Industrialization of Cashew in the state of Ceara, Brazil

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The cashew tree, *Anacardium occidentale L.*, is native to northeast Brazil from where it has spread to other parts of South and Central America. It was introduced into southeast Africa and India by the Portuguese to help control erosion and has since been planted extensively in these areas. Because of its sensitivity to cold, especially when young, growth is limited to tropical areas, the tree being cultivated in the U.S. only in southernmost Florida.

The tree grows well in sandy coastal soils, needs very little attention, and does well with 30-40 inches of rainfall per year. Rainfall exceeding this amount, especially during the time of blossoming, promotes the growth of anthracnose which results in a fall of leaves and blossoms and a decay of forming fruit. All of these factors contribute to a considerable reduction in yield.

Each tree averages 30-40 feet in height, starts producing in the third year, and when mature, after about 15 years, may produce 50-100 pounds of nuts. Because of the open nature of the foliage, cashew trees can be grown with another crop, the young trees with beans, cotton, corn or casava and the mature trees with pasture. An experiment at the present time by the University of Ceará at the Ministry of Agriculture farm in Pacajús, Ceará, is measuring the effect of pasture and livestock production in established cashew orchards.

The cashew nut, which is the true fruit, is encased in a hard, but resilient kidney-shaped shell, which hangs suspended from the soft, pulpy, peduncle (cashew apple). The cashew apple has a distinctive aroma and is either red or yellow with an orange mixture of the two appearing frequently. This color difference has been the basis of the only varietal differentiation used. Another important difference in cashew apple is in the taste of the juice, which is either sour, sweet, or rancid (astringent). Because of the universal practice of propagation from seed, extreme variabiilty in size and shape of both the nut and apple is seen. Attempts to standardize nut size by plant breeding have been hindered by the heterozygous nature of the plant, and attempts at grafting of proven plants have usually resulted in rejection of the graft by the tree. Successful grafts of cashew trees carried out by Dr. LeMoyne Hogan of the University of Arizona in conjunction with the personnel of the Pacajús Experimental Station and the University of Ceará may help lessen variability in future plantings.

Although Brazil produces only 5 percent of the world's cashews, its production is expected to increase greatly in the next few years because of the emphasis and subsidies which are being given to this crop by the Brazilian Government. Another factor which has given added impetus to the

Table 1. Average Quantity of Cashew Nuts Shelled by Individual Firms in Ceará.

Firm Name	*Location*	*Metric Tons/Year*
Brasil Oiticica	**Fortaleza**	**7.000**
Fortaleza Agro-Industrial S.A. (FAISA)	**Fortaleza**	**6.000**
Caju do Brasil S.A. (Cajubras)	**Fortaleza/Pacajús**	**5.000**
Oliveira Cavalcante e Cia. (OLICAL)	**Fortaleza**	**3.000**
Companhia Brasileira Industrial de Castanha (COBICA)	**Fortaleza**	**2.200**
Cascaju	**Cascavel**	**3.000**
Casa Quirino Rodrigues	**Sobral**	**2.000**
Katu do Brasil S.A.	**Fortaleza**	**2.000**
Ind. e Agr. Castanha e Oleos (IACOL)	**Bela Cruz**	**2.000**
Companhia Industrial Oleos do Nordeste (CIONE)	**Fortaleza**	**4.000**
Incassa	**Sobral**	**1.200**
Indústria Agr. Castanha do Nordeste (ICANORTE)	**Marco**	**600**
Araújo e Alves — Lindoia	**Fortaleza**	**2.000**
Exportadora Pontes Ltda.	**Fortaleza**	**1.000**
Caucaia Industrial S.A.	**Caucaia**	**2.300**
Castanha de Caju do Nordeste (CAJUNORTE)	**Bela Cruz**	**500**
Camará Agro-Industrial	**Pacajús**	**2.000**

Source: CODEC — Companhia de Desenvolvimento do Estado do Ceará

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increased production of cashew has been the more than 50 percent increase in 1973 of the price of the shelled cashew nut and the 65 percent increase in the price of its major by-product, cashew nut shell liquid, on the world market. This increase in supply will be welcomed by the cashew industry of Ceará, which produces about 68 percent of Brazil's cashew crop, because processing plants in the state have been operating at about half capacity in recent years due to lack of raw material. At present the average quantity of cashew nuts processed by each of the seventeen firms in Ceará is about 3,000 metric tons.

