, however, unsufficient data on climate and soil fertility are available in Brazil to be able to make reliable estimates on yields in relation with plant density and fertiliser applications. Trials made in some areas of North-Eastern Brazil seem to indicate that a system of densely planting and thinning out later gives the highest net income per ha. Thus it seems to be justified to plant at an initial spacing of 320 trees per ha. However, further trials should be made to provide necessary information for possible future plantations.

The cost of thinning out will depend on the adopted work. As densely planting will be relatively more advantageous when individual costs per tree are lowest a cheap method of eliminating the superfluous trees should be adopted. The use of a chemical tree killer might provide good results and this method should be tried out on trees of similar age as soon as possible.

The great advantage of a high number of trees per ha. at the initial stage of the cultivation - besides an eventual profit raise in the field - is the increase in supply of raw material to the factory, which means an earlier start of the processing operation, an earlier reaching of its maximum capacity and consequently a more economic use of the factory.

Yields

The yield of cashew trees depends on several factors such as age, soil type, rainfall, insect pest attack. Yields, on the other hand , vary considerably from plantation to plantation and from tree to tree. Also in Brazil cashew starts bearing in the third year. It is however only in the sixth/seventh year that the average yield of nuts per tree reaches 7/10 kg. The yield of varieties planted in Brazil is therefore about 700/1.000 kg/ha. and a good average is about 800 kg/ha. Economic yields are produced in the fifth year and the tree is in full bearing by the eigth to the tenth year depending on the soils, climatic conditions and appropriate care.

Varieties and Propagation

At present in Brazil distinction is made only between two varieties : those which when budding have new light-red or dark pink leaves and those which on the contrary get green leaves at once; the former get green in a few weeks. Besides, even in the apples there are some varieties with the typical light-green colour and others with the pink colour.

In Brazil there seems to be ample scope to increase the yields by improving the selection of high yielding trees. Experiments carried out in India show that for an hectare of mature trees, well managed and planted with 300 trees, it is possible to obtain a yearly average yield of 20,000 kgs. and 4,500 kgs. of nuts. Once high yielding trees have been determinated, there is the problem of propagating them. Cashew is a cross-pollinated crop and seeds from individual trees are heterozygous. The obvious method of disseminating the characteristics of a high yielding tree would therefore be by vegetative propagation. Buddings, cuttings and graftings as methods of vegetative propagation have been tried in East Africa and India but without much success. As stated by P. Westergaard and M. Kayumbo, the air-layering method of vegetative propagation is the only method which has given success. Air-layering, however, is a laborious and expensive method of propagation unsuitable for farmers who live in villages scattered over a wide area with no roads. In Mozambique, therefore, patch-budding has been recommended to farmers as a more suitable method of propagation of cashew (Gaz. Agric. Mozambique, 1966, Vol. 18). In any case, the adoption of a vegetative propagation method, either air-layering or budding, ensures uniformity in produce. With regard to size of nuts this is an advantage as machine decorticating is geared to size and shape of the nuts.

Selection

An excellent quality of cashew nut is produced in Brazil. The nuts are large, round and very sound. The percentag of impurities and of rotten nuts is only 2.5/3%. The Brazilian nuts are generally larger in size than those of other producing countries. They are, however, less homogeneous. In fact, in the Brazilian commercial classification the produced kernels are classified into five classes: extra-jumbo; jumbo; large; standard; small.

This considerable heterogeneity is due not only to the ecological factors of the various regions, but also to an hereditary difference, especially because the Brazilian nuts still grow mainly wild, while in other countries - as in East Africa and in India - this plant was introduced by men, especially by the Portugueses.

A methodical and careful seed selection appears indispensable to improve the nuts regarding their weight, shape and yields in kernels and, therefore to supply with a homogeneous product the processing industry. In fact, besides the requirement above mentioned of a regular supply of nuts to the factory for their mechanical processing, the homogeneity of nuts becomes a main factor both for the industry and for a successful plantation scheme.

Pruning

The mature trees grow up to 8-10 metres in Brazil. In a plantation, however, one must avoid the trees to reach this height by pruning them at 3-5 metres high in order to increase the yield and to make the harvesting easier. In fact, by cutting the main trunk of a mature tree new branches sprout on the residual fragment and the tree, having deep roots and less branches to feed, gives a higher yield.

Fertilising

Fertiliser trials should be carried out in the different age-groups of cashew trees obtained when buying the land, and in the new plantation, in order to obtain a maximum of information as soon as possible. A soil fertility experiment in pots with a certain species of grass as an indicator crop should also be tried. Additional experiments in pots should also be carried out in order to observe the deficiency symptoms in the cashew plant.

Foliar analysis should also be executed, thus providing a more complete information on the cashew's reaction to malnutrition which may be of great value in future determination of the plantation's fertiliser requirements. It is also recommended to execute some simple fertilizer trials on groups of seedlings, especially if the young seedlings show some undulation of the leaves and some discolouration which might be due to a nutritional deficiency.

Adequate fencing

All the pieces of land planted with cashew nut trees must be adequately fenced in order to defend the young trees from cattle grazing in the plantation , as cattle is very greedy of the cashew leaves.

Fire Protection

Fire protection is indispensable in Brazil where bush fires are frequent owing to pronounced dry season. A strip of about 10-15 m. wide around the plantation should be kept clean weeded.

Roads

The road communication system must be improved in Brazil, because it is a major obstacle to expanded supply for a fairly big crop.

Pest and Diseases

The cashew nut tree holds on well against insect pests and from experience the tree is not hit by cryptogamic diseases. However, the *Helopeltis antonii* in India, the *H. anacardii*, *H. schoutedeni* and *H. Bergrothi* in Africa, and the *Aleurodicus cocois* ("mosca branca") in Brazil cause severe damage to the crop.

The "môsca branca" appeared for the first time on the cashew in Brazil in 1958 in the State of Pernambuco. In 1960 the various "cajueiros" spread all along the coast were seriously threatened. From these "cajueiros" the "môsca branca" infestation spread into the ones inland passing rapidly from the State of Paraiba in the North to those of Alagoas and Sergipe in the South. In 1964 the "môsca branca" reached the utmost infestation in the first two States causing a loss in the production. In that year the "Instituto de Pesquisas Agronomicas", of Pernambuco in collaboration with the F.A.O. and the Commonwealth Institute of Biological Control of Trinidad, began a campaign based on the biological fight against the "mosca branca" succeeding in reducing considerably the damage of this insect. Recently another infestation due to an "Anthracnose" or die-back has appeared, especially in the State of Pernambuco.

Other important pests are the leaf miner Acrocercops syngramma and the leaf-eating caterpillar Oricula trifenestrata in India, the scale Pseudaonidia trilobitiformis in Kenya, and the apple-attacking beetle Macrodactylus pumilio in Brazil. Several minor diseases and pests are known but do not yet present a great danger.
Raw cashew nuts stored in sacks are also subject to infestation by insect pests.

PROCESSING OF CASHEW NUTS

3 - Hand Processing versus Mechanical Processing

Hand processing has the basic advantage of providing a large amount of employment which is particularly important in a country where unemployment is considerable. However, hand processing provides employment at wages which are usually very low, which is in contrast with the principle of creating an economic activity that gives a sufficient income to the workers in developing countries.

Mechanical processing provides less employment than hand processing, but still provides a substantial number of working posts and wages that are roughly twice as much as hand processing can afford. Mechanical processing has also several other advantages: it can be of substantial aid in the training and factory acclimatization of labor in a country where significant industrialisation is new; it pays the closest possible attention to all matters of hygiene (all the factory staff take showers every morning before working; the staff who comes into contact with the nuts are issued with clean suits of overall daily; factories are spacious and airy and well lit; floors are constantly swept and the machinery kept shining by a force of cleaners, etc); it gives a higher value added per hours of work than in hand processing (where, on the contrary, the value added remains low).

Hand processing has consistently failed in all countries except in India which has been able to supply the U.S. market regularly and considerably.
Hand processing has failed in Mozambique, in Tanzania and in Kenya respectively under conditions which were once more favourable than they are to-day. Particularly, the Kilifi operation in Kenya, despite skills inherited from three generations, despite pressure of unemployment, good incentive schemes, etc. has failed producing a kernel which was worth less than the raw material.

The success obtained by hand processing in India is due to an abundant supply of low cost, skilled labour and particularly to the fact that Indian workers are paid on a piece-rate for whole kernels only, while for the broken ones they are not paid at all. Hand processing elsewhere indicates that labor may work as fast as Indians, but is not so carefully done and thus produces more broken and scorched kernels obtaining therefore lower sale value per ton of nuts.

The processing carried out on village industry lines (equipping each village with a shelling machine which may give results as good as the Indian workers) is also misleading.

