MONTHLY REVIEW

FEDERAL RESERVE BANK OF ATLANTA

Volume XXX | Atlanta, Georgia, November 30, 1945 | Number 11

The Tung Oil Industry: Growth and Prospects

OF the many materials designated as critical during the recent war, one that is of particular interest to the South and that still remains in short supply is tung oil. With the exception of a small amount that comes from Texas, almost all the tung oil produced in the United States comes from Sixth District states. The tung-oil industry, which has developed commercially in this country only since World War I, is a relatively new addition to the South's economy and so may be considered as still an "infant industry." It is, however, an infant with prospects of a lusty though not unlimited growth. Since the tung-oil industry comprises both the raising of tung trees for the sake of their oil-bearing fruit and the extraction of oil from the seed, the future of this industry is a matter of concern to the South from both agricultural and industrial points of view.

The tung tree, which belongs to the same botanical family as the castor bean and poinsettia, is indigenous to China from which it has spread to other countries. In China two species, *Aleurites fordii* and *Aleurites montana*, have been important, but in this country only one, *A. fordii*, is grown commercially. A tung tree, which begins to bear in its third season and whose life may be 30 or more years, grows rapidly but seldom exceeds 25 feet in height, although some of the trees have been known to attain a height between 50 and 60 feet. The trunk is covered by a smooth pale-gray bark, and when the tree is mature it may range in diameter from six to 24 inches. In the fall the tree sheds its large, somewhat heart-shaped leaves and remains dormant during the winter months. In the spring, however, a profusion of white blossoms with pink and yellow markings at the bases of the petals makes the tree a beautiful sight. "But," as one tung grower put it, "a man can't live off of sights even when they're beautiful." The value of the tung tree lies not in its ornamental characteristics but in its fruit.

The fruit of the tung tree resembles somewhat a large brown walnut or a russet apple, and it may appear singly or in clusters, depending upon the variety of the tree. The pulpy exterior covering contains a nut-like shell that, in turn, holds from three to five oil-bearing seeds. These seeds resemble Brazil nuts in shape and color but are much smaller. In September and October the tung fruit matures and drops to the ground, where it is allowed to lie for a time in order to dry. It is then gathered by hand and placed in storage for a further drying period, or until the moisture content is reduced to 12 or 13 per cent. When the moisture is low enough to make milling operations possible, the fruit is ready for the oil mill, where the oil is expressed from the kernels, or seeds.

Tung oil has been known and used in China for several thousand years. Marco Polo, returning from China in the early part of the fourteenth century, described the marvelous "Chinawood oil" that the artisans of Cathay used in the production of their fine enamels and lacquers. This Chinawood oil was none other than the tung oil of modern commerce. In addition to employing it in varnishes, the Chinese have for centuries put tung oil to many other uses. It was used on tools and furniture and, when mixed with lime and chopped hemp, was used to calk junks and small boats. It was also used as a leather dressing and as an ingredient in the manufacture of soap. Burned to a soot, tung oil makes a finely divided carbon that the Chinese employed in the production of India ink. Further use was found for this valuable oil in the waterproofing of paper, shoes, umbrellas, silk, pongees, oilcloth, and other materials.

Although the demand for tung oil was increasing in all industrial countries before the recent war, the United States represented by far the largest part of the world demand. In the last year before political and military disturbances interfered with the Chinese sources of supply, 1937, more than three fourths of the oil exported through Hankow came to the United States, as did 53 per cent of that exported from Hong Kong. During that year the apparent consumption of tung oil in the United States amounted to a little more than 148 million pounds.

The most important consumer of tung oil in this country has been the paint and varnish industry, in which the quick-drying property of the oil is of great advantage. This industry consumed 106 million pounds of the oil in 1937. At first tung oil served in varnish manufacture as a flux for hard gums that were otherwise difficult to fuse without loss of color. When used with rosin, tung oil produces a varnish that is superior in resistance and in waterproof characteristics to varnishes derived from linseed oil and fossil gums. The popularity of tung oil in the varnish field has further increased because of the possibility of using it in conjunction with newly discovered synthetic gums and resins.

Varnish, of course, is important in many fields — for the surfacing of floors and woodwork; in motor-coach, bus, automobile, and railway-car work; for the protective coating of tin; in lithographic printing; as an insulating material in the electrical industry; and as a preservative covering for aeronautical parts that are exposed to the elements. In all these uses, varnishes made with tung oil have proved their superiority.

In industrial operations and in maintenance work tung-oil varnishes have saved many thousands of dollars by speeding up the work and by reducing the necessity for early replacement. The demand for this oil in industrial varnishes is undoubtedly one that will expand in the future.

When used in flat paints tung oil produces a highly resistant surface of enamel-like smoothness. It stands up well when applied to wood, iron, millboard, asbestos, cement, and other bases. Combined with aluminum powder, gilsonite, asphalt, or other preservative materials, tung oil is increasingly employed in the protective covering of ironwork, metal roofs, storage tanks, and sidings.