Products from the Cashew

The shelled nut comes in various sizes, shapes, and shades and is the most important cashew product. Those nuts which have the highest market value are the large, unbroken, white kernels which have no evidence of spotting or of insect damage. The simple splitting of a kernel will decrease the value of a given weight of the nuts by almost half with a corresponding decrease in value for further breakage or darkening.

The spongy interior of the cashew nut shell contains a substance known as cashew nut shell liquid (CNSL) which is very valuable for use in the formulation of plastics, paints, printing inks, and synthetic resins. It contains at least two phenolic compounds, anacardic acid and cardol, the latter being very irritating to the skin and eyes. Over 400 patents have been filed for the industrial use of this liquid, one of the most important being the manufacture of brake linings to which it imparts excellent frictional and antifade characteristics.

The peduncle or pseudo-fruit (cashew apple) is very thin-skinned and perishable, somewhat resembling a pear in size and shape. The juice and fruit are very desirable to the inhabitants of Brazil, and the majority of the crop which is used is eaten in the raw state. Extracted juice has a pH of about 4, a titratable acidity of 0.14, a Brix of 8-12, and has a very high content of Vitamin C, 200-300 mg/cc, surpassing the citrus fruits in that respect. Because of a fairly high tannin content, 0.4 percent, the juice has an astringent or puckering effect. Spilled cashew juice produces an indelible stain on clothing because of the reaction of tannins with the iron in the wash water.

Figure 1. A young three year-old cashew tree which is planted under orchard conditions.

Harvest of the Cashew

Generally the cashew nut and the cashew apple do not mature simultaneously. The nut requires a few additional days to reach full maturity and will be at its optimum ripeness when the cashew apple has over ripened and together with the nut, has fallen to the ground. If it is desired to use the cashew apple, collection must be made every day. Otherwise, as happens in most cases, the cashew apple is discarded, and only the nut is gathered. Eventually the nuts are sold to a central collecting organization which distributes them to each firm according to its capacity for shelling, sorting and packing.

Industrialization of the Cashew Apple

Products that can be made from the juice and fruit are similar to those made from fruits in the U.S., i.e., jelly, jams, various concentrations of turbid juices and nectars, and whole, canned cashew apples. The most popular item is probably the bottled, pulpy juice from which a refreshing cashew drink can be made by dilution with water and addition of sugar and ice. This drink can also be prepared in season from the fresh cashew apple and is liked by the majority of Brazilians. In addition, two typical Brazilian products are made, *cajuína*, a clear drink made by precipitating the tannins in the juice with glue or gelatine, filtering through nylon cloth, bottling and