As stated by C. Parry in his F.A.O. study "such advice ignores the fact that factory organization is a necessity from a consideration of the basic shelling operation alone". "Because the shelling operation is highly machine intensive if it is to be done with as good results as in India, it means significant fixed plant investment and to justify its economic existence the machinery must be worked very intensively".

The development of cashew processing on cottage industry lines was tried in recent year in Mozambique, but had to be abandoned. A new experiment is now taking place in Tanzania, under the influence of the "Ujamaa villages" philosophy, but the prospects of village hand processing even in Tanzania are minimal. In fact, as already mentioned, hand processing has failed in Africa under conditions which were once more favourable than those now offered under "ujamaa village" processing.
The village hand processing technique is valid only to produce goods for local consumption, but not for organizing exports. The "ujamaa" village processing - carried out in Tanzania by "African Cashew Processors" - has to face several difficult problems (for example the difficulty of storing the nuts to be exported, the difficulty of overcoming the distances between the various collecting centers, etc.). In fact, the cashew processing is not an agricultural activity, but an industrial one.

4- Machine - aided Hand Processing

In Brazil the processing of cashew nuts makes use of simple mechanical aid, particularly of a shell cutting machine which the workwoman operates by hand and foot. But this machine aided hand processing technique is unsatisfactory. The result of the shelling and the eventual breakage of the kernels depends wholly on the sensitiveness of the woman's foot and on her experience. The workers are very skilled in the shelling operation, and many of them have been working for years with these machines. The percentage of whole kernels seems to be satisfactory. The best trained workers are able to shell up to 35-40 kg. per day. The result of this machine aided hand processing is, however, very poor as to the quality of the product. In fact, while the Brazilian raw material is excellent (the waste percentage being only 2.5/3%), a high percentage of the product obtained is of inferior quality.

When the nuts undergo the cutting all kernels which do not remain whole are at once contaminated in the sliding container placed under the blades which is full of CNSL and of shell-crumbs. Therefore this product is already spoiled and remains so till the end of the processing. Besides, the small shelling machine lasts for a short period and practically at the end of each month it must be repaired and many times it must be completely changed. Finally, the following steam-peeling over-heats the kernels and makes them considerably yellow. This is the reason why the Brazilian kernels are sold at a lower price in the U.S. market than the ones obtained by the African and Indian grades.

Brazil - which wisely forbids the export of the raw material, but paradoxically at the same time keeps its outdated processing methods - could on the contrary obtain outstanding results by improving radically the processing methods, especially by establishing modern factories, as already realized in East Africa (Mozambique and Tanzania), with mechanical systems. Besides, having an excellent raw material, Brazil has the richest home consumption market (not yet fully exploited) and in the U.S.A. the biggest growth potential market right on its doorstep.

5 - Mechanical Processing

Decortication - the core of a mechanical process - can be done after a "hot" or a "cold" conditioning of raw nuts.
As stated by J.G. Ohler, processing of the cashew nuts usually consists of cleaning, calibration and humidifying. followed by roasting in CNSL oil-bath, CNSL extraction and decortication.
After decortication, the shells are processed for extraction of residual CNSL, the kernels are dried, peeled, graded, sorted, re-humidified and packed.

Cleaning of the nuts consists of the removal of empty or deformed nuts and impurities such as small stones, pieces of wood, etc.

Calibration of the nuts is a very important part of the process. Nuts of different sizes cannot be roasted homogeneously, while grades for size are also determinative for the results of mechanized decortication.

Humidifying of the nuts is done for several purposes. The absorption of water by the shell facilitates the breakage of the cells and the extraction of the CNSL in the later process; the increased moisture content of the kernel protects it against ill effects during roasting of the nut and makes the kernel less frail which is important during the shelling process.

CNSL extraction is usually carried out by passing the nuts through an oil-bath of CNSL heated at about 200°C. In this way about 30% of the CNSL contained in the shell is released. The residual CNSL is extracted from the shells through a chemical process using a special solvent.
"Hot" process greatly favours the later task of extracting the kernel without breaking or damaging it, because the previous expulsion of CNSL causes a partial separation of the kernel from the outer shell to which in its normal state it adheres very closely.

An alternative system is the "cold process" in which no prior roasting of the nut in its own CNSL is involved. The raw nuts are conditioned by means of a steam autoclave. With a "cold" method, the process employed to extract the CNSL consists of cracking the shells obtained from the decortication. In this way about 80% of the CNSL is recovered. The "cold" process however involves the risk of contaminating a portion of the kernel by the raw CNSL.

Mechanized decortication processes can be divided into four main groups:

- decortication with machines provided with opposing curved blades which cut longitudinally the shells;
- decortication with machines consisting of a circular saw of a few very thin blades fitted closely together which cut a groove in the shell;
- decortication with machines using claws that tear up the shell and separate it from the kernel.
- decortication with centrifugal machines with target plates against which the nuts are thrown and shelled.

After the shelling stage the nuts undergo a serie of operations which separate the shells from the kernels. Then the major problem is the peeling, that is the elimination of the thin skin which covers the kernel. Peeling is done by drying the kernels in a drying room at 70°C. for 4-8 hours in a single layer on a metal tray. Then the peeling operation is fully done. The peeling process is either manual or mechanical (usir ; brushes or compressed air).

Grading and sorting of kernels by size and colour is done manually or mechanically. The kernels are graded for export according to certain recognised standards. The main groups into which the kernels are divided are :

- white wholes (divided into categories according to count, the counts being 200/210, 220/240, 300/320 and 400/440),
- butts (wholes with a small chip off the end missing),
- white splits (natural halves of the whole kernels),
- large pieces (over 0.6 cm.)
- small pieces (over 0.4 cm.)
- baby bits (less than 0.4 cm.)

and scorched grades showing some discoloration from the roasting process.

Wholes must be guaranteed to contain at least 90% whole nuts on arrival at their destination.
The white whole kernels must be white, integrally whole and free from spot, blemish or scorching. If they have a spot or blemish, they fall into the lower selling categories called "scorched" and "dessert" wholes.

Re-humidifying is necessary to prevent excessive breakage by handling and transport after peeling. The kernels are kept in a high humid room for a few hours until they have regained a moisture content of no more than 5%.

The final operation is the vacuum packing of the kernels into typical 25-pound tins of the kerosen tin type. To prevent deterioration the air in the tin is removed and may be replaced by CO_2. The tins are packed in carton cases, two in each case.

CNSL is transported in 200 l. drums or in bulk.

6 - Description of the basic mechanical systems

Seven distinct approaches to the mechanical processing of cashew nuts are in commercial scale use in East Africa. However, the mechanical systems used by "Socajù" and "Cajuca" in Mozambique are not economically viable even with further development work. The "Gill & Duffus" and the "Companhia de Culturas de Angoche" mechanical systems in Mozambique did not prove viable and are now substantially following the manual processing. The other three differ considerably from one another in methods of performing component elements of of the total process. The "Oltremare" and the "Sturtevant" are the only mechanical processing systems on sale to-day. The Mtwara Cashew Co.Ltd., based on a Japanese mechanical system, has still to prove its viability and in fact it seems that the Japanese are studying a new type of shelling machine to replace the one experimented at Mtwara.

a) - Oltremare S.p.A. - Bologna, Italy

Stated in simple terms this processing, fully described in Appendix A, is done by a first calibration for size, seasoning, and partial expulsion of the CNSL content; the nuts are then further calibrated, mechanically decorticated with machines provided with rotatory blades and the kernels are mechanically separated from their shells; after passing through drying chambers the kernels are mechanically air-peeled and the grading and sorting operations are also mechanically assisted. The product is gas packed in tin containers, the containers are packed two a carton and it is then ready for marketing.

The Oltremare SpA supplies the whole complex of mechanical devices matching and facilitating the work of the central shelling machines. A pilot plant is established at Zola Predosa (near Bologna, Italy), which enables Oltremare's engineers to maintain a continuous programme of research and development, and to demonstrate the process to visitors to Italy.

This mechanical system - which Oltremare can also supply to small sized factories (for example with a capacity of about 1,000 tons) - was adopted for the first time in 1965 by the "Tanita" plant, located in Dar es Salaam (Tanzania), which has an annual capacity of 9,000 tons of raw cashew nuts and which is now going to increase up to 12,000 tons per year.

In 1966, it was also adopted by the Mocita factory, located at Joao Belo (Mozambique), with an annual capacity of 12,000 tons.

In 1970, it was adopted by the Companhia do Cajù do Monapo,SARL, located at Monapo (Mozambique), with an annual capacity of 15,000 tons, and in 1971 another plant with an annual capacity of 15,000 tons (Industrias de Cajù Antenes Ltda, located in Antonio Enes, Mozambique) is going to begin its activity with the same "Oltremare" mechanical system.