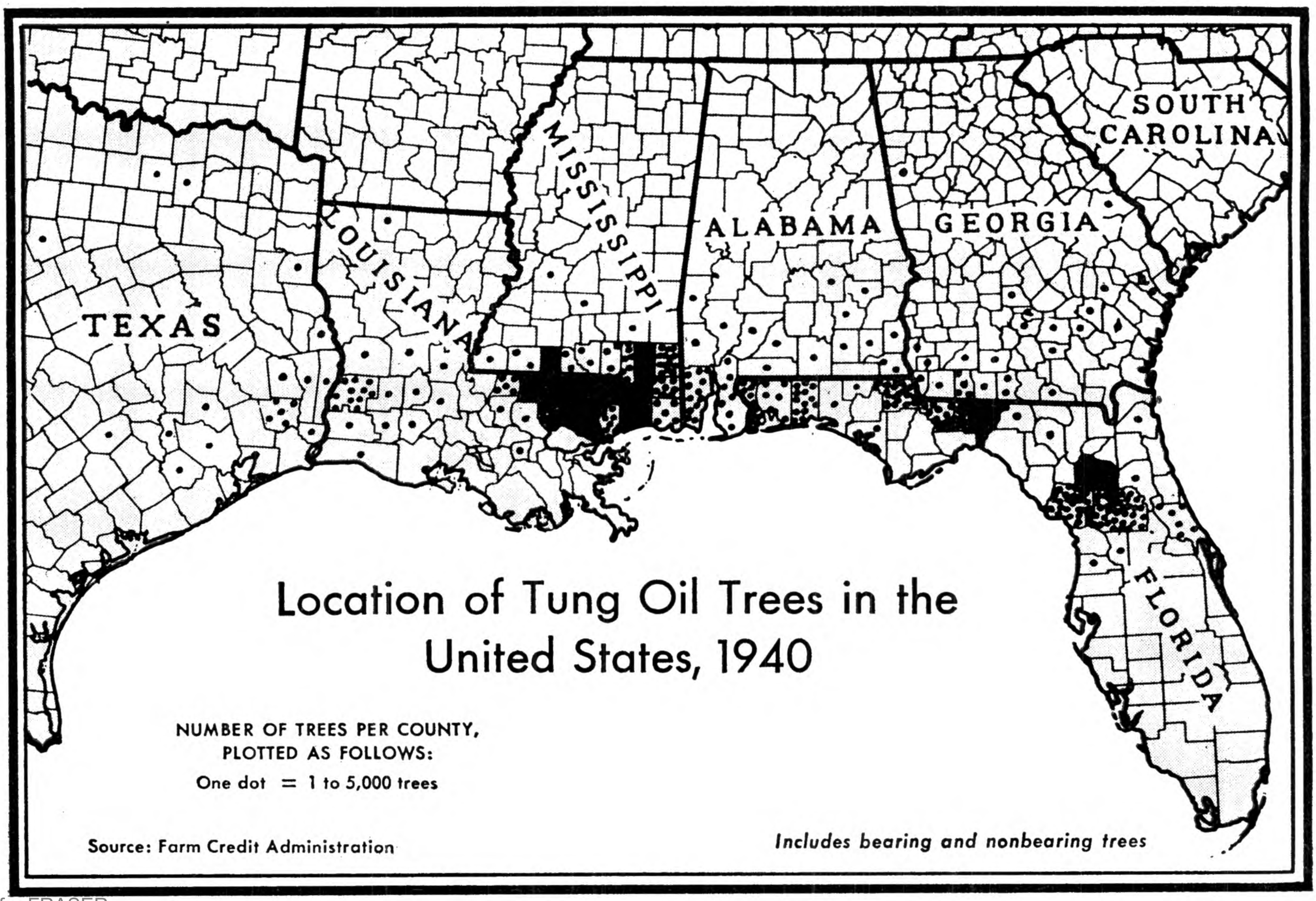
Next to the paint and varnish industry as a consumer of tung oil stands the linoleum and oilcloth industry, which used about seven million pounds of tung oil in 1937. In the making of linoleum, oilcloth, and artificial leather, tung oil is ordinarily not used directly as an impregnating material but rather as a vehicle for other coating substances.

Approximately three million pounds of tung oil were consumed during 1937 in the manufacture of printing inks. These were chiefly specialty inks, such as those used in bronze printing. About five million pounds were consumed in the manufacture of miscellaneous products in 1937, and 28 million pounds were listed as "unaccounted for." Some of this latter quantity went into the making of waterproof compositions for concrete; into the manufacture of gaskets for steam pipes, pumps, and engines; and into the waterproofing of cartridges. During the war the use of tung oil in the waterproofing of shells and other munitions was of great importance.

Since 1937 the consumption of this oil in the United States has declined drastically. In that year tung oil made up 17.3 per cent of the total weight of fats and oils used in the drying industries, but in 1944 it represented only about 1 per cent. From an apparent consumption of 148 million pounds in the former year, tung oil fell to an apparent consumption of only 9.4 million pounds in the latter. This decline in consumption occurred not because of any decline in demand. Demand was actually increasing. It occurred, of course, because of a radical reduction in supply.

Ever since the first recorded shipment of tung oil to the United States — 138,635 pounds valued at $53,641 and brought in by clipper ship from China in 1869 — American tung-oil consumers have been almost wholly dependent upon foreign supplies. China, of course, remained the source of these supplies, although some Chinese oil reached this country indirectly through other hands. Although tung trees grow wild in China, many were planted on cultivated farms. In general, however, the trees were not given systematic cultivation. The fruit, moreover, was gathered by hand and carried to oil presses, where the oil was extracted by primitive methods. The lack of uniformity in the quality of the oil produced under these crude conditions was heightened by the practice of adulteration. Prices, also, moved erratically in response to local growing conditions, Chinese tax policies, and means of transport.

In spite of the undependability of the Chinese supply with respect to quantity, quality, and price, United States imports from that country increased markedly up to 1937, although the trend was far from following a smooth curve. As a matter



Location of Tung Oil Trees in the United States, 1940 of fact, imports fluctuated wildly from year to year. The peak year was 1937, when this country imported 175 million pounds of oil. When war broke out between Japan and China in 1937 and acute difficulties of transport developed, imports of tung oil from China suffered a drastic decline. The following year saw 107 million pounds imported, and the next year 79 million pounds. By 1942 imports of tung oil had fallen to eight million pounds; by 1944 they were down to less than two million pounds, and most of that amount came from the Argentine Republic rather than from China. Out of 1,770,585 pounds imported in 1944 only 31,536 came from China, the traditional source of supply.