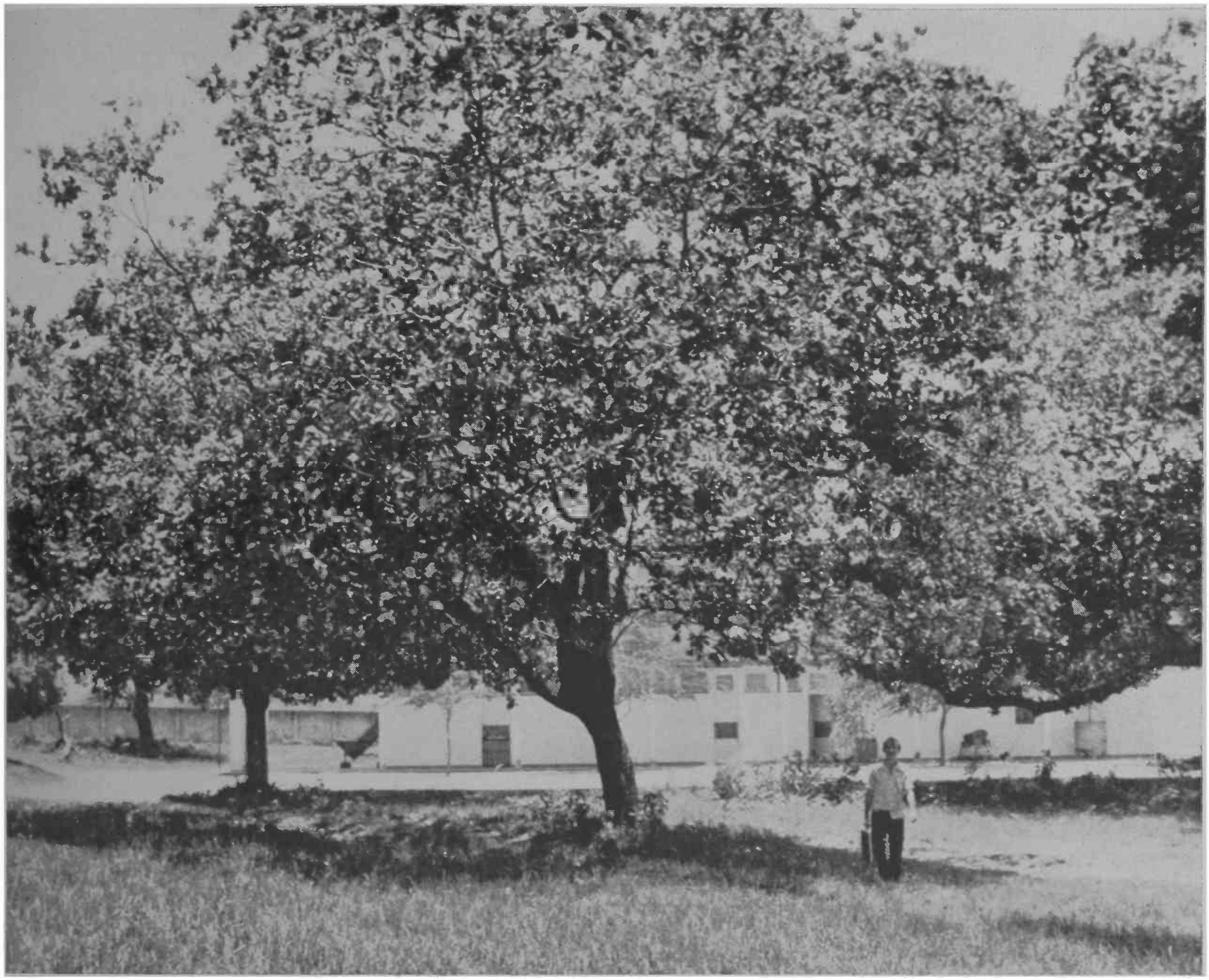

Figure 2. Mature bearing cashew on the campus at Centro de Ciencias Agrarias, Forteleza. The technician is Antenor Silva.

sterilizing. This drink is somewhat like apple cider. *Doce de Cajú,* a semi-solid dessert item, is made with the addition of sugar, acid, and pectin to the pulp and concentrating to a Brix of over 70 before packing and cooling. A small amount of cashew wine is also made. It is estimated that less than 10 percent of the annual production in Ceará of the cashew apple is used industrially with the rest either wasted or eaten by individuals. Only one firm in Ceará has facilities for utilization of the cashew apple. In India up to 85 percent of the crop is not utilized at all.

Industrialization of the Cashew Nut

Upon arrival at the factory, the cashew nuts are stored in piles or are air dried in the sun depending on their moisture content. When they are needed they are removed from the piles and are cleaned.

