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or 50° for 20 or 40 days. Lula avocados stored in air developed considerable decay at both 45° and 50° after 20 days and all fruit were decayed after 40 days.

External darkening.—A dark grayish-brown discoloration of the skin was noted in some fruit after storage and subsequent softening. This darkening appeared to be an external symptom of chilling injury. Only a trace of internal chilling injury was noted in any CA-stored fruit. Air-stored fruit exhibiting severe skin discoloration often did show internal damage. No significant difference was found in the amount of discoloration between avocados stored at 45° and 50° F. After 40 days, anthracnose decay on avocados stored in air was so severe that it was difficult to distinguish between discoloration and the decay.

Time to soften.—Lula avocados stored at 45° F. for 20 days softened significantly more slowly when held at 70° than did comparable fruit stored at 50°. After 20 days, avocados stored in CA at both 45° and 50° softened significantly more slowly than did fruit stored in air at either temperature.

Percentage weight loss.—After the 40-day storage period, the percentage weight loss during storage at 45°F was lower than the weight loss at 50°. After 20 days, avocados stored in CA at both 45° and 50° lost less weight than fruit stored in air at either temperature although this difference was not significant at 45°. In contrast, the total percentage weight loss of fruit after softening was greater in fruit which had been stored in CA. The increased weight loss during softening of avocados previously stored in CA is related to the time required for the fruit to soften; fruit which softened more slowly were subject to physiological weight losses due to respiration and transpiration for longer periods of time. Analysis of the relationship between the number of days for fruit to soften at 70° and the percentage weight loss during softening was highly significant (r=0.741, 14d.f).

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PROSPECTS FOR CASHEW ADVANCEMENT IN COLOMBIA AND VENEZUELA

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The potential of the cashew as an economic crop for Colombia and Venezuela depends on the realization of the problems involved and a firm resolution to apply to their solution the modern techniques vital to the success of any other horticultural and processing venture.

I want to take this opportunity to present a few guidelines based on recently received reports (5, 6, 9, 10) and correspondence and my own observations during a tour of cashew-growing areas in Colombia and Venezuela in July, 1969.

The paper on this subject which I presented at the 17th Annual Meeting of the Tropical Region of the American Society for Horticultural Science, held in Cali, Colombia, and which is pending publication (7), stresses the economic advantage, from the standpoint of labor costs, of planting high-yielding trees producing jumbo-sized nuts, instead of nuts of average size or smaller. It is necessary to add a word of caution: It has been found in nut-size-and-quality studies abroad that very large nuts may have air pockets between the cotyledons or between the kernel and shell. Therefore, weight must be considered jointly with size. In determining quality of seed for planting, superior nuts are those which sink in a solution of 1 ½ lbs. of sugar in 1 gal. of water (8). It would be well to utilize the same test of nut weights in making selections for propagation.

When accumulating seeds from various sources over a period of time, it is well to be aware that seeds wrapped in polyethylene or stored in sealed tins retain viability for as long
Figure 1.—Four-year-old seedling cashew in INCORA’s El Lucero plantation, Norte de Santander, Colombia, with desirable erect habit of growth.

as 12 months—4 to 5 months longer than those kept in ordinary porous sacks.

When evaluating trees for propagation, attention should be given not only to nut character and tree productivity, but also tree form. Among 5-year-old trees seen in the El Lucero plantation, Norte de Santander, Colombia, last year, some were noteworthy for their straight trunks and upright habit of growth. Others were low-branched and bushy. This INCORA plantation, by the way, is on dry, sandy soil, subject to 30 in. annual rainfall. The trees received no water nor fertilizer, showed good development and general health and there were many spontaneous seedlings from nuts left on the ground.

At Rio Cari, not far from El Tigre, Venezuela, I saw many fairly old cashew trees exhibiting the usual uncontrolled sprawling growth. Inside such trees there is nothing but a tangled mass of bare and dead branches. The cashew tree is extremely sensitive to light and produces foliage, flowers and fruit only on its exposed surface.