Experimental plantings of tung trees have been made in many countries other than the United States, but only Brazil and the Argentine Republic seem likely to have any success with them. In China efforts are being made to expand the production of tung oil. The Chinese government in 1936 established a government monopoly to encourage the growth of tung trees and to operate oil mills. It was hoped, furthermore, that the monopoly would have the effect of standardizing quality and stabilizing prices. These activities, however, were disrupted by war. Despite the war the Ministry of Finance has made appropriations over a period of years to foster the planting of more tung trees. When conditions have once more become normal, China may again be expected to be the major source of tung oil.

In the case of such an important industrial raw material as tung oil, dependence upon a foreign source of supply — a source many thousands of miles away, where the oil was produced under conditions that gave no guaranty of assured delivery with respect to quantity, quality, and price — was bound sooner or later to lead to attempts at the development of a domestic supply. A domestic tung-oil industry would involve both the planting of orchards and the building of oil mills.

Tung Growing in the United States

That the tung tree might be grown successfully in the United States was apparently first visualized by L. S. Wilcox, consul general at Hankow, China, who sent tung seed, it is reported, to someone in California in 1902, in 1903, and again in 1904. A small quantity of seed was also sent to Washington, D. C., in 1904 and was distributed by the Department of Agriculture among various experimenters in the warmer parts of the country. A larger shipment of seed was received in 1905, and these were planted at Chico, California. A large number of seedlings resulted from this planting. When these trees were one year old they were sent to many individuals and public agencies in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

The greatest interest in these first plantings of tung trees was manifested in Florida. William H. Raynes of Tallahassee became interested in five trees that had been sent to the superintendent of the local cemetery and in 1906 received permission to transplant them. Only one survived as a monument to this pioneering work. This tree, however, served as an important source of seedlings and produced the fruit from which the first American tung oil was pressed. Mr. Raynes' enthusiasm stimulated a neighbor, Dr. Tennant Ronalds, to plant in 1912 four acres in tung seedlings grown from seeds of the Raynes tree. This area was later expanded to 40 acres. The Ronalds planting was thus the first commercial tung grove in the United States.

A more definite step in the direction of creating an American tung-oil industry was taken when Dr. Fairchild of the Bureau of Plant Industry aroused the interest of the Paint Manufacturers Association and the National Varnish Manufacturers Association in the possibilities of tung culture in this country. Under the auspices of these two associations a survey was made of the commercial possibilities of tung cultivation in the South. An optimistic report was made in 1921, and in 1923 the American Tung Oil Corporation was organized as a subsidiary of the American Paint and Varnish Association. The corporation was a nonprofit venture financed by leading paint and varnish manufacturers to foster the commercial growth of tung trees. About 200 acres were acquired and planted by the corporation near Gainesville, Florida, for the purpose of developing data that might be helpful to the other growers.

Climate and Topography

Important information about the tung tree was gleaned from such experimentation both in early and later years. It was established, for instance, that the area in which tung groves could be expected to thrive consisted of a relatively narrow belt, approximately 100 miles in width, running eastward from Texas along the Gulf coast and across the northern part of Florida.

The northern and southern limits of this belt were determined by temperature. Since tung trees require a period of dormancy during the winter months for their best performance, they should not be planted too far south. The latitude of Gainesville, Florida, is considered by some authorities as the probable southern limit. On the other hand, since tung blossoms are easily killed by frost, the trees should not be planted so far north that crops may frequently be lost from this cause. The importance of temperature in locating tung orchards properly can scarcely be overemphasized. Within a given county temperature may vary greatly because of differences in elevation, with resulting damage to tung fruit in the colder areas. At the Experiment Station Farm at Gainesville, Florida, which is in a generally warm county, four crops were lost between 1936 and 1941 because of cold weather experienced at a low elevation. A commercial orchard in the same county, however, during that period suffered one lost crop and two short crops. The more favorable experience of the commercial orchard was the result of its location in a more elevated part of the county.

Since temperature varies with elevation and air drainage, it is usually advisable to plant tung orchards on somewhat elevated land where there is adequate air drainage. An orchard that may withstand a two-hour night frost may have its crop destroyed if the frost lingers only two hours longer. Obviously, a successful tung farmer must check the records of temperature very carefully and make sure that he locates his orchards in areas of minimum frost danger.

Much also was learned from the first plantings about the soil requirements of the tung tree. Early plantings were made in a wide variety of soils, ranging from deep sands to clays and varying from those possessing little organic matter to organic mucks. Drainage conditions were equally various. Observations made of trees growing under such a variety of conditions have led to some fairly definite conclusions. In general, tung trees in the United States do best in a well-drained, well-aerated sandy loam. Soil of this texture holds moisture and plant nutrients well and allows for a healthy development of root systems. These factors are important because the tung tree is a voracious consumer of water and plant foods and nutrient elements must be in soluble form and must be accessible to the roots.

Since most of the soils in the tung belt are deficient in plant foods, fertilization is usually necessary. Trees should be fertilized every year in the spring, the amount of the application increasing from a half pound to the tree in the first year to from 10 to 12 pounds a tree after the eighth or tenth year.

In addition to fertilization with barnyard manure, guano, or purchased fertilizers, leguminous cover crops should be planted in the orchards to increase the nitrogen content of the soil, for tung trees are heavy consumers of nitrogen. Cultivation is also necessary to keep down weed growth; and moderate mulching of the trees with the hulls of the fruit, it is said, may be very beneficial.

Further research on all aspects of tung-tree culture continues to be carried on at special tung-investigations laboratories of the Bureau of Plant Industry of the United States Department of Agriculture. Experimentation is also being conducted to find the best-yielding and most frost-resistant varieties of trees that may be propagated from seeds, from nursery stock, or by budding. This research work, together with that of state experiment stations, carried on under the leadership of such men as Dr. H. L. Crane and Dr. George F. Potter, is doing much to lay a firm scientific foundation for the tung-oil industry in the United States.