In order to break down the spongy area within the shell and allow the release of the shell liquid (CNSL), the nuts receive a heat treatment. The heat also causes the inner surface of the shell to retract slightly from the kernel, facilitating shelling. This treatment can either be by auto-claving or by submersion in heated, previously extracted, shell liquid. The latter process also extracts about 20 percent of the shell oil from the nuts during heating. The nuts are then cooled and tempered for 12-24 hours before shelling.

Shelling of the cashew nut is one of the most difficult and time consuming operations in the factory because of the kidney-like shape of the nut, the resiliency of the shell, and because of the fragility of the kernel. In one company in Ceará this operation has been mechanized, with the tempered nuts being thrown at a certain angle against a whirling drum until broken. In all of the other factories in Ceará, the nut is opened by hand, the operator having two knives mounted in a small platform. Each nut is placed in a slot, the knives moved together by a foot-operated lever and one of the knives moved at right angles, thus opening the shell. The kernel still must be removed from the bottom half of the shell with a sharp instrument. At this point the shells and kernels are hand separated.

The shells proceed to presses for the removal of a part of the CNSL and then are ground and extracted

with solvent for removal of the remainder. The CNSL is filtered and then heated to 150° C. for decarboxylation of the anacardic acid. After cooling it is ready for exportation.

To loosen and to partially remove the brown skin (testa) which adheres to the kernels, the kernels must be treated with steam and agitated violently. After removal of the last bits of the testa, the kernel is sorted according to size and color. Cashew nuts are separated into 12 different grades with the largest, white, whole kernels receiving the highest grades, and the brown cashew bits receiving the lowest.

The majority of the cashews are then vacuum packed into 5 gallon cans and sealed for export, mainly to the United States. A small amount of lower grade nuts are roasted in coconut oil, salted, and vacuum packed for domestic consumption. The spotted nuts and pieces are also roasted, broken, and sold along with the other small pieces to the confectionary trade.

In 1970, over 6,000 metric tons of shelled nuts with a value of almost seven million dollars were exported to the exterior through the port of Fortaleza. In addition, almost five thousand metric tons CNSL with a value of over half a million dollars was exported.

Research

Because of the increased plantings of cashew and because of the expected increase in cashew production in Northeast Brazil, a process to minimize breaking of the kernel during processing and a way to utilize the great portion of unused cashew apples would be of great financial benefit to Northeast Brazil.

When either mechanical methods or hand labor are used during shelling and de-skinning operations, at least 50 percent of the kernels are split or broken. In addition, steam heating the kernel causes it to darken. Because of the lighter, higher quality kernels produced, the greatest advantage lies in mechanical shelling, but the initial installation is expensive, is as yet a secret process, and still results in a great loss. A similar, patented English process, used largely in Africa, is available and is being considered by several firms. One of the factors which has held back development of mechanical methods is the complete nonhomogenity in size and shape of the unshelled nut.

Figure 3. Typical cashew apple with nut attached. This production frequently appears in clusters.

Much breakage also occurs during the removal of the testa. Hot lye peeling, a common method of removing peel from delicate fruits and vegetables, was attempted by the Department of Food Technology of the University of Ceará in cooperation with technicians of the University of Arizona with some success in removal of the testa. However, because of the high tannin content in the testa, the lye solution immediately turned black, and the kernels, after washing and drying had an undesirable blue tinge.

Some promise has been shown in experiments involving thermoshock of the testa by passing the warm, shelled nuts through a cold area with slight agitation. Exact conditions of humidity, temperature and cold air velocity are still under investigation.

Continued progress in the development of uses for the cashew apple will help utilize this largely wasted product. At present, the demand for bottled cashew juice in Brazil exceeds production and the cost of transportation to the south of Brazil excessively elevates the price to consumer. Although the dehydration of this juice has proven difficult, continued research into drying methods and conditions can produce an instantized, dried cashew juice. Successful liophilization of cashew juice by the Department of Food Technology has shown this to be possible.

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