The "Oltremare" system is the unique complete mechanical unit existing today on the market, as it includes all the processing stages from the cleaning of the raw material to the packing of the kernels. The Oltremare Company can even supply machines for the manufacturing of the typical 25-pounds tins.

In percentage terms the yield of the "Oltremare" system is the highest with respect to all other existing mechanical devices (90-95% of wholes at the decortication stage, 65-70% of whole kernels at the packing).

The shelling machines of "Oltremare" are manually fed; they could be mecanichally fed. However, in this latter case the percentage of wholes decreases of about 10%. Therefore, at present wages, a lower revenue does not reward the saving of manpower.
The shelling machines are very exact. Therefore they need a previous calibration which grades the nuts into eight different sizes. The product obtained is completely free from contamination of the CNSL.

The Oltremare Company continues to study the possibility of further improvements in the mechanical feeding in the shelling stage (so as to get the same economic results of the manual feeding) and in the peeling stage (so as to obtain completely peeled kernels, integrating the actual air-peeling system, which gives a yield of 85-90%).

b) Sturtevant

The Sturtevant plant, fully described in Appendix B, has been developed by the Tropical Products Institute of the British Ministry of Overseas Development. Sturtevant Engineering Co. is licensed to market and manufacture the plant with the full cooperation of the T.P.I. A production unit, with an annual capacity of 650 tons, has been established at Kilifi in Kenya since July 1969. A pilot plant is established at the T.P.I. Development Centre at Culham, England, which enables T.P.I. and Sturtevant engineers to maintain a continuous programme of research and development, and to demonstrate the process to visitors to the U.K. on request.

Stated in the simplest terms with this system the nuts are calibrated, humidified, passed to the roaster (that is a heated bath of CNSL). The nuts are then revolved in sawdust for absorbing the surface CNSL. The shelling is done by a centrifugal machine with target plates against which the nuts are thrown and shelled. The product falls into a perforated plate cone, which allows the detritus to fall through and be collected, while the kernels, broken shell and unshelled nuts are passed to a conveyor. The separation of the nuts from the shells is done by a pneumatic separator.

The "Sturtevant" system reaches only the stage of the shelling operation as it does not include any other mechanical device for necessary further operations (especially for the peeling of the kernels). The Sturtevant Engineering Co. only add that they can also offer means for drying the kernels and carrying out weighing, packing and sealing operations.

The elimination of CNSL with sawdust, after passing of the nuts in the reacter, and the further shelling through a rotatory cylinder which uses the centrifugal power to break the shells, leads to producing a product which is not clean and is contaminated by CNSL. This may cause serious difficulties for the sale of the product on the world markets.

The yield is rather low (75% of wholes at the decorticating stage, 50-55% of wholes at the packing) and therefore causes a substantial economic loss when we consider that the price of the "broken kernels" corresponds only to about 50% of the price of the wholes.

Finally, we note that the basic principle of this system has already been used on a large scale by several industries (particularly by the "Cajuca" in Mozambique since 1965), but in spite of the very favourable economic conditions (lower wages, low price of the raw material, etc.) existing in that country for the processing of the cashew nuts, the adoption of this system has failed for the above mentioned reasons.

c) - Mtwara Cashew Co. Ltd. Tokio

A production unit, originally planned for an annual capacity of 20,000 tons, has been established in 1958 in Mtwara, Tanzania. In 1968 and in 1969 respectively, however, only about 2,000 tons have been processed. The machinery is supplied from Japan and the project is being financed under the Yen Credit Agreement between Tanzania and Export-Import Bank of Japan.

By this system - which is the only "cold" method in operation to-day - the nuts are steamed in a boiler electrically heated for about half an hour. The steamed nuts are then dried and calibrated. Following calibration, the nuts are fed to automatic shelling machines each of them provided with a circular saw 3" in diameter consisting of three very thin blades fitted closely together which cut a groove in the shell between 1 cm. and 2 cms. wide. Three different shelling machines are necessary to treat the different sizes. The nuts and the shells are then transferred, by means of a conveyor belt, to a mechanical separator. At this stage the temperature of the room is kept below 25°C. to prevent the contamination of the kernels by CNSL (as the fusion point of the cashew acid, which is responsible of the contamination, is 24°C.).

After the shell is opened about 20% (according to Arthur D. Little study) or 40% (according to others) of the kernels remain attached to the half of the shell. The separation of these "stuck" kernels from the shell is now done manually at substantial cost. About 5% of the nuts which are not shelled, owing to mistakes made in the calibration operation, are taken out and then fed again to the automatic shelling machines.
The nuts are laid on trays and dried in special rooms for about four hours at 65°C. Then the trays are taken into a cooling room where cold air is

put in. After six hours of this cooling operation the trays are carried into other drying-rooms just like the previous ones but they are less heated. Then the kernels are fed into special peeling machines provided with tubes which suck the detached skins, so that 85-90% of the kernels are completely peeled. The unpeeled kernels are separated manually.

No grading is required with this system because the various sizes and qualities are processed separately. The kernels are inspected and packed into four gallon tins containing "carbon dioxide gas" and are ready for shipping.
The shells from the shelling operation are conveyed to a screw expeller where 80% of CNSL is recovered. The liquid obtained is heated, centrifugated and exported.

Shelling efficiency of the Japanese system is very poor. Machines need to be supplemented by large force to prise out kernel which is still adhering to the shell. Because of this defect - which is the basic defect of the cold system itself and therefore not remediable - the percentage of broken is geared to human not machine performance.
There is continual stoppage of shelling machines as machine breakdown is very frequent. Maintenance staff can only work four hours at a stretch and then must rest. No industrial operation of any kind can survive with such a handicap and if the scale of the present operation is to be expanded, it calls for expansion of present manpower, not reduction.

The Japanese system as such is not new. Short of freezing the liquid - which is however not economic as Gill & Duffus experiments in Hull and Africa have shown - the problem is without a remedy. The greatest danger is in the U.S. Food & Drug finding one case of contaminated kernels and it can lead to suspensions of all Tanzanian exports to the U.S.

The Japanese peeling process is much superior to the shelling one. The Japanese hot/cold prepeeling is however too vulnerable to human errors and if mistakes are made, huge amounts of expensive material can be spoiled.

d) "Cardoso" system of Socajù - Mozambique

A plant has been installed at Nacala, Mozambique, in 1967, with an annual capacity of 15,000 tons.
With this system the nuts are passed to an oven manufactured by the "Desmet Co."; then they are conveyed to the shelling operation by "Cardoso" machines supplied by "Sodecal Co." of Lisbon. The working of these shelling machines is essentially based on the alternate and simultaneous movement of two opposed pairs of claws which penetrate the shell of the nut and pull the kernel out. The separation of the shells from the kernels is made by means of a pneumatic system. Peeling is made manually after drying.
This system too is not complete as it reaches the shelling stage only.

Besides, the shelling machine has the following disadvantages :

- very frequently the nut is not totally shelled and has then to be recycled;
- it pulls out the shell irregularly so that many kernels do not remain completely detached from the shell;
- because of poor calibration many kernels are broken at the shelling operation. The yield, therefore, is rather modest (60% at the shelling stage and only 30-40% at the packing).

e) - "Cajuca" system - Mozambique

A plant was installed in Lourenço Marques (Mozambique) in 1966 with an annual capacity of 15,000 tons.
In the "Cajuca" plant the nuts, after cleaning, size grading and humidification, are roasted in an oven manufactured by a Portuguese industry "Metalurgica Luso Italiana". From the roaster and after cooling, the nuts pass on the shelling machines, which are partly based on centrifugal machines with target plates against which the nuts are thrown, and partly based on "Ilpa" machines consisting of four synchronized blades (two on the upper part and two on the lower part) which penetrate the nut and shell it instantly. The latter machines - one produced by the "Sima Co." in Italy - were manufactured for "Ilpa" in Lisbon which in 1966 was obliged to give up its business because of the bad results obtained.

The serious problem of the "Cajuca" plant lies in the "ILPA" shelling machines. In fact, the four blades have the same shape and the same section; for this reason the nut is cut equally, either on its round section or on the lower section which has a curved shape, causing the breakage of the kernel. Besides, the nut is not kept tight during the cutting. The result is that the nut is often crooked with regard to its axis causing a lot of broken kernels.

The "ILPA" machines have never gone over at the shelling stage the yield of 60% of wholes, while the final production never reached the yield of 40% of wholes at the packing stage, owing to breakage during the peeling.

f) - Gill & Duffus of Pierce & Leslie - Spence & Faure (Mozambique)

A plant has been established at Inhambane, Mozambique, with an annual capacity of 5,000 tons.