Growth of Acreage

From the first tiny commercial tung orchard of four acres planted in 1912, the acreage planted to tung has steadily increased. In 1923, 140 acres had been planted; by 1928 this figure had increased to 4,000 acres; in 1933 it was 44,182 acres; and in 1935 it was 40,162 acres, a decline from the preceding figure caused by the abandonment of unsuccessful orchards. By the year 1936 the tung acreage amounted to 75,000, in 1938 to 140,000, and in 1940 to 175,000. The estimated acreage in 1945 is 178,700, of which 90,000 acres are in Mississippi, 40,000 in Louisiana, 35,000 in Florida, 8,500 in Georgia, 4,500 in Alabama, and 700 in Texas.

Large-scale specialized enterprises have predominated in the growing of tung orchards ever since the industry started. This was a result of the nature of the interests concerned with the promotion of tung. Paint and varnish companies that were interested in developing an independent supply of tung oil were among the first of the large-scale growers. Lumber companies that wanted to find some use for cut-over timber land were also important planters, especially in Mississippi, where some of the largest enterprises are to be found.

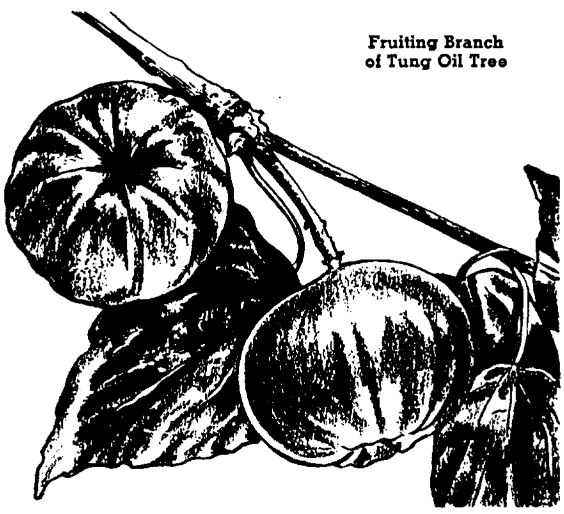
Men who derived the major part of their income from other sources often took up growing of tung as a hobby or, sometimes, as a means of escaping income taxes. Real estate dealers and professional promoters, seeking to capitalize on the public interest in tung oil and on widespread, exaggerated hopes for quick profits, also played an important part in expanding tung acreage. Small investors, too, were drawn into the tung business through the subdivision of larger orchards. In many cases these small investors were absentee landlords who were in no position to supervise the work in their small orchards and who knew little of the methods actually practiced in them. The chances of success for such investors were consequently quite remote.

Though the activity of some of these various classes of investors was conducive to an expansion of acreage, it was not always equally conducive to profitable tung farming. E. C. Wood of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, has estimated that about one half of the 175,000 acres planted in tung trees in 1940 were unsuitable to successful operations. Underestimates of costs and overestimates of yields upon which many tung enterprises have been predicated have too often resulted in financial failure and disillusionment. In this respect, of course, tung growing has been no different from many another farm enterprise in its infancy.

Yields

Yields have been among the most misleading calculations of unwary investors. Too often such calculations have been based upon the yields of particular trees growing under optimum conditions with the result that actual orchard experience has fallen far short of expectations. The yield is dependent upon a great many variable factors, such as climate, topography, soil type, drainage, and orchard practices. To these must be added the inherent characteristics of the seedlings planted. Some of these factors are controllable; others are uncontrollable after the initial investment has once been made, and still others are uncontrollable by their very nature. The result of this situation has been extreme variations in yields among orchards.

Even a single orchard under the same continuous management may be subject to violent fluctuations in yield from year to year. A 640-acre Florida orchard, for example, which is planted 68 trees to the acre, yielded 16.0 tons of fruit in 1934. There was no crop at all the following year because of a freeze. The yield jumped to 107 tons in 1936, but in the next year it fell to 23.8. The year 1938 saw a small increase, the yield of the orchard rising to 76.5 tons, but in 1939 there was again no crop because of a freeze. In 1940 the yield was 107.5 tons and in 1941, 122.5. The year 1942 saw a slight decline to 115.0 tons, but the following year, again because of frost damage, saw it fall to 21.1. The yield in 1944, however, was 121 tons.



Fruiting Branch of Tung Oil Tree

Although this 640-acre orchard is a low-yielding enterprise because of unfavorable location and inadequate cultivation, high-yielding orchards may also suffer from fluctuating yields because of weather conditions. For example, a 2,500-acre Florida orchard that is particularly well located and well managed yielded 750 tons of fruit in 1941. The next year saw the yield rise to 1,240 tons, but in 1943 the crop fell to 727 tons. The yield in 1944 was 1,121 tons, and in 1945 there was a slight decline to 1,050 tons.

Uncertainty of yield, of course, is not peculiar to tung growing. It is a characteristic of most agricultural enterprises. Success in managing a large-scale tung enterprise, however, seems to depend upon a most careful consideration of all pertinent factors before the orchard is ever planted and afterward upon unremitting attention to the best practices. Only in this way can the uncertainty of yields be kept at a minimum. It can never be wholly avoided.

Advantages of Small Orchards

Although large, well-financed and well-managed tung enterprises will undoubtedly continue to be important sources of the domestic supply of tung nuts, and hence of tung oil, increased growing of tung trees as a supplement to other crops by general farmers would also seem to hold certain advantages. A few acres of trees of good strain planted around the house, in fence rows and chicken runs, and in odd corners would add little to a farmer's overhead expense, and the trees could be cared for by labor that would perhaps otherwise be idle. Trees could be fertilized in part by barnyard fowls and cattle that would come to the trees for the sake of their shade. The addition to farm income that would be made by a ton or two of tung fruit would be significant in an area where farm incomes are notoriously low, especially when the increase could be secured with little additional cash outlay.