In contrast, in the yard of Sra. Carmen Alzuru at Soledad, I was impressed with the erect form of a 4-year-old, 18-ft. tree which had received water only when it was first planted. The lower branches had been pruned, as had those of the other bearing trees which are a source of income for the owner. These trees yield better than unpruned trees, according to Sra. Alzuru; but they have reached the stage where it is apparent that, with only 7 m. between them, they are planted too close together. Where branch tips from one tree overlap those of the next, the shaded ones are dead. Apart
from this fact, it has been shown in trials abroad that close-planted trees have reduced resistance to drought (3), while wide-spaced trees (ideally 12 x 12 m.) flourish with annual rainfall of from 30 to 36 inches.

One of the factors that have retarded vegetative propagation and prolonged the backward practice of raising cashews from seed, is that the tree has always proved difficult to transplant successfully. It is now known that this problem can be overcome by raising nursery stock in plastic bags 18 in. deep and setting into the field in due time without removing the bags. Seeds germinate best when planted base-upward and only 1 to 2 inches deep. Germination is expedited by pre-soaking for 1 or 2 days (3).

Agricultural Engineer Juan de Dios Holmquist, Facultad de Agricultura, Universidad Central de Venezuela, at Maracay, has vegetatively propagated 8 selections, using the side-veneer graft technique described by G. Fuentes Marcano in Vol. 1, No. 1 of Fruticultura, published by the Universidad de Oriente in September, 1966.

I have just received from Mozambique a report on tip-grafting of cashew, using 10-month-old rootstocks (11). The "average percentage of success in grafting thousands of seedlings is about 62.5%" (4). Efforts are being made to develop the technique to a commercially feasible operation. Nearly 400 selections have been vegetatively propagated and distributed for trial (4).

The planting site warrants careful consideration. In the words of C. E. Parry of FAO, "Easy growing conditions also unfortunately tend to harbour the natural enemies of the cashew trees . . ." (8). The truth of this statement was borne out in the broad view afforded by last summer's tour. In a humid atmosphere (such as that of Maracay), the foliage is attacked by thrips and the new shoots, flowers and fruits by anthracnose (1). Heavy rains during blooming and bearing may ruin the crop.

At the Campo Experimental de Guanipa, Mesa de Guanipa, Venezuela, 4-year-old trees which had received water and fertilizer the first 2 years were only half the size of the 5-year-old trees at El Lucero, Colombia. They were characterized by too much tender growth irresistible to insects which made lacework of the new leaves.

In contrast, only occasional mite infestation was observed at El Lucero. The chief enemy here is a large wasp which feeds on the immature pedicel, the so-called "cashew apple". The wasp, which is active also in Venezuela, leaves the pedicel shriveled and blackened while the nut is still green. Such nuts, however, may still be usable for producing rootstocks, for it has been discovered that seeds even from very immature "apples" will germinate (3).

Among other insect enemies are the leaf-cutting ants which defoliate the cashew as well as other fruit trees of Tropical America.

Water and fertilizer tests have been made at Campo Experimental de Guanipa. Trees in rows receiving only water were strikingly inferior in growth and foliage production and color to those which received only fertilizer. The latter, spaced at only 7 m.; will soon be so broad as to allow inadequate room for the machinespraying which will be necessary to overcome insect infestation.

In the semi-arid climate of Ciudad Bolivar and Soledad (where there are reportedly 30,000 bearing trees (2), the cashew seems thoroughly at home. Without forcing by irrigation and fertilizing, the tree appears to set its own pace. The numerous specimens observed were robust and nearly pest-free, with very little tender growth and even the new leaves relatively tough. A 40-year-old tree with pruned trunk and wide-spreading top typified the good health of the dooryard cashews in this region.

Wide spacing of cashews naturally raises the question of intercrops. At Rio Frio, Colombia,
I saw ½-year-old seedling cashews interplanted with cassava. Here, where Don Pablo Garcia Franco is replacing bananas with cashew, I suspect the soil and climate may prove too moist for best results.

At the Tanzania Research Centre in East Africa, cashew trees interplanted with legumes such as soybeans, cowpeas and peanuts, yielded better than those simply surrounded by grass, or provided with mulch or manure (8).