In the "Pierce & Leslie" plant the clean nuts are elevated to a 30-ton storage hopper. The nuts then pass through a revolving hexagonal cylinder and are graded into three sizes - large, medium, small - and are again elevated to three large hoppers, stored in their respective sizes. From storage hoppers the nuts are conveyed to a conditioning unit where they are subjected to steam pressure for a short period of time at low temperature. The nuts are then conveyed to a large hot air drier and pass to the automatic shelling machine which use a combination of blade cutting and centrifugal force to free the kernel from the shell.

The "Pierce & Leslie" plant has four shelling machines in production and one machine for cutting recycled nuts. The action of these machines is very rapid having a capacity of 100 lbs/hour/machine, but due to this high output, approximately 20% of the nuts are not efficiently cut. These nuts are hand picked out from the discharge conveyor and recycled to the fifth machine for recutting.

The subsequent process for detaching the shell from the kernel is similar to that used by the other systems. A typical feature of the "Pierce & Leslie" plant is that the kernels , after detachment from their shells, are put on trays and placed in a refrigerating chamber where they are frozen to -40°C. The frozen kernels are then passed through a mechanical peeling unit, which consists of two inclined rubber conveyors moving in opposite directions adjacent to each other, simulating a rubbing motion. It is claimed that with a recycle through the machine, this method gives 100% peeling or "blanching", but this naturally drops the yield of wholes percentage. Gill & Duffus are experimenting with a different method of blanching in order to obtain a higher percentage of whole kernels after sorting and grading. Their present method, i.e. freezing and peeling only gives 30% whole kernels, whereas with their new process they expect this figure to be in the vicinity of 50%. No information is available about this new method of blanching, but it seems that it is based on exposing the kernels to a blow of compressed air.

The "Gill & Duffus" system has not given successful results. At present the "Pierce & Leslie" plant in Mozambique makes a considerable part of its activity by hand processing and because of its bad results this business has been transferred to the holding "Steel Brothers Co.".

g) - Companhia de Culturas de Angoche - Mozambique

A plant has been installed at Antonio Enes, Mozambique, with an annual capacity of 6,000 tons.

This processing system - which uses machines supplied by the Italian Company "Bini" - is quite similar to the one adopted by "Pierce & Leslie".

The economic results of this plant are not satisfactory and for this reason the greater part of the processing is also hand made.

THE MARKETING OF CASHEW NUTS

7 - Cashew nuts Trade

Mozambique is the most important world producer of cashew nuts (137,000 tons in 1969, that is 39 per cent of the total world production). The production of cashew nuts is also considerable and continually increasing in Tanzania (106,000 tons in 1969, that is 29 per cent of the total world production), in Brazil (29,000 tons in 1969, that is 7 per cent of the total world production), in Kenya (12,000 tons in 1969, that is 3 per cent of the total world production), in West Africa and in Malagasy Republic (2,000 tons in 1969, that is 0.5 per cent of the total world production).

A preminent role in the world trade of cashew nuts is, however, detained by India which, besides having a considerable local production, imports an important quantity of the crop of East African countries to be hand-processed and re-exported to the main consumer countries.
In 1968 India exported 61,200 tons of kernels mainly to the U.S.A., the U.S.S.R., the United Kingdom and the German Democratic Republic.

Table 1 - Exports of Cashew Kernels from India

Countries	1965		1966		1967		1968	
	in tons	%	in tons	%	in tons	%	in tons	%
East European countries								
U.S.S.R.	13,315	24,8	12,354	27,4	12,600	24,-	18,430	30,1
German Democr.Rep.	3,640	6,7	2,332	4,8	2,449	4,6	2,470	4,-
Other countries	247	0,4	456	0,9	588	1,1	n.a.	-
Total	17,202	31,9	15,742	32,7	15,637	29,7	20,900	34,1
Western and Asian Countries								
U.S.A.	27,047	50,3	23,245	48,6	26,452	50,6	29,100	47,6
United Kingdom	2,857	5,3	2,299	4,8	2,757	5,3	2,830	4,6
Canada	1,510	2,8	1,311	2,8	1,896	3,7	2,000	3,3
Australia	1,365	2,5	1,245	2,6	1,824	3,5	1,770	2,8
Other countries	3,821	7,2	4,072	8,5	3,722	7,2	4,600	7,6
Total	36,600	68,1	32,172	67,3	36,651	70,3	40,300	65,9

Source : Fruits, Vol. 24, n°9-10, 1969, page 458.

Cashew kernels are one of the most important items exported from India as they represent an amount of over 60 million dollars.
Indian exports of CNSL are also considerable. In fact, in 1968 India exported 9,444 tons of CNSL mainly to the United Kingdom, the U.S.A. and Japan, for an amount of over 10 million dollars.

Table 2 - Exports of CNSL from India

Countries	1964/65		1965/66		1966/67		1967/68	
	in tons	in %	in tons	in %	in tons	in %	in tons	in
United Kingdom	5,966	41.5	4,353	35.6	5,097	43.3	4,270	45
U.S.A.	5,650	39.3	6,083	49.7	3,897	33.1	2,802	29
Japan	2,189	15.2	1,213	9.9	2,448	20.8	2,061	21
Other Countries	548	3.7	572	4.6	316	2.7	311	3
Total	14,353	100.0	12,221	100.0	11,758	100.0	9,444	100

Source : D.G.C.I. & S. Calcutta

The dominant position of India in the world trade of cashew kernels has und-
gone a substantial change in the sixties.
East African countries, in order to get rid of Indian dependance and to earn
more, have started processing locally (by means of mechanical devices) incr
ing quantities of cashew nuts (see Table 3.).

In the last few years the quantity of raw material processed in Mozambique
has steadily increased passing from 4,000 tons in 1961 to 70,000 tons in 19
It is anticipated that in 1972 about 115,000 tons will be used in Mozambiqu
because in the same period of time, three new factories with a total capaci
of 45,000 tons will be put into operation in the north of Mozambique. Equal
in Tanzania the cashew nut locally processed has increased from half a thou
tons in 1965 to 16,000 tons in 1969 and in Kenya from a thousand tons in 19
to 2,000 tons in 1969. On the other hand, it is foreseen that in the near
future, East African producing countries will retain at least 50 per cent
of the total crop for mechanical processing.
As a result of the increase in world production and of the new situation i
East Africa, during the last few years, India has processed a rather stead
quantity of raw material. As a consequence the Indian exports of kernels
and CNSL are, in absolute value, stagnant and in terms of percentage, decr
ing.

Table 3. - Estimates of production of raw cashewnuts for processing and estimates of local processing and export of cashewnuts ('000 tons)

Year	INDIA			MOZAMBIQUE			TANZANIA			KENYA			BRAZIL	WEST AFRICA AND MADAGASCAR	TOTAL PRODUCT
	Domestic production for processing	Imports for processing	Total processing	Production	Processed locally	Export to India	Production	Processed locally	Export to India	Production	Processed locally	Export to India	Production and processed locally	Production and Export to India	
1961	66	132	198	90	4	86	41	—	41	5	—	5	10	—	212,-
1962	66	131	197	89	8	81	48	—	48	2	—	2	10	—	215,-
1963	76	164	241	111	9	102	58	—	58	5	0,5	4	12	—	262,-
1964	81	170	252	141	14	126	40	—	40	5	0,5	4	15	0,2	282,-
1965	82	176	258	126	15	102	66	0,5	65	8	1,0	7	15	1,2	298,2
1966	65	141	206	104	27	77	63	2,5	61	3	1,0	2	18	1,0	254,-
1967	70	143	213	94	29	65	79	9,0	70	8	1,2	6,8	24	1,2	276,2
1968	65	205	270	145	42	103	107	15,0	92	10	1,2	9,8	24	1,5	352,5
1969	60	169	229	137	70	67	106	16,0	90	12	2,0	10,0	29	2,0	346,-
Average 1966-1969	65	164,5	229,5	120	42	78	89	11	,8	8,25	1,35	6,9	23,75	1,425	307,-
% of average production 1966-1969	21	53,5	74,5	39	13,6	25,4	29	3,5	25,5	3	0,5	2,5	7	0,5	—

Source : International Trade Centre UNCTAD/GATT, Cashew Marketing, Geneva, 1968 and National Statistics.

Table 4. - Consumption of Cashew Kernels - World Consumption.

	1968		1969	
	Cases	%	Cases	%
American Zone	2,015,942	57.2 %	1,788,237	47.1 %
European Zone	1,319,801	37.4 %	1,727,612	47.1 %
Asian Zone	72,802	2.1 %	92,424	2.6 %
African Zone	19,180	.5 %	15,876	.4 %
Oceanic Zone	96,808	2.7 %	87,988	2.4 %
Portuguese Market Space	3,263	.1 %	14,312	.4 %
Total	3,527,796	100.0 %	3,666,389	100.0 %

Source : Cajú Industrial de Moçambique, S.A.R.L.; [illegible], Vol.1, April 1970.