A large increase in the number of small plantings would also work to the advantage of the tung-oil industry as a whole. Since frost damage frequently occurs only in a spotty fashion, crop reduction from this cause might well be less if tung acreage were widely distributed in small plantings rather than concentrated in very large orchards of several thousand acres each. If the risk of crop failure could be reduced in this way, a more dependable supply of fruit would be available to the oil mills.

Moreover, if tung fruit was raised as a part of diversified farm programs on a large number of farms, a greater degree of financial stability would be achieved than is the case when a large investment is wholly committed to tung alone, with all the hazards to which this kind of orcharding is subject.

Fortunately for the industry, there is a marked tendency for speculators and promoters to get out of the business and for tung growing to become an enterprise carried on by *bona fide* farmers as an adjunct to other enterprises. If continued, this tendency, which has the encouragement both of the Department of Agriculture and the Department of Commerce, may make tung orcharding a profitable part of Southern agriculture. Even though the tung industry is comparatively young, the contribution that it makes to Southern agriculture is significant. The production of tung fruit in the five states of the tung belt (Georgia, Florida, Alabama, Mississippi, and Louisiana) was in excess of 30,000 tons in 1944. With unhusked, air-dried fruit bringing growers approximately $100 a ton, the 1944 production added more than three million dollars to farm income in the Sixth District.

Harvesting is another agricultural operation in which greater economy would result in benefit to farmers and the whole tung industry. The present practice is to allow the fruit to lie where it falls on the ground until it is dry and then gather it by hand, transporting the whole fruit to the oil mill by truck. The drying is necessary because a maximum tolerance of only 15 per cent moisture is permitted at oil mills. If rains occur while the fruit is still on the ground, the drying process is retarded. Moreover, the efficiency with which oil can be extracted from the nuts decreases gradually after the nuts are ripe. It is important, therefore, that the drying period not be prolonged.

Gathering the fruit by hand may also prove to be a slow process,especially if the crop is very abundant. Just how slow the process may be depends a great deal on the nature of the ground under the trees and the ease with which the fruit can be found and picked up. Tung fruit has a tendency to burst open and thus scatter the smaller oil-bearing seeds among the grass when allowed to lie for any considerable length of time. When this happens the time needed for gathering the seed is greatly increased, as is the cost of harvesting. Under wartime conditions the cost of harvesting an acre has varied among orchards from four dollars to more than $20.

Hauling the fruit to the oil mill costs approximately two dollars a ton in the vicinity of Gainesville, Florida, but may be more or less in other localities depending upon the length of the hauls. Since more than half the weight of the tung fruit is in the hulls and since, if any use is to be made of them, the hulls must be hauled back to the orchards to be deposited around the trees for fertilizer, the cost of transportation is clearly a sizable item in the final cost of the hulled nuts. During the current shortage of labor and equipment the cost of hauling may be less than usual because much of the hull material has been burned instead of being put back in the orchard.

Mechanization

Most of these problems are susceptible of solution by means of greater mechanization. At the United States Tillage Machinery Laboratory, Auburn, Alabama, a hulling machine has been developed that will handle fruit containing from 25 to 35 per cent moisture. It is designed to hull the fruit either in the field or at storage bins. When used in the field this machine will blow the hull material back onto the land, thus saving the cost of transporting it to storage and back again to the orchard. This huller is a small unit and has a capacity of approximately three quarters of a ton of fruit an hour. The machine is now ready for production but will become available only when manufacturers of farm machinery have been persuaded to add it to their lines.

Several types of mechanical harvesters that have been built by tung growers were given preliminary tests last year. Other machines will be in the field for the first time this year. The United States Tillage Machinery Laboratory at Auburn is at present working on a side-delivery, rake-type unit that will lay the tung fruit in windrows from which it can then be put through the huller. If the nuts could be dried in dehydrators after being mechanically harvested and hulled on the farm, the milling season would be lengthened by a couple of months and the economy of operations at oil mills correspondingly increased. Mechanical equipment of the kinds mentioned, however, may be fairly expensive and hence may be economical only when it is employed on large-scale tung farms.

The firm establishment of an American tung-oil industry has required not only the development of its horticultural aspects but also the development of its industrial phase, represented in the extraction of oil from the seed. If American tung oil is to compete with tung oil coming from China, it must do so on a basis of both quality and cost. This necessity requires a deeper scientific knowledge of the composition of the oil and a closer chemical control of the product throughout the milling process. It also requires the substitution of machinery or chemistry for the primitive methods and hand labor used in China.

In the development of the extraction process, as in the growing of the trees, the lead was taken by paint and varnish manufacturers. One of the first tests to get oil from American tung nuts was made by Henry Gardner in 1924 in the laboratory of the Institute of Paint and Varnish Research. This test showed the need for much further study of expression methods, and further experiments were conducted on a larger scale by the American Tung Oil Corporation in 1928.

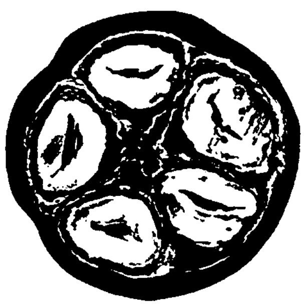
Approximately 14 tons of the 1927 crop were utilized in this experiment. Different kinds of machines for hulling and separating the seeds were tested, and various methods of extracting the oil from the seed were tried. The hulling machine that was finally rated most effective was one that decorticated the whole fruit and discharged the broken hulls and seeds to shaking trays that allowed the passage of only the seed to trays beneath. From the upper trays the hulls were carried away on a moving belt from which they were removed by suction. The seeds in the lower trays were passed through an air-suction chamber to remove hull particles preparatory to inspection, bagging, and ultimate expression.