Instead of intercropping, some growers turn cattle into the plantation to graze on grass and the fallen apples. The trees often suffer, however, from the tendency of cattle to chew the bark.

The processing of cashews is still in a very primitive stage in Venezuela. The nuts are roasted on a sheet of metal over an open fire or are boiled in an oil drum. They are shelled by hand, using wooden mallets, and the kernels are hand-peeled (2). In the Soledad-Ciudad Bolivar area, brokers buy from farmers as much as 10,000 lbs. of kernels each week during the main season of February-March-April (2). Many kernels are broken, some scorched; nevertheless, they are in great demand. A plastic bag containing 13 oz. sells for 90c. Turrón, a 1-lb. block of brown sugar studded with cashews, was priced at $1.50 in July. Mazapán, a confection of ground-up cashews and sugar, cost 90c.

The "apples" are preserved in sirup in quart jars, or cooked in heavy sirup until nearly black and sold unpackaged like Smyrna figs.

I saw only one attempt at processing cashews in Colombia and this was a minor step toward mechanization. At Rio Frio, the nuts are gathered from the ground by women and carried in 1-gal. cans to sheds where they are deposited in 4-ft.-deep cement bins and left to "sweat" for as much as 4 or 5 months, while "shelling" is going on. Without roasting or boiling, nuts are placed 4 in a row in hollows in an iron bar atop a small table. A machete, bolted at the tip of the blade, is brought down with force to cut the nuts in half. There is much beetle infestation in the sweating bins and accordingly many ruined kernels. However, the sound half-kernels are ex-
tracted, heated in an electric roaster, peeled and packed without salting in attractive plastic envelopes. Don Pablo says he can sell all he can produce. His system, though crude, made me realize that splitting Jumbo cashews would actually be advisable to provide the desired number of pieces per pound and make them acceptable to a wider market.

He had, at the time of my visit, no outlet for the shells which were heaped in a shed and oozing CNSL, as attested by dermatitis resulting from a very slight handling of only a few.

Cashew growers in Venezuela and Colombia are eager to obtain equipment for effectively mechanizing the processing of cashews. I have, for several years, encouraged the development of two simple, but quite different, devices which I feel will meet the need. The elaborate, quarter-million-dollar factory operations of Mozambique and Tanzania would not be appropriate in this Hemisphere and are not wholly satisfactory. I recently saw a $28,000 pilot installation (a series of no less than 8 machines) at the Tropical Products Institute Laboratory at Culham, England. A duplicate has been set up on trial in Kenya—in the expectation of processing Kenya's 10,000 tons of cashews at home and selling kernels at $212 a ton, instead of shipping the raw nuts to India and realizing only $141 a ton.

Cold processing offers many advantages and less complex installations. It is being tried in one Japanese factory in Africa. Others have rejected it as too costly, but I am convinced that it will eventually be achieved on an economical basis and that it should be attempted in Venezuela where abundant natural gas could provide inexpensive refrigeration. A second obstacle to simplification is the conventional objective of producing whole kernels. If the cashew were viewed not as a delicacy but as a food, with a potential of playing a vastly larger role than at present in the world food supply, it would matter little whether the kernel were whole or broken. This is certainly of no importance in domestic consumption in Latin America where the nut is...
appreciated more for its flavor and food value than its form.

In comparison with eight other leading nuts, the cashew is lowest in fat and shares with the pistachio top place in protein content. It deserves horticultural attention and I believe it may even become practical to clear away large stands of wild and semi-wild cashew trees and replace them, in these obviously suitable sites, with properly managed, productive plantations of high-yielding, grafted trees.

South American growers and processors, making a late start, will be able to avoid the mistakes of predecessors and profit by the experiences of other countries. An exhaustive cashew research program is under way at the University of Lourenço Marques, Mozambique, including biometric study of the nut and kernel and CNSL. Data are being computerized for the establishment of standards of quality and procedures (4). Cashew enthusiasts should abandon their illusions of reaping profits from a neglected crop. The cashew is emerging from this category and demanding attention.

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