Table 5. - U.S. Imports of Cashewnuts 1963-1969
(Figures in thousands - those in the brackets indicate percentage)

	Total Imports		From India		From Brazil		From Br.E.Africa		From Mozambique	
	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$
1963	73,809 (100)	29,403	68,692 (90.6)	26,898	2,126 (2.8)	712	163 (0.2)	56	1,324 (1.7)	476
1964	69,615 (100)	33,498	62,672 (90)	30,610	1,882 (2.6)	629	212* (0.3)	91*	4,666 (7.4)	1,995
1965	65,612 (100)	34,133	56,614 (86.2)	30,195	676 (1)	261	340* (0.5)	148	6.375 (9.7)	2,789
1966	67,797 (100)	37,469 (100)	53,700 (79.8)	30,837 (82.3)	2,501 (3.7)	1,124 (3.0)	467* (0.7)	250* (0.4)	8,317 (13.0)	4,174 (10.8)
1967	73,022 (100)	36,899 (100)	56,004 (76.7)	29,495 (79.9)	2,234 (3.1)	984 (2.5)	1,623* (2.2)	709* (1.9)	12,715 (17.4)	5,561 (16.1)
1968	92,990 (100)	52,059 (100)	65,286 (70.2)	38,368 (73.7)	5,546 (6.0)	2,673 (5.1)	1,194* (1.8)	617* (1.2)	20,483 (22.0)	10,119 (19.4)
1969	83,663 (100)	46,412 (100)	53,710 (64.2)	31,766 (68.4)	8,158 (9.7)	3,608 (7.7)	1,670* (2.0)	948* (2.0)	19,256 (21.8)	9,626 (20.7)

* Includes Kenya and Tanzania only.

Source : Cashew Bulletin, Vol. VII, No. 10, October 1970, page 7.

This is particularly evident in the U.S.A market (see Table 5.) where in 1969 India supplied 64.2 per cent of total imports of cashew kernels against 90.6 per cent in 1963.

Besides, India has to pay for the raw material imported from East Africa a price higher than the one paid in the fifties and in the future India will receive a much smaller quantity of raw material from its traditional source of supply. India's position within the world market is therefore severely threatened especially in the Western markets.

India, which normally produce a crop between 50,000-70,000 tons, has initiated some new plantations. However, from various reports, it seems that India will not be able to make up for the drying up of the source of raw cashew nuts from East Africa, especially from Mozambique, which seems to be oriented to industrialize its entire crop of raw nuts in a short period of time.

For a few years India can continue to be supplied by Tanzania. However, Tanzania's objective is also to industrialise its crop and whilst Tanzania might take slightly longer than Mozambique to process locally its crop, India's position of dominance will be further reduced.

At present India sells much of its production to Russia and Eastern Europe on the basis of trade agreements. In 1970 it is reported that India and U.S.S.R. have signed a new five year trade agreement which involves larger quantities than heretofore (approximately 20,000 tons per year) and as long as these agreements continue - whilst India's supply of raw material is simultaneously being reduced - it is evident that India will have very much less kernels and CNSL to supply to the markets of the West, especially the American one. In fact, American importers foresee a time in the near future when India will be a marginal supplier of cashew to the U.S. market unless the acreage under cashew planting in India is radically increased.

At present India holds the upperhand in marketing the higher grades viz. Wholes, as a consequence of the increased outturn of brokens in the mechanised production adopted by some firms in Portuguese East Africa, as stated before. However, Western Europe and the U.S.A. to some extent, with their large demand for brokens for their confectionery trade are switching over to certain suppliers of Portuguese East Africa for obtaining their requirements of brokens.

8 - Exports from Brazil

Brazil, a relatively new-comer to the field, is in a very favourable condition to take advantage of the changes which the world trade in cashewnuts is undergoing at present, especially for what regards the supplies to the U.S.A. market where Brazil may turn out to be the most important supplier.

In fact, the Brazilian cashew industry finds a natural outlet for this product in the U.S.A. The geographical proximity of Brazil to the U.S.A. reduces the time taken between placing of orders and effecting supplies when compared with India and African countries. Furthermore, there are some cost advantages as, for example, lesser freight expenses.
In the last few years Brazil - owing to the systematic expansion of the plantations and the assistance granted by the Government which is giving a great deal of aid to those people who wish to put up shelling plants - has considerably increased its production of cashew nuts.

The State of Cearà is indeed hoping to make cashew nuts its number one export, ranking before cotton which is to-days's number one export item.

In 1969 the production of cashew nuts was about 30,000 tons (while it was approximately 24,000 tons in 1965) and in five to ten years time it is foreseen that Brazil will be producing 50,000 tons or even more.
The production of cashew kernels reached in 1969 7,330 tons (while it was 3,400 tons in 1966) and out of these 2,177 tons (that is 29.7% of the total production) were consumed in Brazil, whilst 5,313 tons (that is 70.3% of the total production) were exported mainly to the U.S.A. (where Brazilian supplies represent already 9.7% of total U.S. imports) and, to a less extent, to other Latin American countries (particularly Argentina).

Exports of cashew kernels from Brazil have been increasing continuously in the last few years going from 610 tons in 1962 to 5,313 tons in 1969, which indicates an enormous increase in percentage-rate.

For the C.N.S.L. the Brazilians already claim a production of 4,000 tons. Internal Brazilian consumption seems to stand at 1,000 tons while 3,000 tons are normally exported to the United States and European countries, in particular to the United Kingdom.

Table 6 - Trend of the Production and Exports of Cashew Kernels between 1966 and 1969

Years	Production (in tons)	Domestic Consumption		Exports	
		in tons	in %	in tons	in %
1966	3,420	1,563	45.7	1,857	54.3
1967	6,050	4,464	73.8	1,586	26.2
1968	5,920	2,474	41.8	3,446	58.2
1969	7,330	2,177	29.7	5,153	70.3

Source : Banco do Brasil - CACEX

Table 7 - Exports of Cashew Kernels from Brazil (in tons)

Years	Exports	
	in tons	Index, 1962 = 100
1962	610	100
1963	1,070	176
1964	1,110	182
1965	714	117
1966	1,857	304
1967	1,586	260
1968	3,446	565
1969	5,153	845

Source : Banco do Brasil - CACEX

Whereas in Brazil there were only two factories fifteen years ago, there are many more to-day, with several others projected.

Table 8 - <u>Processing Factories of Cashew Nuts in the North-East of Brazil</u>

Processing factories	Geographical location	Processing Capacity ('000 tons) Estimates		
		1967	1968	1969
Brasil Oiticica S.A.	Fortaleza	6,0	6,0	7,0
Fortaleza Agro Industr. S.A. - FAISA	"	2,0	3,0	4,0
Cajú do Brasil S.A. - CAJUBRAS	"	3,0	3,5	4,0
Cia. Industr. Oleos Nordeste - CIONE	"	4,0	4,0	4,0
Oliveira & Cavalcanti-OLICAL	"	2,0	2,0	2,4
Cia. Bras. Industr. Cast. Cajú - COMBICA	"	2,2	2,2	2,2
Enté do Brasil S.A.	"	—	—	2,0
Casa Quirino	"	—	—	2,0
Camara	"	—	—	2,0
Cascaju S.A.	Cascavel	2,0	2,0	2,0
I.A.C.O.L.	Bela Cruz	0,3	1,0	2,0
INCASSA	Fortaleza	0,6	1,0	1,2
MASHARY	Recife	—	1,2	1,2
TUNA	Fortaleza	—	—	0,6
Empresa Industrial do Cajú	Aracati	0,5	0,5	0,5
Total		22,6	26,4	37,1

However, the processing industry could develop more rapidly if it were not for the shortage of raw material. In fact, in Brazil it is estimated that about 20% of the processing capacity of the actual industries is not fully exploited.

The future for cashew kernels seems to be extremely favourable. Consumption seems to be increasing by considerable amounts in the existing markets, and the new markets seem to be very receptive to the introduction of cashew kernels. Prices on the major world markets continue to remain firm. The New York market has reached in 1970 76 cts. for 320's with 77 cts. being offered for prompt and forward shipments. Russia continues to pay 77 cts/78 cts. for 320's. This, combined with the general shortage of supply and the general increase of the cost of labour (even in India) should result in a further increase for the price of all whole kernels.

Equally, the prices for broken grades seem to be fairly stable on all the most important world markets.