Expression

In the extraction of oil the best results were achieved by so-called expeller methods. A solvent process was tried but was rejected on account of the difficulty that was encountered in finding a suitable solvent and because the process resulted in the production of a solid white mass. Hydraulic-pressure methods were rejected because of the poor yield of oil that was achieved. In the expeller method that was finally favored, meal made from the ground kernels and seeds of the nuts was preheated by steam in a jacketed chamber. The meal was then passed between a cylinder of chilled steel bars and a central shaft of broken-screw design, in which process it was subjected to pressure that built up to 12,000 pounds a square inch. The oil flowed out through the openings between the bars, and the remaining paste or oil cake was discharged at the end. The crude tung oil, which contained a considerable amount of nonoil constituents, was then filtered.

The first commercial expression plant embodying the findings of this experimental work was built at Gainesville, Florida, in the fall of 1928. Because tung growers were using such a large part of their production for the expansion of acreage, however, this plant operated for only one week in 1929 and produced 12,000 pounds of oil that season. In each of the next two years also the plant operated for only one week, but in 1930 it produced 20,000 pounds of oil and 25,000 pounds in 1931. The following year, however, the mill operated for four weeks, and its oil output amounted to 130,000 pounds.

At present, 12 tung mills have been built in the United States. Three of these are in Florida, at Capps, Gainesville, and Brooker; four are in Mississippi, two of which are at Picayune, one at Richton, and one at Lucedale; three are located in Louisiana, at Bogalusa, Franklinton, and Covington.



Cross Section of Tung Oil Fruit, About One Half Natural Size

One mill is located in Alabama at Florala, and one in Georgia at Cairo. The latter mill is now being moved to Lamont, Florida. These mills expressed a total of 10,473,700 pounds of oil in the 1944-45 season. Of this quantity, 2,640,000 pounds were expressed at Florida mills, 4,042,000 pounds at Mississippi mills, 2,191,700 pounds at Louisiana mills, 1,000,000 pounds at the Alabama mill, and 600,000 pounds at the Georgia mill.

Tung-oil mills usually begin operating in January and continue until the entire crop has been processed. The length of the period is fixed by the time required for air-drying the fruit and by the time that the nuts can be held without incurring oil losses. Ordinarily expression comes to an end by July or earlier and the oil mill stands idle for the remainder of the year.

Although expression methods in America are much superior to those employed in China, they are still far from being all that is desired. The weight of oil is generally rated as 20 per cent of the weight of the fruit, on an average. A short ton of fruit, therefore, contains approximately 400 pounds of oil. Present expression methods, however, recover only 85 per cent of this oil, or about 340 pounds from a ton of fruit. The remainder of the oil is lost in various ways, part of it in pieces of the white kernels that are lost in the hulling operation, part in the "foots" that are strained out of the oil when it is filtered, and part in the pomace, or oil cake. When the price of tung oil is at its present level of 39 cents a pound, the loss from unrecovered oil amounts to about $23 on each ton of fruit. Some method for the more complete recovery of oil definitely seems to be called for.

Solvent Extraction

For several years the tung-oil laboratories of the United States Department of Agriculture at Gainesville, Florida, and Bogalusa, Louisiana, under Dr. R. S. McKinney, have been engaged in studying the recovery of oil from tung fruit and press cake. The process on which these laboratories are working is a solvent extraction method by which approximately 99 per cent of the available oil may be recovered. It has been found that the solidification encountered in earlier attempts to extract oil by means of a solvent can be overcome by a heat-treating process, for tung oil becomes permanently liquid if it is heated at 200 degrees centigrade for about 30 minutes.

Even when the additional oil that could be recovered by a solvent extraction process is not taken into account, this method is no more expensive than present expression methods. The present cost of expression in Florida is in the neighborhood of $12 for a ton of fruit. Engineering estimates for a solvent plant capable of handling 50 tons of tung fruit in 24 hours, but one so designed that this capacity could be increased to 100 tons, indicate an extraction cost of $9.72 per ton of fruit when the plant is working 200 days a year, or $12.94 when working only 150 days. A plant that was not overbuilt in the first place would undoubtedly be able to reduce the cost of extraction still further. If the solvent extraction process, enabling as it does the extraction of an additional 50 or 60 pounds of oil, can compete in cost with the present methods of expression on a basis of current oil recovery, the new methods would have an overwhelming competitive advantage.

In Louisiana an experiment has been made in the solvent extraction of tung oil from the foots that accumulate in the filtering. Enough oil was recovered from this source, it is reported, to pay for the plant. It would also seem economical to use the solvent extraction process on press cake from present oil mills. This cake, or pomace, at present has value only as fertilizer. The $15 or $20 worth of oil extracted from a ton of pomace in the solvent process would leave the pomace as valuable as fertilizer as it was before.

Still another economy may result from the adoption of the solvent process. The pomace can now be used only for fertilizer since the presence of certain poisonous agents renders it unfit for cattle feed. Some of these toxic elements are lost in the solvent process, and more are lost in the subsequent heat treatment. Although results are not yet definitive, it seems more than probable that when these toxic elements are removed the residue remaining after the oil extraction may be a valuable cattle feed.

Economic Factors

Ultimately, the future growth of the tung-oil industry will be determined by economic factors. Among these an improving technology, both in the orchard and in the extraction plant, is certainly important, but only as it tends to affect prices, incomes, and costs. The profitableness of the industry is determined by the relations among these latter factors.

The present situation, of course, is quite unusual, with prices at or near the ceiling price of 39 cents a pound for the oil, in drums, at New York. Current high prices are the result of a war-stimulated demand that could be satisfied only in small part by domestic production plus stocks on hand and that could not be satisfied at all by the supply of foreign oil from usual sources, since imports virtually disappeared during the war.

With the return of more normal conditions Chinese oil may be expected to reappear in large quantities and the weight of this foreign oil will again tend to dominate the market. The result will undoubtedly be a pretty drastic fall in prices from their present levels. Some growers think that prices may fall to about 17 cents a pound unless they are bolstered by a rising general price level. In the 28 years from 1912 to 1939 annual prices for tung oil averaged more than 15 cents in only 12 of them, and in the future, unless Chinese oil prices are higher than in the past, the average price may well be closer to 15 cents than to 17 cents.

What the trend of tung-oil prices may be when normal supply and demand relations are reached would be hazardous to predict. The reason for this uncertainty lies in the widely fluctuating prices that characterized the prewar period. Tung oil was selling for seven cents a pound, for example, in 1915, but in 1918 the price had risen to 26 cents. This rise was followed by a decline that brought the price to 12.8 cents in 1921. By 1923 it was up to 23.7 cents, but in 1925 it was down again to 13.5 cents. The year 1927 saw the price rise again to 19.3 cents, but this increase was followed by a decline to 6.3 cents in 1932. The price rose thereafter to 17 cents in 1935 but again fell to 13.5 cents in 1938. By 1940 it was up to 26.3 cents.

In addition to its violent fluctuations, the price trend for tung oil is peculiar in another respect. A 1941 study of the tung-oil industry made for the Farm Credit Administration by Harry C. Trelogen calls attention to the fact that in the past there has been no clear relation between the movement of tung-oil prices and various factors that might reasonably be supposed to influence this movement — factors such as variations in building activity and industrial production, in imports and stocks of tung oil, in supplies and prices of linseed and other competing drying oils, and in the value of Chinese currency.

If it is true that tung-oil prices are highly unstable and that the factors affecting price are not clearly defined, it is equally true that costs differ so radically among various producers that no general picture of potential profit throughout the industry emerges. The initial investment that must be made in the purchase of land can obviously be very different in different parts of the tung belt. A 1935 study of the tung-oil industry by the Farm Credit Administration calls attention to the wide variations that may exist with respect to some other costs. Using a sample of 53 orchards the investigators found that the average cost of planting an acre with tung trees was $18.87 in Florida, $11.43 in Georgia and Alabama, and $4.45 in Mississippi and Louisiana. Variations among individual orchards were even more startling, ranging from 40 cents to $52.55. The variations were explained in part by differences in planting methods and by differences in tree costs, prices paid for trees ranging from one cent to 25 cents each.

Costs

The same study computed, on a basis of 41 groves, the total per-acre costs for tung orchards from the time immediately after planting to the end of the fifth year, when the trees were in commercial production. The total costs an acre to carry an orchard through this period were $55.70 in Florida, $24.75 in Georgia and Alabama, and $18.75 in Mississippi and Louisiana. The variations were explained by the amount of cultivation practiced, the quantities of fertilizer used, the use of zinc sulphate to counteract bronzing, and the degree to which intercropping was practiced.

Few tung orchards from six to 11 years old were in existence when the 1935 Farm Credit Administration study was made. It was therefore impossible to make any precise estimates of profit or loss. On the basis of seven farms in six states, however, total costs per acre for the 1934 growing season were found to average $20.46. For the same group of farms total returns per acre were found to average $5.99. Growers thus realized a net loss of $14.47 an acre on the average, the average yield being only 343 pounds of whole fruit an acre. Not all these orchards, however, showed losses. On one of them a net profit of $9.90 an acre was realized, and on another the net profit was $21 an acre. Some well-managed orchards have yielded average net profits amounting to $36 an acre for the period 1941-45.

Although price fluctuations are felt by all producers, their impact falls very unevenly on growers because of these variations in costs and because of the uncertainty of yields. A price that would yield a substantial profit to one grower might result in a disastrous loss to another. This highly speculative characteristic, one that still marks the tung industry, is the cause of many paradoxical statements. One grower will say that "tung is the most profitable thing you can plant in the ground," whereas another may have only recriminations for ever having embarked on such an enterprise.

Sixth District Statistics

CONDITION OF 20 MEMBER BANKS IN SELECTED CITIES
(In Thousands of Dollars)

Item	Nov. 21 1945	Oct. 24 1945	Nov. 22 1944	Per Cent Change Nov. 21, 1945, from	
				Oct. 24 1945	Nov. 22 1944
Loans and investments—Total	2,076,067	2,020,883	1,721,123	+ 3	+ 21
Loans—total	404,524	344,661	331,840	+ 17	+ 22
Commercial, industrial, and agricultural loans	220,872	192,925	203,603	+ 14	+ 8
Loans to brokers and dealers in securities	8,464	8,810	5,531	— 4	+ 53
Other loans for purchasing and carrying securities	66,735	46,441	32,325	+ 44	+106
Real estate loans	23,245	22,418	23,695	+ 4	— 2
Loans to banks	2,459	1,498	1,001	+ 64	+146
Other loans	82,749	72,569	65,685	+ 14	+ 26
Investments—total	1,671,543	1,676,222	1,389,283	— 0	+ 20
U. S. direct obligations	1,523,526	1,526,933	1,246,049	— 0	+ 22
Obligations guaranteed by U. S.	1,121	1,379	19,402	— 19	— 94
Other securities	146,896	147,910	123,832	— 1	+ 19
Reserve with F. R. Bank	377,846	361,582	337,964	+ 4	+ 12
Cash in vault	31,045	31,452	28,152	— 1	+ 10
Balances with domestic banks	137,235	139,222	137,172	— 1	+ 0
Demand deposits adjusted	1,299,252	1,314,205	1,178,397	— 1	+ 10
Time deposits	414,205	410,332	319,596	+ 1	+ 30
U. S. Gov't deposits	201,409	168,390	123,696	+ 20	+ 63
Deposits of domestic banks	571,800	532,718	500,504	+ 7	+ 14
Borrowings	23,900	16,500	3,000	+ 45	+697