Also for the C.N.SL. prices continue to remain at a satisfactory level. The Brasilian production of C.N.S.L. was sold to the United States in 1970 at a minimum price of $ 167.00 per long ton, C & F New York.

Brazil should receive a good profit from this favourable trend of the prices of cashew products. However, concerning the export of cashew kernels, the considerable differences existing between the average prices received by the exporters of the State of Ceará (43 cents per lb. in 1969) and those obtained by the exporters of East Africa (especially by the exporters of Mozambique) ought to be pointed out. In fact, while the average price received by the exporters of the State of Ceará reached in 1969 approximately 43 cts. per lb., in Mozambique the average price of the total production of the "Mocita" factory (that uses the "Oltremare" shelling system) was 54.5 cts. per lb. in the same year. This difference in price (that is 11.50 cts. per lb. namely 25 cts. per kg.) means that the Brasilian exporters receive a considerable lower return. In fact, by multiplying the difference between the average prices of the "Mocita" factory and the price received by the exporters of the State of Ceará for the quantity (about 5,000 tons) of cashew kernels exported in the United States in 1969 there is a lower return for the Brasilian exporters of about 1,250,000 U.S. dollars, which corresponds to over 25% of the total value of their exports.
The difference pointed out depends mainly on the fact that the "Mocita" mechanised production gives a recovery of wholes and white grades much higher than that of the present Brazilian processing system.

Table 9 - Average Prices Received by the Exporters of the State of Ceará between 1961 and 1969
(U.S.$ cents/lb)

Years	Average prices received by the Brazilian exporters	
	US$ cents per lb.	Index, 1961= 100
1961	30	100
1962	30	100
1963	32	107
1964	32	107
1965	40	133
1966	44	147
1967	40	133
1968	46	153
1969	43	143

Source : Banco do Brasil - CACEX

Table 10 - Prices paid by the United States Importers to the Exporters of the State of Ceará in 1969

Types of kernels	US $ cents
Especial	70
Inteiras 1a	60
Inteiras 2a	54
Bandas 1a	40
Bandas 2a	36
Pedaços 1a	34
Pedaços 2a	38
Pedaços 3a	26
Xerem	23

Source : Banco do Brasil - CACEX

New opportunities for the Cashew Nut Products

Whole kernels are mainly used in the U.S.A., the largest consumer, as an appetizer with drinks. The broken grades are also used (especially in Western Europe) to a large extent by the confectionary industry. Besides, whole kernels and pieces can be fried, candied and used to guarnish roast and boiled meat courses, and in order to formulate new and improved recipes.

Apart from these traditional uses the kernels can be utilized for new purposes. In particular, there is the possibility of using the cashew-flour (which is obtained from the lower grade kernels after skimming the oil) as a product of considerable food value. In fact, according to a survey made by Prof. G. Piva of the University of Piacenza, Italy, the protein contents of cashew-flour is as high as the best types of flour having in addition a high level of essential amino-acids and an excellent digestibility. Its protein contents is higher than the soia one which is considered the best among the vegetal proteins. Therefore, the cashew-flour seems to be going to play an important role in the food sector as an integrating proteinic product for human consumption and as a component for several dietetic products (for children, old people, obese people, athlets, etc.).
During the production of cashew-flour, an excellent quality of edible oil (similar to Tunisian olive oil) - as stated by Prof. U. Pallotta of the Institute of Agricultural Industry, Bologna's University, Italy) - is also obtained. In this way better trade possibilities are offered to producing countries.

The C.N.S.L. (Cashew Nut Shell Liquid) is used in the making of plastics, resins, brake-linings, insulating varnishes, paints, coatings resistant to acids and alkalis, electric insulators, etc.
New opportunities also exist for the CNSL. In particular, as stated by O.Attanasi and L. Caglioti of the Institute of Chemical Industry, University of Bologna, Italy, consumption of CNSL should increase considerably in the following industries: clutch facings, enamels, laminating resins, plywood adhesives, rubber chemicals, insecticide and pesticidal components; paints for cars where the CNSL replaces the caoutchouc.

Other opportunities also exist for the cashew apple which in Latin American countries, particularly in Brasil, is put to considerable economic use in making jams, juices and alcoholic drinks. In fact, as stated by L. Haendler and G. Duverneuil of IFAC, it should be possible for producing countries to export a few products (such as cashew chutneys and candies) to the main consumer markets.

Finally, cashew juices prepared by the Brazilian industries could also find an outlet in the U.S.A. where analcoholic drinks are largely consumed all year round.

ACKNOWLEDGEMENTS

Appreciation is expressed for the kind cooperation of the following Companies and people in supplying information which has been used in preparing this study :

1. Oltremare Company of Bologna
2. Sturtevant Engineering Company of London
3. Mitchel Beck Company of New York
4. Cajù Industrial S.A.R.L. of Mozambique
5. Prof. G. Piva of the University of Piacenza, Italy
6. Professors U. Pallotta, P. Capella, G. Losi, O.Attanasi and L. Caglioti of the University of Bologna, Italy.

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Description of "Oltremare" mechanical system for the Cashew Nut processing

The process may be divided into four sections.

SECTION I.

Cleaning, First Calibration, Washing and Humidification.

The nuts as received are weighed; this weight being referred to as "Basis Raw".

The nuts are then fed into a mechanical appliance to remove dust, sand, foreign matter and empty nuts.

After cleaning, the nuts pass through a revolving hexagonal cylinder, divided into three sections, which separates the nuts into three sizes: large, medium and small. The sized nuts are discharged into hoppers of ample capacity. At this stage the nuts are kept separate in their three sizes and are batch fed through the remainder of the process. From the storage hopper the sized nuts are fed by a conveyor to a washing cylinder and subsequently to a storage area for humidification.

Humidification is necessary as it is essential to have the moisture content of the kernel after shelling, but before drying at 6 - 8%. This humidification process takes about 2 days.

SECTION II.

Roasting, Centrifugation, Cooling and Second Calibration.

Properly conditioned, i.e. possessing the right moisture content, the nuts are hand fed onto a conveyor to be elevated to a storage hopper from which they are automatically fed onto the oil bath scooped conveyor. The temperature of the oil bath and the speed which the nuts pass through depend primarily on the size of the nuts, hence the necessity for the first calibration. The bath is maintained at a temperature between 190 and 200°C by two burners regulated by pyrometers and thermometers, whilst the speed of the conveyor is adjusted by means of a variable speed pulley drive.

After passing through the bath the nuts are discharged into a centrifuge which is heated by hot air taken from the burner combustion chambers. The excess oil removed by the centrifuge and the overflow from the oil bath discharges into a sump and is pumped into storing tanks.

The rated capacity of the oil bath is about 1000 kilos of raw nuts per hour.

The nuts, discharging from the centrifuge are elevated to a cooling cylinder where they are subjected to blasts of cool fresh air, and are then conveyed to storage hoppers, to be stored for at least 12 hours before the second calibration process. After the 12 hours cooling the nuts are conveyed to another long hexagonal rotating cylinder, divided into seven sections graded in 2 mm. sizes, the sizes being -18 mm, 18-20 mm, 20-22 mm, 22-24 mm, 24-26 mm, 26-28 mm, and 28-30 mm. The overflow, not passing through the graded apertures, constitutes the +30 mm. size.

SECTION III.

Shelling and Detachment of Shell.

The calibrated nuts are then conveyed by a pneumatic device to hoppers placed in different lines, each hopper feeding two shelling machines, and each line serving one size only. One operator is required for feeding every machine. The nuts are then automatically passed through the machines where the cut is effected, and discharged onto an outgoing conveyor. Every machine shells 90 nuts per minute, which roughly gives an average of 20 kilos per hour.

The nuts discharging from the machines are normally in three categories, viz :

(i) completely detached kernels and shells.
(ii) Kernels adhering to a half shell.
(iii) Kernels with two half shells adhering at some point.

The discharge conveyor feeds the nuts into a mechanical vibrating sieve, immediately separating detached kernels, which pass through the sieve onto a belt which conveys the kernels to a storage point. Empty shells and shells with kernels still adhering, discharge onto a second belt, pass under an aspiration funnel, which removes the empty shells and then into a pneumatic cyclone. From this cyclone they are discharged onto a second vibrating sieve. Further detached kernels are conveyed to the storage point whilst kernels still adhering to shells are pumped to a second pneumatic cyclone and onto a third vibrating sieve where final separation is normally completed. Throughout this process aspiration points are fitted which extract the shells and pump them to the oil recovery section.

Completely detached kernels arriving at the storage point are loaded onto screens and placed on trolleys ready for drying.

SECTION IV.

Drying, Peeling, Humidification and Packing

The trolleys containing the kernels are packed in the drying chamber and dried until the moisture content of the kernel is between 2½ to 3%. Drying is effected by means of a standard steam heat exchanger operating at 70-80°C.

After drying, the screens containing the kernels are tipped into a hopper and fed to the peeling machines.

These machines detach the peel or skin from kernels: the principal peeling line processes only the whole kernels while an auxiliary line is used for the broken, previously separated by a calibrator. At three different stages along the peeling line, the kernels pass through an electronic machine which rejects the kernels not totally peeled and which have to be recycled: the same sorting is also made for broken grades. All grades are cleaned by pneumatic separators and broken grades are mechanically calibrated.

The graded peeled kernels are again placed on screens, loaded on trolleys and stacked in the humidification chamber where the moisture content of the kernel is raised to 4½ - 5% by means of fine water sprays. Once this has been achieved the kernels are packed in containers ready for despatch.

Description of "Sturtevant" mechanical system for Cashew Nut processing

Description of Process

1. The nuts are weighed off into baskets in 150 lb batches and immersed in a tank of water to soak. After soaking the baskets are transferred to humidifying cabinets where they condition in a saturated atmosphere for approximately 16-24 hours. After conditioning the nuts are transferred to the master feed hopper.

2. The feed to the roaster is via a slotted drum feeder with a variable speed drive. The roaster is a heated bath of cashew nut shell liquid (C.N.S.L.), through which the nuts are conveyed at a controlled rate by a variable sped drive. The roasting process releases CNSL from the "Pericarp", leaving it in a brittle condition for easy removal. From the roaster the nuts are discharged to a cleaning drum.

3. The cleaning drum is fitted with helical flights to assist the passage of nuts. At the inlet, sawdust is added to the nuts to absorb the surface CNSL. During their passage through the drum, they are both cleaned and cooled.

4. From the cleaning drum the nuts pass to a slatted conveyor fitted with a vibrating screen , which removes the sawdust, a second conveyor transfers them to the Decorticator.

5. The Decorticator is a centrifugal machine with target plates against which the nuts are thrown and shelled. The product falls into a perforated plate cone, which allows the detritus to fall through and be collected, while the kernels, broken shell and unshelled nuts are passed to a third conveyor.

6. Mounted over this conveyor are two aspirating heads, these remove the light shell and so reduce the load on the following reciprocating screen.

7. The screen is equipped with two decks, the oversize from the top deck is fed back to the Decorticator via the second conveyor. Throughs from the top deck (whole kernels and large shell) pass to an air separator for sorting. Throughs from the bottom deck (butts, splits, pieces and small shell) are passed to the second air separator for sorting, so producing a clean whole nut and clean broken nut product.

ECONOMIC STUDY

For a mechanical processing plant with a capacity of 3,000 tons of raw cashew nut per year according to the "Oltremare" and "Sturtevant" systems.

- two shifts of 8 hours each per day
- 200 working days per year

1. In this Appendix this report is completed with an economic study pointing out the main factors to be examined thoroughly in order to establish industrial plants suitable to the real possibilities of Brazil (factories with an annual capacity of 3,000 tons) according to the only two mechanical processing systems on sale to-day : the "Oltremare" and the "Sturtevant" systems.

2. The machinery used by these two systems for processing 3,000 tons of raw cashewnut per year, with their relative costs and yields of finished product, is the main factor to be examined thoroughly. Another important factor to point out is the cost of building industrial premises. However, this cost does not present relevant differences according to the type of machinery installed. On the contrary the manpower factor - which is the basic element of the processing cost - presents substantial differences which this study outlines.

3. An annual capacity of 3,000 tons has been chosen because a plant with such an input is the economic dimension to cover the general expenses of the management.
In fact, either the "Oltremare" or the "Sturtevant", offer processing lines respectively of the annual capacity of 1,000 tons and 650 tons for one shift, but at this size general costs would weigh too heavily.

4. The complex of mechanical devices stated in this economic study theoretically offers a productive capacity of about 4,000 tons per year either with the "Oltremare" or the "Sturtevant"; the calculation made in this study, however, refers to a basis of 3,000 tons for prudential reasons and to allow a certain flexibility to the consequent economic evaluations.

5. This study only takes into consideration a plant with an annual intake of 3,000 tons, because even for plants with a higher capacity the trend of the single items here analysed would in most cases be proportional.
In a plant with a higher intake (for example, 6,000 tons) it is possible to realize savings in the investments and in the general costs. On the whole, however, the trading profits in a plant of 6,000 tons would increase of about 10% either in the case of "Oltremare" or in the case of "Sturtevant".

Analysis of the single items

Investments.

Land and Buildings:

Either in a plant supplied with "Oltremare" machinery or in a plant supplied with "Sturtevant" equipment, land and buildings are of the same size.
As a matter of fact, a plant supplied with "Sturtevant" machinery is smaller than that of the "Oltremare's", but it needs more room for the part regarding the manual processing. The cost stated is based on market values.

Machinery :

The cost of "Oltremare" machinery has been stated approximately by the very same Oltremare Co. The cost of the "Sturtevant's" has been obtained multiplying by three the whole cost (including assembling costs) of one line of 650 tons according to the standard pro-forma tender presented by the Sturtevant Engineering Co. Ltd.

Electronic machines and Separators :

The costs of electronic sorting machines not manufactured by Oltremare Co. (and offered by the English Company Gunson's Sortex Ltd.) - which integrate the mechanical peeling operation - have been added to the costs of the "Oltremare" equipment.
The cost of drying chambers for the shelled kernels has also been added to the "Sturtevant" machinery, as this is not included in the processing line tendered.

Electric installation :

The cost concerning electric, water and fuel installations have been assumed hypothesis to be equal in both types of mechanical processing.
The same hypothesis has been adopted for the costs of the ancillary equipment.

Ancillary equipment

This latter cost is supposed to be made up by the following means :

- precision balances, tables, plastic containers, vacuum machine, underground tanks for CNSL;
- motor lorries,
- water tanks,
- external tanks for CNSL,
- No. 15 trolleys and 600 trays to put the kernels into the drying chambers,
- furnishing for the administrative offices.

Processing Costs.

Wages :
The number of workers to be employed has been given by the two Companies, as follows :

For one shift	"Oltremare"	"Sturtevant"
For the warehouse	3 workers	3 workers
" " humidification	5 "	6 "
" " kilns	1 "	9 "
" " calibration	2 "	-
" " shelling	46 "	12 "
" " drying	1 "	1 "
" " mechanical peeling	10 "	-
" " manual peeling and sorting*	45 "	225 "
" " grading	35 "	35 "
" " packing	6 "	6 "
For various operations	10 "	10 "
Totals	164 workers	307 workers

* This operation concerns 10% of the shelled kernels obtained with the "Oltremare" system and 90% of the shelled kernels obtained with the "Sturtevant's".

The wages are those on an average in force in Brasil.

Maintenance and Repairs :
These costs have been calculated on the basis of 2% of the whole cost of machinery.

Salaries :
The salaries for the managers and the administrative employees stated in this study are at the minima levels for the management of a plant. The wages are those on an average in force in Brazil.

Electricity and Fuel Oil :
These costs have been calculated on the basis of the information given by the same producers of the machinery.

Contingencies costs :
These costs are those expenses which regard various items not foreseen for the single ones.

Packing material :
It consists of 25 lbs tins in carton cases containing two tins each. The number of tins and cases has been obtained on the basis of 23-24% yield of the raw material. The relative price is the actual market value.

Sales.

The average sales value has been calculated on the basis of the actual market prices (reduced by about 5% for a cautious evaluation) and of the yield of white wholes stated by the "Oltremare" (on the basis of the real yields obtained by the plants to-day working in Tanzania and Mosambique) and by the "Sturtevant" (on the basis of specific tests).

The same prices have been adopted for the two "mix" productions of kernels obtained from the two mechanical systems under investigation.
In fact, the yield of the "Sturtevant" is rather modest (and in any case rather optimistic in relationship with the results of other similar plants working in Mosambique) and the sale would create serious problems, because it is difficult to sell on the market a production with yields lower than 60% of wholes and 65% of whites at the packing stage.

Concluding, for the "Oltremare" an average return of US$ 1,311/kg is obtained, while for the "Sturtevant" an average return of US$ 1,231/kg is obtained. The latter is about 7% less than the former.

Total returns have been calculated on the basis of the yield of the raw material which varies from 22 to 25%. The more realistic values are those on an average equal to 23-24%.

The CNSL obtained from the kilns has prudentially been limited to 5% as the actual average of recovery in the plants following the "Oltremare" system is about 6-7%.

Selling Expenses.

The selling expenses have been calculated on the basis of transport charges which usually have an incidence of 1,5% on the goods value plus a freight for New York of U.S.$ 65 per ton.
The broker commission of 2.5% is the one paid in the U.S.A.