DEBITS TO INDIVIDUAL BANK ACCOUNTS
(In Thousands of Dollars)

Place	No. of Banks Reporting	Oct. 1945	Sept. 1945	Oct. 1944	Per Cent Change Oct. 1945 from	
					Sept. 1945	Oct. 1944
ALABAMA						
Anniston	3	16,946	15,302	18,549	+ 11	— 9
Birmingham	3	205,630	181,909	189,721	+ 13	+ 8
Dothan	2	11,072	8,589	10,198	+ 29	+ 9
Gadsden	3	13,095	10,602	12,009	+ 24	+ 9
Mobile	4	92,537	92,790	123,301	— 0	— 25
Montgomery	3	50,473	41,847	43,505	+ 21	+ 16
FLORIDA						
Jacksonville	3	175,045	151,891	157,698	+ 15	+ 11
Miami	6	149,067	121,890	108,934	+ 22	+ 37
Greater Miami*	10	203,012	160,266	145,009	+ 27	+ 40
Orlando	2	29,433	24,797	23,402	+ 19	+ 26
Pensacola	3	27,089	31,168	22,954	— 13	+ 18
St. Petersburg	3	31,610	27,938	22,405	+ 13	+ 41
Tampa	3	72,062	68,924	69,261	+ 5	+ 4
GEORGIA						
Albany	2	13,069	9,208	10,905	+ 42	+ 20
Atlanta	4	551,522	456,666	492,164	+ 21	+ 12
Augusta	3	38,680	33,254	35,286	+ 16	+ 10
Brunswick	2	10,728	9,333	13,010	+ 15	— 18
Columbus	4	40,346	35,968	34,409	+ 12	+ 17
Elberton	2	3,418	2,335	2,471	+ 46	+ 38
Macon	3	42,977	42,421	46,366	+ 1	— 7
Newnan	2	5,259	4,379	5,318	+ 20	— 1
Savannah	4	71,632	70,957	86,001	+ 1	— 17
Valdosta	2	9,664	7,382	6,905	+ 31	+ 40
LOUISIANA						
Baton Rouge	3	49,271	41,386	42,154	+ 19	+ 17
Lake Charles	3	18,783	18,226	15,803	+ 3	+ 19
New Orleans	7	435,449	412,187	450,468	+ 6	— 3
MISSISSIPPI						
Hattiesburg	2	14,937	13,551	13,511	+ 10	+ 11
Jackson	4	66,855	65,082	52,877	+ 3	+ 26
Meridian	3	22,368	20,182	18,529	+ 11	+ 21
Vicksburg	2	21,813	15,036	23,598	+ 45	— 8
TENNESSEE						
Chattanooga	4	89,418	84,158	83,533	+ 6	+ 7
Knoxville	4	1[illegible]3,264	112,071	109,218	— 3	+ 0
Nashville	6	195,957	182,162	174,656	+ 8	+ 12
SIXTH DISTRICT 32 Cities	104	2,685,469	2,413,591	2,519,119	+ 11	+ 7
UNITED STATES 334 Cities		81,614,000	71,172,000	73,891,000	+ 15	+ 10

*Not included in Sixth District total

In view of the great variability of net returns to growers, it would seem that only those growers who have well-located orchards, who have heavy-fruiting trees, and who practice the most economical methods of tree culture and harvesting will be able to face the uncertainties of the future with confidence. Growers are paid a price for their whole fruit that varies with the price of the oil. The grower, therefore, must be prepared to absorb the impact of both low yields and low prices. That he also gets the advantage of high yields and high prices is equally true. All this is merely to say that the growing of tung is still a highly speculative enterprise.

Growing Stability

The valuable research work that has been done by the tung laboratories of the Department of Agriculture, by state experiment stations, and by private agencies has tended, however, to reduce the speculative element. The gradual disappearance of professional promoters because of natural forces and the activities of the Securities Exchange Commission has also helped. The tendency to raise tung as merely one part of a diversified farm program serves to spread the risk and make tung growing less of a gamble. Intercropping with leguminous cover crops and the pasturing of cattle in the groves seem to be among the most stabilizing practices that orchardists may follow. These practices not only provide an income that may go far towards carrying the land when trees are not yet bearing but also may help greatly to cushion the shock of intermittent low yields or falling prices. Cattle, moreover, in addition to absorbing some of the overhead expense that otherwise would have to be charged to the tung enterprise alone, tend to reduce other costs. By returning organic matter to the soil they lessen the over-all fertilizer cost, and by grazing under the trees they facilitate the gathering of the nuts and thus reduce the cost of harvesting.

In spite of the work thus far done, however, the tung-oil industry is still in a pioneering stage, and mistakes that arise from this condition will undoubtedly continue to be made, although on a diminishing scale. The industry has suffered in the past from lack of knowledge and lack of skilled growers. These difficulties are now being overcome, and as they are removed the industry's prospects will brighten.

A sound future for the American tung-oil industry will not be furthered, however, by those who, in the words of Dr. Concannon of the Chemical Division of the Bureau of Foreign and Domestic Commerce, "visualize tung oil production and the development of this industry as some sort of a sweet dream set to the music of delightful southern breezes rustling through the branches of tung trees laden with rich fruit, a gift in some magical way from Mother Nature, without care or attention on the part of the owner." It will be furthered by the scientists whose patient investigations in all phases of the industry are providing the foundation of knowledge upon which success can be built. It will also be furthered by the aggressive and far-sighted growers and oil-mill operators who put that knowledge into practice.

Not only does the tung-oil industry offer a new crop to Southern agriculture, but oil mills may in time come to dot the tung belt as cotton gins now dot the cotton belt, affording opportunities for the investment of capital and for the employment of labor. In time, too, as the output of American tung oil increases, the varnish industry that finds in the South a major source of its supply of resin may seek this region as its natural home.

Earle L. Rauber