Profits.

The percentage of trading profits with the "Oltremare" system varies from 28% on the sales (for a yield of 25%) to 19% (for a yield of 22%).

The percentage of profit with the "Oltremare" system on the investments varies, on the contrary, from 40% to 25%.

The percentage trading profits with the "Sturtevant" system is about 10% on sales with a yield of 25%, while the break-even point is reached with a yield of 22%.
The profit on the investments with the "Sturtevant" system is of 25% in the most favourable case and null in the less favourable one.

ECONOMIC STUDY

For mechanical processing plants
of 3,000 tons of raw cashewnuts
per year capacity
(with "Oltremare" system)

- 2 shifts per day of 8 hours each
- 280 working days per year

		US$
A) - [illegible]		
1.	Land 10,000 m2 x $1	10,000
2.	Buildings :	
	factory 3,000 m2 x $ 30	90,000
	stores 1,500 m2 x $ 30	45,000
	services 500 m2 x $ 30	15,000
3.	Machinery :	
	a) "Oltremare" equipment	400,000
	b) Auxillary equipment	36,000
	c) Electronic machines and pneumatic separators	27,500
	d) Electric installation and water and fuel networks	52,000
	TOTAL INVESTMENTS	675,500

B) - WORKING CAPITAL		
	a) ½ raw material for one year: 1,500 tons x $ 100	150,000
	b) Production expenses for about two months	50,000
	TOTAL WORKING CAPITAL	200,000

C) - PROCESSING COST

		US$
a) Wages :		
2 supervisors $ 2,200/year		4,400
4 section chiefs	$ 1300/year	5,200
8 mechanics	$ 900/year	7,200
328 workers	$ 550/year	180,400
b) Maintenance and repairs		8,000
c) Kwh 250 - 16 hours		16,000
d) Fuel oil 25 kg/ton raw material		1,100
e) Salaries :		
1 manager		4,500
1 assistant manager		3,500
1 accountant		3,000
1 storekeeper		1,500
2 employees		2,900
f) Contingencies		2,500
g) Packing material :		
60,000 tins at $ 0.50		30,000
30,000 cases at $ 0.25		7,500
		277,000
Depreciation :		
- 5% Buildings		7,500
- 10% Machinery		51,950
		336,450
- Raw material	at $ 100/ton	300,000
TOTAL PROCESSING COST		636,450

D) - **SALES**

On the basis of the following percentages of grades and respective prices, the average value is US$ 1,311 per kilo.

mix production of kernels	White Wholes	50%	$ 0.72/lb
	Scorched Wholes	5%	$ 0.68/lb
	Dessert Wholes	10%	$ 0.50/lb
	White Pieces	27%	$ 0.45 /lb
	Scorched Pieces	4%	$ 0.43/lb
	Dessert Pieces	4%	$ 0.38/lb

	US$
- 25% kernels outturn : Kg. 750,000	983,250
5% C.N.S.L. = tons 150	22,500
	1,005,750
- 24% kernels outturn : Kg. 720,000	943,920
5% C.N.S.L.	22,500
	966,420
- 23% kernels outturn : Kg. 690,000	904,590
5% C.N.S.L.	22,500
	927,090
- 22% kernels outturn : Kg. 660,000	865,260
5% C.N.S.L.	22,500
	887,760

E) - SELLING EXPENSES

From factory to fob Fortaleza 1.5%
Broker commission 2.5%
Ocean freight $ 65/ton

Total selling expenses :

		US$
25%	=	88,616
24%	=	85,107
23%	=	81,598
22%	=	78,089

F) - NET SALES RECEIPTS

(Total sales less selling expenses)

25%	=	917,134
24%	=	881,313
23%	=	845,492
22%	=	809,670

G) - TRADING PROFIT

(Net sales receipt less total processing costs)

25%	=	280,284
24%	=	244,463
23%	=	208,642
22%	=	172,821

Machinery and ancillary equipment of "Oltremare" plant with a processing capacity of 3,000 tons of raw cashew nuts per year

			LIT
Group	I	: Cleaning, first calibration and washing	16,310,000
Group	II	: Kilns and Centrifuges	24,788,000
Group	III	: Cooling and second Calibration	32,051,000
Group	IV	: Shelling and ancillary equipment	69,680,000
Group	V	: Pneumatic aspiration	48,547,000
Group	VI	: Shell suction and pneumatic transport	7,640,000
Group	VII	: Drying rooms	10,958,000
Group	VIII	: Peeling equipment : 1st and 2nd phases	18,100,000
		Separation Splits-Pieces	3,091,000
		Splits line	8,865,000
		Pieces sorting	2,836,000
Group	IX	: Compressed air equipment	7,875,000
Workshop			5,556,000
		TOTAL "[illegible]" EQUIPMENT	250,137,000
		corresponding to US$	400,000

Note : The cost includes assembling

ECONOMIC STUDY

For mechanical processing plants
of 3,000 tons of raw cashew nuts
per year capacity

(with "Sturtevant" system)

- 2 shifts per day of 8 hours each
- 280 working days per year

	US$
A) - INVESTMENTS	
1. Land - 10,000 m2 x $ 1	10,000
2. Buildings :	
- factory 3,000 m2 x $30	90,000
- stores 1,500 m2 x $30	45,000
- services 500 m2 x $30	15,000
3. Machinery :	
a) "Sturtevant" equipment	194,000
b) Drying equipment	15,000
c) Various equipment	56,000
d) Electric installation, water and fuel networks	38,000
TOTAL INVESTMENTS	437,000

B) - WORKING CAPITAL	
a) ½ raw material for one year: 1,500 tons x $100	150,000
b) Production expenses for about two months	70,000
TOTAL WORKING CAPITAL	450,000

c) - PROCESSING COST

	US$
a) Wages :	
2 supervisors $2,200/year	4,400
4 section chiefs $1,300/year	5,200
4 mechanics $ 900/year	7,200
614 workers $ 550/year	337,700
b) Maintenance and repairs	4,000
c) Kwh 30 - 16 hours	1,500
d) Fuel oil (gas)	1,000
e) Salaries:	
1 manager	4,500
1 assistant manager	3,500
1 accountant	3,500
1 storekeeper	1,500
2 employees	2,500
f) Contingencies	2,500
g) Packing material:	
60,000 tins at $0.50	30,000
30,000 cases at $0.25	7,500
	416,500
Depreciation :	
- 5% Buildings	7,500
- 10% Machinery	69,700
	493,700
Raw material $100/ton	300,000
TOTAL PROCESSING COST	793,700

D) - SALES

On the basis of the following percentages of grades and respective prices, the average value is US$ 1,231 per kilo.

mix-production of kernels	White Wholes	28%	$ 0.72/lb
	Scorched Wholes	17%	$ 0.68/lb
	Dessert Wholes	7%	$ 0.50/lb
	White Pieces	26%	$ 0.45/lb
	Scorched Pieces	17%	$ 0.43/lb
	Dessert Pieces	5%	$ 0.30/lb

	US$
- 25% kernels outturn = kg. 750,000	923,250
5% C.N.S.L. = tons 150	22,500
	945,750
- 24% kernels outturn = kg. 720,000	886,320
5% CNSL	22,500
	908,820
- 23% kernels outturn = kg. 690,000	849,390
5% CNSL	22,500
	871,890
- 22% kernels outturn = kg. 660,000	812,460
5% CNSL	22,500
	834,960

E) - <u>SELLING EXPENSES</u>

From factory to Fortaleza 1.5%
Broker commission 2.5%
Ocean freight $65/ton

Total selling expenses :

		US$
	25%	86,216
	24%	82,803
	23%	79,380
	22%	75,978

F) - <u>NET SALES RECEIPTS</u>

(Total sales less selling expenses)

	25%	839,334
	24%	[illegible],017
	23%	792,380
	22%	759,[illegible]

G) - <u>TRADING PROFIT</u>

(Net sales receipts less total processing costs)

	25%	105,[illegible]
	24%	72,317
	23%	38,[illegible]
	22%	5,[illegible]

Machinery and ancillary equipment of "Sturtevant" plant with a processing capacity of 3,000 tons of raw cashew nuts per year

- No. 3	units of 650 tons capacity for a shift, each consisting of roaster, drum cleaner, decorticator, separators and ancillary equipment		
	each £ 20,350	x 3	£ 61,050
- No. 3	groups of extra equipment (Rotary drum grader, humidifying tanks, etc.)		
	each £ 3,735	x 3	£ 10,805
			£ 71,855
	Assembling cost		£ 9,745
		Total	£ 81,600
		corresponding to	US$ 194,000

29. 5. 72